การเปรียบเทียบปัจจัยที่มีความสำคัญซึ่งมีผลต่อการแปรผันของราคาตราสารอนุพันธ์ประกันความเสี่ยงประเภท Credit Default Swap – ทัศนะในลักษณะมองไปข้างหน้า

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Comparison of Important Factors which Explain Credit Default Swap Premium

Variations – A Forward-Looking Perspective

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ชวลิต กิจการเลิศอุดม : การเปรียบเทียบปัจจัยที่มีความสำคัญซึ่งมีผลต่อการแปรผันของราคาตราสารอนุพันธ์ประกันความเสี่ยงประเภท Credit Default Swap – ทัศนะในลักษณะมองไปข้างหน้า (Comparison of Important Factors which Explain Credit Default Swap Premium Variations – A Forward-Looking Perspective). อ. ที่ปรึกษาวิทยานิพนธ์หลัก : ดร.สิระ สุจินตบัณฑิต, 300 หน้า.

ในตลาดการเงินสมัยใหม่ตลาดอนุพันธ์ประกันความเสี่ยงประเภท Credit Default Swap (CDS) ได้ถูกใช้เพื่อวัดความน่าเชื่อเชื่อถือของผู้กู้ยืมแทนที่ตลาดพันธบัตร ดังนั้นนักลงทุนควรมีความเข้าใจถึงปัจจัยต่างๆที่สำคัญที่มีผลต่อความแปรผันของราคาสัญญาประกันความเสี่ยงประเภท CDS ถ้านักลงทุนสามารถเข้าใจถึงปัจจัยต่างๆที่สำคัญที่มีผลต่อความแปรผันของราคาสัญญา CDS แล้ว นักลงทุนสามารถให้ความสนใจในปัจจัยดังกล่าวเพื่อพัฒนาแบบจำลองที่ใช้หามูลค่าของราคาที่เหมาะสมของสัญญา CDS ที่ดียิ่งขึ้น การพยายามหามูลค่าที่เหมาะสมของสัญญาประกันความเสี่ยงประเภท CDS สามารถทำได้หลายวิธีซึ่งแต่ละวิธีมีสมมุติฐานที่ใช้อธิบายความแปรผันของราคาสัญญาประกันความเสี่ยงประเภท CDS แตกต่างกันออกไป อาทิเช่น การใช้ราคาหลักทรัพย์ที่มีความเกี่ยวโยงกับสัญญา CDS นั้นๆ หรือ การใช้แนวโน้มของเวลา หรือการใช้ค่าสหสัมพันธ์ระหว่างความน่าจะเป็นที่ลูกหนี้จะผิดนัดชำระหนี้กับอัตราส่วนของทรัพย์ที่เรียกคืนได้เมื่อลูกหนี้ผิดนัดชำระหนี้ เพื่อที่จะอธิบายความความแปรผันของราคาสัญญา CDS วิทยาพนธ์ฉบับนี้เป็นบทความทางวิชาการฉบับแรกที่เปรียบเทียบปัจจัยต่างๆที่สำคัญที่มีผลต่อความแปรผันของราคาสัญญาประกันความเสี่ยงประเภท CDS ในช่วงวิกฤตสินเชื่อในประเทศสหรัฐอเมริกาใช่ช่วง ค.ศ. 2008-2009 การเปรียบเทียบปัจจัยที่สำคัญที่มีผลต่อความแปรผันของราคาสัญญา CDS นั้นทำได้ค่อนข้างยากเนื่องจากมีความจำเป็นต้องใช้แบบจำลองที่สามารถจัดการกับปัจจัยต่างๆได้พร้อมกัน เราได้ปรับปรุงแบบจำลองของ Das and Hanouna (2009) เพื่อใช้ในการศึกษาปัจจัยต่างๆที่สำคัญที่มีผลต่อความแปรผันของราคาสัญญา CDS เราพบว่าแนวโน้มของเวลาเป็นปัจจัยที่มีความสำคัญมากที่สุดที่มีผลต่อความแปรผันของราคาสัญญา CDS เรายังได้เปรียบเทียบราคาสัญญา CDS กับราคาสัญญา CDS ที่คำนวณได้จากการใช้แบบจำลองที่ถูกปรับปรุงขึ้น เราพบว่าโดยส่วนใหญ่แล้วแบบจำลองดังกล่าวสามารถใช้คำนวณราคาสัญญา CDSได้อย่างดีในยกเว้นในกรณีที่มีการเปลี่ยนแปลงของตลาดสินเชื่ออย่างรุนแรงในบางช่วงเวลา

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KEYWORDS : FINANCIAL DERIVATIVES / DERIVATIVE PRICING / CREDIT DEFAULTSWAP / RISK MANAGEMENT / ASSET VALUATION

CHAVALIT KITJAKARNLERTUDOM : COMPARISON OF IMPORTANT FACTORS WHICH EXPLAIN CREDIT DEFAULT SWAP PREMIUM VARIATIONS – A FORWARD-LOOKING PERSPECTIVE. ADVISOR : SIRA SUCHINTABANDID,Ph.D. , 300 pp.

In modern financial markets, the credit default swap (CDS) market has supplanted the bond market as the industry gauge for a borrower's credit quality. Therefore, it is very important to understand factors which explain CDS premium variations. That is because if we understand important factors which explain CDS premium variations, we can focus on the important factors to develop better CDS pricing models. There have been a lot of approaches to value CDS contracts. Each approach assumes some factor(s) which explain CDS premium variations such as related security prices, time trend and correlation between probability of default and recovery rate, etc. To the best of our knowledge there have been no studies comparing the contribution to explaining CDS premium variations of these factors during the credit crisis in the US in 2008-2009. That is partly because when doing so we need a model which can handle all of the factors at the same time. Most of the CDS valuation models cannot incorporate many different features simultaneously.   We improve Das and Hanouna (2009)'s jump-to-default model in which many different features can be handled simultaneously. In the study, we found that the time trend is the most powerful feature to explain the CDS premium variations. We also compare market CDS premiums with the fitted premiums from our model in which we include all of the features in our study to check how well our model performs. It can be observed from the results that our model can be used to forecast the CDS spreads very well in all time to maturity CDS contracts except when the CDS market is very volatile and there is a big jump in CDS premiums.

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List of Abbreviations

CDS	Credit Default Swap
DFO	Derivative-Free Optimization
EDF	Expected Default Frequency
LIBOR	London Interbank Offer Rate
ISDA	International Swaps and Derivatives Association
CDX	Credit Default Swap Index
iTraxx	The brand name for the family of credit default swap index products covering regions of Europe, Australia, Japan and non-Japan Asia.
NYSE	New York Stock Exchange
OTC	Over-the-Counter
RFV	Recovery Face Value
RMV	Recovery of Market Value
RT	Recovery Treasury
S.D.	Standard Deviation
SSE	Sum of Squared Errors

CHAPTER I

Introduction

The credit derivative market has become one of the fastest-growing derivative markets since the late 1990s, according to the Bank for International Settlements. Credit default swaps more than doubled in 2008 to US$26 trillion in 2009, per the International Swaps and Derivatives Association. In modern financial markets, the credit default swap market has supplanted the bond market as the industry gauge for a borrower's credit quality. As a result, researchers and practitioners have been focusing on developing credit default swap pricing models by exploring the factors that are important and have strong explanatory power to explain credit risk movements. Investors and risk managers can therefore use these factors as a guideline to determine sound and reasonable credit information to value credit default swap contracts.

There are many types of credit default swap pricing models. Each type of model relies on different features and assumptions to explain the credit default swap spread variations in the credit derivatives markets. Nevertheless, there have been no academicians or practitioners comparing the explanatory power of each feature using the data during the credit crisis in 2008-2009. After conducting a thorough literature review, the features that we have seen most frequently are:

1. Provided that the recovery rates are constant through time, the credit default swap spread variations exist because of the change on the perception of the default probabilities in the credit market. This type of models measures the perception of the default probabilities from securities which are related to the credit default swaps such as the stock prices or bond prices. In this type of models, it is believed that the related security prices reflect the

reference entity's situation including the perception of the default probabilities which firms are facing. For example, Jarrow and Turnbull (1995)'s reduced-form credit risk model which is one of the most widely adopted reduced-form credit default pricing models derives the risk-neutral default probabilities which the credit market assigns to each firm in each moment using the firm's bond market prices. The derived default probabilities can be used to price credit risky assets such as credit default swaps. Higher defaultable bond prices imply lower default probabilities. That is because if compared to bonds yielding the same cash flow, higher bond prices are associated with higher credit quality of the reference entity and thus less likely for the firm to default. There are a number of models similar to Jarrow and Turnbull's (1995) which link the prices of the related securities with the default probabilities such as Chiang (1987), Hull and White (2000) etc. To sum up, for this type of models, the related security prices are used to gauge the perception of the default probabilities and explain credit default swap premium variations. The credit default swap premiums calculated from this type of models are strongly dependent on the related security prices used in each model.

Furthermore, one could argue that the effect of the related security prices on the market perception of the default probabilities does not remain in the same degree over time. Therefore, it is also interesting to add one special feature which allows for the change in the degree of the effect of the related security prices on the market perception of the default probabilities through time. This would enhance the flexibility of the usage of the related securities to measure the market perception on default probabilities.

2. Provided that the recovery rates are constant through time, the credit default swap spread variations also exist because of the change on the time-varying nature of the default probabilities. This type of models uses a process which makes default probabilities vary with time. In other words, this type of models focuses on term structures of the default

probabilities. For instance, Elizalde (2005) contemplated three deterministic hazard (intensity) rate processes to price credit risky assets such as credit default swaps, when the recovery rates are assumed to be constant. In addition, Houweling and Vorst (2005) compared different specifications of (deterministic) time dependent intensity rates. We can typically observe that credit default swap premiums are likely to increase as credit default swaps' maturities are longer. Therefore, it can be inferred that it is expected the default probability will usually increase through time provided the effect of maturity risk premium is very small and negligible. To sum up, for this type of models, a process that makes default probabilities vary with time is used to explain credit default swap premium variations. The credit default swap premiums which are calculated from this type of models are strongly dependent upon the choice of the specification of the time process in the default intensity rate function which is used in each model. There are a lot of other academic works that focus on the time-varying nature of the default intensities such as Truck, Laub and Rachev (2004) and Berd, Marshal and Wang (2004).

3. Even though many credit default swap pricing models ignore the effect of the correlation between default probability and recovery rate, there have been various credit default swap pricing models where the effect of the correlation is added and it is construed as an important feature. That means it is assumed in those models that a chance of a situation where a loan will not be repaid and the amount that a creditor would receive in final satisfaction of the claims on the defaulted loan are statistically dependent. This feature reflects the fact that during an economic recession, it is more likely that a default will happen with a debt and at the same time the recovery rate is likely to be smaller. For example, Duffie and Singleton (1999) allowed for the correlation between default probability and recovery rate. In fact, in their model the behavior of both default probabilities and recovery rates were allowed to depend on firm-specific or macro-economic variables and therefore

they were set to be correlated. There is also extensive empirical evidence to support the existence of the correlation between default probability and recovery rate. For instance, Hu and Perrudin (2006) empirically investigated the dependence between recovery rate and default rate using Moody's historical market bond prices. Having filtered the recovery data to allow for the variation over time in the pool of borrowers rated by Moody's, they studied simple measures of the correlation between aggregate quarterly default and average recovery rates. The results suggest that recoveries tend to be low when default rates are high. By adding the effect of the correlation between the default probability and recovery rate, we could avoid overvaluing credit default swap contracts when the credit market is full of confidence (low default probabilities and high recovery rates) and could avoid under-valuing credit default swap contracts when the credit market is lack of confidence (high default probabilities and low recovery rates).

Having different features in different types of credit default swap pricing models guides us to important research questions. Which was the most prevailing feature to the others during the credit crisis in 2008 to 2009? Which feature plays an important role in explaining short-term or day-to-day credit default swap premium variations? Which feature is important in capturing the term structure of credit default swaps in the credit market? We focus on the period of the credit crisis in 2008 to 2009 because it has highlighted the need for better valuation models.

After the credit crunch in 2008 to 2009, investors have been craving for tools which have features to efficiently evaluate credit risks. The feature which most prevailed in the credit crisis should be implemented and incorporated to ensure that credit default swap valuation models have the feature which is the most capable of explaining the movement of credit default swap premiums during the crisis in the future. During financial a crisis, market participants need very precise asset valuation models to ensure that they have good guidelines

to make reasonable investment decisions. Furthermore, specific information about the features which play a crucial role in explaining the short-term and the long-term perceptions of default probability is very essential to the credit market participants in the sense that modelers can suitably select the appropriate feature when trying to create a model to price credit default swap contracts. In particular, if a modeler would like to come up with a model which is able to explain the daily variations in credit default swap premiums, he/she should focus on the feature which plays an important role in explaining short-term credit default swap premium variations. On the other hand, when a modeler needs to develop a model which is able to explain the difference in credit default swap premiums among different time-to-maturities, a longer time horizon of credit information must be used and he/she must employ a feature that is able to capture the long-term perception on default probability.

The challenge of the effort to determine the feature which prevailed to the others and the features which play a crucial role in explaining the short-term and the long-term perceptions of default probability during the credit crisis in 2008-2009 is that we need a model which can handle all of the features we would like to compare simultaneously. Most of the credit default swap valuation models cannot cope with many different features at the same time. Even though it is possible to do so in some models, it is so mathematically complicated that it is almost computationally infeasible.

Luckily, we found a flexible jump-to-default model which was used in Das and Hanouna (2009). The model employs inputs which are stock prices and stock volatilities in conjunction with credit default swap spreads to identify implied, endogenous, dynamic functions of default probability and recovery rate. The model does not assume that the recovery rates are constant, but instead it imposes the relationship between default probability and recovery rate.

By modifying Das and Hanouna (2009)'s model, we can flexibly define different dynamics of default probability and the recovery rate because Das and Hanouna (2009)'s framework allows any modifications on the functions of default probability and recovery rate to accommodate all of the features we would like to investigate. Therefore, we decided to apply and modify this model and use it as a platform for our study. In fact, Das and Hanouna (2009) did not intended use their model to compare the important features, which explain credit default swap premium variations as in this study. They intended to only use the model to extract forward-looking hazard (intensity) rates and recovery rates with pre-specified default intensity and recovery rate functions. Unlike the original of the purpose, we modify and improve Das and Hanuona (2009)'s model to compare the important features which explain credit default swap premium variations.

We are going to determine the most prevailing feature to the others during the credit crisis in 2008 to 2009 using Das and Hanouna (2009)'s platform by starting with the most basic specification in which both default intensity and recovery rate are constant. After that, we add a new feature and check the degree of improvement of the model after the new feature has been added. We also check the degree of improvement of each feature when there have already been some features added into the model to check the independency of the features in our study.

We use sum of squared errors to measure the goodness of fit and the degree of improvement of each feature.

We are also going to distinguish the feature that plays a crucial role in explaining the short-term perception of the default intensity from the one that captures the long-term term-structure of CDS spreads by checking the degree of improvement of each feature when the dataset contains only a specific time-to-maturity. By doing so, we can eliminate the need of capturing the term-structure of credit default swap spreads with different maturities and we

can therefore focus only the short-term perception. Hence, the feature that prevailed to the other during the crisis in 2008-2009 would be the feature that is most essential to explaining the short-term perception of default probability in the credit market.

We are going to extract parameters and study the features which explain credit default swap premium variations by using unique and very frequent dataset. We use daily stock prices, stock volatilities and credit default swap premiums having maturities 1 to 10 years of the 30 reference entities which are listed in Dow Jones Average Index. The advantage of performing the tedious work by extracting parameters using daily data is that we can observe more frequent movement of the parameters. Furthermore, we choose the reference entities in the study from different industries. Therefore, we can compare and contrast the effect of the different industries on the degree of improvement of each feature.

<center>**CHAPTER II**</center>

<center>**Literature Review**</center>

The current credit default models can be divided into two groups, the structural-form models and the reduced-form models. In the former the default process is driven by the firm's assets value, which when falls below a certain threshold causes a default. The latter is linked to a stochastic jump process which causes a default. A more detailed explanation is given below.

2.1 Pricing of Credit Default Swaps Using Structural-Form Models

Black and Scholes (1973) and Merton (1974) changed the credit default pricing models; they took the value of the firm's assets which is a balance of assets and debt. If the value of asset was less than the total liabilities it caused a default. This structural model means that the payoff at maturity to the bondholder is equal to the face value of the bond minus the premium of a put option on the value of the firm's assets, with a strike price equal to the face value of the bond and a maturity equal to the life of the bond. Leland (1994) and Leland and Toft (1996) developed the original Black and Scholes (1973) and Merton (1974) models with a default boundary linked to changes in taxes, bond covenants, bankruptcy costs and payout ratios. Anderson, Sundaresan and Tychon (1996) and Mella-Barral and Perraudin (1997), developed what is known as the AST-MBP models, which assumes that in an environment of positive bankruptcy costs, equity holders default. It is clear that the structural-form models originally developed by Black and Scholes (1973) and Merton (1974) allow a default to happen only on the date of maturity and are called "the first generation of credit risk models". The "second generation of credit risk models' was initiated by Black and Cox (1976) and all allowed a default to occur at any time in the life of the debt when firm's

asset value reached a threshold level.

Kim, Ramaswamy and Sundaresan (1993) focused on the valuation of coupon-paying defaultable bonds. Nielsen, Saà-Requejo and Santa Clara (1999) developed a model allowing the default boundary to be stochastic and the randomness of the boundary to be tied to the interest rate process. Ericsson and Renault (2002) attempted to improve structural-form models by introducing an additional feature, namely liquidity shocks. They assumed that liquidity premiums (compensation for liquidity shocks), are driven by the probability of default, however, they do not take account of other liquidity factors such as demand and supply.

The advantages of the structural-form models for bank loan departments and corporate bond portfolio managers is that they can be used to calculate estimated default probabilities from market equity prices.

In spite of the advancements and increasing popularity, structural-form models still have three main disadvantages. Firstly the models still require estimates for the parameters of the firm's asset value, which are unobservable. Therefore, the use of proxies for a firm's asset value is still debatable. Secondly, structural-form models do not incorporate credit-rating changes. Empirical studies suggest that rating changes which take place quite frequently for default-risky corporate debts are the most important determinant for credit default swap premiums Aunon-Nerin, Cossin, Hricko and Huang (2002), observed this and introduced linear regression to explore the determinants of credit default swap premiums. They found that the credit rating is the most important determinant which explains CDS premium variations. Finally most structural-form models assume that the value of the firm is continuous in time, neglecting jumps in the firm's value. On a practical level the firm's

asset value is proxied by the value of equity plus the value of debt, when there are jumps in share prices, jumps in firm's asset value are therefore likely.

2.2 Pricing of Credit Default Swaps Using Reduced-Form Models

In the reduced-form models, defaults are defined as exogenous rare events that can be modeled by a jump process. The term "reduced-form" was first used by Duffie and Singleton (1999). This class of model is also referred to as an intensity-based model (e.g. Bielecki and Rutkowski (2000)), instantaneous risk of default (e.g. Blauer and Wilmott (1997)), and hazard rate models (e.g. Madan and Unal (2000)). Similar to the recovery schemes in structural-form models, the recovery rates in reduced-form models can also be endogenously or exogenously derived. Nevertheless, generally speaking, reduced form models assume an exogenous recovery rate that is independent from the probability of default.

In contrast to structural-form models, the time of default in intensity models (reduced form models) is not determined via the value of the firm, but it is the first jump of a point process (for example, a Poisson process). Risk-neutral hazard rates for default are inferred from market data. Default is modeled as the first arrival of a point process with the inferred risk neutral hazard rate.

The reduced form models view risky debt as paying off a fraction of each promised dollar in the event of bankruptcy which is seen as exogenous and does not depend in the firm's underlying assets. This approach considers the probability of default, ignoring the effect of capital structure as an exogenous variable. In reduced form models, defaults are unpredictable events or surprises. However, default events follow a jump process, i.e. the event of default, state 1, is a discontinuity in the life of the firm, state 0. The jump process is associated with an intensity parameter denominated hazard rate. This hazard rate assesses

the frequency of default and can be constant, a deterministic function of relevant state variables such as time to maturity or a stochastic variable implying a term structure of the probability of default.

Reduced form models were first introduced by Jarrow and Turnbull (1992) while other developed the model: Litterman and Iben (1991), Jarrow and Turnbull (1995), Das and Tufano (1996), Duffie and Singleton (1999) and Das and Sundaram (1999).

2.3 The comparison of Structural Form and Reduced Form models

While structural models assume complete knowledge of a very detailed information set, akin to that held by the firm's managers, reduced form models assume knowledge of a less detailed information set, akin to that observed by the market. In most cases, this informational assumption implies that the firm's default time is inaccessible. Given this insight, one sees that the key distinction between structural and reduced form models is not in the characteristic of the default time (predictable versus inaccessible), but in the information set available to the modeler. Jarrow and Protter (2004) argue that the structural and reduced form models are not separated and disjoint model types as is commonly supposed, but rather that they are really the same model which have different informational assumptions. Jarrow and Protter (2004) further argue that structural models can be transformed into reduced form models as the information set changes and becomes less refined, from that observable by the firm's management to that which is observed by the market.

2.4 Recovery Rate Specifications

Recovery rates are most of the time specified arbitrarily, constant and independent of other variables. The recovery rates commonly used in structural-form and reduced-form models can be categorized into 3 groups. Firstly, Recovery of Face Value (RFV) is

characterized by Longstaff and Schwartz (1995) and Saa-Requejo and Santa-Clara (1999) as receiving the same fractional recovery of par at default for bonds issued by a particular company regardless of maturity. Secondly, Recovery of Treasury (RT) is characterized by Collin-Dufresne and Goldstein (2001) as receiving a fixed fraction of default-free bond with the same coupon and maturity as the defaultable bond. Finally, in the Recovery of Market Value (RMV) case, Delianedis and Lagnado (2002) assume that the recovery amount is a fraction of a non-defaulted risky bond of a similar credit quality and maturity as the defaultable bond. Clearly recovery rates are defined based on personal perceptions and thinking with no standard method to define them. The method of calculating recovery rates does determine whether credit default swap spreads obtained from pricing models are correct and fair. It is worth to point out that none of the recovery rate models above takes into account the correlation between recovery rate and other variables, for example default probability or interest rates. In other words, it is assumed that the recovery rate is independent of default probability and interest rates which are not quite intuitive. For instance, it can be argued that high interest rates cause companies to experience financial difficulties and, as a result, default probabilities increase. During economic recession, it is more likely that a default will happen with a debt and at the same time the recovery rate is likely to be smaller.

2.5 Empirical Investigation on the Movement of Credit Default Swap Premiums

The following paragraphs review the literature on comparison and empirical investigation of important factors which affect credit default swap premiums.

Christopher Finger (1998) expressed that the fair value of credit default swap is affected by the quality of the reference credit and the time to maturity of the contract. Similarly, Kamin & von Kleist (1999) showed that the maturity of an instrument is an

important determinant of the degree of uncertainty about repayment and is therefore related to the spread. The greater the maturity of an instrument, the more likely it is that the creditworthiness of the borrower will change during the life of the instrument.

Hull, Predescu and White (2004) tested the relationship between credit spreads which are the differences in yield due to different credit quality and credit default swap premiums. They discovered that the theoretical relationship between credit default swap premiums and credit spreads holds fairly well with the average difference being 10 bps.

Houweling and Vorst's (2003) findings coincides with that of Hull, Predescu and White (2004). Nonetheless, when they separated the sample according to rating classes, the relationship between credit spreads and credit default swap premiums deviates significantly, with absolute deviations increasing for lower credit ratings. In the sub-sample comprised of AAA to A reference entities, bond spreads are higher than credit default swap premiums, while in the sub-sample comprised of BBB to B reference entities credit default swap premiums are materially higher than bond spreads.

Zhu (2003) used a co-integration test to examine the relationship between credit default swap premiums and bond spreads. He discovered that CDS premiums and credit spreads are co-integrated in the long run. It can be concluded from his results that market forces remove the arbitrage opportunity between the two markets in the long run.

Aunon-Nerin, Cossin, Hricko and Huang (2002) applied linear regression to explore the determinants of credit default swap premiums. They investigated the relationship between credit default swap premiums and (1) credit ratings; (2) interest rates; (3) the slope of yield curves; (4) time-to-maturity; (5) share prices; (6) volatility of firm assets; (7) leverage; (8) index returns; (9) idiosyncratic factors. They discover the following: the credit rating is the most important determinant; US interest rates influence reference entities from all countries;

the slope of the US yield curve matters for US companies and other local yield curves influence non-US companies; share price changes are positively linked to credit default swap premium changes and still influential even when adjusted for returns on indices; and leverage has a significant influence on credit default swap premiums.

Jacob and Oviedo-Helfenberger (2004) investigated the theoretical dependence of changes in credit default swap premiums and the so-called structural determinants, namely the parameters in structural-form models. They found that the correlation between leverage, equity volatilities, risk-free interest rates and credit default swap premiums is very significant. Consequently, they suggested that these three structural determinants are important credit default swap premium determinants.

Berndt, Douglas, Duffie, Ferguson and Schronz (2004) examined the relationship between credit default swap premiums and EDFs. Moody's KMV EDFs are conditional probabilities of default, which are fitted non-parametrically from the historical default frequencies of other firms that had the same estimated "distance to default" as the targeted firm. The distance to default is the number of standard deviations of annual asset growth by which its current assets exceed a measure of book liabilities. They found that there is a positive link between 5-year EDFs and 5-year credit default swap premiums. However, the sample only included North American companies from three industries; therefore the result might not be representative of the whole market.

Bystrom (2005) provided some evidence of a link between the iTraxx credit default swap index market and the stock market. He found that for a sample of European sectoral iTraxx credit default swap indices, a correlation study revealed a tendency for iTraxx credit default swap spreads to narrow when stock prices rise and vice versa. Furthermore, there is some evidence of firm-specific information being embedded into stock prices before it is

embedded into credit default swap spreads. In his study, stock price volatility is also found to be significantly correlated with CDS spreads and the spreads are found to increase (decrease) with increasing (decreasing) stock price volatilities. Last but not least, he found significant positive autocorrelation in the iTraxx market.

CHAPTER III

Methodology

3.1 Das and Hanouna (2009)'s platform

Das and Hanouna (2009) actually modified already existing continuous-time credit default swap pricing models to discrete time (binomial tree) models. To illustrate, in the structural-form credit default swap pricing models, the default process is driven by the firm's asset value in continuous-time movement. In Das and Hanouna (2009), the default process is caused by the stock price movement in discrete time manner (binomial tree).

The inputs to Das and Hanouna (2009)'s platform are the term structure of credit default swap spreads at different time maturities, C_j ; j = 1,...,N; forward risk-free rates f_j ; j = 1; : : : ;N, the stock price S and its volatility σ (these last two inputs are the same as required in the application of the Merton (1974)'s model).

The outputs from Das and Hanouna (2009)'s platform are as follows.

(a) Implied functions for default intensities and recovery rates

(b) The term structures of forward default probabilities (λ_j) and forward recovery rates (Φ_j).

(c) Calculated credit default swap spreads.

The only one driving state variable in Das and Hanouna (2009)'s platform is the stock price (S). In particular, stock prices will be used as a driver of the dynamics of the default probabilities in the credit market. The stochastic behavior of stock prices in Das and Hanouna (2009)'s platform is based upon a Cox, Ross and Rubinstein (1979) binomial tree. However, Das and Hanouna (2009)'s platform incorporate an additional feature: the stock

can happen to default with probability λ[i ,j], where λ[i, j] is state-dependent. As a result, we can generate the binomial tree of the stock price and for each node the stock price will proceed to one of the three values in the next period:

$$
S \rightarrow
\begin{cases}
Su = Se^{\sigma\sqrt{h}} & \text{with probability } q\,(1-\lambda) \\[2mm]
Sd = Se^{-\sigma\sqrt{h}} & \text{with probability } (1-q)\,(1-\lambda) \\[2mm]
0 & \text{with probability } \lambda
\end{cases}
$$

(1)

As in Cox, Ross and Rubinstein (1979) binomial tree, the stock rises by factor $u = e^{\sigma\sqrt{h}}$ and falls by factor $d = e^{-\sigma\sqrt{h}}$ where σ is the stock volatility and h is the duration of the time interval in each period during which the stock price goes up or down in units of one year (time step). For example, if h is equal to duration of a month, then it is equal to 1/12 = 0.08333. The last branch represents the case in which the firm defaults and it creates the "jump-to-default" feature of the model. Stock price at each node is therefore equal to $S[i, j] = S[0,0]u^{i}d^{j-i}$. We signify each node on the tree with the index [i, j], where i indicates the number of upward movements the stock price has made since start, and j is the time index in Das and Hanouna (2009)'s platform.

In the model, we imply that the stock price will go to zero when the firm defaults. Practically, this might not be true because after the debt holders receive their recovery payment, it is possible that shareholders could receive the remaining portion of the company if there is remained. However, if the recovery rate for the debt holders is less than 100%, it is reasonable to say that the stock price will go to zero when the firm defaults on its debt.

In order for us to be able to imply the jump-compensated risk-neutral probability, the discounted stock price must be a martingale under risk-neutrality. If f_j is the risk-free

rate of interest for the period under consideration, we can write q[i, j] – the risk-neutral

probability that the stock price will increase of each node as follows[1].

$$q[i, j] = \frac{R_j /(1 - \lambda[i, j]) - d}{u - d}$$

(2)

$R_j = e^{f_j h}$; f_j is the annual risk-free rate at year j

(3)

One of the most important reasons why we use Das and Hanouna (2009)'s jump-to-

default platform to price credit default swaps is because it provides a very common model

of default. To give an example, if we would like to price a credit default swap contract

which pays one dollar if default occurs over the next two years, we can just attach a value of

a dollar to each node where default occurs. Then we perform backward recursion and

aggregate the expected present value of these default cash flows to obtain the fair value of

this credit default swap contract. Conversely, we can observe the true credit default swap

spreads from the market, and then we may extract the "implied" value of default

probabilities that results in the model value which corresponds to the market credit default

swap spreads.

For the stock price binomial tree, the first node is the [0, 0] node. At the end of the

first period, we have 2 nodes [0, 1] and [1, 1]; there are three nodes at the end of the second

period: [0, 2], [1, 2] and [2, 2] and so forth. At each node, we have different default

---

[1]Proof of the risk neutral-probability that the stock price will increase of each node

$$S[i, j] = \frac{q[i, j] \bullet (1 - \lambda[i, j]) \bullet S[i, j] \bullet u + (1 - q[i, j]) \bullet (1 - \lambda[i, j]) \bullet S[i, j] \bullet d}{R_j}$$

$$\frac{R_j}{1 - \lambda[i, j]} = q[i, j] \bullet (u - d) + d$$

$$q[i, j] = \frac{R_j /(1 - \lambda[i, j]) - d}{u - d}$$

probability λ[i, j] and recovery rate Φ[i, j] and they are linked to the stock price. Therefore, it is assumed in our model that default intensity and recovery rate are time and state-dependent. In other words, both default intensity and recovery rate are dynamic, not static. It is worth to emphasize here that we can use Das and Hanouna (2009)'s platform to handle many features at the same time in our study. That is because we can flexibly identify the functional forms of default intensity λ[i, j] and recovery rate Φ[i, j] as we wish. For example, if we would like to incorporate the feature which the credit default swap spread variations exist because of a process which makes default probabilities vary with time, we just simply add a time process into the functional form of default intensity λ [i, j]. In this study, we first specify the default intensity, which is the probability of default per year and is denoted by ζ [i,j]. After that, we convert default intensity to default probability using the equation below.

$$\lambda[i, j] = 1 - e^{-\xi[i,j]h}$$

(4)

In order for the martingale measure to exist, the probability that the stock price will move upward (q) in each binomial tree has to follow the equation (2). It is therefore possible that the probability that the stock price will increase (q) does not fall within the range (0, 1). In order to have the probability that the stock price will increase remains in the range (0, 1), the following restriction is needed in our study[2].

$$\sigma \geq (f + \xi)\sqrt{h} \geq -\sigma$$

(5)

While the latter inequality is trivially satisfied, it is possible that the first inequality is not satisfied. If the inequalities above are violated, the binomial tree will not be sensible. Therefore, we must impose the only one constraint which is the probability that the stock price will increase (q) has to fall within the range (0,1).

---

[2] The full explanation is provided in Impiled Recovery - Das and Hanouna (2009)

3.2 Fair spread calculation

The binomial tree can be used to price a credit default contract given the values of parameter in each model. The fair spread on a credit default contract is the value which makes the present value of expected premiums, which the protection seller receives on the credit default swap, denoted by A[i, j], equal to the present value of expected loss of contingent payment paid by the protection seller following a credit event on the reference security underlying the credit default swap, denoted by B[i,j]. The value of the expected premium paid by the protection buyer to the protection seller - A[i,j] and the expected value of expected loss of contingent payment paid by the protection seller to the protection buyer - B[i, j] can be written as follows.

$$A[i, j] = C + \frac{1}{R_j} \left[q[i, j] \times (1 - \lambda[i, j]) \times A[i + 1, j + 1] + (1 - q[i, j]) \times (1 - \lambda[i, j]) \times A[i, j + 1] \right]$$

(6)

In the recursive operation, the value of the expected premium paid by the protection buyer at each node equals the amount of the premium that the protection buyer has to pay periodically – annually, semi-annually, or quarterly whichever indicated in the credit default swap contract (C) plus the expected discounted value of the two expected premiums adjacent to the node provided that the reference entity does not default in the current time period. If the reference entity defaults in the current period, the protection buyer stops paying the premium in next period. The variable C in the above formula is the premium paid by the protection buyer.

If A[i, j] is the terminal node in the binomial tree, one can simply write the value of the expected premium paid by the protection buyer as

$$A[i,j] = C \qquad (7)$$

The expected value of the loss of contingent payment paid by the protection seller equals the default probability times the loss incurred if the reference entity defaults. In the model, we assume that if the reference entity defaults any time during the current period, the payment made by protection sellers will be paid during next period. In other words, if the reference entity defaults during the period of time i, the contingent payment paid by the protection seller will be paid during the period of time i+1. For instance, if the duration of the time interval in each period (h) is one month and the reference entity defaults anytime in January, the contingent claim payment will be paid in February.

Since we assume that if the reference entity defaults any time during the current period, the payment made by protection sellers will be paid during next period. Therefore, in the recursive operation, the expected loss of contingent payment at each node can be written as follows.

$$B[i, j] = \lambda[i, j-1] \times (1 - \phi[i, j-1])$$

$$+ \frac{1}{R_j} \big[q[i, j-1] \times (1 - \lambda[i, j-1]) \times B[i+1, j+1] + (1 - q[i, j-1]) \times (1 - \lambda[i, j-1]) \times B[i, j+1] \big]$$

(8)

That is, at each node the value of B[i, j] is equal to the expected loss of contingent payment which the protection sell has to pay to the protection buyer in the case where the reference entity defaults plus the expected discounted value of the two expected losses next adjacent to the node provided that the reference entity does not default in the current time period. If the reference entity defaults, the credit default swap will be terminated.

If B[i, j] is the terminal node in the binomial tree, one can simply write the expected loss of contingent payment paid by the protection seller as follows.

$$B[i, j] = \lambda[i, j-1] \times (1 - \phi[i, j-1]) \tag{9}$$
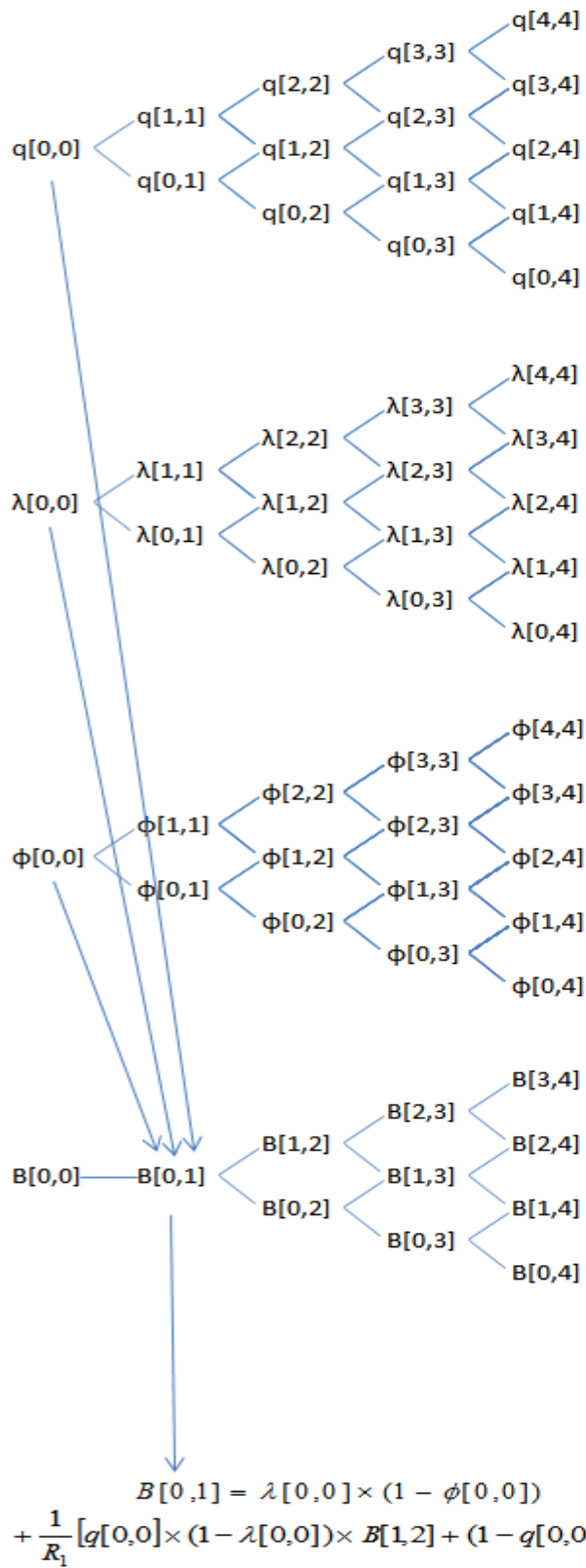
Figure 3.1: The illustration of the calculation of expected loss of contingent payment paid by the protection seller denoted by B[i,j] at each node.

Since we assume that if the reference entity defaults any time during the current period, the payment made by protection sellers will be paid during next period. In other words, if the reference entity defaults during the period of time i, the contingent payment paid by the protection seller will be paid during the period of time i+1, the first node in the recursive operation of the expected loss of contingent payment tree is simply B[0,1]. B[0,0] = (1/R0)• B[0,1]. The fair credit default swap spread is the one that makes the initial present value of expected premium A[0, 0] equal to the present value of expected losses B[0, 0].
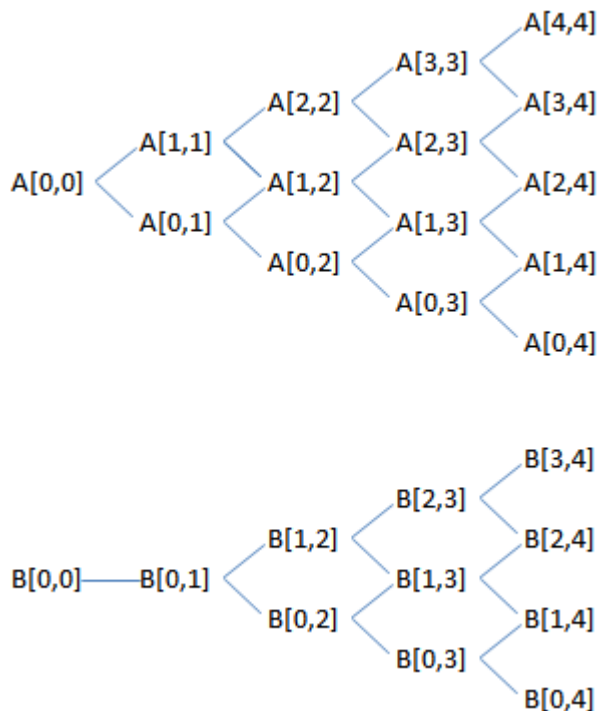
Figure 3.2: The binomial trees which show the calculation of the present value of expected premiums, denoted by A[i, j] and the calculation of the present value of expected loss of contingent payment paid by the protection seller, denoted by B[i, j].

3.3 Feature Comparison

The main objective of this study is to compare important factors which explain credit default swap premium variations. In particular, we would like to investigate if credit default swap pricing models are better when using related security prices, correlation between probability of default and recovery rate, and a process which makes default probabilities vary with time to explain credit default swap premium variations. We also check the degree of improvement after adding these features into the model. As explained earlier, we use Das and Hanouna (2009)'s platform because it allows us to flexibly specify different functions of the default intensities and recovery rates. We stipulate different specifications of the default intensity and the recovery rate which we have seen most frequently including the feature which allows for the change in the degree of the effect of the related security prices through time.

We initially start with the most basic model specification in which both default intensity and recovery rate are constant. After that, we add more factors and check if credit default swap pricing models are better after adding these factors into the model. Each parameter that we add into the model has economic intuition behind it. We will conclude that the credit default swap pricing model is better if after adding one of these factors, the model has better fit. In other words, we check if the credit default swap pricing model after adding these explanatory factors fits the market data better. We use sum of squared errors to measure the goodness of fit or the relative importance of each factor. The relative importance of each factor is compared to the effect of the other factors

The model specifications which are modified in our study are different to the one in Das and Hanouna (2009). Instead of only using the stock price as the measure of the perception on the default intensities in the market as in Das and Hanouna (2009), we

consider to capture credit default swap spread variations using many features and we check which features predominates the others. The features that we incorporate into our models are summarized as follows.

1. As in Das and Hanouna (2009), we use the stock price as the measure of the perception on the default intensities in the credit market (Feature 1).

2. We use a process which makes default probabilities vary with time to explain the change in the market perception on the default intensities in the credit market (Feature 2). The process which makes default probabilities vary with time in our study is the most basic linear function which is $c_0 + c_1t$. We avoid using more complicated linear function because this basic linear function is very easy to work with. Also, it is fair to use the most basic linear function when comparing with the other features because we would like to avoid the bias which occurs from trying to find the best linear function in order to beat the other features.

3. We incorporate the time trend into the effect of the stock price which has stochastic movement in the binomial tree in order to explain the effect of the time trend on the stock price movement (Feature 3). This feature is similar to the feature 2 because this type of models also uses time trend to explain the perception on the default intensities in the credit market. However, this feature is used to capture the change in the effect of the stock prices on the default probabilities through time. That means the effect of the stock prices on the default probabilities may be dynamic and not be constant through time.

4. As in Das and Hanouna (2009), we link the default probability and recovery rate functions with the Probit function or the inverse cumulative distribution function of the standard normal to capture the correlation between default probabilities and recovery rates (Feature4).

There are in total 11 combinations of different models by turning on and off the 4 features. The full model is shown below.

$$\xi[i, j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}} \tag{10}$$

$$\phi[i, j] = N(a_0 + a_1 \lambda[i, j]) \tag{11}$$

By setting some parameters to zero, we effectively turn off some feature and therefore totally have 11 combinations of different models.

The table below illustrates these 11 models. It also shows the specifications of default intensity and recovery rate and provides the intuition behind of each model.

	Model Specifications	Parameters Included	Intuition behind
Model 1	$\xi[i, j] = c_0$ $\phi[i, j] = N(a_0)$	a_0, and c_0	We start with the most basic specification in which both default intensity and recovery rate are constant. $\xi[i, j]$ is the default intensity which is the default probability per year conditional on no earlier default. N(.) is the inverse cumulative distribution function of the standard normal. We use this model as the benchmark to investigate how much the credit default swap pricing model has better fit after adding the stock price (feature 1) or a process which makes default intensities vary with time (feature 2) provided that there is no other feature has previously been incorporated into the model.
Model 2	$\xi[i, j] = c_0 + c_1 t$ $\phi[i, j] = N(a_0)$	a_0, c_0, and c_1	In this model, we add the most basic time trend into the default intensity function (feature 2). The recovery rate remains constant. We can use this model to check how much the credit default swap pricing model has better fit after adding the most basic time trend into the default intensity function (feature 2) when using Model 1 as the benchmark model. Furthermore, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding the stock price

			(feature 1) or the correlation between default intensities and recovery rates (feature 4) provided that the most basic time trend in the default intensity function (feature 2) has already been incorporated into the model.
Model 3	$\xi[i, j] = c_0 + \dfrac{c_2}{s^{b_0}}$ $\phi[i, j] = N(a_0)$	a_0, b_0, c_0, and c_2	In this model, we add the stock price into the default intensity function (feature 1). The recovery rate remains constant. We can use this model to check how much the credit default swap pricing model has better fit after adding the stock price into the default intensity function (feature 1) when using Model 1 as the benchmark model. Furthermore, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding a process which makes default intensities vary with time (feature 2) or the effect of the time trend on the stock price movement (feature 3) or the correlation between default intensities and recovery rates (feature 4) provided that the stock price (feature 1) has already been incorporated into the model.

| Model 4 | $\xi[i, j] = c_0 + \dfrac{c_2}{s^{b_0 + b_1 t}}$ $\phi[i, j] = N(a_0)$ | a_0, b_0, b_1, c_0, and c_2 | In this model, we incorporate the stock price (feature 1) and the effect of the time trend on the stock price movement (feature 3) into the model. The recovery rate remains constant. We can use this model to check how much the credit default swap pricing model has better fit after adding the effect of the time trend on the stock price movement into the default intensity function (feature 3) when using Model 3 as the benchmark model. Furthermore, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding a process which makes default intensities vary with time (feature 2) or the correlation between default intensities and recovery rates (feature 4) provided that the stock price (feature 1) and the effect of the time trend on the stock price movement (feature 3) have already been incorporated into the model. |

Model 5	$\xi[i, j] = c_0 + c_1 t$ $\phi[i, j] = N(a_0 + a_1 \lambda[i, j])$	a_0, a_1, c_0 and c_1	In this model, we add the most basic time trend (feature 2) and the correlation between default intensities and recovery rates (feature 4) into the model. We can use this model to check how much the credit default swap pricing model has better fit after adding the correlation between default intensities and recovery rates (feature 4) provided that the most basic time trend into the default intensity function (feature 2) has already been added by using model 2 as the benchmark model. Furthermore, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding the stock price (feature 1) provided that the most basic time trend into the default intensity function (feature 2) and the correlation between default intensities and recovery rates (feature 4) have already been incorporated into the model.

Model 6	$\xi[i, j] = c_0 + \dfrac{c_2}{s^{b_0}}$ $\phi[i, j] = N(a_0 + a_1\lambda[i, j])$	$a_0, a_1, b_0, c_0,$ and c_2	In this model, we add the stock price (feature 1) and the correlation between default intensities and recovery rates (feature 4) into the model. We can use this model to check how much the credit default swap pricing model has better fit after adding the correlation between default intensities and recovery rates provided that the stock price (feature 1) has already been added by using model 3 as the benchmark model. Furthermore, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding the most basic time trend (feature 2) or the effect of the time trend on the stock price movement (feature 3) provided that the stock price (feature 1) and the correlation between default intensities and recovery rates (feature 4) have already been incorporated into the model.

Model 7	$\xi[i, j] = c_0 + \dfrac{c_2}{s^{b_0 + b_1 t}}$ $\lambda[i, j] = 1 - e^{-\xi[i,j]h}$ $\phi[i, j] = N(a_0 + a_1 \lambda[i, j])$	$a_0, a_1, b_0, b_1,$ c_0 and c_2	We add the stock price (feature 1), the effect of the time trend on the stock price movement (feature 3) and the correlation between default intensities and recovery rates (feature 4) into the model. We can use this model to check how much the credit default swap pricing model has better fit after adding the correlation between default intensities and recovery rates (feature 4) provided that feature 1 and feature 3 have already been added into the model by using model 4 as the benchmark model. Also, we can use this model to check how much the credit default swap pricing model has better fit after adding the effect of the time trend on the stock price movement (feature 3) provided that feature 1 and feature 4 have been added into the model by using model 6 as the benchmark model. Also, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding the most basic time trend (feature 2) or provided that the stock price (feature 1) and the correlation between default intensities and recovery rates (feature 4) have already been incorporated into the model.

Model 8	$\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{b_0}}$ $\phi[i,j] = N(a_0)$	a_0, b_0, c_0, c_1 and c_2	We add the stock price (feature 1), and the most basic time trend (feature 2). We can use this model to check how much the credit default swap pricing model has better fit after adding the stock price (feature 1) provided that feature 2 has already been added into the model by using model 2 as the benchmark model. Also, we can use this model to check how much the credit default swap pricing model has better fit after adding the most basic time trend (feature 2) provided that feature 1 has been added into the model by using model 3 as the benchmark model. Also, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding the effect of the time trend on the stock price movement (feature 3) or the correlation between default intensities and recovery rates (feature 4) provided that the stock price (feature 1) and the most basic time trend (feature 2) have already been incorporated into the model.

| Model 9 | $\xi[i, j] = c_0 + c_1 t + \dfrac{c_2}{s^{b_0 + b_1 t}}$ $\phi[i, j] = N(a_0)$ | $a_0, b_0, b_1, c_0,$ c_1 and c_2 | We add the stock price (feature 1), the most basic time trend (feature 2), and the effect of the time trend on the stock price movement (feature 3). We can use this model to check how much the credit default swap pricing model has better fit after adding the most basic time trend (feature 2) provided that feature 1 and feature 3 have been added into the model by using model 4 as the benchmark model. Furthermore, we can use this model to check how much the credit default swap has better fit after adding the effect of the time trend on the stock price movement (feature 3) provided that feature 1 and feature 2 have been added into the model using model 8 as the benchmark model. Also, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding the correlation between default intensities and recovery rates (feature 4) provided that the stock price (feature 1), the most basic time trend (feature 2), and the effect of the time trend on the stock price movement (feature 3) have already been incorporated into the model. |

Model		a_0, a_1, b_0, c_0, c_1, and c_2	We add the stock price (feature 1), the most basic time trend (feature 2), and the correlation between default intensities and recovery rates (feature 4). We can use this model to investigate how much the credit default swap model has better fit after incorporating feature 1 provided that feature 2 and feature 4 have already been added into the model by using model 5 as the benchmark model. In addition, we can use this model to check how much the credit default swap pricing model has better fit after adding feature 2 provided that feature 1 and feature 4 have been added into the model by using model 6 as the benchmark model. Furthermore, we can use this model to check how much the credit default swap has better fit after adding the correlation between default intensities and recovery rates (feature 4) provided that feature 1 and feature 2 have been added into the model using model 8 as the benchmark model. Also, we can use this model as the benchmark when we would like to investigate how much the credit default swap pricing model has better fit after adding the effect of the time trend on the stock price movement (feature 3) provided that feature 1, feature 2 and feature 4 have already been incorporated into the model.
Model **10**	$\xi[i, j] = c_0 + c_1 t + \dfrac{c_2}{s^{b_0}}$ $\phi[i, j] = N(a_0 + a_1 \lambda[i, j])$		

| Model 11 | $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{b_0 + b_1 t}}$

 $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$ | $a_0, a_1, b_0, b_1,$

 $c_0, c_1,$ and c_2 | This is the final model. All of the 4 features are included in this model. We can use this model to investigate how much the credit default swap model has better fit after incorporating the most basic time trend (feature 2) provided that feature 1, feature 3 and feature 4 have already been added into the model by using model 7 as the benchmark model. In addition, we can use this model to check how much the credit default swap pricing model has better fit after adding the effect of the time trend on the stock price movement (feature 3) provided that feature 1, feature 2 and feature 4 have been added into the model by using model 10 as the benchmark model. Furthermore, we can use this model to check how much the credit default swap has better fit after adding the correlation between default intensities and recovery rates (feature 4) provided that feature 1, feature 2 and feature 3 have been added into the model using model 9 as the benchmark model. |

Table 3.1 : The specifications of default intensity and recovery rates of the 11 models which are used to investigate the contribution to explaining the credit default swap premiums of each feature.

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We can summarize the feature(s) which is/are used in each model as follows.

	Feature 1 (Stock Prices)	Feature 2 (The most basic Linear Time Trend)	Feature 3 (The Effect of Linear Time Trend on the Stock Prices)	Feature 4 (Correlation between Default Probabilities and Recovery Rates)
Model 1	No	No	No	No
Model 2	No	Yes	No	No
Model 3	Yes	No	No	No
Model 4	Yes	No	Yes	No
Model 5	No	Yes	No	Yes
Model 6	Yes	No	No	Yes
Model 7	Yes	No	Yes	Yes
Model 8	Yes	Yes	No	No
Model 9	Yes	Yes	Yes	No
Model 10	Yes	Yes	No	Yes
Model 11	Yes	Yes	Yes	Yes

Table 3.2: The feature(s) which is/are included in each model.

We use all of the 11 features above to explore crucial factors which explain credit default swap spread variations. When comparing the models to check the contribution of the 4 features, we must ensure that the models that we are comparable and it makes sense to compare these 2 models. For example, we cannot get much information when comparing Model 1 (the most basic model) with Model 11 (the full model) because we will not get any information in order to answer our research questions. In contrast, if would like to have information to answer our

research questions, we must hold the other features unchanged except the feature that we are considering in order to make the two models comparable. For example, when we would like to check the contribution of the feature 1 (stock prices) to explain the credit default swap spread variations we can compare model 1 in which there are no features included with model 3 in which only is feature 1 (stock prices) included. We can see that we hold features 2, 3 and 4 unchanged (There are no features 2, 3 and 4 in both models). We only have feature 1 in model 3, but we do not have it in feature 1. Then, we check the improvement (better variation explanation) from model 1 to model 3. In this case, we can clearly see the impact that feature 1 (stock prices) has made to explain the credit default swap premium variations. After that we can compare the impact that each feature has made and check which feature has make the greatest contribution. The tables below summarize how we compare the 11 models to examine the contribution of the 4 features.

Feature 1's contribution (Stock Prices)

Benchmark Model	Model 1	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
		No	No	No	No	Feature 2,3 and 4
Comparable Model	Model 3	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
		Yes	No	No	No	Feature 1

Benchmark Model	Model 2	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
		No	Yes	No	No	Feature 2,3 and 4
Comparable Model	Model 8	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
		Yes	Yes	No	No	Feature 1

Benchmark Model	Model 5	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
		No	Yes	No	Yes	Feature 2,3 and 4
Comparable Model	Model 10	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
		Yes	Yes	No	Yes	Feature 1

Table 3.3: The comparison the stipulated models to examine the contribution of the stock prices
(feature 1) to explaining the credit default swap premium variations.

Feature 2's contribution (Linear Time Trend)

Benchmark Model	Model 1	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		No	No	No	No	Feature 1,3 and 4
Comparable Model	Model 2	Feature 1	Feature2	Feature 3	Feature 4	Feature in Focus
		No	Yes	No	No	Feature 2

Benchmark Model	Model 3	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		Yes	No	No	No	Feature 1,3 and 4
Comparable Model	Model 8	Feature 1	Feature2	Feature 3	Feature 4	Feature in Focus
		Yes	Yes	No	No	Feature 2

Benchmark Model	Model 4	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		Yes	No	Yes	No	Feature 1,3 and 4
Comparable Model	Model 9	Feature 1	Feature2	Feature 3	Feature 4	Feature in Focus
		Yes	Yes	Yes	No	Feature 2

Benchmark Model	Model 6	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		Yes	No	No	Yes	Feature 1,3 and 4
Comparable Model	Model 10	Feature 1	Feature2	Feature 3	Feature 4	Feature in Focus
		Yes	Yes	No	Yes	Feature 2

Benchmark Model	Model 7	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
		Yes	No	Yes	Yes	Feature 1,3 and 4
Comparable Model	Model 11	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
		Yes	Yes	Yes	Yes	Feature 2

Table 3.4: The comparison the stipulated models to examine the contribution of the most basic

time trend (feature 2) to explaining the credit default swap premium variations.

Feature 3's contribution (The Effect of Linear Time Trend on the Stock Prices)

Benchmark Model	Model 3	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
		Yes	No	No	No	Feature 1,2 and 4
Comparable Model	Model 4	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
		Yes	No	Yes	No	Feature 3

Benchmark Model	Model 6	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
		Yes	No	No	Yes	Feature 1,2 and 4
Comparable Model	Model 7	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
		Yes	No	Yes	Yes	Feature 3

Benchmark Model	Model 8	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		Yes	Yes	No	No	Feature 1,2 and 4
Comparable Model	Model 9	Feature 1	Feature2	Feature 3	Feature 4	Feature in Focus
		Yes	Yes	Yes	No	Feature 3

Benchmark Model	Model 10	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		Yes	Yes	No	Yes	Feature 1,2 and 4
Comparable Model	Model 11	Feature 1	Feature2	Feature 3	Feature 4	Feature in Focus
		Yes	Yes	Yes	Yes	Feature 3

Table 3.5: The comparison the stipulated models to examine the contribution of the effect of the linear time trend on the stock price movement (Feature 3) to explaining the credit default swap premium variations.

Feature 4's contribution (Correlation between Default Probabilities and Recovery Rates)

Benchmark Model	Model 2	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		No	Yes	No	No	Feature 1,2 and 3
Comparable Model	Model 5	Feature 1	Feature2	Feature 3	Feature 4	Feature in Focus
		No	Yes	No	Yes	Feature 4

Benchmark Model	Model 3	Feature 1	Feature2	Feature 3	Feature 4	Feature(s) which is/are held constant
		Yes	No	No	No	Feature 1,2 and 3

Comparable	Model 6	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
Model		Yes	No	No	Yes	Feature 4

Benchmark	Model 4	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
Model		Yes	No	Yes	No	Feature 1,2 and 3
Comparable	Model 7	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
Model		Yes	No	Yes	Yes	Feature 4

Benchmark	Model 8	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
Model		Yes	Yes	No	No	Feature 1,2 and 3
Comparable	Model 10	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
Model		Yes	Yes	No	Yes	Feature 4

Benchmark	Model 9	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature(s) which is/are held constant**
Model		Yes	Yes	Yes	No	Feature 1,2 and 3
Comparable	Model 11	**Feature 1**	**Feature2**	**Feature 3**	**Feature 4**	**Feature in Focus**
Model		Yes	Yes	Yes	Yes	Feature 4

Table 3.6: The comparison the stipulated models to examine the contribution of the correlation between default intensities and recovery rates (Feature 4) to explaining the credit default swap premium variations.

The formal mathematical expression of the relative importance or explanatory power of each feature can be written as follows.

$$RI_{feature1} = \frac{SSE\big|_{c_2=0} - SSE\big|_{c_2=c_2^*}}{SSE\big|_{c_2=0}}$$

(10)

$$RI_{feature2} = \frac{SSE\big|_{c_1=0} - SSE\big|_{c_1=c_1^*}}{SSE\big|_{c_1=0}}$$

(11)

$$RI_{feature3} = \frac{SSE\big|_{b_1=0} - SSE\big|_{b_1=b_1^*}}{SSE\big|_{b_1=0}}$$

(12)

$$RI_{feature4} = \frac{SSE\big|_{a_1=0} - SSE\big|_{a_1=a_1^*}}{SSE\big|_{a_1=0}}$$

(13)

These mathematical expressions illustrate how we use sum of squared errors to measure the degree of improvement after the new factor has been added. For example, the degree of improvement after adding feature 1 or the relative importance of feature 1 is the percentage change of sum of squared errors after incorporating parameter c_2 and c_2^* is the parameter c_2 that minimize the sum of squared errors. We apply the same principle to calculate the relative importance of the other features as well. It is noteworthy to mention that we will have not only one, but instead a few explanatory powers of each factor. That is because we will obtain explanatory powers in different situations of turning on and off the other factors.

3.4 Research Procedure

There are in total 7 parameters in the full model (model 11) which are a_0, a_1, b_0, b_1, c_0, c_1, and c_2. The other groups of specifications omit some parameters depending on the number of features which we include into each model. We proceed to extract the parameters in each model by solving the following least-squares program.

$$\min \sum_{i=1}^{k} \sum_{j=1}^{n} (C_{ij} - C_{ij}')^2$$

(14)

where $\{C'_{ij}\}$, $j = 1,2,\ldots,n$ are the observable credit default swap spreads for each reference entity over different times to maturity of the credit default swap contracts, and $\{C_j\}$, $j = 1,2,\ldots,N$ are the calculated spreads over different time to maturities (1 year to 10 years) of the credit default swap contracts produced by our credit default swap pricing model. We minimize the sum of squared errors by optimally selecting the parameters in each model (a_0, a_1, b_0, b_1, c_0, c_1, and c_2). n is the number of years to maturity which are included in the model. Since we include the credit default swaps which have the time to maturities from 1 year to 10 years, n is equal to 10. k is the number of trading days which we include into the least squares program. k equals 30 in our study.

We start with the most basic specification in which both default intensity and recovery rate are constant. We minimize the sum of squared errors using Derivative-Free optimization method. After that, we add more factors and check if credit default swap pricing models are better after adding these factors in the model.

We have to use the historical recovery rate in our study as the initial value when performing Derivative-Free optimization method in order to alleviate the multiple solution problems when simultaneously extract many of the parameters in the model. We obtain the

historical recovery rate in each industry from Moody's whose dataset contains default data from 1982-2003. Table 7 shows average recovery rate by industry obtained from Moody's which was published in December 2003. To illustrate, if we are to compare and to investigate which factors are important and explain credit default swap premium variations of a company in the industrial sector, we have to use the historical recovery rate of the industrial sector which is 34.5% as the initial value when performing Derivative-Free optimization method for the first and the most basic specification (model 1). The recovery rate in model1 is stipulated as;

$$\phi[i, j] = N(a_0)$$

The historical recovery rate of the industrial sector is 34.5%, so

$$34.5\% = N(a_0)$$

$$a_0 = -0.39886$$

Then we use -0.39886 as the initial value for parameter a_0. The other parameter in model 1 is c_0. The initial value for c_0 when performing Derivative-Free optimization method for the first and the most basic specification (Model 1) is 0. After we estimate parameter c_0 from the most basic specification which is both default intensity and recovery rate are deterministic constant, we use the estimated c_0 as the initial value when performing Derivative-Free optimization method for the 2nd group of specifications (Model 2) in which we add the basic time trend in the default intensity function. The recovery rate remains constant. We set the initial value for the new parameter which is c_1 equal to 0. We apply this procedure for more complex models. If the parameter is included in the less complex model, we set the initial value of each parameter equal to the extracted value from the one-step less complex model. If the parameter is new and is not included in the less complex model, we set the initial value of the parameter equal to zero.

Industry	Issuer Weighted Mean
Utility-Gas	51.5
Oil and Oil Services	44.5
Hospitality	42.5
Utility-Electric	41.4
Miscellaneous	39.5
Transport-Ocean	38.8
Media, Broadcasting and Cable	38.2
Transport-Surface	36.6
Finance and Banking	36.3
Industrial	35.4
Retail	34.4
Transport – Air	34.3
Automotive	33.4
Healthcare	32.7
Consumer Goods	32.5
Construction	31.9
Technology	29.5
Real Estate	28.8
Steel	27.4
Telecom	23.2

Table 3.7: Average Recovery Rate by Industry (Source: Moody's Special comment, Recovery Rates on Defaulted Corporate Bonds and Preferred Stocks, 1982–2003, Published on December 2003)

If the sum of squared errors materially reduces after adding the new explanatory factor, we can conclude that the model can substantially explain credit default swap premium variations. In other words, the model after adding the explanatory factors considerably fits the market data better.

However, the sum of squared errors could be reduced because of the more number of iterations in the Derivative-Free optimization since we use the estimated c_0 from the first group

of specification as the initial value when performing Derivative-Free optimization method for the 2nd group of specifications (Model 2). Therefore, we have to obtain the benchmark result by performing Derivative-Free optimization from Model 1 again, but this time we use the estimated c_0 which we obtain when performing Derivative-Free optimization method for the first and the most basic specification (Model 1) as the initial value, not 0. The benchmark results control the factor of the number of iterations in the Derivative-Free optimization method. That is, the better sum of squared errors must be resulted from the new factor added in the model, not the increase in the number of iterations in the Derivative-Free optimization method. In this case, we call the first group of specification as the "benchmark specification". Luckily, the results suggest that there are no the sum of squared errors which reduced because of the more number of iterations in the Derivative-Free optimization.

When we perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round). We repeat the same procedure more complex specifications in which more factors are added.

3.5 Derivative-Free Optimization

As mentioned above, we perform Derivative-Free Optimization to minimize the sum of squared errors. Recent developments show that derivative free optimization is demanded by researches for solving optimization problems in various practical contexts. Although well-known optimization methods that employ derivative information can be very efficient, a derivative free method will be more efficient in cases where the objective function is non-differentiable; the derivative information is not available or is not reliable. Derivative Free Optimization (DFO) was developed for solving small dimensional problems (less than 100 variables) in which the

computation of an objective function is relatively expensive and the derivatives of the objective function are not available. The objective function in our study is the sum of squared errors. Furthermore, as previously discussed the fair CDS spreads calculated from our model is the one that makes the initial present value of expected premiums   A[0, 0] equal to the present value of expected losses B[0, 0]. Both A[0,0] and B[0,0] are obtained from a recursive calculation from the binomial trees. Thus, there is no closed-form function to calculate fair credit default spreads for our model. It is therefore impossible to be able find the derivative of this function and a derivative free method is appropriate in this case. Non-linear least squares cannot be used in this case because the objective functions cannot be expressed in a closed-form.

The details about the derivative free methods will not be discussed in detail because it is not the main objective of this study. However, a brief explanation of the Derivative Free Method is provided below.

The problem of minimizing a nonlinear function $f: R^n \rightarrow R$ of several variables when the derivatives of the function are not available is attempted to be solved by the "derivative free method". This function may in fact be smooth, but a non-smooth function is also possible here. A formal statement of the underlying problem can be found in A.R. Conn, K Scheinberg and Ph.L. Toint, Derivative free optimization algorithm for constrained problems, preprint, IBM T.J. WATSON Research Center, 1999 as follows:

$$\min \quad f(x)$$

$$\text{such that } a_i \leq c_i(x) \leq b_i \qquad (i = 1,2,\ldots,m),$$

$$x \in F \subseteq R^n, \qquad\qquad\qquad (15)$$

where $\nabla f(x)$ cannot be computed or just does not exist for every x. Here, F is an arbitrary subset of R^n, and x $\in$ F is called the easy constraint while the functions $c_i(x)$ ($i = 1, 2, \ldots ,m$)

represent difficult constraints. By easy constraints, we mean bound constraints on the variables, linear constraints, or more general nonlinear smooth constraints whose values and the Jacobian matrix can be computed cheaply. Difficult constraints are any nonlinear constraints whose value is expensive to compute and whose derivatives are unavailable.

The idea of DFO is to approximate the objective function by a model which assumes to describe the objective function well in a trust-region without explicitly modeling its derivatives. This model is computationally less expensive to evaluate and easier to optimize than the objective function itself. The model is obtained by interpolating the objective function using a quadratic interpolation polynomial. Quadratic interpolation is preferred to approximate the objective function since it can be used successfully within a trust-region method.

Derivative free optimization (DFO) methods are typically designed to solve optimization problems whose objective function is computed by a "black box"; hence, the gradient computation is unavailable. Each call to the "black box" is often expensive, so estimating derivatives by finite differences may be prohibitively costly. Finally, the objective function value may be computed with some noise, and the finite differences estimates may not be accurate. All the above properties, such as relatively expensive "black box" computations and presence of noise, are characteristics of Cycle-Tempo optimization problems. However, it is the noise which creates most difficulty in applying gradient based methods to these problems.

3.6 Data

For each reference entity, we obtain daily stock prices and credit default swap spreads from January 2008 to October 2009 from Thomson DataStream. We extract parameters in each model using 30 trading days in each time window. The first trading day of the next time window is the next 10 trading days of the first trading days of the current time window. There are

therefore in total 44 time windows in the study. Hence, for each reference entity, each time window and each group of specifications, we will report the extracted parameters and the sum of squared error. In order to extract all of the parameters in the model, we simply need the following market data.

1. Stock prices

2. Stock price volatilities

3. Credit default swap spreads

4. Risk free rates

Since the credit default swap market is in its infancy and credit default swap transactions are over-the-counter, the quality of available credit default swap data is not as good as that of exchange based transaction data, because exchange-based transaction are normally automatically recorded while OTC transaction data are subject to the recording omissions and/or errors of those who collect them. Therefore, our studies and analyses comprise of only the firms listed in the Dow Jones Industrial Average Index or Dow 30 to ensure that the credit default swap spreads used in this study are from the reference entities which are most liquid. We selected 10 companies listed in the Dow 30 from different industries. The time period of the data in our study is from January 2008 to October 2009. The data covers 22 trading months. When computing stock volatilities, we use 120 days of historical stock prices.

The companies which we randomly selected into the study are: Alcoa Inc., AT&T Inc, Bank of America Corporation, The Boeing Company, Exxon Mobile Corporation, International Business Machines, Kraft Foods Incorporated, Merck & Co. Incorporated, and The Walt Disney Company. These ten companies are in different industries and are listed in Dow Jones Industrial Average Index. Therefore, the movement of credit default swap premiums of these ten

companies should be good representatives of the movement of the credit default swap premiums during the financial crisis. Also, we can compare and contrast the effect of the different industries on the degree of improvement of each feature.

For each reference entity, we obtain daily stock prices and credit default swap spreads from January 2008 to July 2009 from Thomson DataStream. Risk free rates used in the study are US Treasury bill rates. These securities are considered to be risk-free because the likelihood of US Treasury bills defaulting is extremely low, and especially the short maturity of the bill protects the investor from interest-rate risk that is present in all fixed rate bonds.

3.7 Assumptions and Caveats

Before the results in our study are presented, we should point out the assumptions implicitly embedded in the model. There are several caveats and assumptions in our study.

1. No Counter-party risk. In credit default swaps, counterparty risks are understood to be the type and degree of risks associated with each party in a credit default swap arrangement. Essentially, the counterparty risk addresses the financial stability of each party involved. If we take counter-party risk in our consideration, the credit default swap premiums would be higher to compensate the counter-party risk.

2. The parameters in each model do not change over time in the binomial trees.

3. The relationship between default probabilities and recovery rates follows the functional forms in the model. We use the Probit function or the inverse cumulative distribution function of the standard normal to capture the correlation between default probabilities and recovery rates.

4. The relationship between stock prices and default probabilities follows the functional forms in the model. The functional forms can be changed but the functional forms must

have practical characteristic e.g. when the stock price is equal to zero, the firm goes default.

5. Credit Default Swap contracts protect only one reference entity.

6. Liquidity risk is neglected. There has been evidence showing that liquidity characteristics and liquidity risk together could on average account for about 20% of CDS spreads. Yan and Tan (2007) show that the liquidity effect on credit default swap spreads is significant with an estimated liquidity premium on par with those of Treasury bonds and corporate bonds. They also find cross-sectional variations in the liquidity effect highlighting the interplay between search friction and adverse selection in the credit default swap market. Furthermore, they provide supporting evidence for liquidity risk being positively priced beyond liquidity characteristics in credit default swap spreads. Their estimates indicate that liquidity characteristics and liquidity risk together could on average account for about 20% of credit default swap spreads.

7. No partial premium is paid after the reference entity defaults. At each payment date T_i, the buyer has to pay the premium to the seller, where (t_{i-1}, t_i) is the year fraction between t_{i-1} And t_i. Assuming the buyer pay the premium semi-annually, if the reference entity does not default during the year fraction between T_{i-6} and T_i, the buyer make the full premium at time T_i, . However, if default occurs any time t_i during the year fraction between T_{i-6} And T_i, the buyer makes no premium payment to the sellers at time t_i and stops making the remaining premium payments and the CDS seller has to pay contingent claim payment at t_i to the protection buyer.

8. The Derivative-Free optimization method does not guarantee a global optimal solution. However, we in fact do not need the global optimal solution in our study because the goal

of our study is to check if credit default swap pricing models have better fit after adding new factors in the model. As long as after adding new factors, the sum of squared errors which we use to measure the goodness of fit is less than the one of the models in which the new factors are not added provided that the number of the iterations and the initial values in the Derivative-Free optimization method are the same.

9. The credit default swaps protect only corporate defaultable bonds which have their stocks traded in the stock market.

CHAPTER IV

Results

4.1 Investigation of Important Factors Which Explain Credit Default Swap Variations

After extracting the parameters in each model by solving the least-squares program by MATLAB using the procedure discussed in the previous chapter, we can obtain the complete results which are exhibited in Appendix C.

In the models where we do not incorporate the parameter a_1, the values of the parameter a_0 which represent the recovery rates of each reference entity vary over time window. In this case, the values of the parameter a_0 obtained from the derivative-free optimization method are quite near to the initial value provided by the procedure discussed in the previous chapter in order to alleviate the multiple-solution problem.

After including the parameter a_1, it can be noticed that the values of parameter a_1 which represent the correlations between default intensities and recovery rates are all negative. The result is not against the basic intuition. A probability of a situation where a loan will not be repaid and the amount that a creditor would receive in final satisfaction of the claims on the defaulted loan should be statistically and negatively dependent. Recovery rates tend to be lower when a company is in bad time and it is more likely that the company will default during that period of time (more default probability). In contrast, recovery rates are inclined to be higher when a company is in good shape and it is less likely that the company will default during that period of time (less default probability). After adding the parameter a_1, the values of parameter a_0 greatly reduce and the values are quite near to zero in most of the time windows.
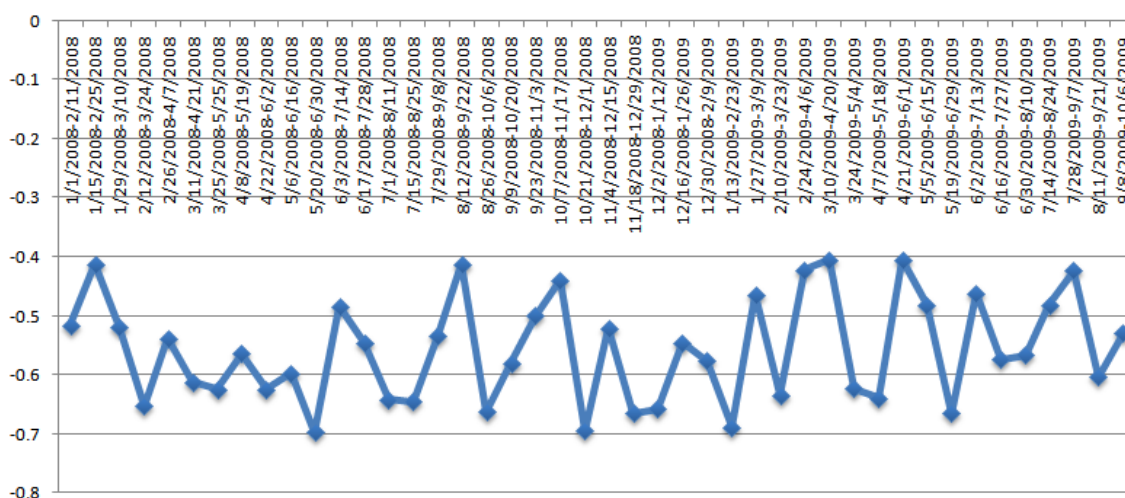
Figure 4.1: The development of the parameter a_0 in model 1 of Alcoa Incorporated.
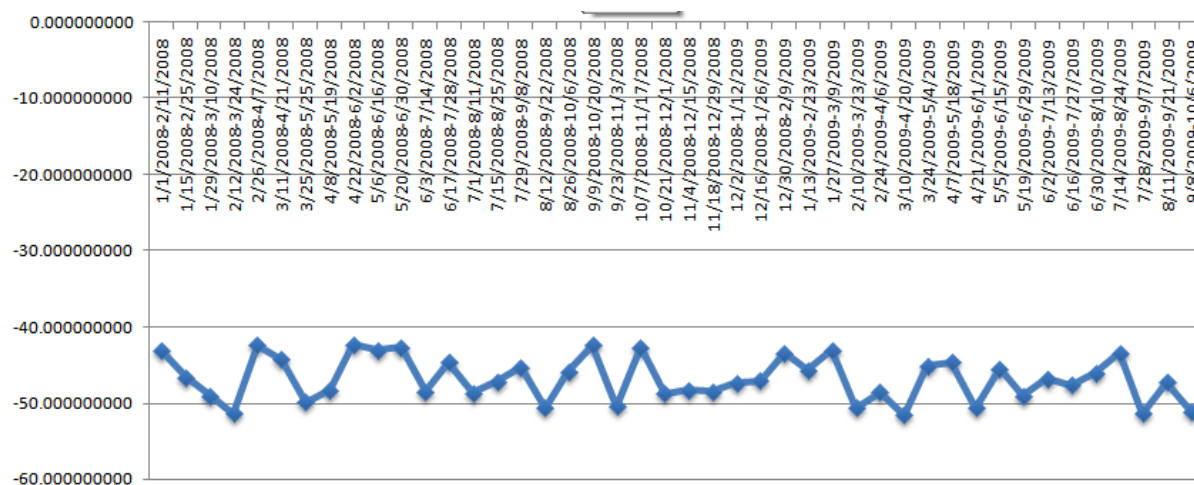
Figure 4.2: The development of the parameter a_1 in model 5 of The Boeing Company.

Moreover, in the models in which the parameter b_1 is not included, the values of the parameter b_0 which represent the effect of the stock prices on default intensities also change over time window. It can be observed from the results that the values of the parameter b_0 tend to be low if the reference entity has relatively high stock prices. In contrast, the values of the

parameter b_0 tend to be high when the reference entity has relatively low stock prices. Considering time dimension, as the credit crisis in the U.S. reached its peak during the period of time of October 2008 through April 2009, the ten reference entities in our study have comparatively low stock prices compared to the other periods of time. The values of the parameter b_0 are higher during the period of time of October 2008 through April 2009 than during the other periods of time. That means when compared within the same reference entity, the values of the parameter b_0 also tend to be high if the reference entity has relatively low stock prices.

Furthermore, the values of the parameter b_0 tend to be averagely higher when its reference entity has lower stock prices compared to other reference entities. For instance, the average stock price of Merck and Co., Inc. (MRK) from January 1, 2008 to October 6, 2009 is around 30.16 dollars. The average value of the parameter b_0 in model 3 for Merck and Co., Inc (MRK) in which we do not incorporate the parameter b_1 in all 44 time windows (from January 1, 2008 to October 6, 2009) is 0.33. The average value of the parameter b_0 is greatly lower for Exxon Mobile Corp. (XOM) as the average stock prices of Exxon Mobile Corp. is greater than the one of Merck and Co., Inc. Specifically, the average stock prices of Exxon Mobile Corp. (XOM) from January 1, 2008 to October 6, 2009 is approximately equal to 73.96 dollars. The average value of the parameter b_0 in model 3 for Exxon Mobile Corp. (XOM) is 0.26.

The graph below shows the development of the parameter b_0 in model 6 of Bank of America.
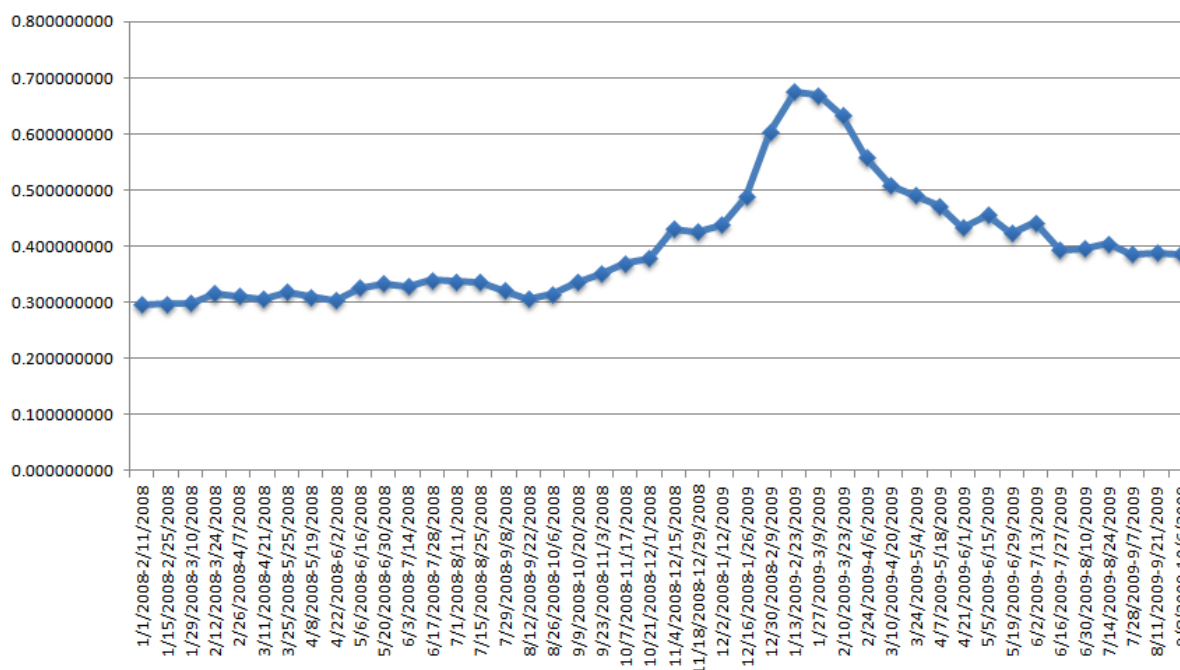
Figure 4.3: The development of the parameter b_0 in model 6 of Bank of America.

The result also does not contradict basic intuition in the sense that the effect of the stock prices on default intensities should be less when companies are in good standing. To illustrate, during the time when a company faces a bad situations and its stock price is low, the stock price movement of the company would be very sensitive to the fundamental of the company which is directly linked to its default probability. In this case the parameter b_0 should be high. For example, when the stock price is only three dollars, it does really matter if the price drops further or increases by one dollar. On the other hand, during the time when a company faces excellent situations and its stock prices shoot up, any slight changes in the stock prices would not much reflect any changes in fundamental of the company. For instance, when the stock price is as high as three hundred dollars, it does not really matter if the price drops or increases by one dollar. In

this case the value of the parameter b_0 should not be as high as when the company is facing bad time.

The values of parameter b_1 are close to zero in all reference entities and all time windows. It can be inferred from this fact that the effect of the most basic linear time trend on the stock prices (feature 3) plays very little role in explaining credit default swap premium variations.
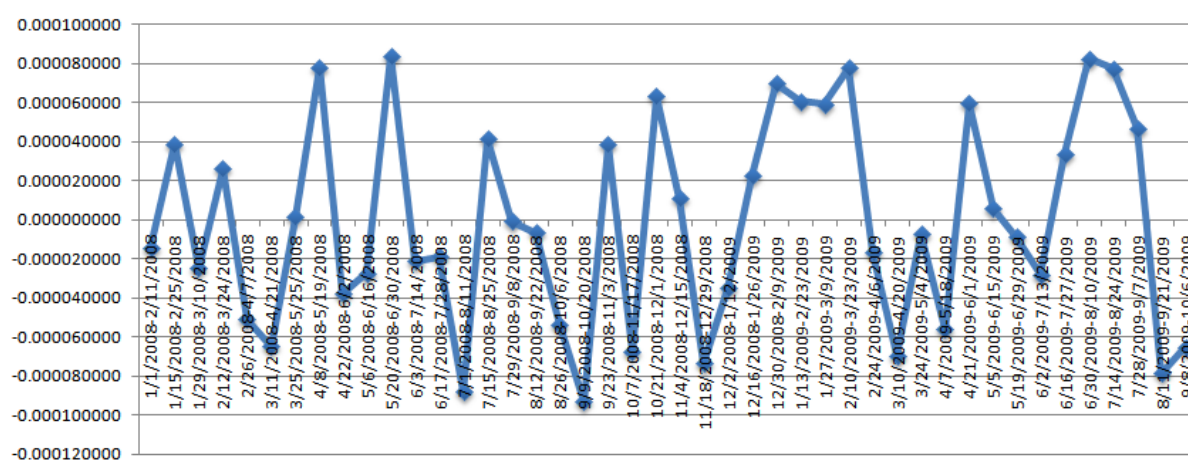
Figure 4.4: The development of the parameter b_1 in model 11 of the Walt Disney Company.

The value of the parameter c_0 in each time window in model 1 where we do not incorporate any feature in the model indicates the average implied default intensity or average implied default probability per year given that the recovery rate is equal to $N(a_0)$. For example, for Alcoa Inc., the value of the parameter c_0 in the first time window (January 1, 2008 to February 11, 2008) is equal to 0.0136. That means if we assume constant default intensity in the next 10 years and investors are risk-neutral, the market perceived that the default probability was equal to 1.36% per year. During the period of time of October 2008 through April 2009 when the credit crisis in the U.S. was the most severe, the credit default swap premiums were

extremely high. Therefore, the values of the parameter c_0 were significantly high during this period to reflect bad expectations of investors during this difficult period of time.

For IBM, average implied default probability is around 0.6% per year but it reached its peak in December 2008 around almost 2% per year.
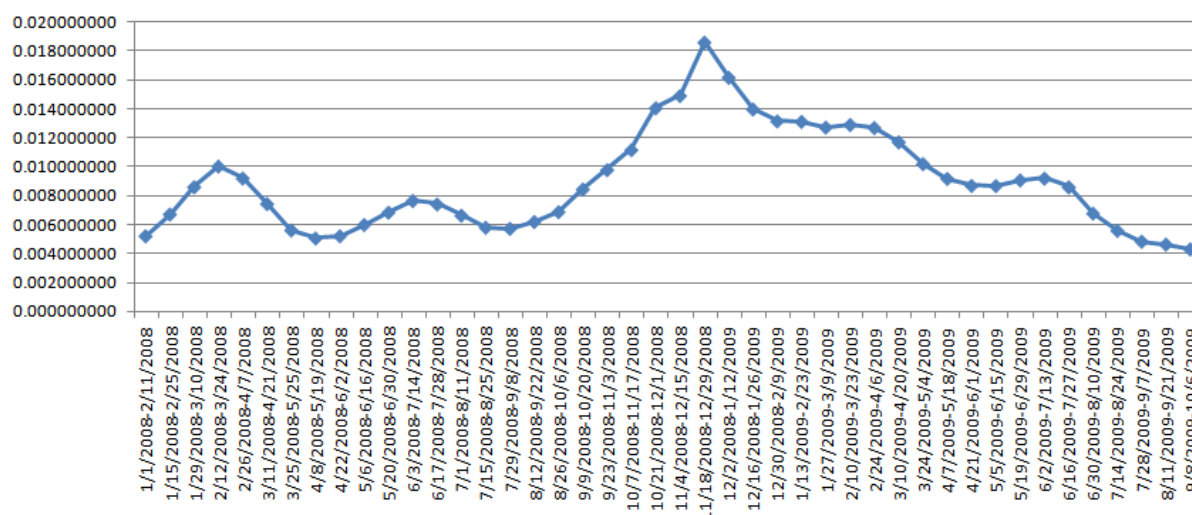
Figure 4.5: The development of parameter c_0 in model 1 of International Business Machine.

In addition, if incorporated, the values of the parameter c_1 which reflect the most basic linear time trend of the default intensity are mostly positive. When the parameter c_1 is positive and if we assume that credit default swap issuers do not expect to receive maturity-risk premiums to compensate for issuing longer time-to-maturity credit default swap contract, it can be inferred that investors expect that the default intensity would increase through time.

However, in practice at longer time to maturities there is more uncertainty and a greater chance of catastrophic events that impact the credit default swap premiums. Therefore, positive values of parameter c_1 can possibly be resulted from higher credit default swap premiums due to

higher maturity-risk, not because the fact that investors expect that the default probability would increase though time.
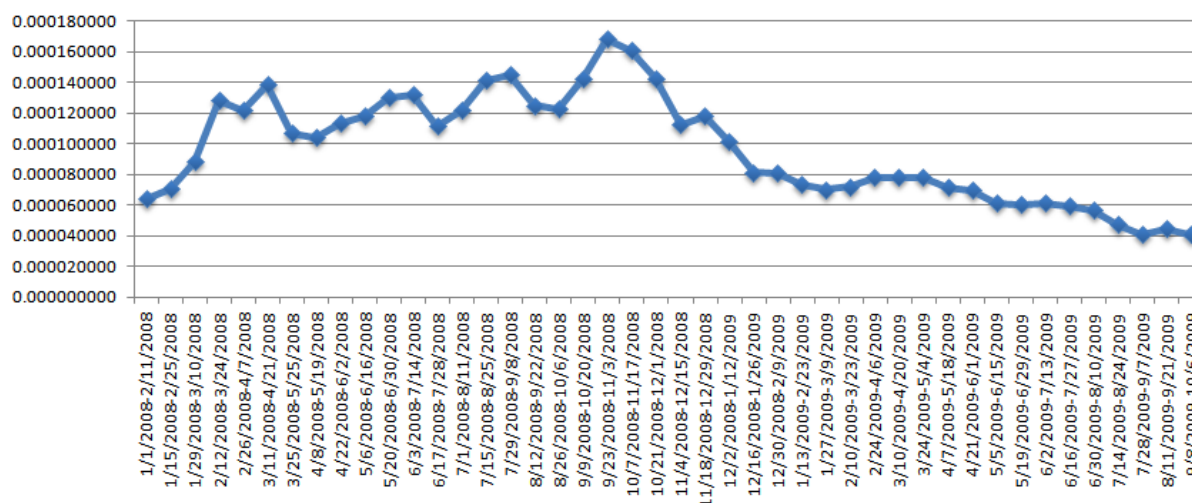
Figure 4.6: The development of the parameter c_1 in model 2 of AT&T

In some reference entities which are Alcoa Inc., The Boeing Co., Bank of America Corp., and Kraft Food Incorporated, we can observe that some of the values of parameter c_1 are negative during the period of time when the credit crisis in the U.S. reached its peak during the period of time of October 2008 through April 2009. It can be clearly seen that investors during that period of time expected that the default probability would decrease in the future because the default intensity rates during that period of time were exceptionally high. For the other reference entities of which the values of the parameters c_1 are still positive during the period of time of October 2008 through April 2009, we can hypothesize that investors during that time did not expect that the default probability would decrease in the future or the effect of the maturity-risk premium prevailed the expectation that the default intensity would decline in the future.
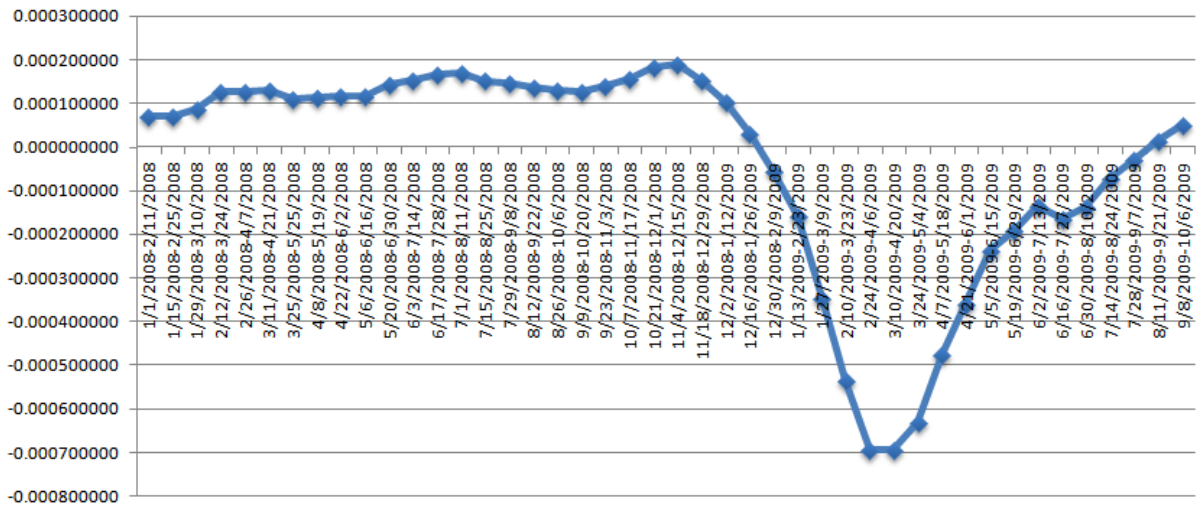
Figure 4.7: The development of parameter c_1 in model 2 of Bank of America

The sum of squared errors in each model and each reference entity can be summarized in the table below. We use the sum of squared errors in the table to investigate the 4 commonly seen features which explain credit default swap premium variations. We check how much the sum of squared errors would decline after adding one of these commonly seen features.

Reference Entity	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Alcoa Inc.	1,556,120.83	806,013.42	968,182.21	922,588.07	707,752.11	799,094.96	753,958.53	614,094.31	579,015.70	490,926.68	440,970.34
AT&T Inc.	76,989.73	21,565.75	45,245.54	41,564.22	18,090.09	35,509.01	33,406.09	12,944.14	11,368.46	9,566.42	9,116.24
Bank of America Corp.	420,921.75	190,412.12	252,963.70	231,769.01	158,999.93	203,400.86	182,576.29	146,275.66	132,486.57	121,101.69	114,460.90
The Boeing Co.	193,369.91	83,285.22	111,485.28	103,753.31	69,645.26	90,909.05	83,814.57	55,318.34	51,809.19	40,513.70	37,737.95
Exxon Mobile Corp.	38,327.45	14,350.37	16,094.84	15,024.99	9,800.02	11,411.51	10,083.14	7,357.26	6,543.05	5,592.73	5,161.59
IBM	53,609.72	36,113.18	40,151.28	36,523.37	29,565.78	31,705.57	30,193.52	22,968.81	20,917.15	18,130.87	16,550.43
Kraft Foods Inc.	85,023.53	36,620.53	55,766.76	51,804.31	27,809.51	43,802.50	40,841.92	21,090.55	19,147.28	15,490.68	13,768.63
Merck & Co. Inc.	34,802.11	13,346.81	20,261.78	18,654.09	12,641.52	18,717.86	17,829.35	7,293.37	6,954.10	6,572.73	6,187.12
Wal-Mart Stores Inc.	25,417.15	16,556.37	14,532.96	12,669.76	13,693.65	11,246.31	10,839.74	9,870.42	9,026.11	7,222.07	6,570.35
The Walt Disney Co.	67,791.47	30,818.05	35,568.79	32,908.38	26,819.81	30,959.41	28,773.31	19,024.62	16,670.43	15,726.35	14,346.81

Table 4.1: The average values of minimized sum of squared errors over 44 time windows and each reference entity when comparing the actual credit default swap premiums with the credit default swap premiums calculated from each stipulated model.

4.1.1 The Contribution to Explaining Credit Default Swap Premium Variations Made by Stock

Prices (Feature 1)

We compared three pairs of models to investigate the contribution to explaining the credit default swap premium variations made by stock prices. The comparison of model 1 and model 3 checks the impact of adding stock prices (feature 1) into the credit default swap pricing model when there are no other features included. The comparison of model 2 and 8 investigates the result of having stock prices (feature 1) when the most basic linear time trend (feature 2) has already been included into the credit default swap pricing model. The comparison of model 5 and model 10 examines the impact of adding stock prices (feature 1) when the linear time trend (feature 2) and the correlation between default probabilities and recovery rates (feature 4) have already been included into the credit default swap pricing model. These three comparisons are shown in table 4.2, 4.3 and 4.4 respectively.

Reference Entity	Model 1	Model 3	% improvement of SSE
Alcoa Inc.	1,556,120.83	968,182.21	0.377823248
AT&T Inc.	76,989.73	45,245.54	0.412317235
Bank of America Corp.	420,921.75	252,963.70	0.399024401
The Boeing Co.	193,369.91	111,485.28	0.423461068
Exxon Mobile Corp.	38,327.45	16,094.84	0.580070301
IBM	53,609.72	40,151.28	0.251044866
Kraft Foods Inc.	85,023.53	55,766.76	0.344102047
Merck & Co. Inc.	34,802.11	20,261.78	0.417800171
Wal-Mart Stores Inc.	25,417.15	14,532.96	0.428222214
The Walt Disney Co.	67,791.47	35,568.79	0.475320489
		Average	0.410918604
		S.D.	0.080328562

Table 4.2: The comparison of model 1 in which we do not incorporate any features and model 3 in which we incorporate only feature 1.

Reference Entity	Model 2	Model 8	% improvement of SSE
Alcoa Inc.	806,013.42	614,094.31	0.238109074
AT&T Inc.	21,565.75	12,944.14	0.399782653
Bank of America Corp.	190,412.12	146,275.66	0.231794352
The Boeing Co.	83,285.22	55,318.34	0.335796361
Exxon Mobile Corp.	14,350.37	7,357.26	0.487312062
IBM	36,113.18	22,968.81	0.363977159
Kraft Foods Inc.	36,620.53	21,090.55	0.424078589
Merck & Co. Inc.	13,346.81	7,293.37	0.453549786
Wal-Mart Stores Inc.	16,556.37	9,870.42	0.40382951
The Walt Disney Co.	30,818.05	19,024.62	0.382679284
		Average	0.372090883
		S.D.	0.079698087

Table 4.3: The comparison of model 2 in which we incorporate only feature 2 and model 8 in which we incorporate feature 1 and feature 2.

Reference Entity	Model 5	Model 10	% improvement of SSE
Alcoa Inc.	707,752.11	490,926.68	0.306357871
AT&T Inc.	18,090.09	9,566.42	0.471178979
Bank of America Corp.	158,999.93	121,101.69	0.23835385
The Boeing Co.	69,645.26	40,513.70	0.418284973
Exxon Mobile Corp.	9,800.02	5,592.73	0.429314145
IBM	29,565.78	18,130.87	0.386761667
Kraft Foods Inc.	27,809.51	15,490.68	0.442971774
Merck & Co. Inc.	12,641.52	6,572.73	0.480068033
Wal-Mart Stores Inc.	13,693.65	7,222.07	0.472597047
The Walt Disney Co.	26,819.81	15,726.35	0.413629385
		Average	0.405951772
		S.D.	0.073954719

Table 4.4: The comparison of model 5 in which we incorporate only feature 2 and feature 4 and model 10 in which we incorporate feature 1, feature 2, and feature 4.

4.1.2 The Contribution to Explaining Credit Default Swap Premium Variations Made by the Linear Time Trend

We compared five pairs of models to investigate the contribution to explaining the credit default swap premium variations made by the linear time trend. The comparison of model 1 and model 2 checks the impact of adding the feature of the linear time trend into the credit default swap pricing model when there are no other features included. The comparison of model 3 and model 8 investigates the impact of having the feature of the linear time trend when the feature of stock prices has already been included into the credit default swap pricing model. The comparison of model 4 and model 9 examines the impact of adding the feature of the linear time trend when the features of stock prices and the effect of the linear time trend on the stock prices have already been included into the credit default swap pricing model. The comparison of model 6 and model 10 looks at the impact of incorporating the feature of the linear time trend when the features of the linear time trend and the correlation between default probabilities and recovery rates have already been included into the credit default swap pricing model. The comparison of model 7 and model 11 inspects the impact of including the feature of the linear time trend when the features of stock prices, the effect of the linear time trend on the stock prices and the correlation between default intensities and recovery rates have already been incorporated into the credit default swap pricing model. These five comparisions are shown in table 4.5, 4.6,4.7,4.8 and 4.9 respectively.

Reference Entity	Model 1	Model 2	% improvement of SSE
Alcoa Inc.	1,556,120.83	806,013.42	0.482036737
AT&T Inc.	76,989.73	21,565.75	0.719887922
Bank of America Corp.	420,921.75	190,412.12	0.547630602
The Boeing Co.	193,369.91	83,285.22	0.569295886
Exxon Mobile Corp.	38,327.45	14,350.37	0.625585217
IBM	53,609.72	36,113.18	0.326368821
Kraft Foods Inc.	85,023.53	36,620.53	0.569289457
Merck & Co. Inc.	34,802.11	13,346.81	0.616494256
Wal-Mart Stores Inc.	25,417.15	16,556.37	0.348614294
The Walt Disney Co.	67,791.47	30,818.05	0.545399304
		Average	0.53506025
		S.D.	0.115204975

Table 4.5: The comparison of model 1 in which we do not incorporate any features and model 2 in which we incorporate only feature 2.

Reference Entity	Model 3	Model 8	% improvement of SSE
Alcoa Inc.	968,182.21	614,094.31	0.365724437
AT&T Inc.	45,245.54	12,944.14	0.713913461
Bank of America Corp.	252,963.70	146,275.66	0.421752352
The Boeing Co.	111,485.28	55,318.34	0.503805859
Exxon Mobile Corp.	16,094.84	7,357.26	0.542880765
IBM	40,151.28	22,968.81	0.427943282
Kraft Foods Inc.	55,766.76	21,090.55	0.6218079
Merck & Co. Inc.	20,261.78	7,293.37	0.640043186
Wal-Mart Stores Inc.	14,532.96	9,870.42	0.320825424
The Walt Disney Co.	35,568.79	19,024.62	0.465131721
		Average	0.502382839
		S.D.	0.120278348

Table 4.6: The comparison of model 3 in which we incorporate only feature 1 and model 8 in which we incorporate feature 1 and feature 2.

Reference Entity	Model 4	Model 9	% improvement of SSE
Alcoa Inc.	922,588.07	579,015.70	0.372400623
AT&T Inc.	41,564.22	11,368.46	0.726484363
Bank of America Corp.	231,769.01	132,486.57	0.428368057
The Boeing Co.	103,753.31	51,809.19	0.500650272
Exxon Mobile Corp.	15,024.99	6,543.05	0.564522261
IBM	36,523.37	20,917.15	0.427294172
Kraft Foods Inc.	51,804.31	19,147.28	0.63039209
Merck & Co. Inc.	18,654.09	6,954.10	0.627207717
Wal-Mart Stores Inc.	12,669.76	9,026.11	0.287585705
The Walt Disney Co.	32,908.38	16,670.43	0.493428914
		Average	**0.505833417**
		S.D.	**0.126555999**

Table 4.7: The comparison of model 4 in which we incorporate only feature 1 and feature 3 and model 9 in which we incorporate feature 1, feature 2, and feature 3.

Reference Entity	Model 6	Model 10	% improvement of SSE
Alcoa Inc.	799,094.96	490,926.68	0.385646627
AT&T Inc.	35,509.01	9,566.42	0.730591854
Bank of America Corp.	203,400.86	121,101.69	0.404615643
The Boeing Co.	90,909.05	40,513.70	0.554349143
Exxon Mobile Corp.	11,411.51	5,592.73	0.509904065
IBM	31,705.57	18,130.87	0.428148844
Kraft Foods Inc.	43,802.50	15,490.68	0.646351607
Merck & Co. Inc.	18,717.86	6,572.73	0.648852613
Wal-Mart Stores Inc.	11,246.31	7,222.07	0.357827062
The Walt Disney Co.	30,959.41	15,726.35	0.492033314
		Average	**0.515832077**
		S.D.	**0.120377714**

Table 4.8: The comparison of model 6 in which we incorporate only feature 1 and feature 4 and model 10 in which we incorporate feature 1, feature 2, and feature 4.

Reference Entity	Model 7	Model 11	% improvement of SSE
Alcoa Inc.	753,958.53	440,970.34	0.415126524
AT&T Inc.	33,406.09	9,116.24	0.727108503
Bank of America Corp.	182,576.29	114,460.90	0.373079062
The Boeing Co.	83,814.57	37,737.95	0.54974478
Exxon Mobile Corp.	10,083.14	5,161.59	0.488097059
IBM	30,193.52	16,550.43	0.451855049
Kraft Foods Inc.	40,841.92	13,768.63	0.662879886
Merck & Co. Inc.	17,829.35	6,187.12	0.652981244
Wal-Mart Stores Inc.	10,839.74	6,570.35	0.393864404
The Walt Disney Co.	28,773.31	14,346.81	0.501384801
		Average	**0.521612131**
		S.D.	**0.116770639**

Table 4.9: The comparison of model 7 in which we incorporate only feature 1, feature 3, and feature 4 and model 11 in which we incorporate feature 1, feature 2, feature 3, and feature 4.

4.1.3 The Contribution to Explaining Credit Default Swap Premium Variations Made by the Effect of the Linear Time Trend on Stock Prices.

We compared fours pairs of models to investigate the contribution to explaining the credit default swap premium variations made by the effect of the linear time trend on stock prices. The comparison of model 3 and model 4 investigates the impact of having the feature of the effect of the time trend on the stock prices when the feature of stock prices has already been included into the credit default swap pricing model. The comparison of model 6 and model 7 checks the impact of having the feature of the ffect of the time trend on the stock prices provided that the features of stock prices and the correlation between default probabilities and recovery rates have already been included into the credit default swap pricing model. The comparison of model 8 and model 9 examines the impact of adding the feature of the effect of the linear time trend on the stock prices when the features of stock prices and the effect of the linear time trend on the stock prices have already been included into the credit default swap pricing model. The

comparison of model 10 and model 11 looks at the impact of incorporating the feature of the linear time trend when the features of stock prices ,the linear time trend and the correlation between default probabilities and recovery rates have already been included into the credit default swap pricing model. These three comparisions are shown in the tables below.

Reference Entity	Model 3	Model 4	% improvement of SSE
Alcoa Inc.	968,182.21	922,588.07	0.047092518
AT&T Inc.	45,245.54	41,564.22	0.081363097
Bank of America Corp.	252,963.70	231,769.01	0.083785499
The Boeing Co.	111,485.28	103,753.31	0.069354241
Exxon Mobile Corp.	16,094.84	15,024.99	0.066471469
IBM	40,151.28	36,523.37	0.09035591
Kraft Foods Inc.	55,766.76	51,804.31	0.071053954
Merck & Co. Inc.	20,261.78	18,654.09	0.079345937
Wal-Mart Stores Inc.	14,532.96	12,669.76	0.128205653
The Walt Disney Co.	35,568.79	32,908.38	0.074796372
		Average	0.079182465
		S.D.	0.019817485

Table 4.10: The comparison of model 3 in which we incorporate only feature 1 and model 4 in which we incorporate feature 1 and feature 3.

Reference Entity	Model 6	Model 7	% improvement of SSE
Alcoa Inc.	799,094.96	753,958.53	0.056484437
AT&T Inc.	35,509.01	33,406.09	0.05922221
Bank of America Corp.	203,400.86	182,576.29	0.10238192
The Boeing Co.	90,909.05	83,814.57	0.078039349
Exxon Mobile Corp.	11,411.51	10,083.14	0.116405768
IBM	31,705.57	30,193.52	0.047690288
Kraft Foods Inc.	43,802.50	40,841.92	0.067589202
Merck & Co. Inc.	18,717.86	17,829.35	0.047468799
Wal-Mart Stores Inc.	11,246.31	10,839.74	0.036150722
The Walt Disney Co.	30,959.41	28,773.31	0.070611806
		Average	0.06820445
		S.D.	0.023855072

Table 4.11: The comparison of model 6 in which we incorporate only feature 1 and feature 4 and model 7 in which we incorporate feature 1, feature 3 and feature 4.

Reference Entity	Model 8	Model 9	% improvement of SSE
Alcoa Inc.	614,094.31	579,015.70	0.057122525
AT&T Inc.	12,944.14	11,368.46	0.121728834
Bank of America Corp.	146,275.66	132,486.57	0.094267867
The Boeing Co.	55,318.34	51,809.19	0.063435723
Exxon Mobile Corp.	7,357.26	6,543.05	0.110667715
IBM	22,968.81	20,917.15	0.089323741
Kraft Foods Inc.	21,090.55	19,147.28	0.092139136
Merck & Co. Inc.	7,293.37	6,954.10	0.046516925
Wal-Mart Stores Inc.	9,870.42	9,026.11	0.085538863
The Walt Disney Co.	19,024.62	16,670.43	0.123744248
		Average	0.088448558
		S.D.	0.02503796

Table 4.12: The comparison of model 8 in which we incorporate only feature 1 and feature 2 and model 9 in which we incorporate feature 1, feature 2, and feature 3.

Reference Entity	Model 10	Model 11	% improvement of SSE
Alcoa Inc.	490,926.68	440,970.34	0.101759263
AT&T Inc.	9,566.42	9,116.24	0.04705829
Bank of America Corp.	121,101.69	114,460.90	0.054836489
The Boeing Co.	40,513.70	37,737.95	0.068513862
Exxon Mobile Corp.	5,592.73	5,161.59	0.077089906
IBM	18,130.87	16,550.43	0.08716848
Kraft Foods Inc.	15,490.68	13,768.63	0.111166796
Merck & Co. Inc.	6,572.73	6,187.12	0.058668227
Wal-Mart Stores Inc.	7,222.07	6,570.35	0.090239838
The Walt Disney Co.	15,726.35	14,346.81	0.087721513
		Average	0.078422266
		S.D.	0.019873622

Table 4.13: The comparison of model 10 in which we incorporate only feature 1, feature 2, and feature 4 and model 11 in which we incorporate feature 1, feature 2, feature 3, and feature 4.

4.1.4 The Contribution to Explaining Credit Default Swap Premium Variations Made by the correlation between default intensities and recovery rates

We compared five pairs of models to investigate the contribution to explaining the credit default swap premium variations made by the correlation between default intensities and recovery rates. The comparison of model 2 and model 5 investigates the impact of having the feature of the correlation between default intensities and recovery rates when the feature of stock prices has already been included into the credit default swap pricing model. The comparison of model 3 and model 6 examines the impact of adding the feature of the correlation between default intensities and recovery rates when the feature of stock prices has already been included into the credit default swap pricing model. The comparison of model 4 and model 7 looks at the impact of incorporating the feature of the correlation between default intensities and recovery rates when the features of stock prices and the effect of the linear time trend on the stock prices have already been included into the credit default swap pricing model. The comparison of model 8 and model 10 inspects the impact of including the feature of the correlation between default intensities and recovery rates when the features of stock prices, the effect of the linear time trend on stock prices and the linear time trend have already been incorporated into the credit default swap pricing model. The comparison of model 9 and model 11 checks the impacts of adding the feature of the correlation between default intensities and recovery rates after the features of stock prices, the linear time trend and the effect of the linear time trend on stock prices have already included into the credit default swap model.

These five comparisions are shown in table 4.13, 4.14, 4.15, 4.16 and 4.17 respectively.

Reference Entity	Model 2	Model 5	% improvement of SSE
Alcoa Inc.	806,013.42	707,752.11	0.121910269
AT&T Inc.	21,565.75	18,090.09	0.161166058
Bank of America Corp.	190,412.12	158,999.93	0.164969457
The Boeing Co.	83,285.22	69,645.26	0.163774029
Exxon Mobile Corp.	14,350.37	9,800.02	0.317088915
IBM	36,113.18	29,565.78	0.181302378
Kraft Foods Inc.	36,620.53	27,809.51	0.240603282
Merck & Co. Inc.	13,346.81	12,641.52	0.052843583
Wal-Mart Stores Inc.	16,556.37	13,693.65	0.172907211
The Walt Disney Co.	30,818.05	26,819.81	0.129736825
		Average	0.170630201
		S.D.	0.06674854

Table 4.14: The comparison of model 2 in which we incorporate only feature 2 and model 5 in which we incorporate feature 2 and feature 4.

Reference Entity	Model 3	Model 6	% improvement of SSE
Alcoa Inc.	968,182.21	799,094.96	0.174644039
AT&T Inc.	45,245.54	35,509.01	0.215193008
Bank of America Corp.	252,963.70	203,400.86	0.195928681
The Boeing Co.	111,485.28	90,909.05	0.184564585
Exxon Mobile Corp.	16,094.84	11,411.51	0.290983133
IBM	40,151.28	31,705.57	0.210347168
Kraft Foods Inc.	55,766.76	43,802.50	0.214541116
Merck & Co. Inc.	20,261.78	18,717.86	0.076198669
Wal-Mart Stores Inc.	14,532.96	11,246.31	0.226151872
The Walt Disney Co.	35,568.79	30,959.41	0.129590615
		Average	0.191814289
		S.D.	0.054793367

Table 4.15: The comparison of model 3 in which we incorporate only feature 1 and model 6 in which we incorporate feature 1 and feature 4.

Reference Entity	Model 4	Model 7	% improvement of SSE
Alcoa Inc.	922,588.07	753,958.53	0.182778802
AT&T Inc.	41,564.22	33,406.09	0.196277675
Bank of America Corp.	231,769.01	182,576.29	0.212248931
The Boeing Co.	103,753.31	83,814.57	0.19217451
Exxon Mobile Corp.	15,024.99	10,083.14	0.328908338
IBM	36,523.37	30,193.52	0.173309574
Kraft Foods Inc.	51,804.31	40,841.92	0.211611537
Merck & Co. Inc.	18,654.09	17,829.35	0.044212558
Wal-Mart Stores Inc.	12,669.76	10,839.74	0.144439326
The Walt Disney Co.	32,908.38	28,773.31	0.125653876
		Average	**0.181161513**
		S.D.	**0.068790582**

Table 4.16: The comparison of model 4 in which we incorporate only feature 1 and feature 3 and model 7 in which we incorporate feature 1, feature 3, and feature 4.

Reference Entity	Model 8	Model 10	% improvement of SSE
Alcoa Inc.	614,094.31	490,926.68	0.200567942
AT&T Inc.	12,944.14	9,566.42	0.260946015
Bank of America Corp.	146,275.66	121,101.69	0.172099555
The Boeing Co.	55,318.34	40,513.70	0.267626395
Exxon Mobile Corp.	7,357.26	5,592.73	0.239834473
IBM	22,968.81	18,130.87	0.21063092
Kraft Foods Inc.	21,090.55	15,490.68	0.265515402
Merck & Co. Inc.	7,293.37	6,572.73	0.098807383
Wal-Mart Stores Inc.	9,870.42	7,222.07	0.268311354
The Walt Disney Co.	19,024.62	15,726.35	0.173368495
		Average	**0.215770793**
		S.D.	**0.053091447**

Table 4.17: The comparison of model 8 in which we incorporate only feature 1 and feature 2 and model 10 in which we incorporate feature 1, feature 2, and feature 4.

Reference Entity	Model 9	Model 11	% improvement of SSE
Alcoa Inc.	579,015.70	440,970.34	0.238413835
AT&T Inc.	11,368.46	9,116.24	0.198111704
Bank of America Corp.	132,486.57	114,460.90	0.136056609
The Boeing Co.	51,809.19	37,737.95	0.271597393
Exxon Mobile Corp.	6,543.05	5,161.59	0.21113351
IBM	20,917.15	16,550.43	0.208762752
Kraft Foods Inc.	19,147.28	13,768.63	0.280909307
Merck & Co. Inc.	6,954.10	6,187.12	0.110292288
Wal-Mart Stores Inc.	9,026.11	6,570.35	0.272072749
The Walt Disney Co.	16,670.43	14,346.81	0.139385805
		Average	**0.206673595**
		S.D.	**0.058233887**

Table 4.18: The comparison of model 9 in which we incorporate only feature 1, feature 2, and feature 3 and model 11 in which we incorporate feature 1, feature 2, feature 3, and feature 4.
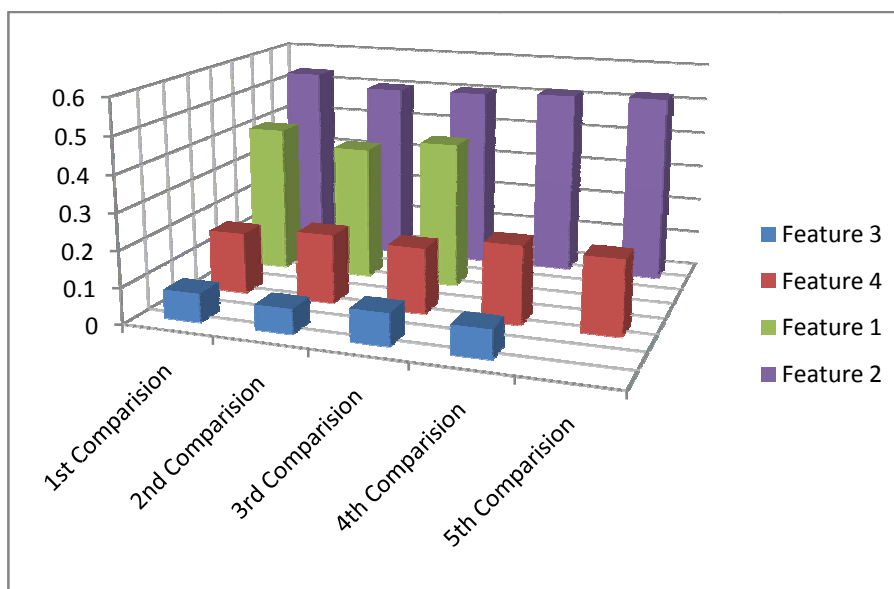
Figure 4.8: The bar charts comparing the contribution of each feature to explaining the credit default swap premium variation. The y-axis represents the average percentage of reduced sum of squared errors after adding each feature into the credit default swap pricing model.

First of all, according to Figure 4.8 which is the bar chart which compares the contribution of each feature to explaining the credit default swap premium variation, it seems like the 4 features are independent. As you can see, the relative improvement of each feature remains quite the same no matter whether or not the other features are added.

The feature which can best explain the credit default swap premium variations is the linear time trend. We compared three pairs of models to investigate the contribution to explaining the credit default swap premium variations made by the linear time trend. Of the selected 10 companies in our study listed in Dow Jones Industrial Index, the sum of squared errors sharply decreases by 53.506025% when comparing model 1 in which we did not include any features in the model with model 3 in which only feature 2 (linear time trend) is incorporated. Moreover, the sum of squared errors materially reduces by 50.2382839% when we make comparison between model 3 and model 8 to investigate the contribution to explaining the credit default swap premium variations made by the linear time tread. Only feature 1 (stock prices) is incorporated in model 3 whereas both feature 1 (stock prices) and feature 2 (linear time trend) are included in model 8. Also, the sum of squared errors greatly diminishes by 50.5833417% when we compare model 4 where we have feature 1 (stock prices) and feature 3 (the effect of the linear time trend on the stock prices) and model 9 where we have feature 1 (stock prices), feature 2 (linear time trend) and feature 3 (the effect of the linear time trend on the stock prices). Also, the sum of squared errors substantially lessens by 51.5832077% when we compare model 6 in which we incorporate feature 1(stock prices) and feature 4 (correlation between default probabilities and recovery rates). Finally, the sum of squared errors considerably

reduces by 52.1612131$ when comparing model 7 where all of the features except feature 2 are incorporated and model 11 in which all of the features are included in the model.

The feature which has the second-best capability to explain the credit default swap premium variations is feature 1 (stock prices). We compared three pairs of models to investigate the contribution to explaining the credit default swap premium variations made by stock prices. On average, of the selected 10 companies in our study listed in Dow Jones Industrial Index, the sum of squared errors improves by 41.0918604% when we compare model 1 in which we did not have any features in the model with model 3 in which we only incorporate feature 1 (stock prices). Furthermore, the sum of squared errors improves by 37.2090883% when we compare model 2 in which we incorporate only feature 1 (stock prices) with model 8 in which we include feature 1 (stock prices) and feature 2 (linear time trend) to see the impact that feature 2 (linear time trend) has made to explain the credit default swap premium variations. In addition, the sum of squared errors improves by 40.5951772% when comparing model 5 in which feature 2 (linear time trend) and feature 4 (correlation between default probabilities and recovery rates) are incorporated and model 10 in which feature 1 (stock prices), feature 2 (linear time trend) and feature 4 (correlation between default probabilities and recovery rates) are included to check how much feature 1 (stock prices) has contributed to explaining the credit default swap premium variations.

The feature which can also explain the credit default swap premium variations, but its contribution is less than the linear time trend and stock prices is correlation between default probabilities and recovery rates. We compared five pairs of models to investigate the contribution to explaining the credit default swap premium variations made by correlation between default probabilities and recovery rates. First of all, of the selected 10 companies in our

study listed in Dow Jones Industrial Index, the sum of squared errors improves by 17.06302011% when we make a comparison between model 2 in which no feature is included except feature 2 (linear time trend) and model 5 where we incorporate feature 2 (linear time trend) and feature 4 (correlation between default probabilities and recovery rates). Secondly, the sum of squared errors is better by 19.1814289% when comparing model 3 in which we incorporate only feature 1 (stock prices) in the model with model 6 in which we have both feature 1 (stock prices) and feature 4 (correlation between default intensities and recovery rates) in the model. Third, the sum of squared error reduces by 18.1161513% after adding feature 4 into model 7 and it becomes model 7. Moreover, the sum of square errors diminishes by 21.5770793% when we compare model 8 in which we have feature 1 (stock prices) and feature 2 (linear time trend) with model 10 in which in include feature 1 (stock prices), feature 2 (linear time trend) and feature 4 (correlation between default probabilities and recovery rates). Finally, If we compare model 9 in which we have feature 1 (stock prices), feature 2 (linear time trend), and feature 3 (the effect of the linear time trend on the stock prices) with model 11 where we incorporate all of the features (feature 1, 2, 3 and 4), we can see that the sum of squared errors improves by 20.66735596%.

The feature which has the worst capability to explain the credit default swap premium variations is feature 3 (the effect of the linear time trend on stock prices). We compared three pairs of models to investigate the contribution to explaining the credit default swap premium variations made by the effect of the linear time trend of the stock prices. On average, of the selected 10 companies in our study listed in Dow Jones Industrial Index, the sum of squared errors slightly improves by 7.9182465% when we compare model 3 with model 4. In model 3 we only include feature 1 (stock prices) whereas in model 4 we have 2 features which are feature

1(stock prices) and feature 3 (the effect of the linear time trend on the stock prices.) Moreover, the sum of squared errors marginally declines by 8.8448558% when we make a comparison between model 8 and model 9. In model 8 we have only two features which are feature 1(stock prices) and feature 2 (linear time trend). In model 9, we incorporate 3 features which are feature 1 (stock prices), feature 2 (linear time trend) and feature 3 (the effect of the linear time trend on the stock prices). Lastly, the sum of squared errors marginally declines by 7.8422266% when making a comparison between model 10 and model 11. In model 10 we have all of the features except feature 3 (the effect of the linear time trend on the stock prices) whereas in model 11 we include all of the four features including feature 3 (the effect of the linear time trend on the stock prices).

We can observe that the values of parameter b_1 which reflects the effect of the linear time trend on the stock prices are nearly equal to zero for all of the ten reference entities and for all of the time windows. The values of all of the parameters are shown in Appendix C. It can be inferred that the effect of the linear time trend on the stock prices plays very little role in explaining the credit default swap premium variations. This confirms the result the feature which has the worst capability to explain the credit default swap premium variations is feature 3 (the effect of the linear time trend on the stock prices). The result does not contradict to the basic intuition. The impact of the change in stock prices remains quite constant through time. That means if a company's strength which is gauged by its stock prices has changed; the effect on its credit default swap spreads does not alter through time.

4.2 The Highest Relative Importance of the Linear Time Trend.

Evidently, we can observe from the previous section that the feature which has the highest relative importance or the highest explanatory power is the most basic linear time trend. This interesting fact leads us to further investigate the reason that makes the most basic linear time trend very special and has the highest explanatory power.

We hypothesize that the most linear time trend has very high explanatory power because it can be used to explain the term structure of credit default swap spreads very well. We therefore perform the comparison of the important factors again. However, for this time instead of combining 1 to 10-year time-to-maturities altogether, we separately do it for each time-to-maturity of credit default swaps. The credit default swap contracts that we include in the study to investigate the reason that the most basic linear time trend is the most powerful factor are only 3-year, 5-year and 7- year. Furthermore, we only use model 1, model 2, model 3, model 5, model 6 and model 10. That is because we already found that feature 3 (the effect of linear time trend on the stock prices) is not significant to explain the credit default swap premium variations. Therefore, we choose to exclude feature 3 in this phase of study.

By separately performing the comparison of the important factors for each time-to-maturity, we can eliminate the need of explaining the term structure of credit default swap spreads. On one hand, if we found that the most basic linear time trend is still the best after eliminating the need of explaining the term structure of credit default swap spreads, we can conclude that the linear time trend is not playing an important role in explaining the term structure of credit default swap spreads. On the other hand, if we found that that most basic linear time trend has less explanatory power, we can conclude that the most basic linear time

trend has very impressive explanatory power because it can be effectively used to explain the term structure of credit default swap spreads.

By comparing model 1 with model 3, we will be able to observe the relative importance of feature 1 (stock prices) when the effect of the correlation between default intensities and recovery rates has not been incorporated. By comparing model 1 with model 2, we can check the relative importance of feature 2 (the most basic linear time trend) when the effect of the correlation between default intensities and recovery rates has not been added. When comparing model 5 with model 10, we can investigate the explanatory power of feature 1 (stock prices) when the effect of the correlation between default intensities and recover rates has already been incorporated. When comparing model 6 with model 10, we can check the explanatory power of feature 2 (the most basic linear time trend) provided that the effect the correlation between default intensities and recovery rates has already added.

The sum of squared errors in each model and each reference entity including the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) are shown below.

Reference Entity: AA	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	107014.8	124199	138435.1
Model 2	100593.7	106789.1	123857.6
Model 3	81608.88	81180.42	97971.84
Model 5	90672.49	96561.63	145993.5
Model 6	65101.75	78048.7	84938.88
Model 10	58199.54	71552.91	80258.4

First Comparison (without correlation)

Improvement Made by Feature 1	0.237406	0.346368	0.292291
Improvement Made by Feature 2	0.060002	0.140178	0.105303

Second Comparison (with correlation)

Improvement Made by Feature 1	0.358134	0.258992	0.450261
Improvement Made by Feature 2	0.106022	0.083227	0.055104

Table 4.19: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of Alcoa Inc. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: T	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	5296.922	6146.991	6857.693
Model 2	5007.589	5674.534	5930.923
Model 3	4018.516	3965.827	4500.877
Model 5	3473.992	4145.849	4577.371
Model 6	2754.264	3275.112	3550.254
Model 10	2514.712	2883.03	3212.009

First Comparison (without correlation)

Improvement Made by Feature 1	0.241349	0.354834	0.343675
Improvement Made by Feature 2	0.054623	0.07686	0.135143

Second Comparison (with correlation)

Improvement Made by Feature 1	0.276132	0.304598	0.298285
Improvement Made by Feature 2	0.086975	0.119716	0.095274

Table 4.20: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of AT&T Inc. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: BAC	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	28967	33789.75	37207.38
Model 2	25366.15	31086.22	34675.56
Model 3	21932.46	24922.58	25335.73
Model 5	20099.17	26665.06	24729.8
Model 6	14662.21	17442.93	19531.12
Model 10	13635.02	15789.86	17555.82

First Comparison (without correlation)

Improvement Made by Feature 1	0.242847	0.262422	0.319067
Improvement Made by Feature 2	0.124309	0.08001	0.068046

Second Comparison (with correlation)

Improvement Made by Feature 1	0.321613	0.407845	0.290094
Improvement Made by Feature 2	0.070057	0.09477	0.101136

Table 4.21: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of Bank of America Corp. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: BA	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	13345.51	15304.9	17244.79
Model 2	12228.82	13953.14	15347.54
Model 3	7940.465	10383.96	10912.65
Model 5	9735.772	11116.12	11655.17
Model 6	7124.07	8004.449	8591.375
Model 10	6306.149	7123.992	8086.503

First Comparison (without correlation)

Improvement Made by Feature 1	0.405009	0.321527	0.367192
Improvement Made by Feature 2	0.083675	0.088322	0.110019

Second Comparison (with correlation)

Improvement Made by Feature 1	0.35227	0.35913	0.306187
Improvement Made by Feature 2	0.114811	0.109996	0.058765

Table 4.22: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of The Boeing Co. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: XOM	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	2484.229	3092.016	3422.06
Model 2	2419.651	2799.587	3157.034
Model 3	1590.043	1960.954	2324.716
Model 5	1982.737	2220.679	2246.109
Model 6	1374.648	1648.79	1801.413
Model 10	1226.753	1434.016	1597.39

First Comparison (without correlation)

Improvement Made by Feature 1	0.359945	0.365801	0.320668
Improvement Made by Feature 2	0.025995	0.094575	0.077446

Second Comparison (with correlation)

Improvement Made by Feature 1	0.381283	0.354244	0.288819
Improvement Made by Feature 2	0.107588	0.130261	0.113257

Table 4.23: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of Exxon Mobil Corp. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: IBM	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	3695.431	4317.827	4745.192
Model 2	3431.13	3851.028	4380.878
Model 3	2921.353	3205.023	3258.787
Model 5	2379.957	2927.263	3345.605
Model 6	1833.724	2332.053	2465.622
Model 10	1746.295	2051.745	2205.648

First Comparison (without correlation)

Improvement Made by Feature 1	0.209469	0.257723	0.313244
Improvement Made by Feature 2	0.071521	0.10811	0.076775

Second Comparison (with correlation)

Improvement Made by Feature 1	0.266249	0.299091	0.340733
Improvement Made by Feature 2	0.047679	0.120198	0.10544

Table 4.24: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of International Business Machines when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: KFT	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	5884.105	6848.161	7541.567
Model 2	5152.742	5941.896	6914.325
Model 3	4423.904	4634.423	4740.462
Model 5	4700.365	4162.175	4965.558
Model 6	3430.101	3571.08	4136.559
Model 10	2772.899	3213.281	3533.728

First Comparison (without correlation)

Improvement Made by Feature 1	0.24816	0.32326	0.371422
Improvement Made by Feature 2	0.124295	0.132337	0.083171

Second Comparison (with correlation)

Improvement Made by Feature 1	0.410067	0.22798	0.288352
Improvement Made by Feature 2	0.191598	0.100193	0.145733

Table 4.25: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of Kraft Food Inc. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: MRK	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	2400.355	2788.535	3112.327
Model 2	2193.307	2546.823	2840.986
Model 3	1548.374	1998.459	2067.608
Model 5	1911.707	1773.421	2173.28
Model 6	1230.459	1444.858	1610.058
Model 10	1149.759	1294.27	1456.445

First Comparison (without correlation)

Improvement Made by Feature 1	0.35494	0.28333	0.335671
Improvement Made by Feature 2	0.086257	0.086681	0.087183

Second Comparison (with correlation)

Improvement Made by Feature 1	0.398569	0.270185	0.32984
Improvement Made by Feature 2	0.065585	0.104224	0.095408

Table 4.26: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of Merck & Co. Inc. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: WMT	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	1752.564	2016.602	2262.093
Model 2	1506.137	1920.216	2080.533
Model 3	1336.905	1455.196	1529.388
Model 5	1402.402	1461.802	1422.823
Model 6	918.2827	1092.402	1115.423
Model 10	833.8379	950.5178	1075.247

First Comparison (without correlation)

Improvement Made by Feature 1	0.237172	0.278392	0.323906
Improvement Made by Feature 2	0.14061	0.047796	0.080262

Second Comparison (with correlation)

Improvement Made by Feature 1	0.405421	0.349763	0.244286
Improvement Made by Feature 2	0.091959	0.129883	0.036019

Table 4.27: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of Wal-Mart Stores Inc. when separately performing the comparison of the important factors for each time-to-maturity.

Reference Entity: DIS	Time-to-Maturity		
	3-year	5-year	7-year
Model 1	4628.847	5495.742	6000.033
Model 2	4020.572	5025.603	5657.669
Model 3	3610.173	3782.505	3900.426
Model 5	3368.435	3811.233	3751.213
Model 6	2423.457	2882.884	3116.618
Model 10	2144.649	2576.991	2779.529

First Comparison (without correlation)

Improvement Made by Feature 1	0.220071	0.311739	0.349933
Improvement Made by Feature 2	0.13141	0.085546	0.05706

Second Comparison (with correlation)

Improvement Made by Feature 1	0.36331	0.323843	0.259032
Improvement Made by Feature 2	0.115046	0.106107	0.108159

Table 4.28: The sum of squared errors and the explanatory power of feature 1 (stock prices) and feature 2 (the most basic linear time trend) of The Walt Disney Co. when separately performing the comparison of the important factors for each time-to-maturity.

From the result, we can clearly see that that most basic linear time trend has a lot less explanatory power when separately performing the comparison of the important factors for each

time-to-maturity. Hence, we can conclude that the most basic linear time trend has very impressive explanatory power because it can be effectively used to explain the term structure of credit default swap spreads.

4.3 The Comparison of Market Credit Default Swap Spreads with Calculated Credit Default Swap Spreads from Das and Hanouna (2009)'s Platform

We also compare market credit default swap spreads with the calculated credit default swap spreads from our model to check how well our model performs. We use model 11 which is our full model because it has the largest numbers of parameter and thus has the most predictive power. For each trading month and each reference entity, we would obtain one set of parameters of a_0, a_1, b_0, b_1, c_0, c_1, and c_2. We use these parameters to forecast credit default swap spreads in the next month. For instance, if we are trying to find a fair value of a credit default swap spread of a reference entity on January 19, 2009, we need to obtain the extracted parameters a_0, a_1, b_0, b_1, c_0, c_1, and $c_2$using the trading data of the last trading month which is December 2008. Then, we use the actual stock price and volatility on January 19, 2009 to create the binomial tree in order to calculate the forecasted credit default swap spreads as explained in the subsection 3.2. After that we compare the actual market credit default swap spreads on January 19, 2009 with our forecasted credit default swap spreads to check how well our model performs and estimate the parameter in the study.

Reference Entity:	Alcoa Inc.		NYSE:	AA				Industry:	Steel	

Extraction of Parameters									Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	-0.6175	0.5939	0.0000	0.0011	-0.0221	0.0003	0.0268	44,835.70	2/1/2008-2/29/2008	660,467.82
2/1/2008-2/29/2008	20	-0.7483	174.5330	0.6216	-0.0052	0.0218	0.0008	-0.1045	23,182.81	3/3/2008-3/31/2008	36,196.94
3/3/2008-3/31/2008	20	-0.5759	-9.4230	0.4035	-0.0030	0.0535	0.0010	-0.1769	27,227.51	4/1/2008-4/30/2008	138,286.59
4/1/2008-4/30/2008	22	-0.7356	146.2528	0.0000	-0.0002	-0.1683	0.0000	0.1779	36,818.17	5/1/2008-5/30/2008	57,254.12
5/1/2008-5/30/2008	21	-0.6918	195.1891	0.0000	-0.0009	-0.1952	-0.0003	0.2001	6,783.80	6/2/2008-6/30/2008	29,249.10
6/2/2008-6/30/2008	21	-0.6173	-0.0099	0.0000	0.0028	0.0163	0.0001	-0.0090	9,134.00	7/1/2008-7/31/2008	64,568.13
7/1/2008-7/31/2008	22	-0.7553	250.5639	0.0000	-0.0015	-0.0574	0.0000	0.0636	10,104.17	8/1/2008-8/29/2008	57,488.36
8/1/2008-8/29/2008	21	-0.5839	-50.2760	0.0000	-0.0008	-0.5123	-0.0010	0.5199	10,450.02	9/1/2008-9/30/2008	481,161.01
9/1/2008-9/30/2008	21	-0.7714	240.4192	0.0000	0.0026	0.0000	0.0006	0.0071	14,212.68	10/1/2008-10/31/2008	9,534,486.07
10/1/2008-10/31/2008	22	-0.5844	-0.0274	0.1826	-0.0018	-0.1798	-0.0010	0.3251	197,458.13	11/3/2008-11/28/2008	658,779.12
11/3/2008-11/28/2008	19	-0.5833	-0.2962	0.4308	-0.0029	-0.0015	-0.0014	0.1361	301,467.91	12/1/2008-12/31/2008	1,322,677.45
12/1/2008-12/31/2008	22	-0.7398	26.2507	0.0000	-0.0012	-0.1973	0.0014	0.2607	153,835.95	1/1/2009-1/30/2009	2,218,041.38
1/1/2009-1/30/2009	20	-0.5787	-0.9333	0.4431	-0.0030	0.0439	-0.0018	0.0908	622,751.15	2/2/2009-2/27/2009	5,029,887.41
2/2/2009-2/27/2009	19	-0.6172	-0.0044	0.3169	-0.0018	0.1411	-0.0002	-0.0157	412,881.31	3/2/2009-3/31/2009	7,389,306.56
3/2/2009-3/31/2009	22	-0.6146	-0.1982	0.0348	0.0000	-1.1252	-0.0036	1.3679	3,778,763.65	4/1/2009-4/30/2009	6,463,100.42
4/1/2009-4/30/2009	21	-0.6173	0.0025	0.0000	0.0007	-0.0081	-0.0004	0.1087	1,021,899.95	5/1/2009-5/29/2009	7,843,628.05
5/1/2009-5/29/2009	20	-0.5941	-2.5470	0.8589	-0.0061	0.0609	-0.0010	0.0334	565,014.15	6/1/2009-6/30/2009	296,591.36
6/1/2009-6/30/2009	22	-0.5840	-0.1526	0.2280	-0.0011	-0.0255	-0.0010	0.1362	73,999.26	7/1/2009-7/31/2009	826,164.60
7/1/2009-7/31/2009	23	-0.6619	19.8992	0.0600	-0.0004	-0.6319	-0.0010	0.7755	208,655.80	8/3/2009-8/31/2009	284,819.92
8/3/2009-8/31/2009	21	-0.6083	0.0299	0.0000	-0.0016	-0.0782	-0.0001	0.1087	93,100.21	9/1/2009-9/30/2009	800,748.18

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2.   We use these parameters to forecast CDS spreads in the next month.

Table 4.29: The extracted parameters in each month and the sum of squared errors of prediction for Alcoa Inc. The extracted parameters of

each month are used to forecast credit default swap spreads in the next calendar month.

| Reference Entity: | AT&T Inc. | | | | | NYSE: | | T | | | Industry: | Telecom | |

Extraction of Parameters												Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters									Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2					
1/1/2008-1/31/2008	23	-0.7476	-0.0056	0.0003	0.0072	-0.0001	0.0001	0.0008			2,018.45	2/1/2008-2/29/2008	39,795.59
2/1/2008-2/29/2008	20	-0.7475	-0.3333	0.0000	-0.0013	0.0638	0.0005	-0.0630			5,062.96	3/3/2008-3/31/2008	93,338.59
3/3/2008-3/31/2008	20	-0.7473	0.0000	0.0774	-0.0068	0.0030	0.0002	-0.0003			6,950.06	4/1/2008-4/30/2008	130,897.36
4/1/2008-4/30/2008	22	-0.7465	-7.3820	0.0000	0.0012	-0.0187	0.0002	0.0204			5,997.84	5/1/2008-5/30/2008	12,422.35
5/1/2008-5/30/2008	21	-0.7120	-51.5151	0.0000	0.0015	-0.0080	0.0002	0.0090			984.52	6/2/2008-6/30/2008	1,759.00
6/2/2008-6/30/2008	21	-0.7183	11.7524	0.0000	-0.0014	-0.0061	0.0001	0.0072			1,425.36	7/1/2008-7/31/2008	7,352.37
7/1/2008-7/31/2008	22	-0.8129	684.1883	0.0000	0.0060	-0.0045	0.0003	0.0055			1,256.01	8/1/2008-8/29/2008	12,442.40
8/1/2008-8/29/2008	21	-0.6416	-1199.35	0.0000	-0.0024	0.0091	0.0002	-0.0085			4,007.19	9/1/2008-9/30/2008	14,326.65
9/1/2008-9/30/2008	21	-0.7476	0.0001	0.0000	-0.0055	0.0032	0.0002	-0.0020			6,434.41	10/1/2008-10/31/2008	193,547.01
10/1/2008-10/31/2008	22	-0.7781	167.8262	0.0000	0.0014	-0.0664	0.0004	0.0706			15,676.95	11/3/2008-11/28/2008	74,242.93
11/3/2008-11/28/2008	19	-0.7447	0.1159	0.0000	0.0007	-0.0900	0.0002	0.0995			23,117.78	12/1/2008-12/31/2008	75,709.71
12/1/2008-12/31/2008	22	-0.7476	-0.0216	0.0000	-0.0030	-0.0018	0.0000	0.0116			33,372.26	1/1/2009-1/30/2009	50,011.45
1/1/2009-1/30/2009	20	-1.1098	485.5377	0.0000	0.0017	-0.0104	0.0002	0.0196			21,819.21	2/2/2009-2/27/2009	81,748.94
2/2/2009-2/27/2009	19	-0.7757	47.1422	0.0000	-0.0030	-0.0027	0.0000	0.0098			22,718.39	3/2/2009-3/31/2009	51,383.77
3/2/2009-3/31/2009	22	-0.6130	-241.8832	0.1786	-0.0015	-0.0337	-0.0002	0.0686			10,997.23	4/1/2009-4/30/2009	6,569.79
4/1/2009-4/30/2009	21	-0.7014	-39.2847	0.4460	-0.0018	-0.0106	-0.0001	0.0637			4,895.85	5/1/2009-5/29/2009	14,025.55
5/1/2009-5/29/2009	20	-0.9746	929.6036	0.0000	0.0005	0.0570	0.0001	-0.0542			415.90	6/1/2009-6/30/2009	5,609.22
6/1/2009-6/30/2009	22	-0.9556	1013.84	0.0281	-0.0001	0.0253	0.0001	-0.0247			1,874.32	7/1/2009-7/31/2009	7,408.18
7/1/2009-7/31/2009	23	-0.7399	-9.8746	0.0000	0.0009	-0.0834	0.0003	0.0870			5,294.17	8/3/2009-8/31/2009	17,208.32
8/3/2009-8/31/2009	21	-0.8977	1291.21	0.0045	0.0046	0.0123	0.0000	-0.0109			1,784.16	9/1/2009-9/30/2009	2,099.27

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.30: The extracted parameters in each month and the sum of squared errors of prediction for ATT&T Inc. The extracted parameters of each month are used to forecast credit default swap spreads in the next calendar month.

| Reference Entity: | Bank of America Corp. | | NYSE: | | BAC | | | Industry: | Finance and Banking | |

Extraction of Parameters									Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	-0.4034	80.0706	0.1428	0.0000	-0.1818	0.0000	0.3173	14,659.83	2/1/2008-2/29/2008	47,610.66
2/1/2008-2/29/2008	20	-0.3311	-0.1321	0.3413	-0.0004	-0.0021	0.0000	0.0428	22,618.01	3/3/2008-3/31/2008	267,839.15
3/3/2008-3/31/2008	20	-0.3699	-0.0036	0.0000	-0.0050	0.0138	0.0001	-0.0005	117,187.23	4/1/2008-4/30/2008	267,516.50
4/1/2008-4/30/2008	22	-0.3535	32.8706	0.0000	0.0025	0.0297	0.0000	-0.0217	18,146.23	5/1/2008-5/30/2008	60,953.70
5/1/2008-5/30/2008	21	-0.5047	436.2390	0.0000	0.0046	0.0029	0.0004	0.0004	4,932.70	6/2/2008-6/30/2008	106,044.14
6/2/2008-6/30/2008	21	-0.5201	336.5169	0.0000	-0.0002	-0.0006	0.0005	0.0054	16,520.36	7/1/2008-7/31/2008	166,306.20
7/1/2008-7/31/2008	22	-0.5629	269.5919	0.0000	0.0015	-0.0104	0.0006	0.0185	16,768.16	8/1/2008-8/29/2008	20,098.86
8/1/2008-8/29/2008	21	-0.3698	-0.0552	0.0000	0.0019	0.0182	0.0001	-0.0051	24,626.89	9/1/2008-9/30/2008	365,017.68
9/1/2008-9/30/2008	21	-0.3326	1.0668	0.0602	-0.0007	-0.1669	-0.0004	0.2221	124,435.24	10/1/2008-10/31/2008	1,376,543.84
10/1/2008-10/31/2008	22	-0.3593	-0.0265	0.0069	-0.0013	-0.0399	0.0003	0.0524	100,644.80	11/3/2008-11/28/2008	325,886.02
11/3/2008-11/28/2008	19	-0.3629	19.6485	0.0767	-0.0003	-0.1476	-0.0011	0.2018	49,965.49	12/1/2008-12/31/2008	585,873.62
12/1/2008-12/31/2008	22	-0.3698	-0.0473	0.0409	-0.0017	0.0026	0.0002	0.0173	127,537.70	1/1/2009-1/30/2009	259,568.29
1/1/2009-1/30/2009	20	-0.5436	96.7353	0.0627	-0.0002	-0.0500	-0.0006	0.0851	115,823.41	2/2/2009-2/27/2009	795,059.73
2/2/2009-2/27/2009	19	-0.3487	-3.0091	0.0000	0.0001	-0.3892	-0.0008	0.4391	372,967.05	3/2/2009-3/31/2009	2,850,058.05
3/2/2009-3/31/2009	22	0.9915	-198.1056	0.0189	0.0001	-0.0538	-0.0013	0.1409	372,025.72	4/1/2009-4/30/2009	720,225.18
4/1/2009-4/30/2009	21	-0.0816	-44.7997	0.0596	-0.0001	-0.0242	-0.0021	0.1077	483,463.14	5/1/2009-5/29/2009	2,759,316.73
5/1/2009-5/29/2009	20	1.6943	-557.9791	0.0578	-0.0001	0.0156	-0.0007	0.0335	457,612.11	6/1/2009-6/30/2009	1,111,851.43
6/1/2009-6/30/2009	22	1.0276	-591.7508	0.0000	-0.0010	-0.0309	0.0003	0.0589	303,295.14	7/1/2009-7/31/2009	1,287,370.50
7/1/2009-7/31/2009	23	-0.3698	-0.0001	0.0111	-0.0016	0.0340	-0.0001	-0.0023	157,750.89	8/3/2009-8/31/2009	132,638.74
8/3/2009-8/31/2009	21	-0.8111	232.3585	0.0000	-0.0017	0.0015	0.0000	0.0228	21,628.22	9/1/2009-9/30/2009	343,713.17

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.31: The extracted parameters in each month and the sum of squared errors of prediction for Bank of America Corp. The extracted

parameters of each month are used to forecast credit default swap spreads in the calendar next month.

Reference Entity: The Boeing Co.   NYSE: BA   Industry: Industrial

Extraction of Parameters										Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	-0.3100	-226.1916	0.1140	0.0000	-0.1357	0.0001	0.2276	1,767.07	2/1/2008-2/29/2008	64,297.99
2/1/2008-2/29/2008	20	-0.3936	0.0000	0.0065	-0.0069	0.0048	0.0002	-0.0004	14,590.34	3/3/2008-3/31/2008	661,273.41
3/3/2008-3/31/2008	20	-0.5375	383.6335	0.0000	-0.0001	0.0073	0.0003	-0.0031	13,674.63	4/1/2008-4/30/2008	138,046.96
4/1/2008-4/30/2008	22	-0.3080	-286.0530	0.1042	-0.0001	-0.1139	0.0000	0.1827	3,751.20	5/1/2008-5/30/2008	59,207.39
5/1/2008-5/30/2008	21	-0.5124	475.3901	0.5344	-0.0022	-0.0108	0.0000	0.1431	19,165.31	6/2/2008-6/30/2008	46,796.50
6/2/2008-6/30/2008	21	-0.3613	9.7097	0.3781	-0.0007	-0.0138	0.0000	0.0983	3,434.94	7/1/2008-7/31/2008	27,447.77
7/1/2008-7/31/2008	22	-0.5259	309.6910	0.0000	-0.0040	-0.0055	0.0000	0.0113	20,788.22	8/1/2008-8/29/2008	23,242.83
8/1/2008-8/29/2008	21	-0.2363	-345.7197	0.0000	-0.0028	0.0270	0.0005	-0.0226	1,516.68	9/1/2008-9/30/2008	113,924.49
9/1/2008-9/30/2008	21	-0.3434	-59.8478	0.1710	0.0000	-0.0912	0.0000	0.1990	16,507.32	10/1/2008-10/31/2008	78,055.62
10/1/2008-10/31/2008	22	-0.3549	-0.4302	0.0000	0.0005	-0.3809	0.0007	0.3994	58,762.45	11/3/2008-11/28/2008	247,059.40
11/3/2008-11/28/2008	19	-0.3648	-0.0031	0.4798	-0.0030	-0.0133	-0.0008	0.2032	143,831.45	12/1/2008-12/31/2008	308,288.04
12/1/2008-12/31/2008	22	-0.3954	1.0304	0.0000	-0.0022	-0.1138	-0.0004	0.1336	59,086.62	1/1/2009-1/30/2009	917,060.39
1/1/2009-1/30/2009	20	-0.3952	1.2415	0.0000	-0.0019	-0.0818	-0.0002	0.0974	56,738.27	2/2/2009-2/27/2009	96,874.72
2/2/2009-2/27/2009	19	-0.3555	-0.0159	0.0439	-0.0037	0.0254	0.0001	-0.0017	49,188.63	3/2/2009-3/31/2009	804,311.43
3/2/2009-3/31/2009	22	-0.3508	-1.8298	0.0000	0.0006	-0.4006	0.0007	0.4320	307,417.67	4/1/2009-4/30/2009	104,955.60
4/1/2009-4/30/2009	21	-0.6105	170.4942	0.0000	-0.0010	0.0150	0.0009	0.0020	32,836.72	5/1/2009-5/29/2009	562,072.63
5/1/2009-5/29/2009	20	-0.5986	221.2860	0.0000	-0.0006	-0.3872	0.0000	0.3995	39,885.62	6/1/2009-6/30/2009	390,361.49
6/1/2009-6/30/2009	22	-0.5091	120.9658	0.2189	-0.0004	-0.0393	-0.0001	0.1223	10,455.70	7/1/2009-7/31/2009	54,191.72
7/1/2009-7/31/2009	23	-0.3922	0.1025	0.3482	-0.0009	0.0032	0.0000	0.0379	53,069.93	8/3/2009-8/31/2009	84,709.03
8/3/2009-8/31/2009	21	-0.3556	-0.0096	0.0010	-0.0064	0.0110	0.0001	0.0000	30,332.05	9/1/2009-9/30/2009	27,368.11

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.32: The extracted parameters in each month and the sum of squared errors of prediction for The Boeing Co. The extracted

parameters of each month are used to forecast credit default swap spreads in the next calendar month.

Reference Entity: __Exxon Mobil Corp.__ NYSE: __XOM__ Industry: __Oil & Oil Service__

Extraction of Parameters										Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	-0.0709	-1045.13	0.0000	0.0001	-0.0009	0.0001	0.0013	1,116.38	2/1/2008-2/29/2008	10,173.71
2/1/2008-2/29/2008	20	-0.1589	494.4002	0.0000	-0.0033	0.0026	0.0003	-0.0017	1,633.19	3/3/2008-3/31/2008	2,141.94
3/3/2008-3/31/2008	20	-0.1402	23.1713	0.3206	0.0002	-0.0192	0.0001	0.0890	2,102.42	4/1/2008-4/30/2008	3,983.76
4/1/2008-4/30/2008	22	-0.1768	249.1724	0.2368	0.0001	-0.0724	0.0001	0.2116	679.87	5/1/2008-5/30/2008	2,317.37
5/1/2008-5/30/2008	21	-0.1670	651.0161	0.0893	-0.0001	-0.0078	0.0001	0.0128	329.79	6/2/2008-6/30/2008	436.55
6/2/2008-6/30/2008	21	-0.1163	-0.2424	0.3858	0.0000	-0.0151	0.0001	0.0922	512.81	7/1/2008-7/31/2008	1,557.45
7/1/2008-7/31/2008	22	-0.1891	707.0391	0.0000	-0.0002	-0.0016	0.0002	0.0026	270.56	8/1/2008-8/29/2008	2,663.93
8/1/2008-8/29/2008	21	-0.1885	631.6071	0.0003	0.0001	0.0009	0.0002	0.0003	940.86	9/1/2008-9/30/2008	5,874.11
9/1/2008-9/30/2008	21	-0.1609	0.2697	0.3739	0.0002	-0.0021	0.0001	0.0237	2,284.18	10/1/2008-10/31/2008	11,950.89
10/1/2008-10/31/2008	22	-0.1158	-0.0830	0.0000	-0.0027	0.0140	0.0002	-0.0100	5,109.16	11/3/2008-11/28/2008	197,721.25
11/3/2008-11/28/2008	19	-0.1158	-0.0011	0.0000	-0.0036	0.0075	0.0001	-0.0001	43,645.16	12/1/2008-12/31/2008	447,932.51
12/1/2008-12/31/2008	22	-0.1272	-44.3604	0.0000	-0.0018	-0.0486	0.0000	0.0573	13,096.33	1/1/2009-1/30/2009	50,047.27
1/1/2009-1/30/2009	20	-0.1659	7.0620	0.0000	-0.0016	-0.0330	0.0001	0.0412	20,322.52	2/2/2009-2/27/2009	193,484.49
2/2/2009-2/27/2009	19	-0.3381	337.2732	0.0000	-0.0005	-0.0385	0.0002	0.0461	4,655.94	3/2/2009-3/31/2009	24,269.10
3/2/2009-3/31/2009	22	-0.3193	209.8726	0.0000	0.0008	-0.2963	0.0010	0.3055	8,053.22	4/1/2009-4/30/2009	11,967.38
4/1/2009-4/30/2009	21	-0.1925	58.6672	0.2946	0.0000	-0.0009	0.0001	0.0255	1,902.66	5/1/2009-5/29/2009	11,134.13
5/1/2009-5/29/2009	20	-0.3913	621.7336	0.0000	0.0010	0.0043	0.0002	0.0000	654.49	6/1/2009-6/30/2009	987.60
6/1/2009-6/30/2009	22	-0.3338	554.2560	0.6102	-0.0027	-0.0009	0.0001	0.0713	819.77	7/1/2009-7/31/2009	2,162.16
7/1/2009-7/31/2009	23	-0.2165	144.3136	0.3092	-0.0002	-0.0192	0.0000	0.0887	1,226.92	8/3/2009-8/31/2009	4,619.84
8/3/2009-8/31/2009	21	-0.3275	484.1689	0.5010	0.0017	0.0016	0.0001	0.0205	872.10	9/1/2009-9/30/2009	2,078.04

 * When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

 **for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.33: The extracted parameters in each month and the sum of squared errors of prediction for Exxon Mobil Corp. The extracted

parameters of each month to forecast credit default swap spreads in the next calendar month.

Reference Entity: <u>International Business Machines</u>　　　NYSE: 　<u>IBM</u>　　　Industry: 　<u>Technology</u>

Extraction of Parameters										Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	-0.5766	725.8330	0.5501	-0.0100	0.0002	0.0002	-0.0002	1,661.78	2/1/2008-2/29/2008	124,851.90
2/1/2008-2/29/2008	20	-0.5612	461.1209	0.0001	0.0062	0.0038	0.0003	-0.0032	21,875.29	3/3/2008-3/31/2008	46,650.57
3/3/2008-3/31/2008	20	-0.5527	-0.0014	0.0000	0.0043	0.0222	0.0000	-0.0195	26,877.51	4/1/2008-4/30/2008	219,411.43
4/1/2008-4/30/2008	22	-0.5776	717.2005	0.0000	-0.0007	-0.0737	0.0000	0.0744	6,543.64	5/1/2008-5/30/2008	4,614.05
5/1/2008-5/30/2008	21	-0.5790	705.6914	0.0000	-0.0003	-0.0006	0.0002	0.0014	3,988.55	6/2/2008-6/30/2008	32,697.61
6/2/2008-6/30/2008	21	-0.5514	579.0829	0.0000	0.0073	0.0098	0.0002	-0.0097	4,945.42	7/1/2008-7/31/2008	23,557.25
7/1/2008-7/31/2008	22	-0.5320	0.7158	0.2134	-0.0002	-0.1048	0.0000	0.3011	9,769.13	8/1/2008-8/29/2008	14,431.33
8/1/2008-8/29/2008	21	-0.6598	807.4390	0.7105	-0.0001	-0.0003	0.0002	0.0618	867.48	9/1/2008-9/30/2008	10,951.74
9/1/2008-9/30/2008	21	-0.6497	670.8217	0.4176	-0.0001	-0.0043	0.0003	0.0419	4,283.96	10/1/2008-10/31/2008	125,701.27
10/1/2008-10/31/2008	22	-0.6267	431.7744	0.0000	-0.0016	0.0117	0.0005	-0.0092	11,531.63	11/3/2008-11/28/2008	351,018.92
11/3/2008-11/28/2008	19	-0.5560	0.0040	0.0000	0.0029	0.0040	0.0001	0.0100	128,190.59	12/1/2008-12/31/2008	126,412.93
12/1/2008-12/31/2008	22	-0.5558	-0.1721	0.0000	-0.0028	-0.0858	-0.0014	0.1022	78,977.54	1/1/2009-1/30/2009	170,893.26
1/1/2009-1/30/2009	20	-0.5128	-46.2841	0.1341	-0.0001	-0.1200	-0.0003	0.2363	13,483.56	2/2/2009-2/27/2009	3,342.11
2/2/2009-2/27/2009	19	-0.5218	-0.0157	0.0000	0.0026	0.0175	0.0000	-0.0077	1,829.21	3/2/2009-3/31/2009	10,998.71
3/2/2009-3/31/2009	22	-0.5503	0.0000	0.0000	-0.0045	0.0106	0.0000	-0.0002	9,930.31	4/1/2009-4/30/2009	82,302.07
4/1/2009-4/30/2009	21	-0.6000	62.0944	0.0000	0.0005	-0.1053	0.0002	0.1139	13,041.18	5/1/2009-5/29/2009	14,553.97
5/1/2009-5/29/2009	20	-0.8885	732.2463	0.3723	-0.0010	-0.0113	0.0001	0.0934	1,452.10	6/1/2009-6/30/2009	6,838.37
6/1/2009-6/30/2009	22	-0.7726	431.2872	0.0000	-0.0003	-0.0494	0.0000	0.0563	6,578.87	7/1/2009-7/31/2009	57,384.13
7/1/2009-7/31/2009	23	-0.3648	-498.6029	0.0000	-0.0013	0.3410	0.0023	-0.3374	4,499.51	8/3/2009-8/31/2009	21,008.37
8/3/2009-8/31/2009	21	-0.7954	1266.3817	0.0000	-0.0002	0.0017	0.0001	0.0007	2,594.91	9/1/2009-9/30/2009	10,609.13

 * When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

 **for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.34: The extracted parameters in each month and the sum of squared errors of prediction for International Business Machines. The

extracted parameters of each month are used to forecast credit default swap spreads in the next calendar month.

Reference Entity:	Kraft Foods Inc.			NYSE:		KFT			Industry:	Consumer Goods	

Extraction of Parameters										Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	-0.6055	-0.8345	0.0000	-0.0013	0.0599	0.0005	-0.0560	6,398.65	2/1/2008-2/29/2008	167,892.75
2/1/2008-2/29/2008	20	-0.8052	332.8183	0.0000	0.0011	0.0125	0.0003	-0.0056	25,992.35	3/3/2008-3/31/2008	180,967.78
3/3/2008-3/31/2008	20	-0.8030	286.7040	0.0000	0.0003	0.0018	0.0005	0.0046	66,770.11	4/1/2008-4/30/2008	236,390.14
4/1/2008-4/30/2008	22	-0.6446	62.1513	0.3579	-0.0002	-0.0244	0.0001	0.1037	19,475.23	5/1/2008-5/30/2008	19,003.64
5/1/2008-5/30/2008	21	-0.8073	281.4330	0.0000	-0.0029	-0.0499	-0.0005	0.0572	13,011.63	6/2/2008-6/30/2008	22,508.34
6/2/2008-6/30/2008	21	-0.8015	360.8729	0.0000	-0.0006	-0.0234	0.0003	0.0294	7,299.41	7/1/2008-7/31/2008	35,322.05
7/1/2008-7/31/2008	22	-0.6272	-16.8271	0.0000	0.0008	-0.3686	0.0011	0.3764	23,942.23	8/1/2008-8/29/2008	12,546.93
8/1/2008-8/29/2008	21	-0.6058	0.0000	0.0000	0.0002	-0.0004	0.0001	0.0067	2,970.31	9/1/2008-9/30/2008	15,564.66
9/1/2008-9/30/2008	21	-0.8089	405.1275	0.0000	0.0081	0.0028	0.0003	0.0020	8,044.02	10/1/2008-10/31/2008	128,996.70
10/1/2008-10/31/2008	22	-0.6307	0.0225	0.1987	-0.0002	-0.0467	0.0001	0.1068	7,303.54	11/3/2008-11/28/2008	62,421.28
11/3/2008-11/28/2008	19	-0.6040	-3.0848	0.2450	-0.0006	-0.0629	-0.0001	0.1579	9,703.32	12/1/2008-12/31/2008	62,724.60
12/1/2008-12/31/2008	22	-0.6091	4.1695	0.0000	-0.0024	-0.1448	-0.0010	0.1542	28,146.66	1/1/2009-1/30/2009	239,352.78
1/1/2009-1/30/2009	20	-0.6779	44.2844	0.2423	-0.0006	-0.0585	-0.0003	0.1549	4,428.97	2/2/2009-2/27/2009	36,102.40
2/2/2009-2/27/2009	19	-0.6378	-0.4652	0.0000	0.0026	0.0277	-0.0001	-0.0156	7,093.62	3/2/2009-3/31/2009	38,220.49
3/2/2009-3/31/2009	22	-1.1252	546.3227	0.0000	-0.0014	-0.0556	0.0001	0.0664	5,858.87	4/1/2009-4/30/2009	92,517.36
4/1/2009-4/30/2009	21	-0.3714	-283.4966	0.2469	-0.0009	-0.0831	-0.0004	0.1999	13,613.62	5/1/2009-5/29/2009	8,531.67
5/1/2009-5/29/2009	20	-0.6084	3.3453	0.2871	-0.0004	-0.0312	-0.0001	0.0961	4,886.69	6/1/2009-6/30/2009	11,526.92
6/1/2009-6/30/2009	22	-0.9185	642.9918	0.0000	-0.0024	-0.0369	-0.0002	0.0420	2,408.31	7/1/2009-7/31/2009	73,947.19
7/1/2009-7/31/2009	23	-0.6748	146.4859	0.0532	0.0005	-0.4362	0.0008	0.5236	2,350.76	8/3/2009-8/31/2009	4,685.98
8/3/2009-8/31/2009	21	-0.8866	1231.46	0.5919	-0.0025	-0.0033	0.0000	0.0397	1,987.36	9/1/2009-9/30/2009	229,387.03

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.35: The extracted parameters in each month and the sum of squared errors of prediction for Kraft Foods Inc. The extracted

parameters of each month are used to forecast credit default swap spreads in the next calendar month.

Reference Entity: <u>Merck & Co. Inc.</u> NYSE: <u>MRK</u> Industry: <u>Healthcare</u>

| Extraction of Parameters | | | | | | | | | | Expected CDS Spreads | |
Period of time in which the parameters are extracted	The number of trading days	a0	a1	b0	b1	c0	c1	c2	Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
1/1/2008-1/31/2008	23	-0.5266	494.8067	0.0000	0.0006	-0.1407	0.0004	0.1422	1,523.23	2/1/2008-2/29/2008	24,089.73
2/1/2008-2/29/2008	20	-0.5456	649.4591	0.2532	0.0003	-0.0001	0.0002	0.0034	1,501.61	3/3/2008-3/31/2008	38,430.81
3/3/2008-3/31/2008	20	-0.4300	-0.6753	0.2616	-0.0001	-0.0264	0.0001	0.0773	12,406.23	4/1/2008-4/30/2008	98,726.45
4/1/2008-4/30/2008	22	-0.4944	163.8552	0.0000	-0.0011	-0.1449	-0.0004	0.1468	13,683.45	5/1/2008-5/30/2008	19,144.95
5/1/2008-5/30/2008	21	-0.5432	763.4711	0.4935	-0.0010	0.0000	0.0001	0.0063	345.12	6/2/2008-6/30/2008	463.54
6/2/2008-6/30/2008	21	-0.4807	461.7593	0.0000	-0.0004	-0.1624	-0.0001	0.1636	261.37	7/1/2008-7/31/2008	4,047.88
7/1/2008-7/31/2008	22	-0.5391	697.8495	0.1097	-0.0013	-0.0190	0.0000	0.0296	311.61	8/1/2008-8/29/2008	1,737.76
8/1/2008-8/29/2008	21	-0.5052	537.8517	0.0000	-0.0007	-0.0595	0.0000	0.0610	82.83	9/1/2008-9/30/2008	13,669.27
9/1/2008-9/30/2008	21	-0.4935	213.9133	0.1717	0.0000	-0.0433	0.0001	0.0820	2,247.26	10/1/2008-10/31/2008	5,930.44
10/1/2008-10/31/2008	22	-0.5239	362.6897	0.4078	-0.0016	-0.0062	0.0001	0.0334	780.84	11/3/2008-11/28/2008	9,172.14
11/3/2008-11/28/2008	19	-0.4302	-0.0030	0.0023	0.0025	0.0030	0.0001	0.0025	9,196.30	12/1/2008-12/31/2008	47,048.55
12/1/2008-12/31/2008	22	-0.2440	-367.1579	0.3830	-0.0023	-0.0075	-0.0002	0.0490	2,740.79	1/1/2009-1/30/2009	10,617.31
1/1/2009-1/30/2009	20	-0.4311	0.9220	0.2054	-0.0043	-0.0159	-0.0003	0.0422	4,207.70	2/2/2009-2/27/2009	144,466.76
2/2/2009-2/27/2009	19	-0.4663	-0.0015	0.0038	0.0020	0.0032	-0.0001	0.0093	31,649.35	3/2/2009-3/31/2009	91,355.33
3/2/2009-3/31/2009	22	-0.4115	-22.3523	0.0000	-0.0025	-0.0240	-0.0002	0.0340	26,755.28	4/1/2009-4/30/2009	23,224.73
4/1/2009-4/30/2009	21	-0.4525	-0.0014	0.0108	-0.0044	0.0091	0.0001	-0.0005	2,950.46	5/1/2009-5/29/2009	53,712.68
5/1/2009-5/29/2009	20	-0.8551	833.9798	0.0000	-0.0052	0.0061	0.0001	-0.0001	2,552.66	6/1/2009-6/30/2009	17,584.21
6/1/2009-6/30/2009	22	-0.6644	476.1865	0.0079	-0.0010	-0.0354	-0.0001	0.0414	281.88	7/1/2009-7/31/2009	26,151.65
7/1/2009-7/31/2009	23	-0.4403	26.6907	0.3084	-0.0008	-0.0082	0.0000	0.0342	826.76	8/3/2009-8/31/2009	9,967.07
8/3/2009-8/31/2009	21	-0.6037	1128.22	0.0000	-0.0035	0.0039	0.0001	-0.0022	1,046.16	9/1/2009-9/30/2009	902.75

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.36: The extracted parameters in each month and the sum of squared errors of prediction for Merck & Co. Inc. The extracted

parameters of each month are used to forecast credit default swap spreads in the next calendar month.

Reference Entity:	Wal-Mart Stores Inc.			NYSE:		WMT		Industry:	Retail	

Extraction of Parameters									Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	0.1994	-2337.57	0.2972	0.0054	0.0045	0.0000	-0.0044	3,399.76	2/1/2008-2/29/2008	26,989.83
2/1/2008-2/29/2008	20	0.5596	-2647.13	0.0000	-0.0014	0.0421	0.0003	-0.0379	5,917.39	3/3/2008-3/31/2008	11,937.64
3/3/2008-3/31/2008	20	-0.3837	-0.0672	0.0000	0.0061	0.0137	0.0000	-0.0098	14,000.09	4/1/2008-4/30/2008	30,233.69
4/1/2008-4/30/2008	22	-0.3830	-0.0077	0.0000	0.0007	-0.0247	0.0001	0.0291	2,629.86	5/1/2008-5/30/2008	966.59
5/1/2008-5/30/2008	21	-0.6672	847.1220	0.0000	-0.0004	0.0026	0.0001	0.0013	866.35	6/2/2008-6/30/2008	3,154.45
6/2/2008-6/30/2008	21	-0.3826	-1.4520	0.0111	0.0001	-0.7565	0.0003	0.7945	510.49	7/1/2008-7/31/2008	3,578.53
7/1/2008-7/31/2008	22	-0.6437	830.3994	0.0000	0.0018	0.0002	0.0001	0.0035	2,963.50	8/1/2008-8/29/2008	850.94
8/1/2008-8/29/2008	21	-0.4405	72.4466	0.0000	0.0002	-0.0059	0.0001	0.0099	522.63	9/1/2008-9/30/2008	9,475.64
9/1/2008-9/30/2008	21	-0.4164	-10.3328	0.0000	-0.0009	0.0517	0.0002	-0.0473	3,335.85	10/1/2008-10/31/2008	247,855.60
10/1/2008-10/31/2008	22	-0.4795	70.8395	0.0000	0.0007	-0.7466	0.0018	0.7583	25,075.36	11/3/2008-11/28/2008	63,328.78
11/3/2008-11/28/2008	19	-0.4212	1.1152	0.2063	-0.0008	-0.1551	-0.0007	0.3756	9,584.68	12/1/2008-12/31/2008	24,218.42
12/1/2008-12/31/2008	22	-0.4603	74.7299	0.0000	-0.0002	-0.5191	-0.0003	0.5313	20,011.17	1/1/2009-1/30/2009	22,620.46
1/1/2009-1/30/2009	20	-0.4131	-0.0627	0.2109	-0.0002	-0.0225	0.0000	0.0785	7,659.53	2/2/2009-2/27/2009	13,855.99
2/2/2009-2/27/2009	19	-0.3981	-18.3392	0.0751	-0.0006	-0.0735	-0.0002	0.1171	4,508.01	3/2/2009-3/31/2009	10,352.98
3/2/2009-3/31/2009	22	-0.3937	-11.8177	0.3421	-0.0006	0.0012	-0.0001	0.0526	5,869.72	4/1/2009-4/30/2009	39,494.36
4/1/2009-4/30/2009	21	0.0877	-476.4843	0.0000	-0.0002	-0.0012	0.0000	0.0140	16,004.81	5/1/2009-5/29/2009	91,173.91
5/1/2009-5/29/2009	20	0.9727	-1738.29	0.4552	-0.0013	-0.0017	-0.0001	0.0658	8,032.14	6/1/2009-6/30/2009	36,136.32
6/1/2009-6/30/2009	22	-0.4204	0.0531	0.0000	0.0052	0.0130	0.0000	-0.0075	1,955.04	7/1/2009-7/31/2009	17,501.85
7/1/2009-7/31/2009	23	-0.4176	-6.4006	0.5866	-0.0010	-0.0001	0.0000	0.0486	4,079.20	8/3/2009-8/31/2009	9,680.52
8/3/2009-8/31/2009	21	-0.4198	-2.1556	0.8300	-0.0037	0.0093	0.0002	-0.1698	2,219.30	9/1/2009-9/30/2009	15,375.63

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2.   We use these parameters to forecast CDS spreads in the next month.

Table 4.37: The extracted parameters in each month and the sum of squared errors of prediction for Wal-Mart Stores Inc. The extracted

parameters of each month are used to forecast credit default swap spreads in the next calendar month.

Reference Entity:	The Walt Disney Co.			NYSE:		DIS		Industry:		Media, Broadcasting, Cable	

Extraction of Parameters										Expected CDS Spreads	
Period of time in which the parameters are extracted	The number of trading days	Extracted Parameters							Minimized Sum of squared errors*	Period of time in which expected CDS spreads are calculated from the extracted parameters	Sum of squared errors of prediction**
		a0	a1	b0	b1	c0	c1	c2			
1/1/2008-1/31/2008	23	-0.1800	5.2803	0.0000	0.0005	-0.2199	0.0005	0.2227	5,339.92	2/1/2008-2/29/2008	52,365.95
2/1/2008-2/29/2008	20	-0.1849	284.1755	0.0000	0.0163	0.0014	0.0005	0.0000	12,182.99	3/3/2008-3/31/2008	17,261.28
3/3/2008-3/31/2008	20	-0.2138	270.8870	1.0471	-0.0048	0.0000	0.0005	0.0271	12,631.82	4/1/2008-4/30/2008	124,513.84
4/1/2008-4/30/2008	22	-0.1805	-60.1345	0.0000	-0.0014	0.1256	0.0008	-0.1248	7,586.94	5/1/2008-5/30/2008	2,015.82
5/1/2008-5/30/2008	21	0.1011	-2186.08	0.0000	-0.0028	0.0262	0.0004	-0.0251	944.68	6/2/2008-6/30/2008	5,059.98
6/2/2008-6/30/2008	21	-0.1436	7.4642	0.0099	0.0001	-2.0650	0.0012	2.1389	2,889.87	7/1/2008-7/31/2008	17,697.36
7/1/2008-7/31/2008	22	-0.1403	-4.9375	0.4597	0.0000	-0.0029	0.0001	0.0291	5,687.02	8/1/2008-8/29/2008	4,802.03
8/1/2008-8/29/2008	21	-0.2027	441.8778	0.0000	-0.0024	-0.0050	0.0002	0.0064	1,035.95	9/1/2008-9/30/2008	2,596.06
9/1/2008-9/30/2008	21	-0.1415	-0.2657	0.2146	-0.0002	-0.0171	0.0001	0.0437	4,541.14	10/1/2008-10/31/2008	29,949.18
10/1/2008-10/31/2008	22	-0.2959	219.5205	0.0000	0.0011	-0.1405	0.0007	0.1464	11,993.92	11/3/2008-11/28/2008	159,602.17
11/3/2008-11/28/2008	19	-0.2743	220.5779	0.0000	-0.0035	0.0046	0.0005	-0.0004	116,104.41	12/1/2008-12/31/2008	320,760.62
12/1/2008-12/31/2008	22	-0.1587	-22.1997	0.0000	-0.0021	-0.0978	0.0001	0.1025	60,469.02	1/1/2009-1/30/2009	211,226.36
1/1/2009-1/30/2009	20	-0.1692	-13.7107	0.3601	-0.0017	0.0014	-0.0003	0.0395	12,046.02	2/2/2009-2/27/2009	10,993.95
2/2/2009-2/27/2009	19	-0.5944	373.1117	0.0000	-0.0004	-0.0775	0.0000	0.0905	2,741.71	3/2/2009-3/31/2009	23,685.92
3/2/2009-3/31/2009	22	-0.1756	29.1397	0.1926	-0.0008	-0.0424	-0.0003	0.0958	1,466.31	4/1/2009-4/30/2009	11,844.39
4/1/2009-4/30/2009	21	-0.1839	-0.0348	0.0064	0.0021	0.0019	0.0000	0.0092	5,496.31	5/1/2009-5/29/2009	4,108.52
5/1/2009-5/29/2009	20	-0.0003	-216.8475	0.3275	-0.0035	-0.0140	-0.0005	0.0669	1,382.20	6/1/2009-6/30/2009	12,014.00
6/1/2009-6/30/2009	22	-0.1014	-148.9792	0.1481	-0.0017	-0.0719	-0.0005	0.1248	3,402.14	7/1/2009-7/31/2009	6,461.31
7/1/2009-7/31/2009	23	-0.1662	-34.3227	0.0740	-0.0006	-0.2835	-0.0006	0.3649	1,937.95	8/3/2009-8/31/2009	11,365.53
8/3/2009-8/31/2009	21	-0.1857	-0.0535	0.0000	-0.0008	-0.0521	-0.0001	0.0561	9,136.70	9/1/2009-9/30/2009	7,675.93

* When performing Derivative-Free optimization, we use MATLAB. The number of iterations equal to 10,000 times (10 rounds with 1,000 times of iterations in each round)

**for each trading month and each reference entity, we would obtain one set of parameters of a0, a1, b0, b1, c0, c1, and c2. We use these parameters to forecast CDS spreads in the next month.

Table 4.38: The extracted parameters in each month and the sum of squared errors of prediction for The Walt Disney Co. The extracted

parameters of each month are used to forecast credit default swap spreads in the next calendar month.

We also graphically compare the actual credit default swap spreads with the predicted credit default swap spreads from our model. It can be observed that our model can be used to forecast the credit default swap spreads very well in all time to maturity credit default swap contracts except in some extreme cases when there is a big jump in credit default swap spreads. For example, we obtained the extracted parameters a_0, a_1, b_0, b_1, c_0, c_1, and c_2 to predict the credit default swap spreads in October 2008 using the trading data of September 2008. However, the 1-year credit default swap spread of Alcoa, Inc. (AA) jumped from 88.1 basis points in October 1, 2008 to 361.1 basis points in October 27, 2008. Therefore, our model cannot cope with such a big jump in credit default swap spreads and cannot well predict the credit default swap spreads in this case. Nevertheless, our model can generally be used to forecast the credit default swap spreads very well in all time to maturity credit default swap contracts.
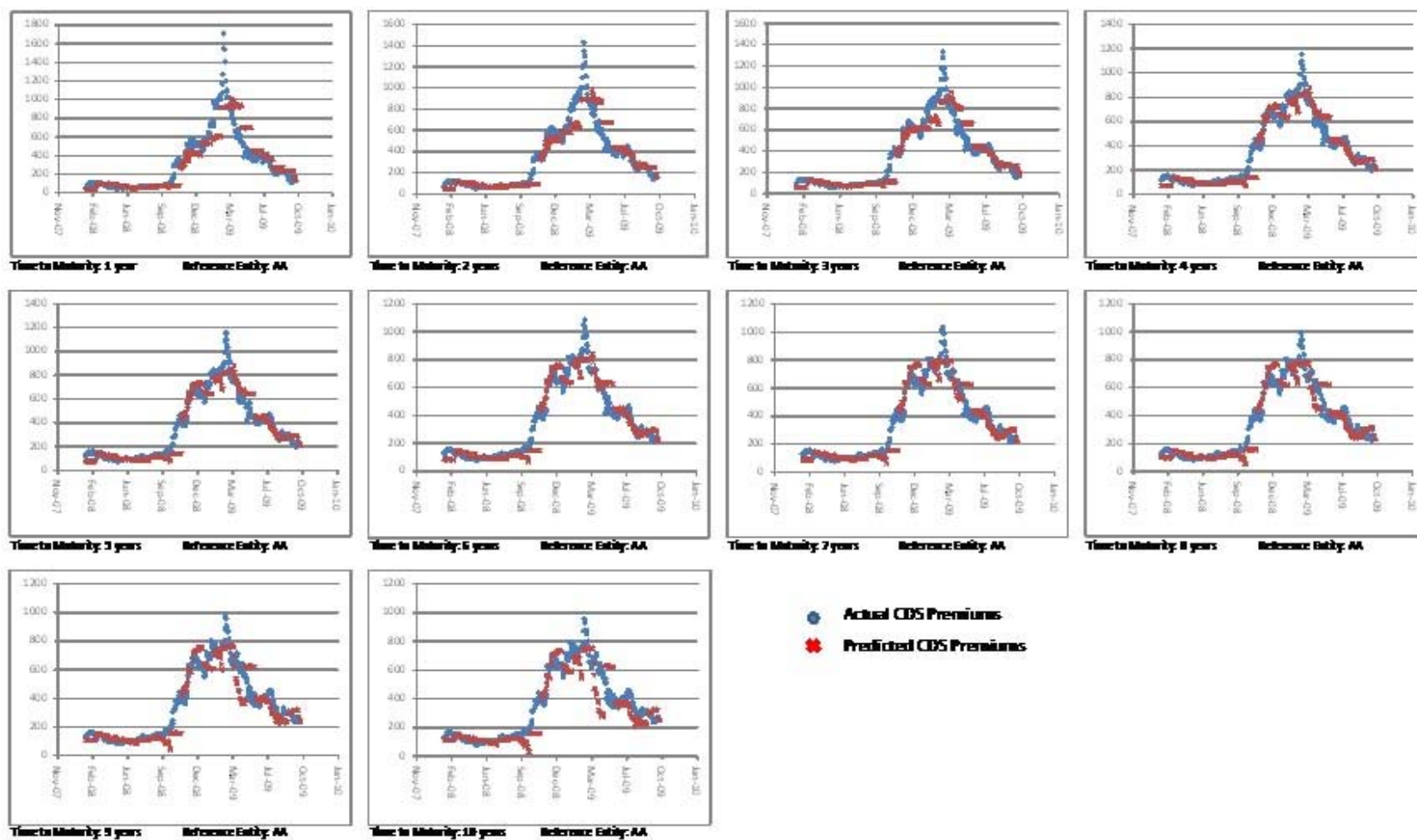
Figure 4.9: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of Alcoa Inc. across different maturities during February 2008 to August 2009.
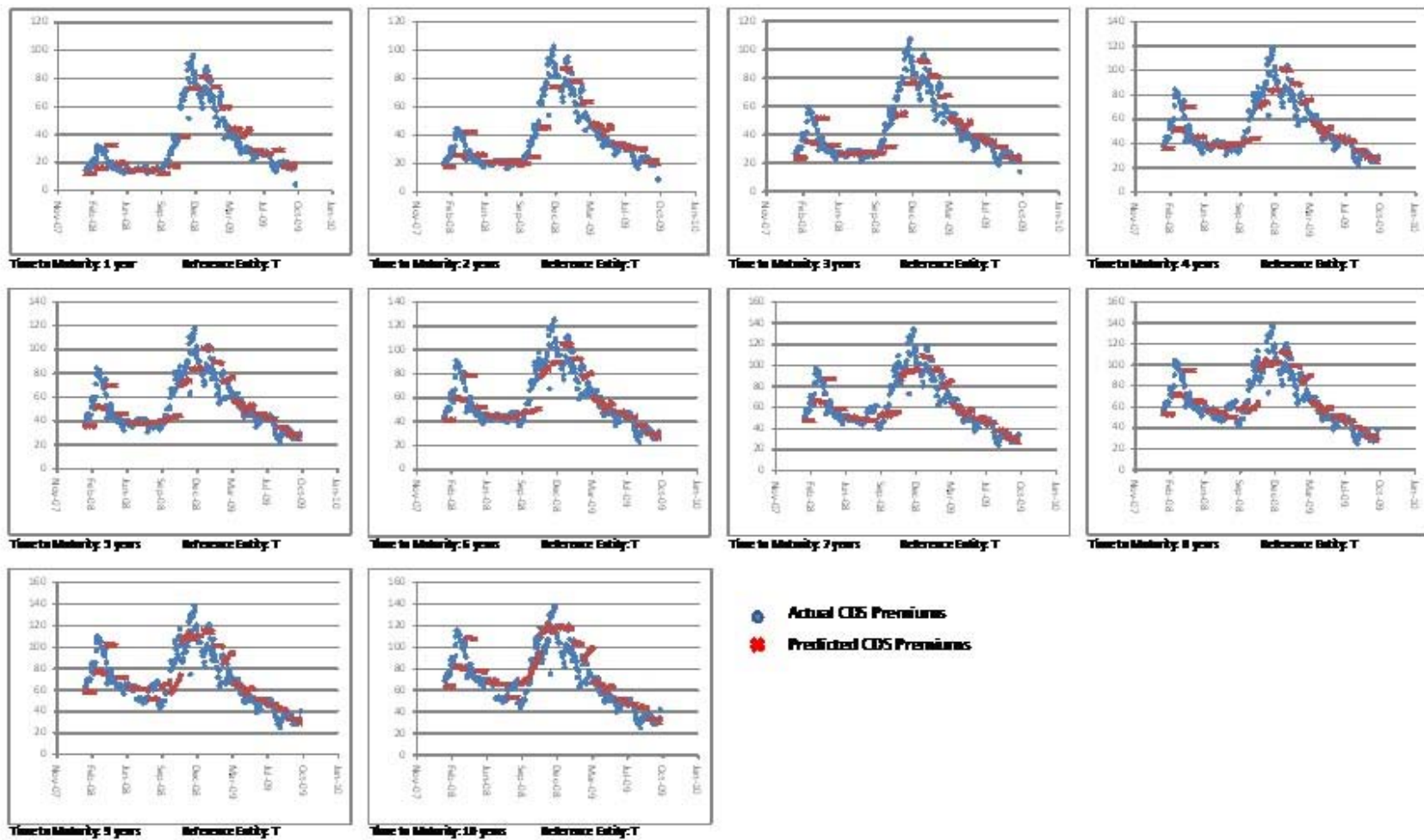
Figure 4.10: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of AT&T Inc. across different maturities during February 2008 to August 2009.
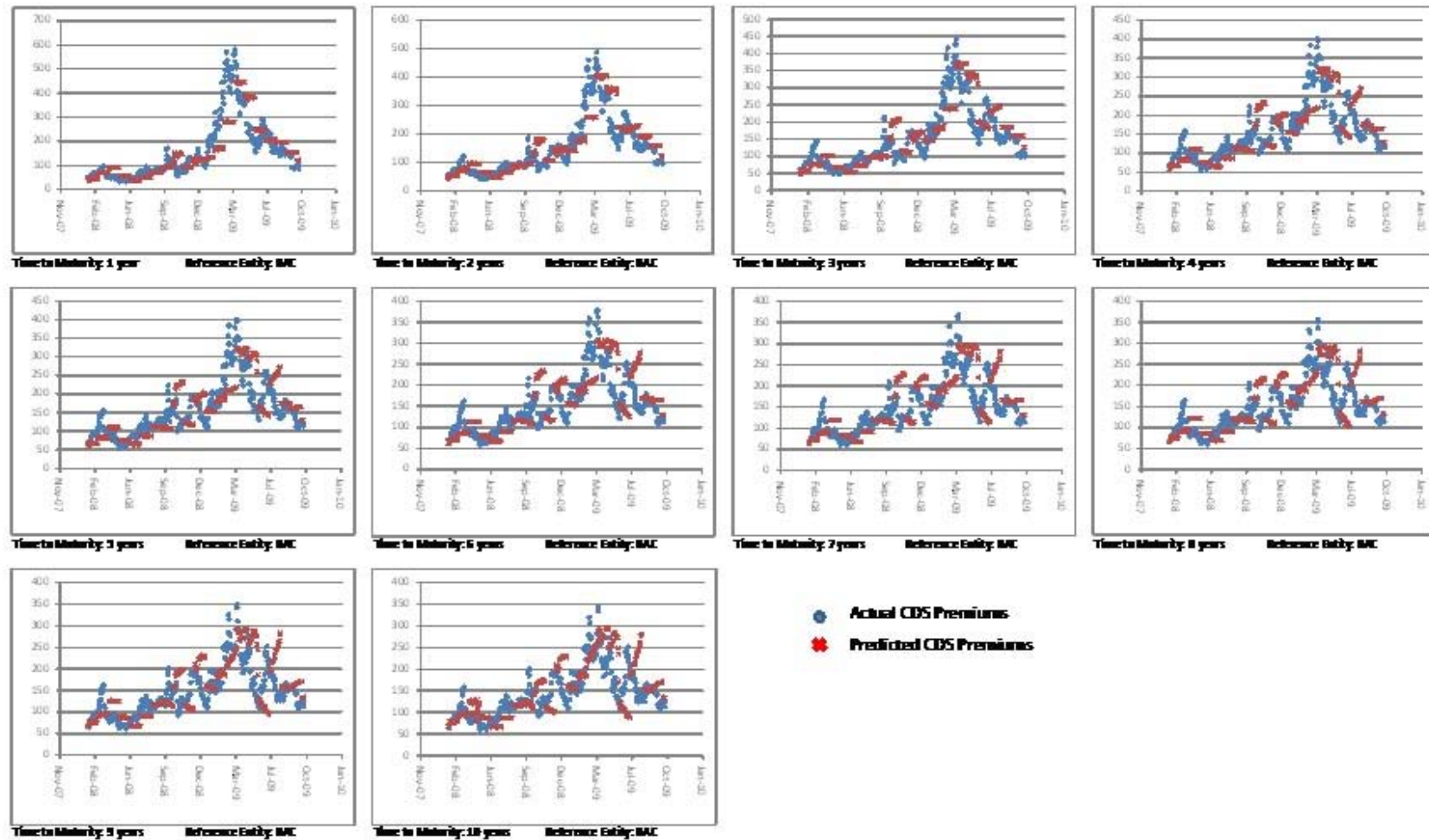
Figure 4.11: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of Bank of America Corp. across different maturities during February 2008 to August 2009.
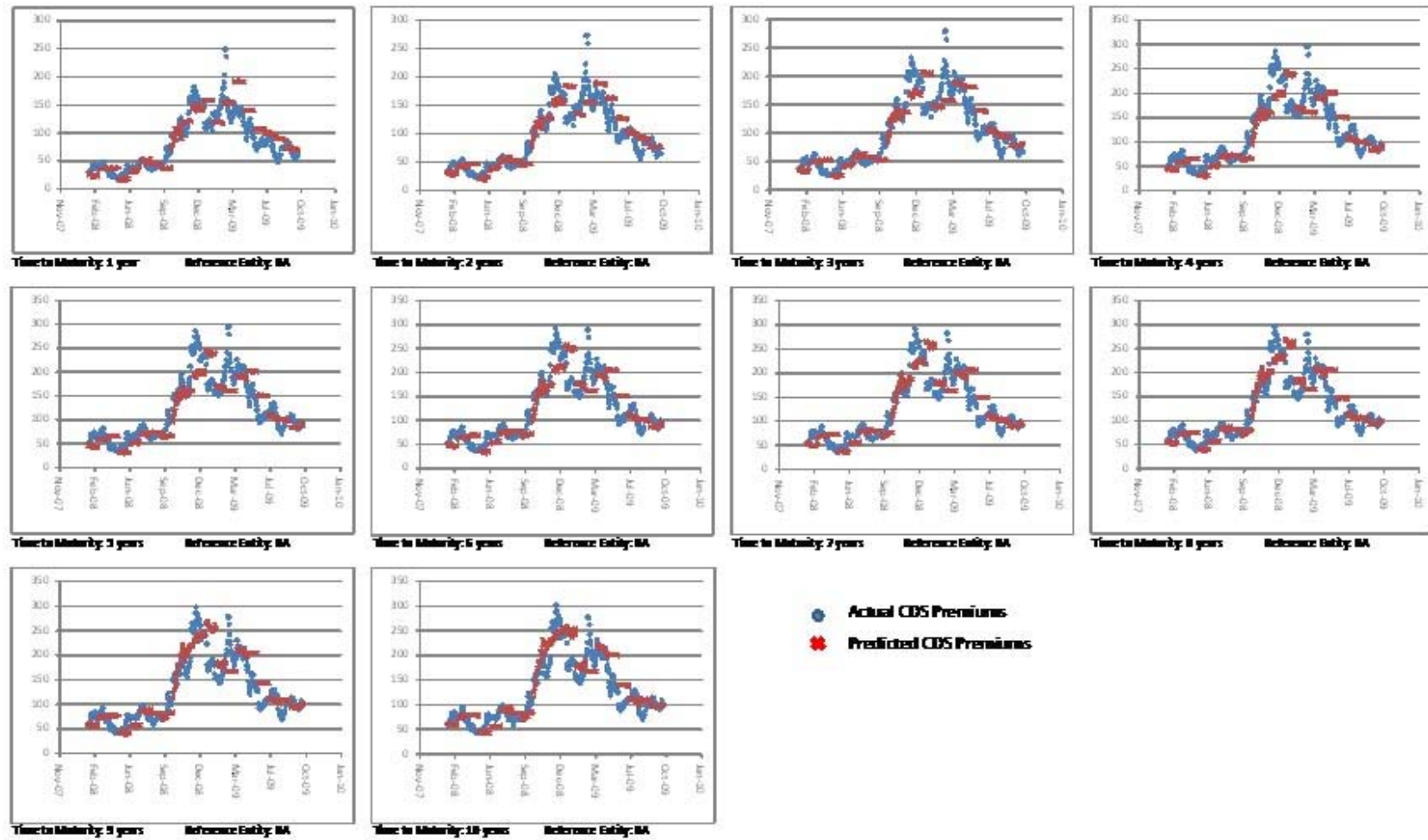
Figure 4.12: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of The Boeing Co. across different maturities during February 2008 to August 2009.
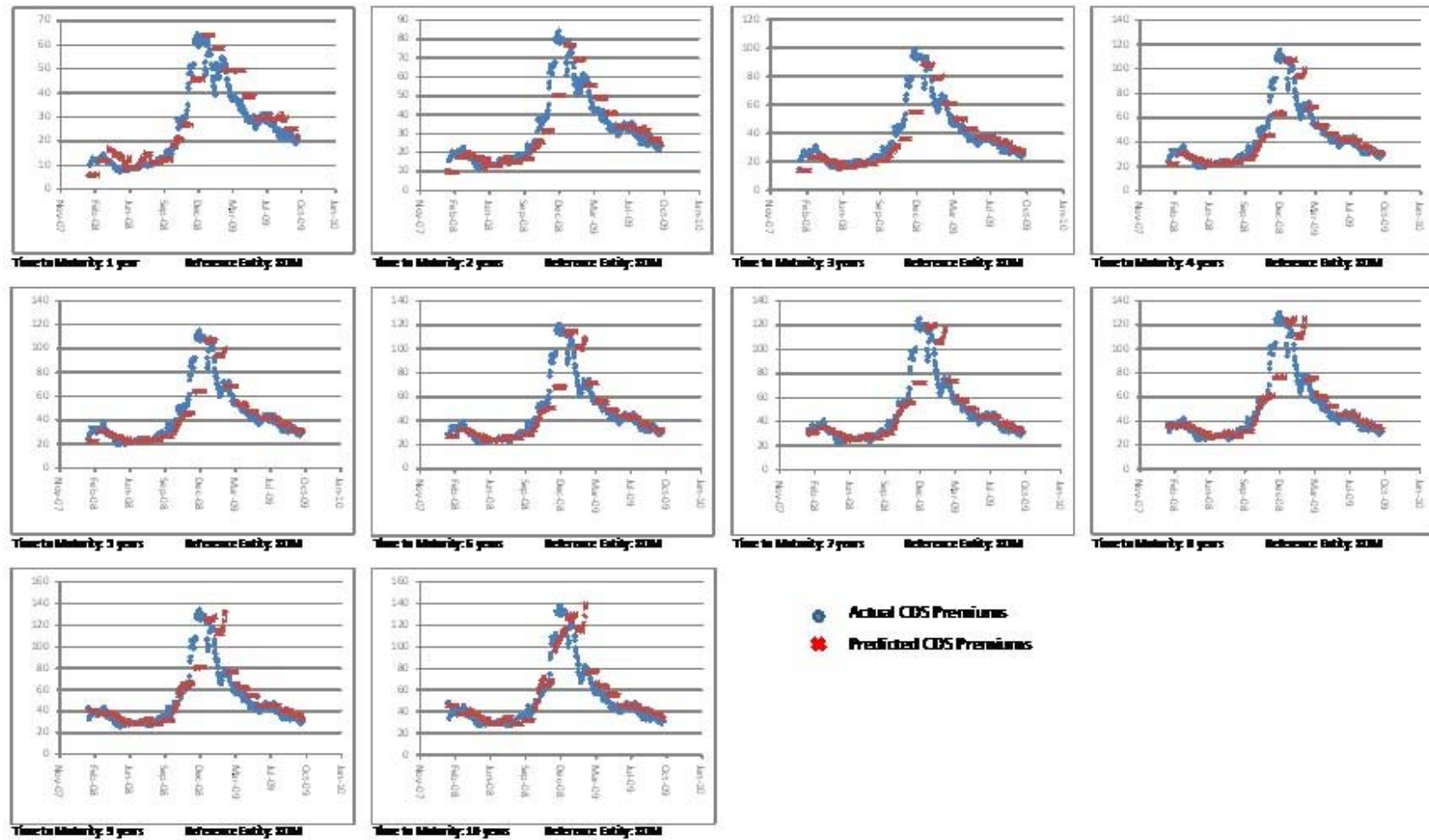
Figure 4.13: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of Exxon Mobil Corp. across different maturities during February 2008 to August 2009.
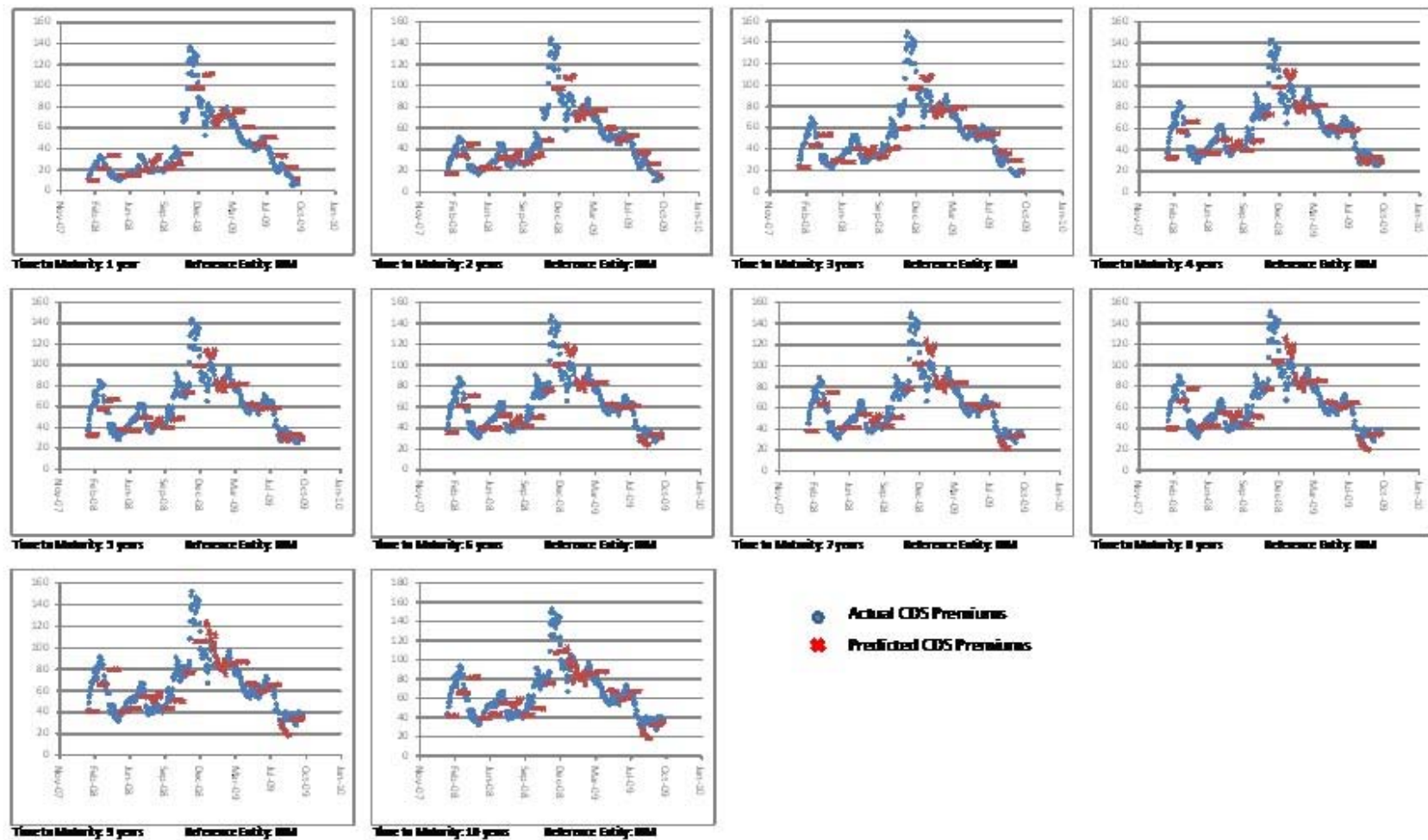
Figure 4.14: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of International Business Machines across different maturities during February 2008 to August 2009.
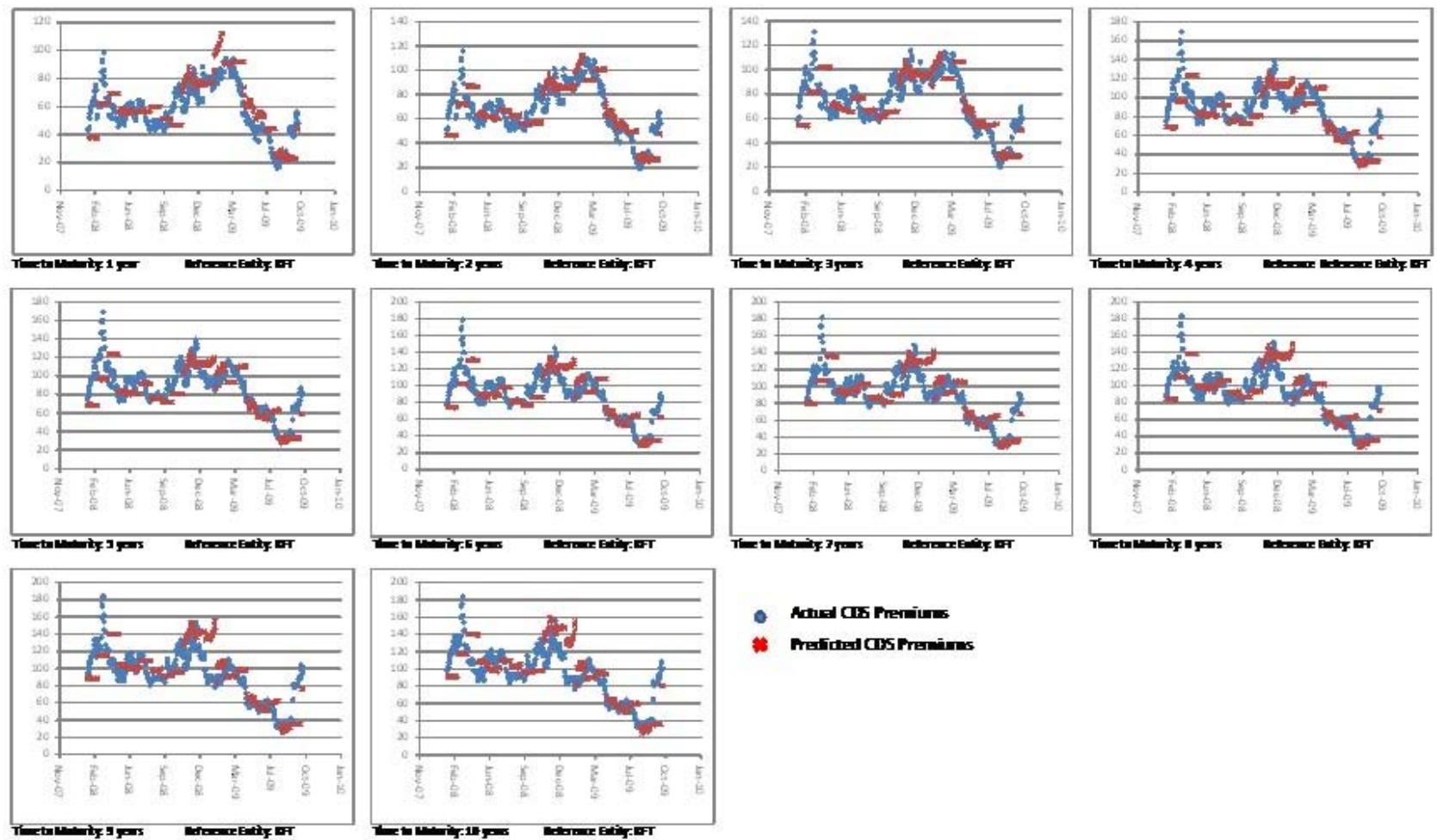
Figure 4.15: The comparison of the model credit default swap premiums calculated from the model with the market credit default swap premiums of Kraft Foods Inc. across different maturities during February 2008 to August 2009.
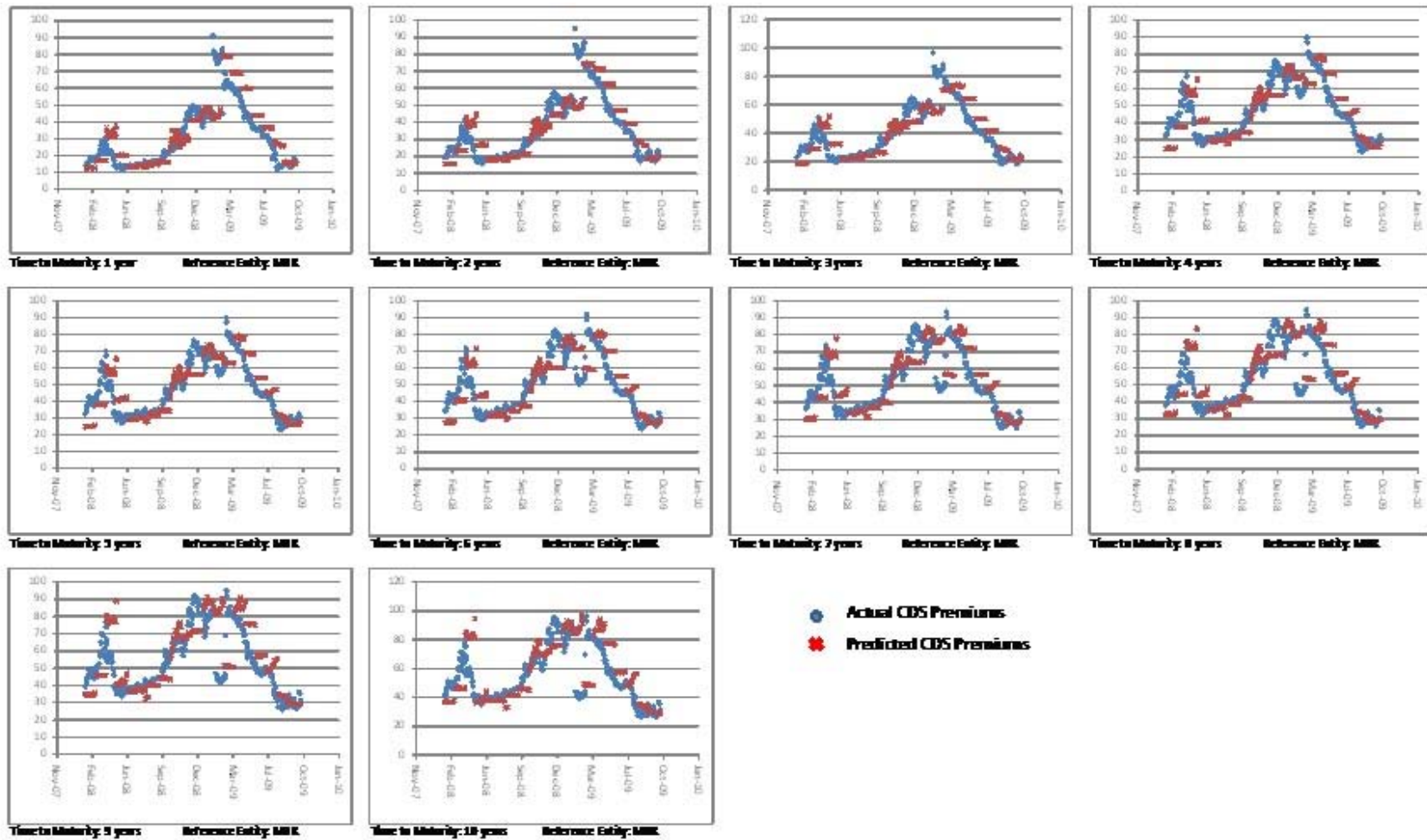
Figure 4.16: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of Merck & Co. Inc. across different maturities during February 2008 to August 2009.
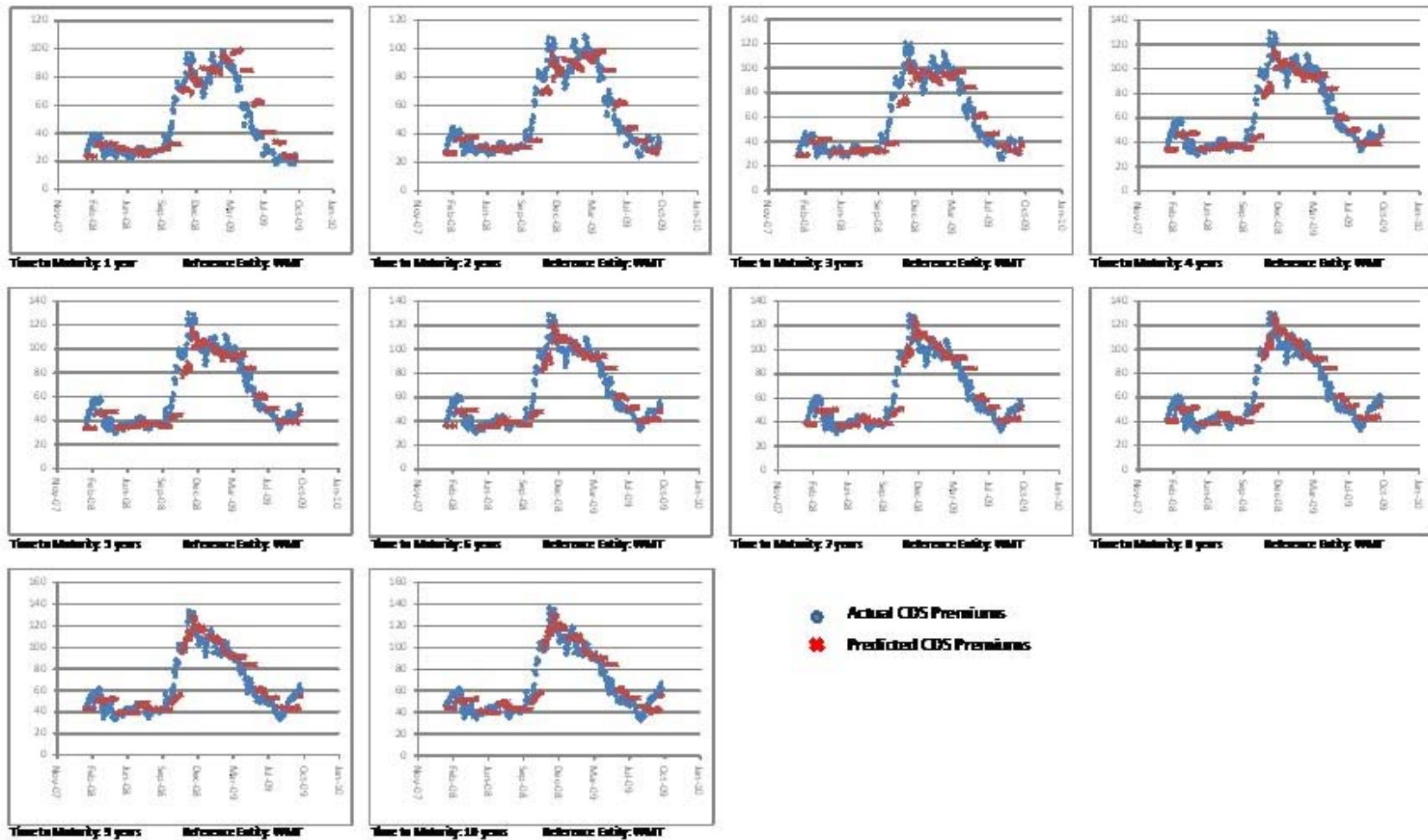
Figure 4.17: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of Wal-Mart Stores Inc. across different maturities during February 2008 to August 2009.
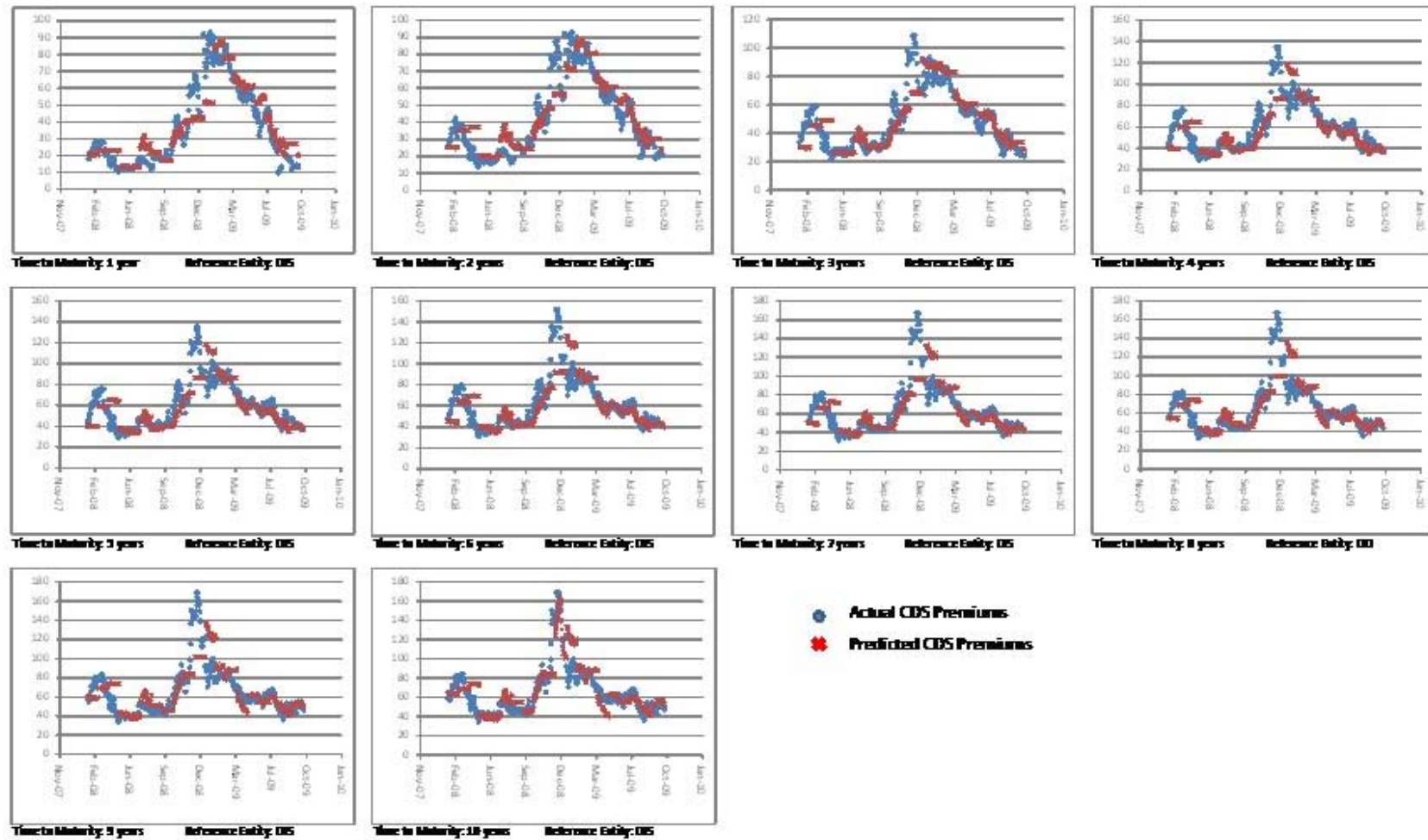
Figure 4.18: The comparison of the credit default swap premiums calculated from the model with the market credit default swap premiums of The Walt Disney Co. across different maturities during February 2008 to August 2009.

If we know the estimated values of default probabilities and recovery rates, we can also compute credit default swap spreads using historical credit information (conventional method) to check how well our model using the forward-looking credit information performs when it is compared to the conventional method. However, it is very difficult in practice to observe estimated values of default probabilities and recovery rates on daily basis. The easiest way to do it is observe the implied default probabilities and recovery rates by bootstrapping the market credit default swap premiums. Nevertheless, there are 2 main advantages of bootstrapping the market credit default swap premiums to observe the implied default probabilities and recovery rates.

First of all, it is impossible to concurrently extract the implied default probabilities and recovery rates by bootstrapping the market credit default swaps. Howeling and Vorst (2001) show that there is a singularity in the conventional credit default price model that causes more than one particular combinations of the recovery rate and the default intensity to give more or less the same credit default swap prices. Thus we must arbitrarily stipulate either a term structure of recovery rates and default probabilities when bootstrap the market credit default swaps. If we would like to observe the implied default probabilities, we must stipulate an arbitrary term structure of recovery rates. On the other hand, if we would like to calculate the implied default probabilities, we must arbitrarily specify a term structure of default intensities. This fact leads to important but difficult to solve questions. How can we find an appropriate term structure of default intensities? How can we estimate a reasonable term structure of recovery rates? The calculated credit default swaps from conventional models heavily depend on the term structures of default intensities and recovery rates which we specify.

In addition to the first disadvantage, it is quite unreasonable to compare any credit default swaps pricing models with a conventional model using implied default intensities or implied recovery rates obtained by directly bootstrapping the market credit default swap premiums. The reason is very straight-forward. If we use implied default intensities or implied recovery rates as inputs when calculating credit default swap premiums, the calculated premiums that we calculate from the model will be definitely equal to the market prices.

CHAPTER V

Conclusion

Credit default swaps have become the most utilized credit derivative as they enable investors to artificially trade pure credit risk. Furthermore, when investors wish to judge a borrower's credit quality the credit default swap market has become the desired option, taking over this mantle from the bond market. This has provoked the attention of investors and practitioners to focus on credit default swap pricing models. Credit default swap pricing models come in various guises. The most common features frequently found in credit default swap pricing modes are as follows: 1.When measuring the default probability, securities that are tied to credit default swaps are used; stock prices or bond prices are examples of these. These security prices tend to fluctuate over time corresponding to the situation of the reference entity. Due to this, a feature that takes the relation between the default probability and security prices into account should be considered. 2. Credit default swap spreads change over time to reflect the changing time-varying nature of the default probabilities in the credit market. In the most basic framework, a deterministic time trend is used with this type of models to capture the change of the default probabilities. 3. Credit default swap pricing models also sometimes include correlations between recovery rates and default intensities. This shows that if there is an increased chance that a default could occur, the recovery rate will also decrease accordingly.

There are important research questions that arise from the different aspects in different types of credit default swap pricing models. Which commonly-used feature was the most

prevailing feature during the credit crisis in 2008 to 2009? Which feature plays a crucial role in explaining short-term credit default swap premiums? Which feature is essential to explaining variations of the long-term the perception of the default probabilities in the credit market? The credit crisis period during 2008-2009 is focused on as it was here when people realized the need for better valuation models. Features that prevailed during the credit crises should be included to make sure credit default swap valuation models include an explanation for the movement of credit default swap premiums during times of crisis. In addition, the knowledge about the features that are important in explaining the short-term and the long-term perceptions on the default probabilities are essential to investors and risk managers in the credit markets because modelers can select the appropriate feature according to their needs when attempting to develop a model to price credit default swap contracts.

The major hurdle when trying to answers these research questions is the desire to opt for a model that allows a comparison of several features simultaneously. This is difficult as most models do not allow different features to be compared side by side. It is theoretically possible in some models but it nearly becomes practically infeasible to compute due to its mathematical complexity. However, Das and Hanouna (2009) presented a model which upon some modifications can be used in this case. This model allows a comparison of different dynamics of recovery rates and the probability of defaults. This is perfectly suitable for this work as it allows us to modify and investigate all the intended dynamics. Different specifications of default intensity and recovery rates were set from the most commonly used sets in the literature.

Our studies and analyses comprise of only the firms listed in the Dow Jones Industrial Average Index or Dow 30 to ensure that the credit default swap spreads used in this study are from the reference entities which are most liquid. We selected 10 companies listed in the Dow 30

from different industries. The time period of the data in our study is from January 2008 to October 2009. The data covers 22 trading months. When computing stock volatilities, we use 120 days of historical stock prices.

We determine the feature which has the most explanatory power by initially setting both default intensity and the recovery rate constant. Next, more factors are be included. This would enable us to check to see how much credit default swap pricing models will provide better fit after each feature has been included. The degree of improvement is measured by the percentage change of the reduced sum of squared errors. In summary, the features considered in the model will be as follows: 1. Stock prices will be used as a driver of the dynamics of the default intensities in the credit market (Feature 1), much like Das and Hanouna (2009) used. 2. Deterministic time trend will highlight the change in the market perception on the default intensities in the credit market (Feature 2). The most basic linear function in this study, $c_0 + c_1 t$, will be used as a process which makes default probabilities vary with time. This function is easy to work with and avoids any unnecessary complex issues that may arise from using a complicated linear function. This also avoids bias when comparing the features as it prevents the chance to find the best function in order to beat the other features or over-fitting the model. 3. Time trends will be incorporated into the effect of the stock price which has stochastic movement in the binomial tree to explain the effect of the time trend on the stock price movement (Feature 3). Feature 2 shares a common characteristic with that model as this also used the most basic linear time trend to explain the perception on the default probabilities in the credit market. This feature does differ though as here the effect of the time trend on the stock price movement is measured. This will allow for the change in the effect of the stock prices on the default probabilities as discussed above 4. The default probability and recovery rate functions

are linked with the Probit function to capture the correlation between default probability and recovery rate (Feature4), as in Das and Hanouna (2009). The linear time trend, feature 2, has been determined to be the best feature to evaluate the credit default swap premium variations. Stock prices, feature 1, were seen as the next best feature that could explain the credit default swap premium variations. After this comes the correlation between default probabilities and recovery rates, with feature 3 (the effect of the linear time trend on stock prices) being seen to be the worst feature that could explain the issue. Also, we check the independency of the features by investigating the degrees of improvement of each feature when there have been some other features already included and when they are omitted. We can observe from the results that all of the features seem to be independent.

We also try to distinguish the feature that is best capable of explaining the short-term perception of default probability from the one that is more suitable to explain the long-term perception of default probability. We attempt to classify the features which capture the short-term and the long-term term structures of default probability by checking the degree of improvement of each feature when the dataset contains only a specific time-to-maturity. According to the results, stock prices or feature 1 has been determined to be the most capable of capturing the short-term perception whereas the linear time trend (a process that makes default probability vary with time) or feature 2 is the most suitable when a modeler would like to have a feature that can efficiently explain the long-term term structures of default probability. Interestingly, the results that all of the four features seem to be independent have been confirmed when considering only a specific time-to-maturity CDS contracts.

Additionally, to check the robustness of the model that we used and to evaluate the effectiveness of the parameters estimations in the study, actual credit default swap premiums

have been used to compare with the credit default swap premiums calculated from our platform using out-of-the-sample testing. To gain the best predictive power, the full model is used as it incorporates all the features, with its larger number of parameters giving it this power. The results indicate that the model can be extremely effective in predicting credit default swap spreads over all the duration of the credit crises. It falls short in some extreme cases when there is a big change in credit default swap spreads. Therefore, we can conclude that the model that we selected to use in our study is robust and the parameter extractions in our study are sound and reasonable.

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APPENDICES

APPENDIX A

MATLAB source codes for extracting the parameters using Derivative-Free Optimization Method.

Filename: main.m

```
clc
close all
clear all
tic

filename='IBM';

filename_f1=[filename,'_f1_wd.xls'];
filename_f2=[filename,'_f2_wd.xls'];
filename_f3=[filename,'_f3_wd.xls'];
filename_f4=[filename,'_f4_wd.xls'];
filename_f5=[filename,'_f5_wd.xls'];
filename_f6=[filename,'_f6_wd.xls'];
filename_f7=[filename,'_f7_wd.xls'];
filename_f8=[filename,'_f8_wd.xls'];
filename_f9=[filename,'_f9_wd.xls'];
filename_f10=[filename,'_f10_wd.xls'];
filename_f11=[filename,'_f11_wd.xls'];


filename_f1_bm=[filename,'_f1_wd_bm.xls'];
filename_f2_bm=[filename,'_f2_wd_bm.xls'];
filename_f3_bm=[filename,'_f3_wd_bm.xls'];
filename_f4_bm=[filename,'_f4_wd_bm.xls'];
filename_f8_bm=[filename,'_f8_wd_bm.xls'];
filename_f10_bm=[filename,'_f10_wd_bm.xls'];




MaxFun_Evals=1000;
nmax=10;
nmax_bm=20;

windows=30;
step=10;

%------------f1------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');




dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
```

```matlab
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end


rd=0;


while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);
    xlswrite(filename_f1,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f2,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f3,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f1_bm,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f2_bm,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f3_bm,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');


    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
```

```matlab
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f1,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
    th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax_bm
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f1(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 125print('function 1    iteration -> %d/%d    2 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax_bm,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 125print('    v-> %4.5f \n',v);
        disp(str);
        if n==nmax
            [yy CSD] = fitness_sg_daily_f1(x,pp,th_r);
            CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
            iii=1;
            for ii=1:size(dammy_dmy_1,1)
                Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
                Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    CSDm(ii,:)=CSD(iii,:);
                    iii=iii+1;
                end
            end

            vm=ones(size(dammy_dmy_1,1),8)*NaN;
            iii=1;
            for jj=find(~isnan(vv))
                vm(:,jj)=x(iii);
                iii=iii+1;
            end
            vm(:,8)=fval;
            xlswrite(filename_f1,CSDm,['window',num2str(rd)],'L2');
            xlswrite(filename_f1,vm,['window',num2str(rd)],'AC2');
            dataoutput_v_f2=vm(:,1:end-1);
            dataoutput_v_f2(:,4)=0;
            xlswrite(filename_f2,dataoutput_v_f2,['window',num2str(rd)],
'V2');
            xlswrite(filename_f2_bm,dataoutput_v_f2,['window',num2str(rd)],
'V2');
            dataoutput_v_f3=vm(:,1:end-1);
            dataoutput_v_f3(:,[1 5])=0;
            xlswrite(filename_f3,dataoutput_v_f3,['window',num2str(rd)],
'V2');
            xlswrite(filename_f3_bm,dataoutput_v_f3,['window',num2str(rd)],
'V2');
```

```matlab
            end
        end
        [yy CSD] = fitness_sg_daily_f1(x,pp,th_r);
        CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
        iii=1;
        for ii=1:size(dammy_dmy_1,1)
            Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
            Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
            if ~isempty(Id_2) && ~isempty(Id_3)
                CSDm(ii,:)=CSD(iii,:);
                iii=iii+1;
            end
        end

        vm=ones(size(dammy_dmy_1,1),8)*NaN;
        iii=1;
        for jj=find(~isnan(vv))
            vm(:,jj)=x(iii);
            iii=iii+1;
        end
        vm(:,8)=fval;
        xlswrite(filename_f1_bm,CSDm,['window',num2str(rd)],'L2');
        xlswrite(filename_f1_bm,vm,['window',num2str(rd)],'AC2');


        rd=rd+1;
end


%------------f2------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');



dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
```

```matlab
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end


rd=0;


while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);
    xlswrite(filename_f5,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');


    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);


    [input_1_v txt_1_v raw] =
xlsread(filename_f2,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);


    vv =input_1_v(1,:);
%    th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax_bm
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f2(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 127print('function 2    iteration -> %d/%d    3 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax_bm,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 127print('    v-> %4.5f \n',v);
        disp(str);
        if n==nmax
            [yy CSD] = fitness_sg_daily_f2(x,pp,th_r);
            CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
            iii=1;
            for ii=1:size(dammy_dmy_1,1)
```

```matlab
                Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
                Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    CSDm(ii,:)=CSD(iii,:);
                    iii=iii+1;
                end
            end

            vm=ones(size(dammy_dmy_1,1),8)*NaN;
            iii=1;
            for jj=find(~isnan(vv))
                vm(:,jj)=x(iii);
                iii=iii+1;
            end
            vm(:,8)=fval;
            xlswrite(filename_f2,CSDm,['window',num2str(rd)],'L2');
            xlswrite(filename_f2,vm,['window',num2str(rd)],'AC2');
            dataoutput_v_f5=vm(:,1:end-1);
            dataoutput_v_f5(:,7)=0;
            xlswrite(filename_f5,dataoutput_v_f5,['window',num2str(rd)],
'V2');
        end
    end
    [yy CSD] = fitness_sg_daily_f2(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
        vm(:,jj)=x(iii);
        iii=iii+1;
    end
    vm(:,8)=fval;
    xlswrite(filename_f2_bm,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f2_bm,vm,['window',num2str(rd)],'AC2');

    rd=rd+1;
end


%------------f3------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
```

```matlab
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');



dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;

while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);
    xlswrite(filename_f4,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f6,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f8,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f4_bm,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f8_bm,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');

    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
```

```
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f3,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);


    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax_bm
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f3(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 130print('function 3    iteration -> %d/%d    4 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax_bm,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 130print('    v-> %4.5f \n',v);
        disp(str);
        if n==nmax
            [yy CSD] = fitness_sg_daily_f3(x,pp,th_r);
            CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
            iii=1;
            for ii=1:size(dammy_dmy_1,1)
                Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
                Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    CSDm(ii,:)=CSD(iii,:);
                    iii=iii+1;
                end
            end

            vm=ones(size(dammy_dmy_1,1),8)*NaN;
            iii=1;
            for jj=find(~isnan(vv))
                vm(:,jj)=x(iii);
                iii=iii+1;
            end
            vm(:,8)=fval;
            xlswrite(filename_f3,CSDm,['window',num2str(rd)],'L2');
            xlswrite(filename_f3,vm,['window',num2str(rd)],'AC2');
            dataoutput_v_f4=vm(:,1:end-1);
            dataoutput_v_f4(:,2)=0;
            xlswrite(filename_f4,dataoutput_v_f4,['window',num2str(rd)],
'V2');
            xlswrite(filename_f4_bm,dataoutput_v_f4,['window',num2str(rd)],
'V2');
```

```matlab
            dataoutput_v_f6=vm(:,1:end-1);
            dataoutput_v_f6(:,7)=0;
            xlswrite(filename_f6,dataoutput_v_f6,['window',num2str(rd)],
'V2');
            dataoutput_v_f8=vm(:,1:end-1);
            dataoutput_v_f8(:,4)=0;
            xlswrite(filename_f8,dataoutput_v_f8,['window',num2str(rd)],
'V2');
            xlswrite(filename_f8_bm,dataoutput_v_f8,['window',num2str(rd)],
'V2');

        end
    end
    [yy CSD] = fitness_sg_daily_f3(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
        vm(:,jj)=x(iii);
        iii=iii+1;
    end
    vm(:,8)=fval;
    xlswrite(filename_f3_bm,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f3_bm,vm,['window',num2str(rd)],'AC2');

    rd=rd+1;
end




%------------f4-------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');




dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
```

```matlab
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;

while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);
    xlswrite(filename_f7,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');


    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f4,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax_bm
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f4(x,pp,th_r),v,options);
```

```matlab
        format short e
        v=x;
        str = 133print('function 4    iteration -> %d/%d    5 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax_bm,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 133print('    v-> %4.5f \n',v);
        disp(str);
        if n==nmax
            [yy CSD] = fitness_sg_daily_f4(x,pp,th_r);
            CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
            iii=1;
            for ii=1:size(dammy_dmy_1,1)
                Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
                Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    CSDm(ii,:)=CSD(iii,:);
                    iii=iii+1;
                end
            end

            vm=ones(size(dammy_dmy_1,1),8)*NaN;
            iii=1;
            for jj=find(~isnan(vv))
                vm(:,jj)=x(iii);
                iii=iii+1;
            end
            vm(:,8)=fval;
            xlswrite(filename_f4,CSDm,['window',num2str(rd)],'L2');
            xlswrite(filename_f4,vm,['window',num2str(rd)],'AC2');
            dataoutput_v_f7=vm(:,1:end-1);
            dataoutput_v_f7(:,7)=0;
            xlswrite(filename_f7,dataoutput_v_f7,['window',num2str(rd)],
'V2');
        end
    end
    [yy CSD] = fitness_sg_daily_f4(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
        vm(:,jj)=x(iii);
        iii=iii+1;
```

```
    end
    vm(:,8)=fval;
    xlswrite(filename_f4_bm,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f4_bm,vm,['window',num2str(rd)],'AC2');


    rd=rd+1;
end


%------------f5-----------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');




dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;

while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);

    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
```

```matlab
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f5,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f5(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 135print('function 5    iteration -> %d/%d    4 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 135print('    v-> %4.5f \n',v);
        disp(str);
    end
    [yy CSD] = fitness_sg_daily_f5(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
        vm(:,jj)=x(iii);
        iii=iii+1;
    end
    vm(:,8)=fval;
    xlswrite(filename_f5,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f5,vm,['window',num2str(rd)],'AC2');

    rd=rd+1;
end
```

```matlab
%------------f6------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');



dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;

while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);


    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
```

```matlab
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f6,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
%    th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f6(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 137print('function 6    iteration -> %d/%d    5 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 137print('    v-> %4.5f \n',v);
        disp(str);
     end
     [yy CSD] = fitness_sg_daily_f6(x,pp,th_r);
     CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
     iii=1;
     for ii=1:size(dammy_dmy_1,1)
         Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
         Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
         if ~isempty(Id_2) && ~isempty(Id_3)
             CSDm(ii,:)=CSD(iii,:);
             iii=iii+1;
         end
     end

     vm=ones(size(dammy_dmy_1,1),8)*NaN;
     iii=1;
     for jj=find(~isnan(vv))
         vm(:,jj)=x(iii);
         iii=iii+1;
     end
     vm(:,8)=fval;
     xlswrite(filename_f6,CSDm,['window',num2str(rd)],'L2');
     xlswrite(filename_f6,vm,['window',num2str(rd)],'AC2');

     rd=rd+1;
end


%------------f7------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
```

```matlab
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');




dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;

while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);


    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f7,['window',num2str(rd)],'V2:AB462');
```

```
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f7(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 139print('function 7    iteration -> %d/%d    6 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 139print('    v-> %4.5f \n',v);
        disp(str);
    end
    [yy CSD] = fitness_sg_daily_f7(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
        vm(:,jj)=x(iii);
        iii=iii+1;
    end
    vm(:,8)=fval;
    xlswrite(filename_f7,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f7,vm,['window',num2str(rd)],'AC2');


    rd=rd+1;
end


%------------f8------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');



dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
```

```matlab
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end


rd=0;


while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);
    xlswrite(filename_f9,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
    xlswrite(filename_f10,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
     xlswrite(filename_f10_bm,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');


    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f8,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);
```

```
    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax_bm
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f8(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 141print('function 8    iteration -> %d/%d    5 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax_bm,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 141print('     v-> %4.5f \n',v);
        disp(str);
        if n==nmax
            [yy CSD] = fitness_sg_daily_f8(x,pp,th_r);
            CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
            iii=1;
            for ii=1:size(dammy_dmy_1,1)
                Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
                Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    CSDm(ii,:)=CSD(iii,:);
                    iii=iii+1;
                end
            end

            vm=ones(size(dammy_dmy_1,1),8)*NaN;
            iii=1;
            for jj=find(~isnan(vv))
                vm(:,jj)=x(iii);
                iii=iii+1;
            end
            vm(:,8)=fval;
            xlswrite(filename_f8,CSDm,['window',num2str(rd)],'L2');
            xlswrite(filename_f8,vm,['window',num2str(rd)],'AC2');
            dataoutput_v_f9=vm(:,1:end-1);
            dataoutput_v_f9(:,2)=0;
            xlswrite(filename_f9,dataoutput_v_f9,['window',num2str(rd)],
'V2');
            dataoutput_v_f10=vm(:,1:end-1);
            dataoutput_v_f10(:,7)=0;
            xlswrite(filename_f10,dataoutput_v_f10,['window',num2str(rd)],
'V2');
            xlswrite(filename_f10_bm,dataoutput_v_f10,['window',num2str(rd)],
'V2');
        end
    end
    [yy CSD] = fitness_sg_daily_f8(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
```

```
            if ~isempty(Id_2) && ~isempty(Id_3)
                CSDm(ii,:)=CSD(iii,:);
                iii=iii+1;
            end
        end

        vm=ones(size(dammy_dmy_1,1),8)*NaN;
        iii=1;
        for jj=find(~isnan(vv))
            vm(:,jj)=x(iii);
            iii=iii+1;
        end
        vm(:,8)=fval;
        xlswrite(filename_f8_bm,CSDm,['window',num2str(rd)],'L2');
        xlswrite(filename_f8_bm,vm,['window',num2str(rd)],'AC2');

        rd=rd+1;
end


%------------f9------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');




dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;

while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
```

```matlab
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);

    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f9,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax
        [x,fval] = fminsearch(@(x) fitness_sg_daily_f9(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 143print('function 9    iteration -> %d/%d    6 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 143print('    v-> %4.5f \n',v);
        disp(str);
    end
    [yy CSD] = fitness_sg_daily_f9(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
```

```matlab
        vm(:,jj)=x(iii);
        iii=iii+1;
    end
    vm(:,8)=fval;
    xlswrite(filename_f9,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f9,vm,['window',num2str(rd)],'AC2');


    rd=rd+1;
end


% ------------f10-----------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');



dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;

while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);
    xlswrite(filename_f11,raw11([1
(step*rd+1:step*rd+ship)+1],:),['window',num2str(rd)],'A1');
```

```matlab
    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f10,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax_bm
        [x,fval] = fminsearch(@(x)
fitness_sg_daily_f10(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 145print('function 10    iteration -> %d/%d    6 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax_bm,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 145print('    v-> %4.5f \n',v);
        disp(str);
        if n==nmax
            [yy CSD] = fitness_sg_daily_f10(x,pp,th_r);
            CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
            iii=1;
            for ii=1:size(dammy_dmy_1,1)
                Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
                Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    CSDm(ii,:)=CSD(iii,:);
                    iii=iii+1;
                end
            end

            vm=ones(size(dammy_dmy_1,1),8)*NaN;
            iii=1;
            for jj=find(~isnan(vv))
                vm(:,jj)=x(iii);
                iii=iii+1;
            end
            vm(:,8)=fval;
            xlswrite(filename_f10,CSDm,['window',num2str(rd)],'L2');
```

```
            xlswrite(filename_f10,vm,['window',num2str(rd)],'AC2');
            dataoutput_v_f11=vm(:,1:end-1);
            dataoutput_v_f11(:,2)=0;
            xlswrite(filename_f11,dataoutput_v_f11,['window',num2str(rd)],
'V2');
        end
    end
    [yy CSD] = fitness_sg_daily_f10(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
        vm(:,jj)=x(iii);
        iii=iii+1;
    end
    vm(:,8)=fval;
    xlswrite(filename_f10_bm,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f10_bm,vm,['window',num2str(rd)],'AC2');

    rd=rd+1;
end


% ------------f11------------------
[input_11 txt_11 raw11] = xlsread(filename, 'Sheet1','A1:AJ462');
[input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
[input_2 txt_2] = xlsread('historical-volatility_IBM.xls',
'Sheet1','A2:D688');
[input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');




dmy_1=zeros(size(txt_1,1),3);
for i=1:size(txt_1,1)
    dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
    dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
    dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
end

dmy_2=zeros(size(txt_2,1),3);
for i=1:size(txt_2,1)
    dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
    dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
```

```matlab
    dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
end

dmy_3=zeros(size(txt_3,1),3);
for i=1:size(txt_3,1)
    dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
    dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
    dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
end

rd=0;


while (size(dmy_1,1)-(step*rd)) > (windows-step)
    if (size(dmy_1,1)-(step*rd))>=windows
        ship=windows;
    else
        ship=(size(dmy_1,1)-(step*rd));
    end
    pp=[];
    dammy_dmy_1=dmy_1(step*rd+1:step*rd+ship,:);


    for ii=1:size(dammy_dmy_1,1)
        Id_1=find(dmy_1(:,1)==dammy_dmy_1(ii,1)&
dmy_1(:,2)==dammy_dmy_1(ii,2)& dmy_1(:,3)==dammy_dmy_1(ii,3));
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            pp=[pp;[input_2(Id_2,[1 3]) input_1(Id_1,:)
InterestRate(input_3(Id_3,:))]];
        end
    end
    options = optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-
6,'TolFun',1e-6);

    [input_1_v txt_1_v raw] =
xlsread(filename_f11,['window',num2str(rd)],'V2:AB462');
    input_1_v=cell2mat(raw);

    vv =input_1_v(1,:);
%     th_r=vv(6);
    v=vv(~isnan(vv));
    for n=1:nmax
        [x,fval] = fminsearch(@(x)
fitness_sg_daily_f11(x,pp,th_r),v,options);
        format short e
        v=x;
        str = 147print('function 11    iteration -> %d/%d    7 variables
%d/%d/%d  ->  %d/%d/%d\n',n,nmax,dammy_dmy_1(1,:),dammy_dmy_1(end,:));
        disp(str);
        str = 147print('    v-> %4.5f \n',v);
        disp(str);
```

```matlab
        end
    [yy CSD] = fitness_sg_daily_f11(x,pp,th_r);
    CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
    iii=1;
    for ii=1:size(dammy_dmy_1,1)
        Id_2=find(dmy_2(:,1)==dammy_dmy_1(ii,1)&
dmy_2(:,2)==dammy_dmy_1(ii,2)& dmy_2(:,3)==dammy_dmy_1(ii,3));
        Id_3=find(dmy_3(:,1)==dammy_dmy_1(ii,1)&
dmy_3(:,2)==dammy_dmy_1(ii,2)& dmy_3(:,3)==dammy_dmy_1(ii,3));
        if ~isempty(Id_2) && ~isempty(Id_3)
            CSDm(ii,:)=CSD(iii,:);
            iii=iii+1;
        end
    end

    vm=ones(size(dammy_dmy_1,1),8)*NaN;
    iii=1;
    for jj=find(~isnan(vv))
        vm(:,jj)=x(iii);
        iii=iii+1;
    end
    vm(:,8)=fval;
    xlswrite(filename_f11,CSDm,['window',num2str(rd)],'L2');
    xlswrite(filename_f11,vm,['window',num2str(rd)],'AC2');

    rd=rd+1;
end

toc
```

Filename: fitness_sg_daily_f1.m

```
function [yy CSDm] = fitness_sg_daily_f1(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
     p=pp(i,:);
     [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
     yy =yy+ yy_d;
     CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

const_0 = xx(1);
a_0 = xx(2);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
         HR(i,j)=const_0;

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];
```

```matlab
%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0;
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
CSD=CSD*10000;

if  ~(q(end,end)>0 && q(end,end)<1)
    yy=NaN;
```

```
end


bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f2.m

```matlab
function [yy CSDm] = fitness_sg_daily_f2(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
     p=pp(i,:);
     [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
     yy =yy+ yy_d;
     CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

const_0 = xx(1);
const_1 = xx(2);
a_0 = xx(3);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
          HR(i,j)=const_0+const_1*j;

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
```

```matlab
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
         Recov(i,j)=a_0;
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
```

```
CSD=CSD*10000;

if  ~(q(end,end)>0 && q(end,end)<1)
     yy=NaN;
end


bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f3.m

```matlab
function [yy CSDm] = fitness_sg_daily_f3(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
    p=pp(i,:);
    [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
    yy =yy+ yy_d;
    CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
const_0 = xx(2);
const_2 = xx(3);
a_0 = xx(4);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
        HR(i,j)=const_0+(const_2)/(SPT(i,j)^(b_0));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
```

```matlab
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
         Recov(i,j)=a_0;
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
```

```matlab
CSD=CSD*10000;
if  ~(q(end,end)>0 && q(end,end)<1)
     yy=NaN;
end




bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f4.m

```matlab
function [yy CSDm] = fitness_sg_daily_f4(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
    p=pp(i,:);
    [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
    yy =yy+ yy_d;
    CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
b_1 = xx(2);
const_0 = xx(3);
const_2 = xx(4);
a_0 = xx(5);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
        HR(i,j)=const_0+(const_2)/(SPT(i,j)^(b_0+b_1*j));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
        Dprob(i,j)=1-exp(-h*HR(i,j));
```

```matlab
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0;
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
CSD=CSD*10000;
```

```
if  ~(q(end,end)>0 && q(end,end)<1)
    yy=NaN;
end
```

Filename: fitness_sg_daily_f5.m

```matlab
function [yy CSDm] = fitness_sg_daily_f5(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
     p=pp(i,:);
     [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
     yy =yy+ yy_d;
     CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;


const_0 = xx(1);
const_1 = xx(2);
a_0 = xx(3);
a_1 = xx(4);


%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
          HR(i,j)=const_0+const_1*j;

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
```

```matlab
    for i=1:j
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0+a_1*Dprob(i+1,j);
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;
```

```matlab
yy=sum((CSD*10000-ASD*10000).^2);
CSD=CSD*10000;



if  ~(q(end,end)>0 && q(end,end)<1)
     yy=NaN;
end


bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f6.m

```matlab
function [yy CSDm] = fitness_sg_daily_f6(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
    p=pp(i,:);
    [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
    yy =yy+ yy_d;
    CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0=xx(1);
const_0 = xx(2);
const_2 = xx(3);
a_0 = xx(4);
a_1 = xx(5);
%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
            HR(i,j)=const_0+(const_2)/(SPT(i,j)^(b_0));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
        Dprob(i,j)=1-exp(-h*HR(i,j));
```

```matlab
        end
    end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
         Recov(i,j)=a_0+a_1*Dprob(i+1,j);
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
CSD=CSD*10000;
```

```matlab
if  ~(q(end,end)>0 && q(end,end)<1)
     yy=NaN;
end




bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f7.m

```matlab
function [yy CSDm] = fitness_sg_daily_f7(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
     p=pp(i,:);
     [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
     yy =yy+ yy_d;
     CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
b_1 = xx(2);
const_0 = xx(3);
const_2 = xx(4);
a_0 = xx(5);
a_1 = xx(6);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
          HR(i,j)=const_0+(const_2)/(SPT(i,j)^(b_0+b_1*j));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
```

```matlab
            Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
         Recov(i,j)=a_0+a_1*Dprob(i+1,j);
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
```

```matlab
CSD=CSD*10000;

if  ~(q(end,end)>0 && q(end,end)<1)
    yy=NaN;
end




bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f8.m

```matlab
function [yy CSDm] = fitness_sg_daily_f8(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
    p=pp(i,:);
    [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
    yy =yy+ yy_d;
    CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
const_0 = xx(2);
const_1 = xx(3);
const_2 = xx(4);
a_0 = xx(5);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
        HR(i,j)=const_0+const_1*j+(const_2)/(SPT(i,j)^(b_0));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
        Dprob(i,j)=1-exp(-h*HR(i,j));
```

```matlab
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0;
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
CSD=CSD*10000;
```

```
if  ~(q(end,end)>0 && q(end,end)<1)
     yy=NaN;
end


bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f9.m

```matlab
function [yy CSDm] = fitness_sg_daily_f9(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
    p=pp(i,:);
    [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
    yy =yy+ yy_d;
    CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
b_1 = xx(2);
const_0 = xx(3);
const_1 = xx(4);
const_2 = xx(5);
a_0 = xx(6);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
        HR(i,j)=const_0+const_1*j+(const_2)/(SPT(i,j)^(b_0+b_1*j));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
```

```matlab
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0;
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
```

```
CSD=CSD*10000;

if  ~(q(end,end)>0 && q(end,end)<1)
    yy=NaN;
end

bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f10.m

```matlab
function [yy CSDm] = fitness_sg_daily_f10(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
     p=pp(i,:);
     [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
     yy =yy+ yy_d;
     CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
const_0 = xx(2);
const_1 = xx(3);
const_2 = xx(4);
a_0 = xx(5);
a_1 = xx(6);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
          HR(i,j)=const_0+const_1*j+(const_2)/(SPT(i,j)^(b_0));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
    for i=1:j
```

```matlab
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0+a_1*Dprob(i+1,j);
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end

ASD=p(3:12)'/10000;

yy=sum((CSD*10000-ASD*10000).^2);
```

```matlab
CSD=CSD*10000;
if  ~(q(end,end)>0 && q(end,end)<1)
     yy=NaN;
end


bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

Filename: fitness_sg_daily_f11.m

```matlab
function [yy CSDm] = fitness_sg_daily_f11(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
     p=pp(i,:);
     [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
     yy =yy+ yy_d;
     CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
b_1 = xx(2);
const_0 = xx(3);
const_1 = xx(4);
const_2 = xx(5);
a_0 = xx(6);
a_1 = xx(7);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
         HR(i,j)=const_0+const_1*j+(const_2)/(SPT(i,j)^(b_0+b_1*j));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
for j=1:120
```

```matlab
    for i=1:j
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0+a_1*Dprob(i+1,j);
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end


ASD=p(3:12)'/10000;
```

```matlab
yy=sum((CSD*10000-ASD*10000).^2);
CSD=CSD*10000;


if a_1>0
    yy=NaN;
end

if  b_0<0
    yy=NaN;
end

if  b_1<0
    yy=NaN;
end

if  const_0<0
    yy=NaN;
end

if  const_2<0
    yy=NaN;
end

if  ~(q(end,end)>0 && q(end,end)<1)
     yy=NaN;
end

bo=0.2;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

APPENDIX B

MATLAB source codes for comparing market CDS spreads with the CDS spreads calculated from our model.

File name: main.m

```
clc
close all
clear all
tic

name{1}='MMM';name{2}='AA';name{3}='AXP';name{4}='T';name{5}='BAC';
name{6}='BA';name{7}='CAT';name{8}='CVX';name{9}='CSCO';name{10}='KO';
name{11}='DD';name{12}='XOM';name{13}='GE';name{14}='HPQ';name{15}='HD';
name{16}='INTC';name{17}='IBM';name{18}='JNJ';name{19}='JPM';name{20}='KFT';
name{21}='MCD';name{22}='MRK';name{23}='MSFT';name{24}='PFE';name{25}='PG';
name{26}='TRV';name{27}='UTX';name{28}='VZ';name{29}='WMT';name{30}='DIS';

a0=[39.5 27.4 36.3 23.2 36.3 35.4 35.4 44.5 29.5 26.7 39.5 44.5 39.5 29.5...
    34.4 29.5 29.5 26.7 36.3 26.7 39.5 32.7 29.5 32.7 26.7 36.3 39.5 36.3
34.4 43.5];

MaxFun_Evals=1000;
nmax=10;

for nn=1:size(name,2)
    filename=name{nn};
    [input_1 txt_1 raw1] = xlsread(filename, 'Sheet1','A2:K462');
    vvv=zeros(size(input_1,1),7);
    vvv(:,6)=norminv(a0(nn)/100);
    xlswrite(filename,vvv,'Sheet1', 'V2');

    [input_2 txt_2] = xlsread(['historical-volatility_',filename,'.xls'],
'Sheet1','A2:D688');
    [input_3 txt_3] = xlsread('Interest Rate.xls', 'Daily','A2:J502');
    [input_1_v txt_1_v raw] = xlsread(filename, 'Sheet1','V2:AB462');
    input_1_v=cell2mat(raw);

    [input_s2 txt_s2 raws2] = xlsread(filename, 'Sheet1','A1:U462');
    xlswrite(filename,raws2,'Sheet2', 'A1');


    dmy_1=zeros(size(txt_1,1),3);
    for i=1:size(txt_1,1)
        dmy_1(i,1)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),7));
        dmy_1(i,2)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),5));
        dmy_1(i,3)= str2double(datestr(datenum(txt_1{i},'mm/dd/yy'),10));
    end

    dmy_2=zeros(size(txt_2,1),3);
    for i=1:size(txt_2,1)
```

```matlab
        dmy_2(i,1)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),7));
        dmy_2(i,2)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),5));
        dmy_2(i,3)= str2double(datestr(datenum(txt_2{i},'mm/dd/yy'),10));
    end

    dmy_3=zeros(size(txt_3,1),3);
    for i=1:size(txt_3,1)
        dmy_3(i,1)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),7));
        dmy_3(i,2)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),5));
        dmy_3(i,3)= str2double(datestr(datenum(txt_3{i},'mm/dd/yy'),10));
    end


    min_year=min(dmy_1(1,3));
    max_year=max(dmy_1(end,3));

    dataoutput_v=[];
    dataoutput_CSD=[];
    data_my=[];
    for year_i=min_year:max_year
        minmax_month = unique(dmy_1(dmy_1(:,3)==year_i,2), 'first')';
        data_my=[data_my;[minmax_month' year_i*ones(size(minmax_month'))]];
        for month_i=minmax_month
            pp=[];
            dammy_dmy_1=dmy_1((dmy_1(:,2)==month_i) &
(dmy_1(:,3)==year_i),:);
            dammy_dmy_2=dmy_2((dmy_2(:,2)==month_i) &
(dmy_2(:,3)==year_i),:);
            dammy_dmy_3=dmy_3((dmy_3(:,2)==month_i) &
(dmy_3(:,3)==year_i),:);

            dammy_input_1=input_1((dmy_1(:,2)==month_i) &
(dmy_1(:,3)==year_i),:);
            dammy_input_2=input_2((dmy_2(:,2)==month_i) &
(dmy_2(:,3)==year_i),:);
            dammy_input_3=input_3((dmy_3(:,2)==month_i) &
(dmy_3(:,3)==year_i),:);
            dammy_input_1_v=input_1_v((dmy_1(:,2)==month_i) &
(dmy_1(:,3)==year_i),:);


            for ii=1:size(dammy_dmy_1,1)
                Id_2=find(dammy_dmy_2(:,1)==dammy_dmy_1(ii,1));
                Id_3=find(dammy_dmy_3(:,1)==dammy_dmy_1(ii,1));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    pp=[pp;[dammy_input_2(Id_2,[1 3]) dammy_input_1(ii,:)
InterestRate(dammy_input_3(Id_3,:))]];
                end
            end
            options =
optimset('Display','iter','MaxFunEvals',MaxFun_Evals,'TolX',1e-6,'TolFun',1e-
6);

            vv =dammy_input_1_v(1,:);
            th_r=vv(6);
```

```matlab
            v=vv(~isnan(vv));
            for n=1:nmax
                [x,fval] = fminsearch(@(x)
fitness_sg_daily_f11(x,pp,th_r),v,options);
                v=x;
                format short e
                str = 184print('  %s    iteration -> %d/%d    7 variables
%d/%d months  %d/%d
years\n',filename,n,nmax,month_i,minmax_month(end),year_i,max_year);
                disp(str);
                str = 184print('    v-> %4.5f \n',v);
                disp(str);
            end

            [yy CSD] = fitness_sg_daily_f11(x,pp,th_r);
            CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
            iii=1;
            for ii=1:size(dammy_dmy_1,1)
                Id_2=find(dammy_dmy_2(:,1)==dammy_dmy_1(ii,1));
                Id_3=find(dammy_dmy_3(:,1)==dammy_dmy_1(ii,1));
                if ~isempty(Id_2) && ~isempty(Id_3)
                    CSDm(ii,:)=CSD(iii,:);
                    iii=iii+1;
                end
            end
            dataoutput_CSD=[dataoutput_CSD;CSDm];

            vm=ones(size(dammy_dmy_1,1),8)*NaN;
            iii=1;
            for ii=find(~isnan(vv))
                vm(:,ii)=x(iii);
                iii=iii+1;
            end
            vm(:,8)=fval;
            dataoutput_v=[dataoutput_v;vm];
        end
    end

    xlswrite(filename,dataoutput_CSD,'Sheet1', 'L2');
    xlswrite(filename,dataoutput_v,'Sheet1', 'AC2');

    [input_1_v txt_1_v raw] = xlsread(filename, 'Sheet1','AC2:AI462');
    input_1_v=cell2mat(raw);

    dataoutput_CSD=ones(size(dmy_1((dmy_1(:,2)==data_my(1,1)) &
(dmy_1(:,3)==data_my(1,2)),:),1),11)*NaN;

    for my=2:size(data_my,1)
        pp=[];
        dammy_dmy_1=dmy_1((dmy_1(:,2)==data_my(my,1)) &
(dmy_1(:,3)==data_my(my,2)),:);
        dammy_dmy_2=dmy_2((dmy_2(:,2)==data_my(my,1)) &
(dmy_2(:,3)==data_my(my,2)),:);
        dammy_dmy_3=dmy_3((dmy_3(:,2)==data_my(my,1)) &
(dmy_3(:,3)==data_my(my,2)),:);
```

```matlab
        dammy_input_1=input_1((dmy_1(:,2)==data_my(my,1)) &
(dmy_1(:,3)==data_my(my,2)),:);
        dammy_input_2=input_2((dmy_2(:,2)==data_my(my,1)) &
(dmy_2(:,3)==data_my(my,2)),:);
        dammy_input_3=input_3((dmy_3(:,2)==data_my(my,1)) &
(dmy_3(:,3)==data_my(my,2)),:);
        dammy_input_1_v=input_1_v((dmy_1(:,2)==data_my(my-1,1)) &
(dmy_1(:,3)==data_my(my-1,2)),:);

        for ii=1:size(dammy_dmy_1,1)
            Id_2=find(dammy_dmy_2(:,1)==dammy_dmy_1(ii,1));
            Id_3=find(dammy_dmy_3(:,1)==dammy_dmy_1(ii,1));
            if ~isempty(Id_2) && ~isempty(Id_3)
                pp=[pp;[dammy_input_2(Id_2,[1 3]) dammy_input_1(ii,:)
InterestRate(dammy_input_3(Id_3,:))]];
            end
         end

         vv =dammy_input_1_v(1,:);
         th_r=vv(6);
         v=vv(~isnan(vv));
        [yy CSD] = fitness_sg_daily_f11(v,pp,th_r);
        CSDm=ones(size(dammy_dmy_1,1),10)*NaN;
        iii=1;
        for ii=1:size(dammy_dmy_1,1)
            Id_2=find(dammy_dmy_2(:,1)==dammy_dmy_1(ii,1));
            Id_3=find(dammy_dmy_3(:,1)==dammy_dmy_1(ii,1));
            if ~isempty(Id_2) && ~isempty(Id_3)
                CSDm(ii,:)=CSD(iii,:);
                iii=iii+1;
            end
        end
        dataoutput_CSD=[dataoutput_CSD;[CSDm ones(size(CSDm,1),1)*yy]];

    end
    xlswrite(filename,dataoutput_CSD,'Sheet2', 'L2');
end

toc
```

File name: fitness_sg_daily_f11.m

```matlab
function [yy CSDm] = fitness_sg_daily_f11(xx,pp,th_r)
yy=0;
CSDm=[];
for i=1:size(pp,1)
    p=pp(i,:);
    [yy_d,CSD] = fitness_sg_p_nf(xx,p,th_r);
    yy =yy+ yy_d;
    CSDm=[CSDm;CSD'];
end


function [yy,CSD] = fitness_sg_p_nf(xx,p,th_r)

So = p(1);
vol = p(2)*100;
h = 0.083333;
u = exp(vol*sqrt(h)/100);
d = 1/u;

b_0 = xx(1);
b_1 = xx(2);
const_0 = xx(3);
const_1 = xx(4);
const_2 = xx(5);
a_0 = xx(6);
a_1 = xx(7);

%%%Interest Rate Term Structure
IRTS=p(13:end);

%%%Stock Price Tree
SPT=zeros(120,120);
SPT(1,1)=So;
for j=2:120
    SPT(1,j)=SPT(1,j-1)*u;
    for i=2:j
        SPT(i,j)=SPT(i-1,j-1)*d;
    end
end

%%%Hazard Rate
HR=zeros(120,120);
for j=1:120
    for i=1:j
            HR(i,j)=const_0+const_1*j+(const_2)/(SPT(i,j)^(b_0+b_1*j));

    end
end

%%%Default Probability
Dprob=zeros(120,120);
```

```
for j=1:120
    for i=1:j
        Dprob(i,j)=1-exp(-h*HR(i,j));
    end
end
Dprob=[zeros(1,120);Dprob];

%%%Recovery Rate
Recov=zeros(120,120);
for j=1:120
    for i=1:j
        Recov(i,j)=a_0+a_1*Dprob(i+1,j);
    end
end
Recov=normcdf(Recov,zeros(size(Recov)),ones(size(Recov)));
%%%q
q=zeros(120,120);
for j=1:120
    for i=1:j
        q(i,j)=(exp(IRTS(1,j)*h)/(1-Dprob(i+1,j))-d)/(u-d);
    end
end
q=[zeros(1,120);q];

%%%State price
Sprice=zeros(121,120);
Sprice(2,1)=1;
stotal=zeros(1,120);
stotal(1,1)=sum(Sprice(:,1));
for j=2:120
    for i=2:j+1
        Sprice(i,j)=Sprice(i-1,j-1)*(1-Dprob(i-1,j-1))*(1-q(i-1,j-1))*exp(-
IRTS(1,j-1)*h)+Sprice(i,j-1)*(1-Dprob(i,j-1))*q(i,j-1)*exp(-IRTS(1,j-1)*h);
    end
    if mod(j-1,6)==0
        stotal(1,j)=sum(Sprice(:,j));
    end
end
Sprice=[stotal;Sprice];

%%%Contingent Claim Payment
Ccpayment=zeros(120,120);
for j=1:120
    for i=1:j
        Ccpayment(i,j)= Sprice(i+2,j)*Dprob(i+1,j)*(1-Recov(i,j));
    end
end
M=[2 2 2 2 2 2 2 2 2 2];
% Calculated Spread
CSD=zeros(10,1);
for i=1:10
    CSD(i)=sum(sum(Ccpayment(1:12*i,1:12*i)))/sum(stotal(1:12*i))*M(i);
end


ASD=p(3:12)'/10000;
```

```matlab
yy=sum((CSD*10000-ASD*10000).^2);
CSD=CSD*10000;

if  ~(q(end,end)>0 && q(end,end)<1)
    yy=NaN;
end

bo=0.02;
th_r=normcdf(th_r);
if ~(Recov(1,1)>(th_r-bo*abs(th_r)) && Recov(1,1)<(th_r+bo*abs(th_r)))
    yy=NaN;
end
```

APPENDIX C

The sum of squared errors of each time window and of each reference entity for each model specification

Reference Entity:	Alcoa Inc.	NYSE:	AA	Industry:	Steel

Model 1 Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.515883951	N/A	N/A	N/A	0.013578763	N/A	N/A	312266.67
2	1/15/2008-2/25/2008	30	-0.411907123	N/A	N/A	N/A	0.017210709	N/A	N/A	314870.38
3	1/29/2008-3/10/2008	30	-0.519657845	N/A	N/A	N/A	0.019460608	N/A	N/A	193561.13
4	2/12/2008-3/24/2008	30	-0.653054738	N/A	N/A	N/A	0.020267950	N/A	N/A	101688.39
5	2/26/2008-4/7/2008	30	-0.538131707	N/A	N/A	N/A	0.018306016	N/A	N/A	136701.19
6	3/11/2008-4/21/2008	30	-0.611470383	N/A	N/A	N/A	0.016703240	N/A	N/A	116583.71
7	3/25/2008-5/25/2008	30	-0.624129238	N/A	N/A	N/A	0.014222270	N/A	N/A	102844.14
8	4/8/2008-5/19/2008	30	-0.563838165	N/A	N/A	N/A	0.013144768	N/A	N/A	104544.49
9	4/22/2008-6/2/2008	30	-0.624583651	N/A	N/A	N/A	0.012327322	N/A	N/A	76973.55
10	5/6/2008-6/16/2008	30	-0.59714473	N/A	N/A	N/A	0.012785681	N/A	N/A	82481.54
11	5/20/2008-6/30/2008	30	-0.697645663	N/A	N/A	N/A	0.013343062	N/A	N/A	90858.96
12	6/3/2008-7/14/2008	30	-0.483998008	N/A	N/A	N/A	0.014058951	N/A	N/A	117898.86
13	6/17/2008-7/28/2008	30	-0.546196683	N/A	N/A	N/A	0.014909239	N/A	N/A	137245.86
14	7/1/2008-8/11/2008	30	-0.641524244	N/A	N/A	N/A	0.015712900	N/A	N/A	140722.98
15	7/15/2008-8/25/2008	30	-0.645454504	N/A	N/A	N/A	0.016644917	N/A	N/A	170296.54
16	7/29/2008-9/8/2008	30	-0.533720622	N/A	N/A	N/A	0.017618064	N/A	N/A	181270.17
17	8/12/2008-9/22/2008	30	-0.411591303	N/A	N/A	N/A	0.019006400	N/A	N/A	215837.36
18	8/26/2008-10/6/2008	30	-0.662267198	N/A	N/A	N/A	0.020430688	N/A	N/A	312533.09
19	9/9/2008-10/20/2008	30	-0.580343037	N/A	N/A	N/A	0.028599303	N/A	N/A	2220519.03
20	9/23/2008-11/3/2008	30	-0.499982442	N/A	N/A	N/A	0.042917929	N/A	N/A	4094197.97
21	10/7/2008-11/17/2008	30	-0.438945408	N/A	N/A	N/A	0.054857429	N/A	N/A	1275067.20
22	10/21/2008-12/1/2008	30	-0.635047095	N/A	N/A	N/A	0.068083694	N/A	N/A	2575046.52
23	11/4/2008-12/15/2008	30	-0.520304079	N/A	N/A	N/A	0.070271674	N/A	N/A	4650518.05
24	11/18/2008-12/29/2008	30	-0.664863463	N/A	N/A	N/A	0.094102350	N/A	N/A	1313544.20
25	12/2/2008-1/12/2009	30	-0.657630784	N/A	N/A	N/A	0.095349383	N/A	N/A	875391.25
26	12/16/2008-1/26/2009	30	-0.545525297	N/A	N/A	N/A	0.097526491	N/A	N/A	1415699.52
27	12/30/2008-2/9/2009	30	-0.575882827	N/A	N/A	N/A	0.106685359	N/A	N/A	2595049.34
28	1/13/2009-2/23/2009	30	-0.688062629	N/A	N/A	N/A	0.100832772	N/A	N/A	1764476.01
29	1/27/2009-3/9/2009	30	-0.463599411	N/A	N/A	N/A	0.111630637	N/A	N/A	4648962.11
30	2/10/2009-3/23/2009	30	-0.634069898	N/A	N/A	N/A	0.119139860	N/A	N/A	7860288.91
31	2/24/2009-4/6/2009	30	-0.422347659	N/A	N/A	N/A	0.116124702	N/A	N/A	9079893.21
32	3/10/2009-4/20/2009	30	-0.404842149	N/A	N/A	N/A	0.104049615	N/A	N/A	8632391.72
33	3/24/2009-5/4/2009	30	-0.623613566	N/A	N/A	N/A	0.087594336	N/A	N/A	2332631.62
34	4/7/2009-5/18/2009	30	-0.638706473	N/A	N/A	N/A	0.074616425	N/A	N/A	2519537.24
35	4/21/2009-6/1/2009	30	-0.405724192	N/A	N/A	N/A	0.064566678	N/A	N/A	1942245.94
36	5/5/2009-6/15/2009	30	-0.480692029	N/A	N/A	N/A	0.055206805	N/A	N/A	759475.50
37	5/19/2009-6/29/2009	30	-0.665338256	N/A	N/A	N/A	0.052781038	N/A	N/A	208005.99
38	6/2/2009-7/13/2009	30	-0.460904456	N/A	N/A	N/A	0.053307919	N/A	N/A	246551.29
39	6/16/2009-7/27/2009	30	-0.574042783	N/A	N/A	N/A	0.062006766	N/A	N/A	446587.30
40	6/30/2009-8/10/2009	30	-0.566100279	N/A	N/A	N/A	0.054324353	N/A	N/A	1658212.34
41	7/14/2009-8/24/2009	30	-0.48175874	N/A	N/A	N/A	0.047090344	N/A	N/A	1150099.72
42	7/28/2009-9/7/2009	30	-0.423657312	N/A	N/A	N/A	0.042099496	N/A	N/A	242573.81
43	8/11/2009-9/21/2009	30	-0.603552884	N/A	N/A	N/A	0.040547943	N/A	N/A	401586.63
44	9/8/2009-10/6/2009	30	-0.529754293	N/A	N/A	N/A	0.036818590	N/A	N/A	651585.27

Average Sum of Squared Errors 1,556,120.83

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Alcoa Inc.   NYSE: AA   Industry: Steel

Model 2 Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.68144022	N/A	N/A	N/A	0.0069373555	0.000210581	N/A	118115.66
2	1/15/2008-2/25/2008	30	-0.558867365	N/A	N/A	N/A	0.0107546116	0.000205516	N/A	125222.47
3	1/29/2008-3/10/2008	30	-0.42658313	N/A	N/A	N/A	0.0140789293	0.000171636	N/A	68829.42
4	2/12/2008-3/24/2008	30	-0.50848912	N/A	N/A	N/A	0.0157157373	0.000145127	N/A	26678.31
5	2/26/2008-4/7/2008	30	-0.473212084	N/A	N/A	N/A	0.0145868143	0.000118126	N/A	61355.00
6	3/11/2008-4/21/2008	30	-0.505116266	N/A	N/A	N/A	0.0132839458	0.000108407	N/A	52408.29
7	3/25/2008-5/25/2008	30	-0.571249508	N/A	N/A	N/A	0.0108086643	0.000108124	N/A	42645.79
8	4/8/2008-5/19/2008	30	-0.612585517	N/A	N/A	N/A	0.0093366810	0.000120688	N/A	37839.82
9	4/22/2008-6/2/2008	30	-0.621098468	N/A	N/A	N/A	0.0080488903	0.000135715	N/A	13329.46
10	5/6/2008-6/16/2008	30	-0.689558632	N/A	N/A	N/A	0.0081459011	0.000147475	N/A	10623.95
11	5/20/2008-6/30/2008	30	-0.532875445	N/A	N/A	N/A	0.0083870618	0.000157895	N/A	10196.05
12	6/3/2008-7/14/2008	30	-0.50753563	N/A	N/A	N/A	0.0086715680	0.000171821	N/A	19044.21
13	6/17/2008-7/28/2008	30	-0.672763104	N/A	N/A	N/A	0.0089593231	0.000189983	N/A	19159.13
14	7/1/2008-8/11/2008	30	-0.436143374	N/A	N/A	N/A	0.0094751299	0.000199242	N/A	14604.41
15	7/15/2008-8/25/2008	30	-0.4104701	N/A	N/A	N/A	0.0100836330	0.000209762	N/A	22933.30
16	7/29/2008-9/8/2008	30	-0.549112946	N/A	N/A	N/A	0.0106777473	0.000221881	N/A	23079.23
17	8/12/2008-9/22/2008	30	-0.470939078	N/A	N/A	N/A	0.0113016141	0.000246440	N/A	23892.87
18	8/26/2008-10/6/2008	30	-0.44083227	N/A	N/A	N/A	0.0119402891	0.000272034	N/A	62500.70
19	9/9/2008-10/20/2008	30	-0.475053803	N/A	N/A	N/A	0.0184061313	0.000330284	N/A	1246122.69
20	9/23/2008-11/3/2008	30	-0.69080743	N/A	N/A	N/A	0.0331956228	0.000320582	N/A	2489040.67
21	10/7/2008-11/17/2008	30	-0.660945785	N/A	N/A	N/A	0.0461062862	0.000292430	N/A	698362.77
22	10/21/2008-12/1/2008	30	-0.574604853	N/A	N/A	N/A	0.0603610253	0.000261322	N/A	1575226.70
23	11/4/2008-12/15/2008	30	-0.493106083	N/A	N/A	N/A	0.0722733690	0.000332997	N/A	2872542.98
24	11/18/2008-12/29/2008	30	-0.531550497	N/A	N/A	N/A	0.0831776205	0.000378821	N/A	668745.82
25	12/2/2008-1/12/2009	30	-0.653895746	N/A	N/A	N/A	0.0841140759	0.000389418	N/A	373594.14
26	12/16/2008-1/26/2009	30	-0.659714632	N/A	N/A	N/A	0.0857623194	0.000408759	N/A	714652.78
27	12/30/2008-2/9/2009	30	-0.436344825	N/A	N/A	N/A	0.0993066243	0.000259169	N/A	1604728.53
28	1/13/2009-2/23/2009	30	-0.557177795	N/A	N/A	N/A	0.1051316110	-0.000148703	N/A	1107320.72
29	1/27/2009-3/9/2009	30	-0.475084203	N/A	N/A	N/A	0.1292485281	-0.000612801	N/A	2331027.34
30	2/10/2009-3/23/2009	30	-0.491300437	N/A	N/A	N/A	0.1757332345	-0.001293106	N/A	2970985.25
31	2/24/2009-4/6/2009	30	-0.589166185	N/A	N/A	N/A	0.1706262921	-0.001234046	N/A	3866831.79
32	3/10/2009-4/20/2009	30	-0.401899067	N/A	N/A	N/A	0.1466447491	-0.000878085	N/A	4580047.73
33	3/24/2009-5/4/2009	30	-0.469227601	N/A	N/A	N/A	0.0955934031	-0.000272245	N/A	1367515.54
34	4/7/2009-5/18/2009	30	-0.449465811	N/A	N/A	N/A	0.0763390228	-0.000057881	N/A	1630743.58
35	4/21/2009-6/1/2009	30	-0.52063448	N/A	N/A	N/A	0.0663207480	-0.000058561	N/A	1255059.73
36	5/5/2009-6/15/2009	30	-0.521294456	N/A	N/A	N/A	0.0569559845	-0.000057961	N/A	486165.57
37	5/19/2009-6/29/2009	30	-0.644735676	N/A	N/A	N/A	0.0542715809	-0.000049387	N/A	129749.62
38	6/2/2009-7/13/2009	30	-0.480631881	N/A	N/A	N/A	0.0533388957	-0.000001029	N/A	160255.98
39	6/16/2009-7/27/2009	30	-0.451622635	N/A	N/A	N/A	0.0601875079	0.000061037	N/A	284447.47
40	6/30/2009-8/10/2009	30	-0.507254848	N/A	N/A	N/A	0.0506745269	0.000121469	N/A	1053926.89
41	7/14/2009-8/24/2009	30	-0.651057345	N/A	N/A	N/A	0.0426174345	0.000147709	N/A	709778.82
42	7/28/2009-9/7/2009	30	-0.59332835	N/A	N/A	N/A	0.0367856144	0.000174423	N/A	105422.24
43	8/11/2009-9/21/2009	30	-0.605223994	N/A	N/A	N/A	0.0336678151	0.000225332	N/A	173178.42
44	9/8/2009-10/6/2009	30	-0.631777855	N/A	N/A	N/A	0.0273733686	0.000308158	N/A	256658.88

Average Sum of Squared Errors   806,013.42

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Alcoa Inc.   NYSE: AA   Industry: Steel

Model 3   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_2}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.548558659	N/A	0.324697032	N/A	0.004503283	N/A	0.026283702	213483.37
2	1/15/2008-2/25/2008	30	-0.565891165	N/A	0.322793514	N/A	0.005460925	N/A	0.036083268	208655.17
3	1/29/2008-3/10/2008	30	-0.666591105	N/A	0.300295652	N/A	0.006473351	N/A	0.038094878	135960.26
4	2/12/2008-3/24/2008	30	-0.511520321	N/A	0.309581689	N/A	0.006921649	N/A	0.038885467	71299.74
5	2/26/2008-4/7/2008	30	-0.596406266	N/A	0.310418187	N/A	0.005950406	N/A	0.035036866	95716.65
6	3/11/2008-4/21/2008	30	-0.683186378	N/A	0.305893879	N/A	0.005694044	N/A	0.031784991	82023.32
7	3/25/2008-5/25/2008	30	-0.533120533	N/A	0.298746280	N/A	0.004518391	N/A	0.027747246	70365.18
8	4/8/2008-5/19/2008	30	-0.487084985	N/A	0.299042371	N/A	0.00454136	N/A	0.025524566	30597.78
9	4/22/2008-6/2/2008	30	-0.682647083	N/A	0.305571996	N/A	0.004155541	N/A	0.024241006	53230.34
10	5/6/2008-6/16/2008	30	-0.597814401	N/A	0.313901486	N/A	0.004187621	N/A	0.024657994	54475.73
11	5/20/2008-6/30/2008	30	-0.694113751	N/A	0.303114106	N/A	0.004422237	N/A	0.027913177	61744.03
12	6/3/2008-7/14/2008	30	-0.544666581	N/A	0.300195516	N/A	0.004808171	N/A	0.026856938	13479.73
13	6/17/2008-7/28/2008	30	-0.475452137	N/A	0.319767881	N/A	0.004977515	N/A	0.029678243	95189.13
14	7/1/2008-8/11/2008	30	-0.478314377	N/A	0.313593488	N/A	0.00543426	N/A	0.032105841	97456.79
15	7/15/2008-8/25/2008	30	-0.515803103	N/A	0.323269374	N/A	0.005388188	N/A	0.034098588	118648.53
16	7/29/2008-9/8/2008	30	-0.442366271	N/A	0.342882046	N/A	0.005687584	N/A	0.035382907	125379.64
17	8/12/2008-9/22/2008	30	-0.542098652	N/A	0.322646202	N/A	0.006310996	N/A	0.039343572	138468.85
18	8/26/2008-10/6/2008	30	-0.441976975	N/A	0.345560805	N/A	0.006795093	N/A	0.039160289	206610.40
19	9/9/2008-10/20/2008	30	-0.45031736	N/A	0.377981208	N/A	0.010006089	N/A	0.054502574	997483.79
20	9/23/2008-11/3/2008	30	-0.518694086	N/A	0.431101692	N/A	0.014677222	N/A	0.082244178	1472762.85
21	10/7/2008-11/17/2008	30	-0.663672463	N/A	0.459408876	N/A	0.01876974	N/A	0.104784467	825215.90
22	10/21/2008-12/1/2008	30	-0.692754	N/A	0.507236625	N/A	0.021916479	N/A	0.138236508	1105266.75
23	11/4/2008-12/15/2008	30	-0.534861475	N/A	0.482388676	N/A	0.022624189	N/A	0.137339925	2661937.54
24	11/18/2008-12/29/2008	30	-0.505021232	N/A	0.482050068	N/A	0.032887925	N/A	0.191809688	870018.16
25	12/2/2008-1/12/2009	30	-0.580145048	N/A	0.474569348	N/A	0.032590244	N/A	0.190091069	588816.26
26	12/16/2008-1/26/2009	30	-0.695472166	N/A	0.489001403	N/A	0.033966975	N/A	0.195756565	851438.78
27	12/30/2008-2/9/2009	30	-0.416842568	N/A	0.545950922	N/A	0.03637061	N/A	0.205932758	1763497.32
28	1/13/2009-2/23/2009	30	-0.640128639	N/A	0.561842154	N/A	0.033670075	N/A	0.198294778	1177273.56
29	1/27/2009-3/9/2009	30	-0.633675875	N/A	0.605033112	N/A	0.038116472	N/A	0.218002194	3059174.94
30	2/10/2009-3/23/2009	30	-0.616002731	N/A	0.598077211	N/A	0.040340323	N/A	0.249049828	5313606.23
31	2/24/2009-4/6/2009	30	-0.535921313	N/A	0.563206502	N/A	0.040175615	N/A	0.2234741	6192156.97
32	3/10/2009-4/20/2009	30	-0.623818724	N/A	0.487526721	N/A	0.034999555	N/A	0.218161435	5834571.53
33	3/24/2009-5/4/2009	30	-0.483850993	N/A	0.520376437	N/A	0.030546203	N/A	0.179214787	1493997.41
34	4/7/2009-5/18/2009	30	-0.607454177	N/A	0.505512169	N/A	0.02554764	N/A	0.146227815	1728718.24
35	4/21/2009-6/1/2009	30	-0.624757254	N/A	0.487262639	N/A	0.021366427	N/A	0.125004082	1327677.54
36	5/5/2009-6/15/2009	30	-0.591897966	N/A	0.448387001	N/A	0.019321076	N/A	0.112003777	498792.84
37	5/19/2009-6/29/2009	30	-0.439039589	N/A	0.466669984	N/A	0.01696719	N/A	0.108339014	133136.03
38	6/2/2009-7/13/2009	30	-0.436432578	N/A	0.469774953	N/A	0.01752838	N/A	0.110307688	165915.70
39	6/16/2009-7/27/2009	30	-0.666935683	N/A	0.433544727	N/A	0.020856595	N/A	0.123895623	291784.33
40	6/30/2009-8/10/2009	30	-0.478359594	N/A	0.451562793	N/A	0.018213719	N/A	0.103706528	909301.25
41	7/14/2009-8/24/2009	30	-0.614707179	N/A	0.425068252	N/A	0.014936599	N/A	0.091779505	592997.72
42	7/28/2009-9/7/2009	30	-0.469469866	N/A	0.410878205	N/A	0.014304561	N/A	0.086975494	155435.80
43	8/11/2009-9/21/2009	30	-0.417872918	N/A	0.408599999	N/A	0.013704304	N/A	0.082435361	260023.98
44	9/8/2009-10/6/2009	30	-0.567189558	N/A	0.432660442	N/A	0.011776356	N/A	0.076766921	456231.03

Average Sum of Squared Errors   968,182.21

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Alcoa Inc.</u>　　　NYSE: 　　　<u>AA</u>　　　Industry: <u>Steel</u>

Model 4　Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 + b_1 t}}$　Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$　Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.537708495	N/A	0.327706444	-0.000032893	0.004455363	N/A	0.026277707	201574.32
2	1/15/2008-2/25/2008	30	-0.585335896	N/A	0.305139497	0.000066411	0.005531685	N/A	0.036020174	204255.00
3	1/29/2008-3/10/2008	30	-0.422204925	N/A	0.296394917	-0.000010635	0.006773294	N/A	0.038425903	127067.06
4	2/12/2008-3/24/2008	30	-0.581522950	N/A	0.321233455	0.000021164	0.006429592	N/A	0.040801079	66418.51
5	2/26/2008-4/7/2008	30	-0.531274240	N/A	0.300086126	0.000036545	0.006145973	N/A	0.037079174	87865.85
6	3/11/2008-4/21/2008	30	-0.542491365	N/A	0.310152104	-0.000063761	0.005753242	N/A	0.034995019	75700.15
7	3/25/2008-5/25/2008	30	-0.584011800	N/A	0.325622675	-0.000027652	0.004778884	N/A	0.028898247	67565.61
8	4/8/2008-5/19/2008	30	-0.664208540	N/A	0.315904040	-0.000080297	0.004493143	N/A	0.026545443	30535.62
9	4/22/2008-6/2/2008	30	-0.656362071	N/A	0.304129067	-0.000081227	0.004191821	N/A	0.023359119	49784.19
10	5/6/2008-6/16/2008	30	-0.677836467	N/A	0.304117761	0.000091746	0.004099462	N/A	0.025756206	51211.76
11	5/20/2008-6/30/2008	30	-0.666767171	N/A	0.300569501	-0.000021238	0.004542946	N/A	0.025300387	58859.48
12	6/3/2008-7/14/2008	30	-0.611339000	N/A	0.318932943	-0.000070037	0.004779102	N/A	0.029333668	12460.02
13	6/17/2008-7/28/2008	30	-0.451350294	N/A	0.320640496	-0.000048327	0.004753697	N/A	0.028402550	89425.85
14	7/1/2008-8/11/2008	30	-0.487683983	N/A	0.316959972	-0.000011331	0.005103538	N/A	0.032605206	91444.34
15	7/15/2008-8/25/2008	30	-0.548674893	N/A	0.313470009	0.000010062	0.005358352	N/A	0.031660479	110918.76
16	7/29/2008-9/8/2008	30	-0.498072071	N/A	0.334460183	-0.000021313	0.006159330	N/A	0.034002452	119733.09
17	8/12/2008-9/22/2008	30	-0.654289593	N/A	0.320597942	0.000068573	0.006252212	N/A	0.038686081	121208.49
18	8/26/2008-10/6/2008	30	-0.550403010	N/A	0.352093278	0.000064529	0.006910381	N/A	0.041635257	201094.81
19	9/9/2008-10/20/2008	30	-0.459480742	N/A	0.384587821	-0.000067921	0.009756583	N/A	0.056269943	927879.60
20	9/23/2008-11/3/2008	30	-0.592412157	N/A	0.423022717	-0.000008428	0.014828642	N/A	0.089851706	1374611.11
21	10/7/2008-11/17/2008	30	-0.553397297	N/A	0.488367946	0.000075319	0.018432657	N/A	0.105631508	796981.48
22	10/21/2008-12/1/2008	30	-0.586186060	N/A	0.472543674	0.000094074	0.022771974	N/A	0.142239171	1078512.59
23	11/4/2008-12/15/2008	30	-0.649620529	N/A	0.483256317	-0.000074752	0.023425614	N/A	0.133604557	2480616.65
24	11/18/2008-12/29/2008	30	-0.438325042	N/A	0.481966437	-0.000069234	0.029940167	N/A	0.181526016	862984.21
25	12/2/2008-1/12/2009	30	-0.415360168	N/A	0.509692303	0.000060671	0.032775637	N/A	0.190722774	565305.19
26	12/16/2008-1/26/2009	30	-0.656000992	N/A	0.475525281	0.000069001	0.031173335	N/A	0.188722076	826566.52
27	12/30/2008-2/9/2009	30	-0.503408246	N/A	0.542915181	0.000094733	0.036383659	N/A	0.218199344	1676350.55
28	1/13/2009-2/23/2009	30	-0.532960787	N/A	0.587996305	0.000035710	0.033113682	N/A	0.211207317	1142227.58
29	1/27/2009-3/9/2009	30	-0.401534668	N/A	0.617879452	0.000009620	0.038518498	N/A	0.226027205	3015111.70
30	2/10/2009-3/23/2009	30	-0.596459785	N/A	0.565532975	0.000055198	0.038503112	N/A	0.236034257	5160170.44
31	2/24/2009-4/6/2009	30	-0.633199657	N/A	0.535822891	0.000018280	0.040637330	N/A	0.229461673	5980374.48
32	3/10/2009-4/20/2009	30	-0.665218919	N/A	0.500347873	0.000065966	0.033400082	N/A	0.203804004	5555057.15
33	3/24/2009-5/4/2009	30	-0.417409938	N/A	0.506962453	-0.000091045	0.029929994	N/A	0.182036042	1215515.60
34	4/7/2009-5/18/2009	30	-0.688831937	N/A	0.466179090	-0.000095465	0.023763165	N/A	0.151923926	1613806.49
35	4/21/2009-6/1/2009	30	-0.567500981	N/A	0.490185295	-0.000034925	0.020861457	N/A	0.133287268	1267998.71
36	5/5/2009-6/15/2009	30	-0.463693984	N/A	0.478267341	-0.000081366	0.017507149	N/A	0.111224413	472305.48
37	5/19/2009-6/29/2009	30	-0.641046198	N/A	0.460722779	0.000089056	0.017185313	N/A	0.109305388	125205.03
38	6/2/2009-7/13/2009	30	-0.415869494	N/A	0.463479178	-0.000034059	0.018058838	N/A	0.106118895	163140.31
39	6/16/2009-7/27/2009	30	-0.524444879	N/A	0.441232407	-0.000013130	0.020848418	N/A	0.129990800	289966.92
40	6/30/2009-8/10/2009	30	-0.599644225	N/A	0.456293395	-0.000037520	0.018459352	N/A	0.104201851	893284.12
41	7/14/2009-8/24/2009	30	-0.608169561	N/A	0.437996580	-0.000087565	0.016073791	N/A	0.091978942	546347.46
42	7/28/2009-9/7/2009	30	-0.573716328	N/A	0.426027864	0.000009654	0.013904315	N/A	0.085435944	136106.38
43	8/11/2009-9/21/2009	30	-0.497174158	N/A	0.426709751	0.000008130	0.013945131	N/A	0.083641252	241229.97
44	9/8/2009-10/6/2009	30	-0.664771814	N/A	0.399365001	0.000076130	0.012386278	N/A	0.071050860	419096.44

Average Sum of Squared Errors　922,588.07

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	Alcoa Inc.		NYSE:	AA		Industry:	Steel		

Model 5 Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.099723991	-43.519751532	N/A	N/A	0.006763354	0.000200281	N/A	100969.02
2	1/15/2008-2/25/2008	30	-0.066784347	-40.738796477	N/A	N/A	0.011187584	0.000204826	N/A	110027.49
3	1/29/2008-3/10/2008	30	-0.066299349	-47.583828501	N/A	N/A	0.013712917	0.000173262	N/A	56924.64
4	2/12/2008-3/24/2008	30	-0.037616838	-43.552303267	N/A	N/A	0.016286428	0.000141844	N/A	23346.86
5	2/26/2008-4/7/2008	30	-0.096785987	-42.179908382	N/A	N/A	0.015273653	0.000118031	N/A	54488.48
6	3/11/2008-4/21/2008	30	-0.095448353	-48.144426305	N/A	N/A	0.012922394	0.000104172	N/A	45939.61
7	3/25/2008-5/25/2008	30	0.071521857	-40.651087293	N/A	N/A	0.011230543	0.000109209	N/A	37166.31
8	4/8/2008-5/19/2008	30	0.012541045	-41.736543649	N/A	N/A	0.009782863	0.000115410	N/A	33207.94
9	4/22/2008-6/2/2008	30	-0.077048075	-47.866804933	N/A	N/A	0.007720338	0.000130503	N/A	11439.36
10	5/6/2008-6/16/2008	30	0.050097672	-44.786207312	N/A	N/A	0.007764926	0.000150226	N/A	9276.97
11	5/20/2008-6/30/2008	30	-0.047033713	-44.419597750	N/A	N/A	0.008177676	0.000156962	N/A	8490.31
12	6/3/2008-7/14/2008	30	0.076917022	-44.105189448	N/A	N/A	0.008528387	0.000166448	N/A	17064.97
13	6/17/2008-7/28/2008	30	0.046146358	-41.061295749	N/A	N/A	0.009055188	0.000181591	N/A	16745.22
14	7/1/2008-8/11/2008	30	-0.054919654	-46.074403968	N/A	N/A	0.009687252	0.000202879	N/A	12742.18
15	7/15/2008-8/25/2008	30	-0.011687612	-48.177977445	N/A	N/A	0.009888969	0.000204924	N/A	20485.81
16	7/29/2008-9/8/2008	30	-0.007183207	-46.662318610	N/A	N/A	0.010285098	0.000216539	N/A	20812.38
17	8/12/2008-9/22/2008	30	-0.022697241	-45.959192017	N/A	N/A	0.011070707	0.000255376	N/A	21070.27
18	8/26/2008-10/6/2008	30	-0.097697039	-40.086795872	N/A	N/A	0.011919693	0.000281134	N/A	52859.54
19	9/9/2008-10/20/2008	30	0.003854847	-41.232034516	N/A	N/A	0.018110335	0.000317852	N/A	1036106.87
20	9/23/2008-11/3/2008	30	-0.073220617	-41.478512740	N/A	N/A	0.034292629	0.000333167	N/A	2249551.20
21	10/7/2008-11/17/2008	30	0.058642182	-45.997412768	N/A	N/A	0.044773269	0.000281021	N/A	628099.46
22	10/21/2008-12/1/2008	30	-0.063879087	-47.614219631	N/A	N/A	0.057638477	0.000254596	N/A	1407714.94
23	11/4/2008-12/15/2008	30	-0.010662817	-40.384669291	N/A	N/A	0.072026402	0.000346663	N/A	2483266.87
24	11/18/2008-12/29/2008	30	-0.040589239	-48.141469393	N/A	N/A	0.083352421	0.000389181	N/A	606326.41
25	12/2/2008-1/12/2009	30	0.054495270	-40.131425272	N/A	N/A	0.087811731	0.000400720	N/A	307727.72
26	12/16/2008-1/26/2009	30	-0.070602226	-40.343134344	N/A	N/A	0.084947594	0.000410262	N/A	645372.32
27	12/30/2008-2/9/2009	30	0.002751721	-46.334314628	N/A	N/A	0.097329685	0.000257144	N/A	1340994.83
28	1/13/2009-2/23/2009	30	0.007563586	-48.406724323	N/A	N/A	0.102073889	-0.000149716	N/A	962116.70
29	1/27/2009-3/9/2009	30	0.077077282	-42.065657317	N/A	N/A	0.128141847	-0.000627429	N/A	2098349.87
30	2/10/2009-3/23/2009	30	0.059657595	-43.186832532	N/A	N/A	0.181519236	-0.001335773	N/A	2676613.69
31	2/24/2009-4/6/2009	30	0.043927921	-46.851861070	N/A	N/A	0.170596403	-0.001179957	N/A	3435575.08
32	3/10/2009-4/20/2009	30	-0.096351267	-45.663906982	N/A	N/A	0.145606462	-0.000917481	N/A	4067865.53
33	3/24/2009-5/4/2009	30	-0.051479145	-45.853901891	N/A	N/A	0.098637091	-0.000269977	N/A	1152417.22
34	4/7/2009-5/18/2009	30	0.040298923	-41.166090274	N/A	N/A	0.077259710	-0.000057747	N/A	1421016.69
35	4/21/2009-6/1/2009	30	0.029008506	-40.079656312	N/A	N/A	0.063171656	-0.000058183	N/A	1089647.63
36	5/5/2009-6/15/2009	30	0.004544610	-48.435386608	N/A	N/A	0.055264127	-0.000056672	N/A	405008.02
37	5/19/2009-6/29/2009	30	-0.074399795	-41.998217435	N/A	N/A	0.052308689	-0.000050048	N/A	115191.88
38	6/2/2009-7/13/2009	30	-0.000863217	-43.424686001	N/A	N/A	0.050704326	-0.000001040	N/A	138201.89
39	6/16/2009-7/27/2009	30	-0.094148814	-42.859419631	N/A	N/A	0.062862934	0.000060945	N/A	246641.72
40	6/30/2009-8/10/2009	30	0.056581232	-43.885443491	N/A	N/A	0.052193686	0.000121352	N/A	909036.34
41	7/14/2009-8/24/2009	30	0.077048925	-40.295385984	N/A	N/A	0.043114469	0.000152212	N/A	594774.11
42	7/28/2009-9/7/2009	30	-0.066667801	-48.009717622	N/A	N/A	0.035599269	0.000180221	N/A	93262.90
43	8/11/2009-9/21/2009	30	0.053310942	-41.818318525	N/A	N/A	0.034420977	0.000219555	N/A	146623.82
44	9/8/2009-10/6/2009	30	-0.072237514	-44.287203765	N/A	N/A	0.027335222	0.000297688	N/A	230531.84

Average Sum of Squared Errors 707,752.11

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Alcoa Inc.</u> NYSE: <u>AA</u> Industry: <u>Steel</u>

Model 6 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.039078363	-45.307144791	0.313254751	N/A	0.004590864	N/A	0.028203531	166421.41
2	1/15/2008-2/25/2008	30	-0.029551485	-46.103605088	0.332155634	N/A	0.005632422	N/A	0.035511976	180901.42
3	1/29/2008-3/10/2008	30	-0.054535667	-47.765638843	0.299948492	N/A	0.006355357	N/A	0.039998212	111727.88
4	2/12/2008-3/24/2008	30	-0.033080386	-42.332433519	0.306847689	N/A	0.006492298	N/A	0.038840598	55979.32
5	2/26/2008-4/7/2008	30	0.076296615	-40.280638813	0.298444781	N/A	0.006142459	N/A	0.037865455	73924.28
6	3/11/2008-4/21/2008	30	0.045723944	-46.347179494	0.311892643	N/A	0.005710620	N/A	0.032429419	64479.68
7	3/25/2008-5/25/2008	30	-0.041739514	-43.123107464	0.309878930	N/A	0.004938987	N/A	0.027210493	54608.89
8	4/8/2008-5/19/2008	30	-0.003842829	-47.731654669	0.295206720	N/A	0.004179150	N/A	0.027237118	25954.70
9	4/22/2008-6/2/2008	30	-0.033330434	-47.837282856	0.292272265	N/A	0.004072133	N/A	0.023894666	44425.87
10	5/6/2008-6/16/2008	30	-0.022793783	-45.894413071	0.307339576	N/A	0.004243536	N/A	0.024303865	43610.38
11	5/20/2008-6/30/2008	30	0.092327346	-42.170760583	0.315591359	N/A	0.004647614	N/A	0.026110735	49445.68
12	6/3/2008-7/14/2008	30	-0.096854526	-44.840719182	0.312117992	N/A	0.004632012	N/A	0.028638150	10124.85
13	6/17/2008-7/28/2008	30	0.057135265	-42.839284463	0.320925838	N/A	0.004751800	N/A	0.030074860	72306.51
14	7/1/2008-8/11/2008	30	0.029807930	-39.936973497	0.331517802	N/A	0.005114501	N/A	0.030787752	75804.13
15	7/15/2008-8/25/2008	30	-0.072203439	-46.963162147	0.333817475	N/A	0.005343904	N/A	0.032078248	89226.52
16	7/29/2008-9/8/2008	30	0.093970279	-40.833094388	0.338075059	N/A	0.005693654	N/A	0.036903548	104035.20
17	8/12/2008-9/22/2008	30	0.088812386	-43.368564770	0.324295281	N/A	0.006311679	N/A	0.038126443	123660.78
18	8/26/2008-10/6/2008	30	-0.047103040	-47.438079996	0.345988645	N/A	0.007044422	N/A	0.039458552	163705.34
19	9/9/2008-10/20/2008	30	0.053398789	-43.203698197	0.404490523	N/A	0.009138624	N/A	0.059811598	825718.40
20	9/23/2008-11/3/2008	30	-0.036012478	-46.683010186	0.440995371	N/A	0.014807009	N/A	0.086729400	1144978.61
21	10/7/2008-11/17/2008	30	-0.012471185	-40.392388058	0.469601425	N/A	0.018506174	N/A	0.109704661	698276.90
22	10/21/2008-12/1/2008	30	0.023468316	-45.813745238	0.505606786	N/A	0.023688547	N/A	0.132761914	930892.90
23	11/4/2008-12/15/2008	30	0.075437353	-44.109606558	0.498172494	N/A	0.023919087	N/A	0.147382448	2117429.49
24	11/18/2008-12/29/2008	30	-0.046620482	-40.140643059	0.476211047	N/A	0.031047375	N/A	0.179517068	754344.74
25	12/2/2008-1/12/2009	30	-0.004607812	-42.562577202	0.482092136	N/A	0.031546563	N/A	0.184992178	487687.03
26	12/16/2008-1/26/2009	30	0.053211357	-45.082772437	0.509766281	N/A	0.033413724	N/A	0.199680821	715802.32
27	12/30/2008-2/9/2009	30	0.020043799	-41.410923946	0.519673319	N/A	0.036103418	N/A	0.206299402	1434126.20
28	1/13/2009-2/23/2009	30	0.025229048	-47.021359055	0.554343339	N/A	0.033879962	N/A	0.206928003	1001169.70
29	1/27/2009-3/9/2009	30	0.076484374	-47.001164582	0.623327088	N/A	0.037444676	N/A	0.214651829	2465814.07
30	2/10/2009-3/23/2009	30	-0.096709582	-41.835746942	0.598044016	N/A	0.040508439	N/A	0.241330143	4491737.88
31	2/24/2009-4/6/2009	30	-0.069676362	-44.342133561	0.539765290	N/A	0.038821334	N/A	0.221442446	5080846.01
32	3/10/2009-4/20/2009	30	-0.071559261	-45.003572928	0.491029558	N/A	0.034654936	N/A	0.208060373	4894614.90
33	3/24/2009-5/4/2009	30	-0.005061101	-44.988834577	0.482316607	N/A	0.030143852	N/A	0.168751859	1282289.66
34	4/7/2009-5/18/2009	30	0.083822514	-44.439980407	0.495701293	N/A	0.024843297	N/A	0.156508537	1428349.32
35	4/21/2009-6/1/2009	30	-0.039407739	-43.484952282	0.474736395	N/A	0.022523790	N/A	0.126942555	1069928.20
36	5/5/2009-6/15/2009	30	-0.002813279	-40.898003695	0.480997720	N/A	0.018250377	N/A	0.114518276	401132.26
37	5/19/2009-6/29/2009	30	0.041175597	-42.064338645	0.464134350	N/A	0.017025825	N/A	0.105416470	120316.78
38	6/2/2009-7/13/2009	30	-0.007890319	-47.552921860	0.475232590	N/A	0.017524645	N/A	0.106089492	139220.46
39	6/16/2009-7/27/2009	30	-0.041099422	-44.495937279	0.464281841	N/A	0.020080335	N/A	0.119606596	243457.52
40	6/30/2009-8/10/2009	30	0.066541737	-43.173704475	0.436368932	N/A	0.017938253	N/A	0.105490248	714961.98
41	7/14/2009-8/24/2009	30	0.088344976	-48.158032753	0.432793050	N/A	0.015523374	N/A	0.096083111	486237.52
42	7/28/2009-9/7/2009	30	-0.064576482	-41.648268440	0.418938837	N/A	0.014515938	N/A	0.087338732	134827.26
43	8/11/2009-9/21/2009	30	-0.060996923	-44.082693326	0.439530466	N/A	0.013180248	N/A	0.078501111	226713.91
44	9/8/2009-10/6/2009	30	-0.071311316	-46.730771224	0.410513481	N/A	0.012151035	N/A	0.074856839	358961.18

Average Sum of Squared Errors 799,094.96

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Alcoa Inc.</u>   NYSE: <u>AA</u>   Industry: <u>Steel</u>

Model 7 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.063583793	-40.726896514	0.316315548	0.000081655	0.004341313	N/A	0.026534989	150646.18
2	1/15/2008-2/25/2008	30	-0.077300059	-48.581579047	0.325224561	0.000075546	0.005641697	N/A	0.033955040	164698.42
3	1/29/2008-3/10/2008	30	-0.001703924	-46.013848756	0.308565918	-0.000088356	0.006552982	N/A	0.038402261	104885.13
4	2/12/2008-3/24/2008	30	0.022334801	-47.033415217	0.301583889	-0.000097077	0.006511902	N/A	0.038744485	55309.44
5	2/26/2008-4/7/2008	30	0.009501530	-43.312390969	0.306001171	-0.000024476	0.005944445	N/A	0.038233232	72326.49
6	3/11/2008-4/21/2008	30	0.099632467	-44.117484751	0.296385239	0.000023707	0.005335929	N/A	0.032895074	55786.03
7	3/25/2008-5/25/2008	30	0.070465937	-40.436986453	0.296411462	-0.000093394	0.004831476	N/A	0.029836537	50038.53
8	4/8/2008-5/19/2008	30	-0.084849121	-43.874697263	0.304884449	-0.000008721	0.004577811	N/A	0.027005130	25111.11
9	4/22/2008-6/2/2008	30	0.062146760	-46.648287438	0.295228751	0.000014446	0.004169109	N/A	0.023477284	40583.38
10	5/6/2008-6/16/2008	30	-0.071706516	-41.059203995	0.302120625	-0.000080263	0.004435732	N/A	0.024534099	39260.98
11	5/20/2008-6/30/2008	30	0.058941699	-40.395604789	0.305440507	-0.000078556	0.004659386	N/A	0.025654378	47168.60
12	6/3/2008-7/14/2008	30	-0.085022361	-39.983903921	0.323249807	0.000005975	0.004506037	N/A	0.027151613	10039.16
13	6/17/2008-7/28/2008	30	-0.002683599	-43.123173363	0.325693271	0.000034682	0.004898735	N/A	0.030298019	70644.57
14	7/1/2008-8/11/2008	30	-0.076717435	-42.410240192	0.333538289	-0.000012307	0.005474814	N/A	0.031718237	74999.95
15	7/15/2008-8/25/2008	30	-0.025013734	-40.034608482	0.309576085	-0.000026686	0.005332277	N/A	0.032495068	85441.57
16	7/29/2008-9/8/2008	30	0.007317324	-44.181404664	0.339275772	-0.000035368	0.005990610	N/A	0.034265011	94156.25
17	8/12/2008-9/22/2008	30	-0.085975872	-46.180557598	0.325623942	-0.000093804	0.006118830	N/A	0.037825004	112282.86
18	8/26/2008-10/6/2008	30	-0.050511213	-42.389430947	0.361822410	-0.000029849	0.006724458	N/A	0.041188711	146918.56
19	9/9/2008-10/20/2008	30	0.051914097	-40.809020347	0.384416788	-0.000014853	0.009813172	N/A	0.056172984	742941.80
20	9/23/2008-11/3/2008	30	-0.039596057	-43.673018716	0.449753657	-0.000018733	0.013775135	N/A	0.083193160	1110357.38
21	10/7/2008-11/17/2008	30	0.067607084	-40.798826217	0.464198078	-0.000026575	0.018999223	N/A	0.107455530	672259.69
22	10/21/2008-12/1/2008	30	-0.038730763	-40.113793817	0.486417263	0.000066673	0.023662050	N/A	0.133014191	898381.90
23	11/4/2008-12/15/2008	30	0.081488232	-46.794553755	0.496809984	-0.000042099	0.024470197	N/A	0.139609266	2066551.95
24	11/18/2008-12/29/2008	30	-0.065346460	-45.802521715	0.503393214	-0.000098607	0.029861494	N/A	0.190952548	715300.03
25	12/2/2008-1/12/2009	30	-0.062378334	-45.480642425	0.470021596	0.000014213	0.032675578	N/A	0.192424493	485346.33
26	12/16/2008-1/26/2009	30	-0.099341616	-44.755841643	0.495920388	0.000068086	0.031812455	N/A	0.190621633	712748.96
27	12/30/2008-2/9/2009	30	0.081634502	-43.052644562	0.527406324	0.000048128	0.036025678	N/A	0.217988248	1349589.51
28	1/13/2009-2/23/2009	30	0.066252637	-46.724141641	0.603836273	-0.000015204	0.031976297	N/A	0.210132089	950179.81
29	1/27/2009-3/9/2009	30	-0.029502583	-48.528235205	0.625597550	-0.000000985	0.036428423	N/A	0.212908640	2373751.85
30	2/10/2009-3/23/2009	30	0.005797018	-45.473066946	0.580750814	-0.000080711	0.037958012	N/A	0.234294761	4460316.69
31	2/24/2009-4/6/2009	30	0.035662864	-47.757871007	0.551528338	-0.000043676	0.039021473	N/A	0.240936616	4841277.29
32	3/10/2009-4/20/2009	30	0.004362446	-46.001173894	0.490909321	-0.000072299	0.035329006	N/A	0.212774128	4479405.33
33	3/24/2009-5/4/2009	30	0.025780508	-46.326748146	0.480857057	-0.000045583	0.029046296	N/A	0.180066548	1020071.56
34	4/7/2009-5/18/2009	30	-0.061374656	-46.037253413	0.478714877	0.000078907	0.024267774	N/A	0.146871534	1308564.92
35	4/21/2009-6/1/2009	30	0.024543168	-42.532935140	0.487651826	0.000080124	0.021830264	N/A	0.123627369	900048.30
36	5/5/2009-6/15/2009	30	0.061055103	-46.141883709	0.466976054	-0.000007326	0.019126483	N/A	0.115535227	390252.20
37	5/19/2009-6/29/2009	30	-0.059552792	-45.075312301	0.462159112	0.000083183	0.018289772	N/A	0.108142762	111055.31
38	6/2/2009-7/13/2009	30	0.031379626	-46.690167614	0.467528981	-0.000025258	0.017754801	N/A	0.111860405	131297.55
39	6/16/2009-7/27/2009	30	0.003301915	-40.365969457	0.443175895	-0.000043098	0.020349601	N/A	0.125703034	231998.62
40	6/30/2009-8/10/2009	30	0.042627764	-45.994974751	0.420105392	0.000046599	0.017425313	N/A	0.107769950	710324.93
41	7/14/2009-8/24/2009	30	-0.006209198	-44.926867265	0.418040323	0.000086884	0.015597182	N/A	0.091126256	438406.40
42	7/28/2009-9/7/2009	30	-0.033235054	-44.004502158	0.442042365	-0.000078404	0.013459263	N/A	0.087677993	130312.68
43	8/11/2009-9/21/2009	30	-0.022441747	-44.361745589	0.414701983	-0.000078260	0.013319767	N/A	0.082020682	206942.30
44	9/8/2009-10/6/2009	30	-0.050871065	-41.731568977	0.421691821	-0.000094844	0.012255620	N/A	0.075836054	336194.71

Average Sum of Squared Errors   753,958.53

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Alcoa Inc.</u>   NYSE: <u>AA</u>   Industry: <u>Steel</u>

Model 8   Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{1}{s_0}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.521104817	N/A	0.315460330	N/A	0.006702523	0.000131085	0.011170003	98990.14
2	1/15/2008-2/25/2008	30	-0.668277819	N/A	0.309465545	N/A	0.010694828	0.000118401	0.013345968	97341.81
3	1/29/2008-3/10/2008	30	-0.635376316	N/A	0.301799910	N/A	0.014727891	0.000098134	0.015802497	53960.82
4	2/12/2008-3/24/2008	30	-0.493297163	N/A	0.305704051	N/A	0.016469007	0.000084223	0.015944368	21156.01
5	2/26/2008-4/7/2008	30	-0.693947754	N/A	0.312320535	N/A	0.014900164	0.000068009	0.014754251	46654.24
6	3/11/2008-4/21/2008	30	-0.642410515	N/A	0.323427328	N/A	0.013049166	0.000067461	0.012833983	41577.97
7	3/25/2008-5/25/2008	30	-0.690076026	N/A	0.312854752	N/A	0.010520452	0.000063090	0.010933583	32584.22
8	4/8/2008-5/19/2008	30	-0.413334963	N/A	0.304107480	N/A	0.009363351	0.000069030	0.010655449	30593.98
9	4/22/2008-6/2/2008	30	-0.596604231	N/A	0.290441021	N/A	0.007971360	0.000082238	0.009564397	11066.85
10	5/6/2008-6/16/2008	30	-0.407973868	N/A	0.300224208	N/A	0.008442639	0.000087158	0.010576785	8289.82
11	5/20/2008-6/30/2008	30	-0.475519335	N/A	0.321436247	N/A	0.008615389	0.000096258	0.010391624	8394.65
12	6/3/2008-7/14/2008	30	-0.661447355	N/A	0.316197267	N/A	0.008850877	0.000107769	0.010685083	12998.02
13	6/17/2008-7/28/2008	30	-0.592707442	N/A	0.304987371	N/A	0.008626089	0.000112423	0.011496096	15484.82
14	7/1/2008-8/11/2008	30	-0.483991002	N/A	0.323090082	N/A	0.009593550	0.000114708	0.012188775	11812.81
15	7/15/2008-8/25/2008	30	-0.512888305	N/A	0.306712698	N/A	0.010349233	0.000130845	0.013588641	18689.55
16	7/29/2008-9/8/2008	30	-0.606446215	N/A	0.319280801	N/A	0.011068252	0.000134707	0.013630407	18518.81
17	8/12/2008-9/22/2008	30	-0.519741783	N/A	0.347009348	N/A	0.011435344	0.000144488	0.014907400	19524.91
18	8/26/2008-10/6/2008	30	-0.527545053	N/A	0.359405884	N/A	0.012221628	0.000155739	0.016417727	50115.95
19	9/9/2008-10/20/2008	30	-0.665943447	N/A	0.402057237	N/A	0.018396732	0.000189183	0.022192435	952992.36
20	9/23/2008-11/3/2008	30	-0.517636318	N/A	0.453131372	N/A	0.034077353	0.000185494	0.034867506	1452849.27
21	10/7/2008-11/17/2008	30	-0.699111679	N/A	0.468059942	N/A	0.044803893	0.000174252	0.042869252	537533.83
22	10/21/2008-12/1/2008	30	-0.586757562	N/A	0.492900750	N/A	0.063298623	0.000154789	0.052801368	1028927.99
23	11/4/2008-12/15/2008	30	-0.406496240	N/A	0.470310047	N/A	0.072940132	0.000195503	0.054439245	2294455.99
24	11/18/2008-12/29/2008	30	-0.676648477	N/A	0.504987970	N/A	0.081585601	0.000217460	0.078105891	513938.81
25	12/2/2008-1/12/2009	30	-0.548879110	N/A	0.508555482	N/A	0.086934697	0.000239936	0.074180898	286182.99
26	12/16/2008-1/26/2009	30	-0.577324863	N/A	0.494400611	N/A	0.087579133	0.000239839	0.077683254	580902.44
27	12/30/2008-2/9/2009	30	-0.665036020	N/A	0.534093527	N/A	0.097491621	0.000158169	0.085748620	1267384.41
28	1/13/2009-2/23/2009	30	-0.616541081	N/A	0.603073877	N/A	0.107729522	-0.000084935	0.083660168	919245.92
29	1/27/2009-3/9/2009	30	-0.502363962	N/A	0.585047564	N/A	0.127181057	-0.000351567	0.091795168	1791855.83
30	2/10/2009-3/23/2009	30	-0.403937973	N/A	0.588437009	N/A	0.177823063	-0.000807089	0.090857776	2305474.89
31	2/24/2009-4/6/2009	30	-0.506451298	N/A	0.541116993	N/A	0.171867431	-0.000766022	0.097525057	2955648.09
32	3/10/2009-4/20/2009	30	-0.516839567	N/A	0.524810922	N/A	0.144439091	-0.000547072	0.080921130	3532868.16
33	3/24/2009-5/4/2009	30	-0.456379322	N/A	0.492690427	N/A	0.094156608	-0.000168633	0.067655583	1069829.15
34	4/7/2009-5/18/2009	30	-0.642675006	N/A	0.476122626	N/A	0.076687961	-0.000035186	0.058071656	1293123.06
35	4/21/2009-6/1/2009	30	-0.487763880	N/A	0.454639289	N/A	0.063188521	-0.000035170	0.052231708	975636.81
36	5/5/2009-6/15/2009	30	-0.671399991	N/A	0.459926903	N/A	0.058684387	-0.000034394	0.042592322	374999.69
37	5/19/2009-6/29/2009	30	-0.607930427	N/A	0.470098588	N/A	0.053142817	-0.000030474	0.040932065	108867.07
38	6/2/2009-7/13/2009	30	-0.438989528	N/A	0.468232285	N/A	0.053810639	-0.000000593	0.043914240	128521.76
39	6/16/2009-7/27/2009	30	-0.635111311	N/A	0.458335303	N/A	0.058863595	0.000035503	0.050656981	235933.41
40	6/30/2009-8/10/2009	30	-0.416040535	N/A	0.452286358	N/A	0.052310149	0.000072786	0.042251229	806908.64
41	7/14/2009-8/24/2009	30	-0.526669048	N/A	0.454508455	N/A	0.043239074	0.000087065	0.038697377	571157.58
42	7/28/2009-9/7/2009	30	-0.602652856	N/A	0.432768952	N/A	0.038163102	0.000102383	0.035115511	84075.65
43	8/11/2009-9/21/2009	30	-0.427101889	N/A	0.418940253	N/A	0.032715879	0.000134564	0.030825171	138802.26
44	9/8/2009-10/6/2009	30	-0.687342338	N/A	0.432281617	N/A	0.027535102	0.000188742	0.028642578	214278.39

Average Sum of Squared Errors   614,094.31

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Alcoa Inc.</u> NYSE: <u>AA</u> Industry: <u>Steel</u>

Model9 Default Intensity: $\xi[i,j]=c_0+c_1t+\frac{c_2}{s^{a_0+a_1t}}$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.452082320	N/A	0.314598722	0.000044584	0.006733196	0.000121354	0.011116618	84,965.46
2	1/15/2008-2/25/2008	30	-0.625975360	N/A	0.321875502	0.000087301	0.010755385	0.000127716	0.013483273	93,112.88
3	1/29/2008-3/10/2008	30	-0.478423675	N/A	0.302834965	-0.000078300	0.014582922	0.000103135	0.016241378	50,180.17
4	2/12/2008-3/24/2008	30	-0.485626683	N/A	0.320590815	-0.000083205	0.015269077	0.000089366	0.016517718	19,976.21
5	2/26/2008-4/7/2008	30	-0.666721855	N/A	0.315622886	0.000055752	0.014699321	0.000072560	0.015029251	44,480.96
6	3/11/2008-4/21/2008	30	-0.407349563	N/A	0.307882923	-0.000075297	0.013896155	0.000062032	0.013639935	38,441.57
7	3/25/2008-5/25/2008	30	-0.405420634	N/A	0.322091912	-0.000024527	0.011313015	0.000066643	0.011635079	30,043.48
8	4/8/2008-5/19/2008	30	-0.484032622	N/A	0.304575696	0.000041608	0.009022813	0.000071196	0.010233045	29,217.04
9	4/22/2008-6/2/2008	30	-0.598827474	N/A	0.317802411	-0.000019875	0.007774648	0.000078710	0.010276827	9,684.05
10	5/6/2008-6/16/2008	30	-0.615183136	N/A	0.313558776	0.000087899	0.008000839	0.000088464	0.009808568	8,249.83
11	5/20/2008-6/30/2008	30	-0.413007291	N/A	0.315629894	0.000083624	0.008702828	0.000094045	0.010286982	7,272.90
12	6/3/2008-7/14/2008	30	-0.511631668	N/A	0.306641846	0.000035804	0.008978035	0.000101442	0.011671526	12,134.73
13	6/17/2008-7/28/2008	30	-0.463290982	N/A	0.326381921	-0.000067575	0.008707794	0.000116752	0.011606083	14,927.21
14	7/1/2008-8/11/2008	30	-0.660515437	N/A	0.311666883	0.000040242	0.009809379	0.000116103	0.012907877	10,939.07
15	7/15/2008-8/25/2008	30	-0.490985534	N/A	0.322123894	-0.000056768	0.009847402	0.000129376	0.013000506	17,843.59
16	7/29/2008-9/8/2008	30	-0.498063464	N/A	0.327546980	0.000099447	0.010638365	0.000138988	0.013769975	17,881.80
17	8/12/2008-9/22/2008	30	-0.442207119	N/A	0.348952524	-0.000008713	0.011049874	0.000142749	0.015844620	18,382.24
18	8/26/2008-10/6/2008	30	-0.439116069	N/A	0.360655740	0.000055187	0.011890699	0.000159568	0.016393993	46,160.54
19	9/9/2008-10/20/2008	30	-0.675216192	N/A	0.398366255	0.000048215	0.019035416	0.000194674	0.023482249	909,675.91
20	9/23/2008-11/3/2008	30	-0.524562257	N/A	0.460880534	-0.000063750	0.033802737	0.000189009	0.034639052	1,308,112.10
21	10/7/2008-11/17/2008	30	-0.691128885	N/A	0.473641208	0.000068701	0.043843354	0.000170263	0.044867118	519,857.50
22	10/21/2008-12/1/2008	30	-0.432138375	N/A	0.472423894	0.000037862	0.060691000	0.000153334	0.052972325	936,377.90
23	11/4/2008-12/15/2008	30	-0.639286848	N/A	0.489638272	-0.000062792	0.074553270	0.000197533	0.056285462	2,152,756.39
24	11/18/2008-12/29/2008	30	-0.579174536	N/A	0.499767807	-0.000052998	0.085548906	0.000219673	0.073419499	479,551.13
25	12/2/2008-1/12/2009	30	-0.688006661	N/A	0.503194381	0.000046796	0.086636789	0.000228537	0.077041763	277,700.70
26	12/16/2008-1/26/2009	30	-0.400974193	N/A	0.477975417	-0.000048034	0.084719700	0.000234746	0.078965098	532,358.92
27	12/30/2008-2/9/2009	30	-0.464868914	N/A	0.537184570	0.000025499	0.101043033	0.000148954	0.087258629	1,172,033.52
28	1/13/2009-2/23/2009	30	-0.407441252	N/A	0.548257562	-0.000061798	0.109746030	-0.000090330	0.077767748	828,117.99
29	1/27/2009-3/9/2009	30	-0.444167694	N/A	0.575191018	0.000063935	0.123425158	-0.000368798	0.086054378	1,690,797.26
30	2/10/2009-3/23/2009	30	-0.531861250	N/A	0.577026904	0.000002951	0.184279524	-0.000749532	0.092035908	2,293,900.41
31	2/24/2009-4/6/2009	30	-0.497826936	N/A	0.556593805	0.000026469	0.162597555	-0.000742990	0.088418868	2,774,084.06
32	3/10/2009-4/20/2009	30	-0.513438673	N/A	0.491298958	-0.000018846	0.148849961	-0.000545280	0.085219386	3,532,161.66
33	3/24/2009-5/4/2009	30	-0.637828466	N/A	0.502760630	-0.000081102	0.099229853	-0.000161271	0.072356343	1,016,811.02
34	4/7/2009-5/18/2009	30	-0.426493453	N/A	0.496168422	-0.000054907	0.072645934	-0.000035516	0.061001745	1,151,068.61
35	4/21/2009-6/1/2009	30	-0.459857370	N/A	0.483175103	-0.000080133	0.068086482	-0.000033748	0.053603179	887,135.20
36	5/5/2009-6/15/2009	30	-0.444569301	N/A	0.459128614	-0.000007245	0.057516745	-0.000034261	0.046162965	356,176.03
37	5/19/2009-6/29/2009	30	-0.482657390	N/A	0.489853808	-0.000000642	0.054056581	-0.000030684	0.043616808	98,097.59
38	6/2/2009-7/13/2009	30	-0.535635652	N/A	0.476443910	0.000081808	0.054476144	-0.000000626	0.042712179	116,714.21
39	6/16/2009-7/27/2009	30	-0.638328707	N/A	0.433749049	0.000007834	0.057848098	0.000035482	0.050672924	208,078.93
40	6/30/2009-8/10/2009	30	-0.464277556	N/A	0.454043413	0.000086486	0.048853651	0.000070485	0.045103480	764,610.10
41	7/14/2009-8/24/2009	30	-0.653600388	N/A	0.455110462	-0.000060224	0.041899949	0.000089831	0.038916881	514,795.18
42	7/28/2009-9/7/2009	30	-0.481354580	N/A	0.421003773	0.000022459	0.036484054	0.000108096	0.033359917	78,267.93
43	8/11/2009-9/21/2009	30	-0.579578097	N/A	0.411993536	0.000059838	0.034967879	0.000131495	0.031139674	124,560.02
44	9/8/2009-10/6/2009	30	-0.615329568	N/A	0.437065113	0.000049001	0.027004158	0.000177481	0.028931233	198,996.68

Average Sum of Squared Errors 579,015.70

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Alcoa Inc.</u>   NYSE: <u>AA</u>   Industry: <u>Steel</u>

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{1}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.093929966	-44.748736691	0.335452526	N/A	0.006640961	0.000122122	0.010741587	74053.97
2	1/15/2008-2/25/2008	30	0.032633787	-43.311803151	0.307611189	N/A	0.010431348	0.000128403	0.013483500	79168.07
3	1/29/2008-3/10/2008	30	-0.006152280	-46.770996629	0.307607030	N/A	0.013975872	0.000105844	0.015385745	41346.02
4	2/12/2008-3/24/2008	30	0.001065603	-45.046207144	0.294407720	N/A	0.016362008	0.000089494	0.015504393	16071.73
5	2/26/2008-4/7/2008	30	-0.001336650	-47.766372397	0.324627170	N/A	0.014653404	0.000071471	0.014515121	36526.01
6	3/11/2008-4/21/2008	30	-0.072758913	-43.526364582	0.312609684	N/A	0.013136966	0.000063025	0.012930367	34174.98
7	3/25/2008-5/25/2008	30	0.009697509	-44.062379266	0.296382162	N/A	0.011106635	0.000067845	0.011457398	25867.94
8	4/8/2008-5/19/2008	30	0.092147087	-46.042149333	0.297844648	N/A	0.009300414	0.000074282	0.010786369	23196.00
9	4/22/2008-6/2/2008	30	-0.096241163	-48.191822947	0.315853893	N/A	0.008260491	0.000082433	0.009896695	8531.22
10	5/6/2008-6/16/2008	30	0.030143942	-45.605928030	0.315122078	N/A	0.008258906	0.000092648	0.009868405	6357.02
11	5/20/2008-6/30/2008	30	-0.013555040	-45.138666235	0.312461685	N/A	0.008396167	0.000094009	0.011039728	6270.44
12	6/3/2008-7/14/2008	30	0.002737452	-45.443568507	0.300928849	N/A	0.008507601	0.000098656	0.010812659	9308.07
13	6/17/2008-7/28/2008	30	0.061889604	-45.124909367	0.304168385	N/A	0.008886153	0.000109314	0.011394555	11405.05
14	7/1/2008-8/11/2008	30	-0.093396199	-40.850308168	0.323478086	N/A	0.009223046	0.000118873	0.012754794	8844.22
15	7/15/2008-8/25/2008	30	0.060869811	-43.804738090	0.324831909	N/A	0.010322633	0.000129943	0.012772247	13730.63
16	7/29/2008-9/8/2008	30	0.012922395	-44.423410729	0.338636742	N/A	0.010705801	0.000132788	0.013855093	14005.24
17	8/12/2008-9/22/2008	30	0.090204867	-43.924472349	0.345142154	N/A	0.010994280	0.000154936	0.015283672	15678.01
18	8/26/2008-10/6/2008	30	0.078470126	-41.422479456	0.373319943	N/A	0.011508206	0.000159437	0.015837252	40387.94
19	9/9/2008-10/20/2008	30	0.048908443	-42.204097004	0.389475362	N/A	0.019276017	0.000197600	0.022992722	754647.22
20	9/23/2008-11/3/2008	30	-0.003668196	-44.068237099	0.450731777	N/A	0.032396559	0.000185724	0.035846250	1127745.84
21	10/7/2008-11/17/2008	30	0.037297713	-47.280368884	0.473529551	N/A	0.044863088	0.000169280	0.042000890	426448.59
22	10/21/2008-12/1/2008	30	0.099263341	-47.162034998	0.432825363	N/A	0.062247014	0.000164333	0.054831911	908083.18
23	11/4/2008-12/15/2008	30	0.062302113	-46.121590747	0.476921986	N/A	0.070985580	0.000194703	0.053781320	1764967.70
24	11/18/2008-12/29/2008	30	0.026150567	-41.782656817	0.491115784	N/A	0.086999594	0.000234327	0.071945435	403593.89
25	12/2/2008-1/12/2009	30	-0.063103953	-44.243779875	0.475727120	N/A	0.087914792	0.000232620	0.076112884	231904.15
26	12/16/2008-1/26/2009	30	0.098652467	-41.947794035	0.522651556	N/A	0.088866268	0.000257483	0.077528746	453713.81
27	12/30/2008-2/9/2009	30	0.067169508	-41.832621444	0.549274872	N/A	0.101674187	0.000157552	0.084605710	996633.75
28	1/13/2009-2/23/2009	30	-0.014891939	-42.643124819	0.560897042	N/A	0.104735091	-0.000089953	0.082802014	699628.00
29	1/27/2009-3/9/2009	30	-0.003684560	-42.618213144	0.573069037	N/A	0.133314564	-0.000367654	0.085045748	1487339.08
30	2/10/2009-3/23/2009	30	0.054545230	-44.538267973	0.588676508	N/A	0.184054342	-0.000792131	0.092196369	1765911.04
31	2/24/2009-4/6/2009	30	-0.016698594	-43.119460502	0.535345217	N/A	0.177333438	-0.000771975	0.092574299	2372097.30
32	3/10/2009-4/20/2009	30	-0.008414600	-43.500305299	0.521526363	N/A	0.140145970	-0.000539922	0.086340080	2970344.92
33	3/24/2009-5/4/2009	30	0.017531134	-44.170722473	0.513860387	N/A	0.093428952	-0.000162983	0.067221983	835547.15
34	4/7/2009-5/18/2009	30	-0.013628398	-41.308556498	0.467174819	N/A	0.078333316	-0.000035490	0.060253761	1044696.50
35	4/21/2009-6/1/2009	30	-0.044089257	-44.238710822	0.468127158	N/A	0.068560278	-0.000034259	0.049653218	808752.24
36	5/5/2009-6/15/2009	30	0.084274302	-40.792056787	0.485834166	N/A	0.058265970	-0.000034390	0.045498816	303048.13
37	5/19/2009-6/29/2009	30	0.007563217	-42.941028791	0.476890892	N/A	0.053403570	-0.000030079	0.042921764	82462.50
38	6/2/2009-7/13/2009	30	0.052193860	-47.768742216	0.467778466	N/A	0.055653241	-0.000000634	0.040549627	95781.49
39	6/16/2009-7/27/2009	30	0.034990539	-47.040266969	0.476533697	N/A	0.059593106	0.000036766	0.048639285	171517.27
40	6/30/2009-8/10/2009	30	0.004179466	-42.003272734	0.461173381	N/A	0.053119916	0.000074658	0.045212239	648160.81
41	7/14/2009-8/24/2009	30	-0.035776197	-46.071089306	0.454021607	N/A	0.042724067	0.000086728	0.037405772	454798.86
42	7/28/2009-9/7/2009	30	0.053166585	-45.148309250	0.430748562	N/A	0.038348216	0.000104768	0.033619847	68524.33
43	8/11/2009-9/21/2009	30	-0.008914160	-45.144969792	0.415711129	N/A	0.034952330	0.000140892	0.032259876	107276.00
44	9/8/2009-10/6/2009	30	-0.039775272	-44.809237332	0.409905465	N/A	0.026432025	0.000185123	0.030347263	152227.67

Average Sum of Squared Errors   490,926.68

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Alcoa Inc.</u>　　NYSE: <u>AA</u>　　Industry: <u>Steel</u>

Model11　Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$　Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$　Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.052461265	-45.075064332	0.333468914	0.000039398	0.006610976	0.000129131	0.010327885	70658.08
2	1/15/2008-2/25/2008	30	0.074046734	-47.306877012	0.305259902	0.000001800	0.010294808	0.000125747	0.013506377	71294.52
3	1/29/2008-3/10/2008	30	-0.013241458	-43.926718239	0.298927698	0.000067751	0.014142797	0.000100485	0.015108882	40944.93
4	2/12/2008-3/24/2008	30	-0.088177345	-47.135591031	0.306389707	0.000008032	0.016324995	0.000089789	0.015629808	15442.47
5	2/26/2008-4/7/2008	30	0.033427029	-48.641228790	0.310676249	-0.000089047	0.014807901	0.000071281	0.014380913	35654.47
6	3/11/2008-4/21/2008	30	0.038970399	-44.710604434	0.307033688	-0.000032395	0.013037526	0.000063773	0.013043042	31370.14
7	3/25/2008-5/25/2008	30	0.074365690	-42.069504742	0.314570299	0.000099723	0.011165843	0.000064879	0.010832031	25829.98
8	4/8/2008-5/19/2008	30	0.033487839	-48.088826702	0.292726837	0.000087209	0.009529881	0.000069399	0.010959510	22457.52
9	4/22/2008-6/2/2008	30	-0.093275996	-44.769842279	0.294925970	-0.000009077	0.008032313	0.000080771	0.009596499	7674.10
10	5/6/2008-6/16/2008	30	-0.090458026	-47.913372742	0.306544972	0.000039738	0.008193112	0.000090855	0.010376650	6235.99
11	5/20/2008-6/30/2008	30	-0.019495772	-43.782342023	0.298304695	-0.000029968	0.008565561	0.000095007	0.011145579	5971.59
12	6/3/2008-7/14/2008	30	0.099193548	-41.554040547	0.324548459	0.000055651	0.008795246	0.000107442	0.011708470	9024.97
13	6/17/2008-7/28/2008	30	-0.060758929	-40.066148935	0.328141122	-0.000022033	0.008903861	0.000108361	0.011531706	11395.18
14	7/1/2008-8/11/2008	30	-0.072270418	-43.785544790	0.311045513	0.000067504	0.009941277	0.000117969	0.012025451	8035.54
15	7/15/2008-8/25/2008	30	0.076977616	-44.182518826	0.316718033	0.000041737	0.009825938	0.000131379	0.013753153	13483.50
16	7/29/2008-9/8/2008	30	-0.075968148	-41.131560846	0.334858252	-0.000098848	0.010198818	0.000129459	0.014456661	13357.56
17	8/12/2008-9/22/2008	30	0.084327894	-46.158177156	0.345524684	0.000051560	0.011483454	0.000145182	0.014959239	14565.62
18	8/26/2008-10/6/2008	30	-0.059819409	-46.198547824	0.377528288	-0.000061053	0.011675870	0.000164280	0.017001723	38783.30
19	9/9/2008-10/20/2008	30	0.065683137	-44.854512935	0.393990471	-0.000056305	0.018258707	0.000193373	0.022863267	706140.83
20	9/23/2008-11/3/2008	30	-0.092653422	-41.595419315	0.433128411	-0.000044250	0.031878510	0.000184359	0.034676441	28235.12
21	10/7/2008-11/17/2008	30	-0.057158406	-46.251112428	0.486270444	0.000074576	0.046090980	0.000174127	0.044205594	408359.03
22	10/21/2008-12/1/2008	30	0.037990045	-46.776465112	0.464580514	-0.000010042	0.061269113	0.000152056	0.054285289	858462.42
23	11/4/2008-12/15/2008	30	-0.035841518	-40.061710838	0.472052869	0.000069412	0.071262927	0.000194027	0.056764384	1693363.50
24	11/18/2008-12/29/2008	30	-0.077031342	-42.442686001	0.486915319	-0.000068112	0.086035926	0.000225073	0.072495473	387041.16
25	12/2/2008-1/12/2009	30	0.050215709	-47.930112634	0.494673656	-0.000065082	0.085043095	0.000240357	0.078833002	212354.09
26	12/16/2008-1/26/2009	30	-0.079610268	-40.345202735	0.522257389	0.000078787	0.086271536	0.000241346	0.074476598	410144.49
27	12/30/2008-2/9/2009	30	0.070203797	-46.769807185	0.564803443	-0.000097245	0.095887751	0.000149392	0.087672887	901695.87
28	1/13/2009-2/23/2009	30	0.006181622	-46.072558704	0.581265511	0.000029133	0.105953353	-0.000085681	0.083737202	623236.34
29	1/27/2009-3/9/2009	30	0.050455858	-46.004292435	0.575151390	0.000093566	0.129232418	-0.000366971	0.092560391	1419870.89
30	2/10/2009-3/23/2009	30	0.038382313	-46.107158389	0.612045738	0.000004626	0.171016210	-0.000797202	0.096572794	1704067.51
31	2/24/2009-4/6/2009	30	-0.048686202	-48.665251556	0.562313400	-0.000087903	0.172504810	-0.000767023	0.089398068	2287745.62
32	3/10/2009-4/20/2009	30	0.050555252	-42.985129118	0.497917273	0.000077443	0.145565620	-0.000510096	0.085806672	2800464.79
33	3/24/2009-5/4/2009	30	0.007749019	-43.049728427	0.483231145	0.000019596	0.099362135	-0.000160338	0.073454821	832927.36
34	4/7/2009-5/18/2009	30	-0.083391374	-41.735504939	0.493307096	0.000021527	0.074680021	-0.000033755	0.061171376	947093.63
35	4/21/2009-6/1/2009	30	0.060371967	-41.631502049	0.460837698	-0.000032006	0.069142119	-0.000036619	0.050942941	742359.40
36	5/5/2009-6/15/2009	30	-0.075417450	-42.449657018	0.487437144	-0.000043870	0.058288402	-0.000033524	0.043630525	290647.75
37	5/19/2009-6/29/2009	30	-0.084798578	-41.458996923	0.485974875	0.000020994	0.055833669	-0.000030449	0.041646623	75382.33
38	6/2/2009-7/13/2009	30	0.066078596	-40.018725355	0.472872927	-0.000057234	0.052141156	-0.000000588	0.043923797	92818.23
39	6/16/2009-7/27/2009	30	0.062423010	-45.119231319	0.468171978	-0.000077588	0.059654771	0.000035734	0.048928608	163448.55
40	6/30/2009-8/10/2009	30	-0.016896064	-48.277247026	0.426979407	-0.000086722	0.052741892	0.000075256	0.042823066	625246.44
41	7/14/2009-8/24/2009	30	0.097030664	-43.557470450	0.429562293	0.000060577	0.044475370	0.000089818	0.038005072	426639.72
42	7/28/2009-9/7/2009	30	-0.059433900	-43.014544789	0.411177079	-0.000057986	0.037742627	0.000100479	0.034434205	64019.80
43	8/11/2009-9/21/2009	30	-0.080367312	-43.506366682	0.406115162	-0.000055261	0.032776562	0.000131507	0.033948901	106544.17
44	9/8/2009-10/6/2009	30	-0.090709515	-42.322192859	0.425294115	0.000089864	0.028508970	0.000181947	0.028776600	152206.64

Average Sum of Squared Errors　　440,970.34

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __AT&T Inc.__   NYSE: __T__   Industry: __Telecom__

Model 1 Default Intensity: $\xi[i, j] = c_0$ Default Probability: $\lambda[i, j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i, j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.720430172	N/A	N/A	N/A	0.005539359	N/A	N/A	86079.00
2	1/15/2008-2/25/2008	30	-0.726705795	N/A	N/A	N/A	0.006301905	N/A	N/A	107240.98
3	1/29/2008-3/10/2008	30	-0.773466591	N/A	N/A	N/A	0.007562307	N/A	N/A	166396.73
4	2/12/2008-3/24/2008	30	-0.685163069	N/A	N/A	N/A	0.009039796	N/A	N/A	188658.15
5	2/26/2008-4/7/2008	30	-0.674154315	N/A	N/A	N/A	0.009377128	N/A	N/A	192030.53
6	3/11/2008-4/21/2008	30	-0.709860851	N/A	N/A	N/A	0.008606426	N/A	N/A	182362.34
7	3/25/2008-5/25/2008	30	-0.751161799	N/A	N/A	N/A	0.007262670	N/A	N/A	139900.87
8	4/8/2008-5/19/2008	30	-0.668863678	N/A	N/A	N/A	0.006386761	N/A	N/A	104325.36
9	4/22/2008-6/2/2008	30	-0.655651886	N/A	N/A	N/A	0.005932204	N/A	N/A	90467.72
10	5/6/2008-6/16/2008	30	-0.64877528	N/A	N/A	N/A	0.005746524	N/A	N/A	87179.08
11	5/20/2008-6/30/2008	30	-0.723502942	N/A	N/A	N/A	0.005662431	N/A	N/A	82119.66
12	6/3/2008-7/14/2008	30	-0.647446338	N/A	N/A	N/A	0.005574352	N/A	N/A	69446.80
13	6/17/2008-7/28/2008	30	-0.726033343	N/A	N/A	N/A	0.005442822	N/A	N/A	54061.25
14	7/1/2008-8/11/2008	30	-0.764680188	N/A	N/A	N/A	0.005451210	N/A	N/A	61259.71
15	7/15/2008-8/25/2008	30	-0.769589851	N/A	N/A	N/A	0.005631533	N/A	N/A	82706.88
16	7/29/2008-9/8/2008	30	-0.77927027	N/A	N/A	N/A	0.005579398	N/A	N/A	85927.84
17	8/12/2008-9/22/2008	30	-0.829847315	N/A	N/A	N/A	0.005542580	N/A	N/A	69427.81
18	8/26/2008-10/6/2008	30	-0.798617353	N/A	N/A	N/A	0.006067235	N/A	N/A	82308.59
19	9/9/2008-10/20/2008	30	-0.795713694	N/A	N/A	N/A	0.007469336	N/A	N/A	136007.68
20	9/23/2008-11/3/2008	30	-0.805045815	N/A	N/A	N/A	0.009267729	N/A	N/A	162391.68
21	10/7/2008-11/17/2008	30	-0.746018389	N/A	N/A	N/A	0.010603935	N/A	N/A	118764.69
22	10/21/2008-12/1/2008	30	-0.747585106	N/A	N/A	N/A	0.011716031	N/A	N/A	110483.03
23	11/4/2008-12/15/2008	30	-0.771874479	N/A	N/A	N/A	0.013534437	N/A	N/A	117886.77
24	11/18/2008-12/29/2008	30	-0.821847552	N/A	N/A	N/A	0.014070455	N/A	N/A	92961.79
25	12/2/2008-1/12/2009	30	-0.802382022	N/A	N/A	N/A	0.013520767	N/A	N/A	97061.21
26	12/16/2008-1/26/2009	30	-0.708405743	N/A	N/A	N/A	0.012723773	N/A	N/A	52179.45
27	12/30/2008-2/9/2009	30	-0.655496639	N/A	N/A	N/A	0.012265717	N/A	N/A	53347.05
28	1/13/2009-2/23/2009	30	-0.732286211	N/A	N/A	N/A	0.011478158	N/A	N/A	90948.86
29	1/27/2009-3/9/2009	30	-0.646073837	N/A	N/A	N/A	0.010415139	N/A	N/A	54871.20
30	2/10/2009-3/23/2009	30	-0.74641223	N/A	N/A	N/A	0.009456181	N/A	N/A	43766.01
31	2/24/2009-4/6/2009	30	-0.738557744	N/A	N/A	N/A	0.009173005	N/A	N/A	50750.32
32	3/10/2009-4/20/2009	30	-0.827550808	N/A	N/A	N/A	0.008311736	N/A	N/A	34883.65
33	3/24/2009-5/4/2009	30	-0.694246378	N/A	N/A	N/A	0.007569681	N/A	N/A	33692.11
34	4/7/2009-5/18/2009	30	-0.699235188	N/A	N/A	N/A	0.006903312	N/A	N/A	31898.28
35	4/21/2009-6/1/2009	30	-0.801545853	N/A	N/A	N/A	0.006396930	N/A	N/A	23216.92
36	5/5/2009-6/15/2009	30	-0.779685985	N/A	N/A	N/A	0.005857629	N/A	N/A	19641.53
37	5/19/2009-6/29/2009	30	-0.669921203	N/A	N/A	N/A	0.005740643	N/A	N/A	17837.49
38	6/2/2009-7/13/2009	30	-0.727003275	N/A	N/A	N/A	0.005644013	N/A	N/A	16871.41
39	6/16/2009-7/27/2009	30	-0.648278186	N/A	N/A	N/A	0.005705636	N/A	N/A	17442.21
40	6/30/2009-8/10/2009	30	-0.69038972	N/A	N/A	N/A	0.004921271	N/A	N/A	28403.73
41	7/14/2009-8/24/2009	30	-0.779994441	N/A	N/A	N/A	0.004338930	N/A	N/A	21493.27
42	7/28/2009-9/7/2009	30	-0.793116264	N/A	N/A	N/A	0.003942303	N/A	N/A	10121.81
43	8/11/2009-9/21/2009	30	-0.643415381	N/A	N/A	N/A	0.004007371	N/A	N/A	9479.10
44	9/8/2009-10/6/2009	30	-0.650383905	N/A	N/A	N/A	0.003855029	N/A	N/A	9247.47

Average Sum of Squared Errors   76,989.73

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: AT&T Inc.   NYSE: T   Industry: Telecom

Model 2   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.703406453	N/A	N/A	N/A	0.0006316515	0.000064286	N/A	4812.27
2	1/15/2008-2/25/2008	30	-0.740563014	N/A	N/A	N/A	0.0009611514	0.000070930	N/A	12796.07
3	1/29/2008-3/10/2008	30	-0.706052791	N/A	N/A	N/A	0.0018230285	0.000088542	N/A	44132.67
4	2/12/2008-3/24/2008	30	-0.799192617	N/A	N/A	N/A	0.0025037338	0.000128851	N/A	40359.19
5	2/26/2008-4/7/2008	30	-0.82018248	N/A	N/A	N/A	0.0027504487	0.000122079	N/A	33482.76
6	3/11/2008-4/21/2008	30	-0.776019005	N/A	N/A	N/A	0.0022865894	0.000138514	N/A	42669.95
7	3/25/2008-5/25/2008	30	-0.731455578	N/A	N/A	N/A	0.0016927956	0.000107114	N/A	24636.72
8	4/8/2008-5/19/2008	30	-0.70629483	N/A	N/A	N/A	0.0012177418	0.000104706	N/A	5303.64
9	4/22/2008-6/2/2008	30	-0.647005478	N/A	N/A	N/A	0.0008536582	0.000113938	N/A	2036.24
10	5/6/2008-6/16/2008	30	-0.744731231	N/A	N/A	N/A	0.0007589569	0.000118117	N/A	1117.13
11	5/20/2008-6/30/2008	30	-0.794522968	N/A	N/A	N/A	0.0008784510	0.000130580	N/A	1887.09
12	6/3/2008-7/14/2008	30	-0.78338027	N/A	N/A	N/A	0.0013218260	0.000132119	N/A	3837.52
13	6/17/2008-7/28/2008	30	-0.651440794	N/A	N/A	N/A	0.0017611856	0.000111708	N/A	3971.75
14	7/1/2008-8/11/2008	30	-0.732500181	N/A	N/A	N/A	0.0015140029	0.000122395	N/A	5601.47
15	7/15/2008-8/25/2008	30	-0.67773188	N/A	N/A	N/A	0.0010663008	0.000141464	N/A	6880.28
16	7/29/2008-9/8/2008	30	-0.64995158	N/A	N/A	N/A	0.0010873462	0.000145535	N/A	9705.22
17	8/12/2008-9/22/2008	30	-0.685240374	N/A	N/A	N/A	0.0014710374	0.000125330	N/A	10166.80
18	8/26/2008-10/6/2008	30	-0.657880423	N/A	N/A	N/A	0.0021562079	0.000122972	N/A	27091.27
19	9/9/2008-10/20/2008	30	-0.693892007	N/A	N/A	N/A	0.0030074709	0.000142454	N/A	57680.44
20	9/23/2008-11/3/2008	30	-0.682524001	N/A	N/A	N/A	0.0038699970	0.000168545	N/A	50270.12
21	10/7/2008-11/17/2008	30	-0.807825669	N/A	N/A	N/A	0.0053494967	0.000160991	N/A	29238.42
22	10/21/2008-12/1/2008	30	-0.733813178	N/A	N/A	N/A	0.0074747789	0.000142366	N/A	45768.11
23	11/4/2008-12/15/2008	30	-0.81391833	N/A	N/A	N/A	0.0104900086	0.000113022	N/A	71444.61
24	11/18/2008-12/29/2008	30	-0.776611649	N/A	N/A	N/A	0.0102967035	0.000117950	N/A	48457.00
25	12/2/2008-1/12/2009	30	-0.706699278	N/A	N/A	N/A	0.0099690115	0.000101374	N/A	60155.37
26	12/16/2008-1/26/2009	30	-0.744604184	N/A	N/A	N/A	0.0102232035	0.000081497	N/A	24451.71
27	12/30/2008-2/9/2009	30	-0.732700655	N/A	N/A	N/A	0.0097677390	0.000081300	N/A	27433.70
28	1/13/2009-2/23/2009	30	-0.749756711	N/A	N/A	N/A	0.0089717787	0.000073341	N/A	68424.18
29	1/27/2009-3/9/2009	30	-0.805753694	N/A	N/A	N/A	0.0081318227	0.000070391	N/A	36979.13
30	2/10/2009-3/23/2009	30	-0.712094732	N/A	N/A	N/A	0.0066447009	0.000072224	N/A	24442.18
31	2/24/2009-4/6/2009	30	-0.798245618	N/A	N/A	N/A	0.0061712089	0.000078598	N/A	27451.73
32	3/10/2009-4/20/2009	30	-0.644767779	N/A	N/A	N/A	0.0057614780	0.000078016	N/A	10165.70
33	3/24/2009-5/4/2009	30	-0.732345656	N/A	N/A	N/A	0.0050481763	0.000077980	N/A	12261.80
34	4/7/2009-5/18/2009	30	-0.641842597	N/A	N/A	N/A	0.0043282659	0.000071695	N/A	13040.22
35	4/21/2009-6/1/2009	30	-0.641669379	N/A	N/A	N/A	0.0040406932	0.000069567	N/A	6140.24
36	5/5/2009-6/15/2009	30	-0.774883592	N/A	N/A	N/A	0.0036764337	0.000061736	N/A	5196.35
37	5/19/2009-6/29/2009	30	-0.743302606	N/A	N/A	N/A	0.0035561688	0.000060194	N/A	4109.09
38	6/2/2009-7/13/2009	30	-0.68920225	N/A	N/A	N/A	0.0036863298	0.000061757	N/A	3387.95
39	6/16/2009-7/27/2009	30	-0.790917784	N/A	N/A	N/A	0.0036612969	0.000059750	N/A	3275.68
40	6/30/2009-8/10/2009	30	-0.810108679	N/A	N/A	N/A	0.0030564044	0.000057039	N/A	17440.34
41	7/14/2009-8/24/2009	30	-0.77773174	N/A	N/A	N/A	0.0028743211	0.000047808	N/A	12686.44
42	7/28/2009-9/7/2009	30	-0.79343364	N/A	N/A	N/A	0.0024823775	0.000041390	N/A	3146.38
43	8/11/2009-9/21/2009	30	-0.756275358	N/A	N/A	N/A	0.0024646430	0.000045082	N/A	2479.76
44	9/8/2009-10/6/2009	30	-0.734608101	N/A	N/A	N/A	0.0025479433	0.000040988	N/A	2878.42

Average Sum of Squared Errors   21,565.75

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>AT&T Inc.</u> NYSE: <u>T</u> Industry: <u>Telecom</u>

Model 3 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^h}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.739681187	N/A	0.300914829	N/A	0.001729612	N/A	0.010856274	63123.48
2	1/15/2008-2/25/2008	30	-0.713397139	N/A	0.310905327	N/A	0.002286855	N/A	0.013513649	71461.75
3	1/29/2008-3/10/2008	30	-0.794000147	N/A	0.333327013	N/A	0.002806722	N/A	0.016683143	116188.61
4	2/12/2008-3/24/2008	30	-0.701880258	N/A	0.329816646	N/A	0.003252489	N/A	0.020553068	134844.44
5	2/26/2008-4/7/2008	30	-0.693239436	N/A	0.318192579	N/A	0.003030996	N/A	0.017910829	135167.83
6	3/11/2008-4/21/2008	30	-0.836992011	N/A	0.301854090	N/A	0.002439794	N/A	0.01539809	128279.58
7	3/25/2008-5/25/2008	30	-0.684757139	N/A	0.317796109	N/A	0.001831852	N/A	0.011414026	102698.57
8	4/8/2008-5/19/2008	30	-0.743781424	N/A	0.302106571	N/A	0.001697727	N/A	0.00994518	71395.93
9	4/22/2008-6/2/2008	30	-0.670519144	N/A	0.323301321	N/A	0.001766166	N/A	0.01010055	7152.62
10	5/6/2008-6/16/2008	30	-0.81131314	N/A	0.322521083	N/A	0.002076237	N/A	0.012361661	61860.47
11	5/20/2008-6/30/2008	30	-0.822037158	N/A	0.322170695	N/A	0.002311868	N/A	0.013902107	56914.03
12	6/3/2008-7/14/2008	30	-0.706717666	N/A	0.313577980	N/A	0.002620195	N/A	0.015279433	49463.73
13	6/17/2008-7/28/2008	30	-0.819452777	N/A	0.333485834	N/A	0.002541663	N/A	0.014331435	37630.99
14	7/1/2008-8/11/2008	30	-0.665787549	N/A	0.326854069	N/A	0.002200797	N/A	0.013455086	41930.05
15	7/15/2008-8/25/2008	30	-0.692373316	N/A	0.346079313	N/A	0.001910251	N/A	0.011497365	56677.48
16	7/29/2008-9/8/2008	30	-0.690027928	N/A	0.316798001	N/A	0.001892378	N/A	0.011628039	59711.30
17	8/12/2008-9/22/2008	30	-0.796743989	N/A	0.321072331	N/A	0.002036158	N/A	0.01290401	48466.83
18	8/26/2008-10/6/2008	30	-0.812410185	N/A	0.333843999	N/A	0.002256749	N/A	0.013738976	15577.63
19	9/9/2008-10/20/2008	30	-0.836341892	N/A	0.336879621	N/A	0.002785296	N/A	0.017248706	87177.40
20	9/23/2008-11/3/2008	30	-0.754610829	N/A	0.335520602	N/A	0.003349908	N/A	0.019246301	109216.73
21	10/7/2008-11/17/2008	30	-0.653824694	N/A	0.365464695	N/A	0.003645904	N/A	0.021693719	73049.18
22	10/21/2008-12/1/2008	30	-0.756712238	N/A	0.352438879	N/A	0.00477663	N/A	0.027345023	28443.82
23	11/4/2008-12/15/2008	30	-0.807956319	N/A	0.355654841	N/A	0.004870988	N/A	0.030754312	76326.96
24	11/18/2008-12/29/2008	30	-0.640763368	N/A	0.335940117	N/A	0.006076248	N/A	0.035587292	33826.00
25	12/2/2008-1/12/2009	30	-0.659662429	N/A	0.335669809	N/A	0.00536631	N/A	0.031737309	54537.08
26	12/16/2008-1/26/2009	30	-0.742074703	N/A	0.362853091	N/A	0.004704703	N/A	0.029218257	26744.18
27	12/30/2008-2/9/2009	30	-0.835154423	N/A	0.358220692	N/A	0.004299315	N/A	0.025265407	17032.00
28	1/13/2009-2/23/2009	30	-0.812364828	N/A	0.346619919	N/A	0.004362972	N/A	0.025382129	53713.75
29	1/27/2009-3/9/2009	30	-0.821984223	N/A	0.364437174	N/A	0.004172361	N/A	0.025833264	34836.56
30	2/10/2009-3/23/2009	30	-0.821424585	N/A	0.336598006	N/A	0.004210202	N/A	0.026695811	20939.70
31	2/24/2009-4/6/2009	30	-0.677257731	N/A	0.364025985	N/A	0.00436125	N/A	0.026048734	12857.17
32	3/10/2009-4/20/2009	30	-0.658475822	N/A	0.362613943	N/A	0.004033538	N/A	0.02239189	5389.65
33	3/24/2009-5/4/2009	30	-0.690504795	N/A	0.354114111	N/A	0.00352365	N/A	0.020880239	9139.36
34	4/7/2009-5/18/2009	30	-0.714587426	N/A	0.357900570	N/A	0.00302743	N/A	0.017724905	5091.82
35	4/21/2009-6/1/2009	30	-0.826063861	N/A	0.351778550	N/A	0.002952126	N/A	0.018095673	17040.00
36	5/5/2009-6/15/2009	30	-0.706586417	N/A	0.357670789	N/A	0.003018401	N/A	0.017371642	3050.68
37	5/19/2009-6/29/2009	30	-0.648721634	N/A	0.369483350	N/A	0.002892449	N/A	0.018470455	3757.26
38	6/2/2009-7/13/2009	30	-0.65872776	N/A	0.369207885	N/A	0.002922565	N/A	0.018021119	11316.91
39	6/16/2009-7/27/2009	30	-0.672384872	N/A	0.364764157	N/A	0.002832947	N/A	0.017717014	12463.99
40	6/30/2009-8/10/2009	30	-0.718856708	N/A	0.332231603	N/A	0.002151823	N/A	0.01403123	1928.74
41	7/14/2009-8/24/2009	30	-0.651873641	N/A	0.336411823	N/A	0.001772793	N/A	0.011093079	14294.77
42	7/28/2009-9/7/2009	30	-0.688083347	N/A	0.329392891	N/A	0.001599424	N/A	0.009243712	7241.42
43	8/11/2009-9/21/2009	30	-0.710118743	N/A	0.353800865	N/A	0.001548088	N/A	0.00968257	6598.21
44	9/8/2009-10/6/2009	30	-0.724349389	N/A	0.337099386	N/A	0.001386927	N/A	0.008366903	6244.91

Average Sum of Squared Errors 45,245.54

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **AT&T Inc.**   NYSE: **T**   Industry: **Telecom**

Model 4   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 - b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.826997968	N/A	0.326860314	-0.000029342	0.001716123	N/A	0.010316140	59412.03
2	1/15/2008-2/25/2008	30	-0.754828943	N/A	0.325321459	-0.000065043	0.002146256	N/A	0.013377729	62566.82
3	1/29/2008-3/10/2008	30	-0.792323755	N/A	0.318678895	-0.000047223	0.002983207	N/A	0.017055087	101908.52
4	2/12/2008-3/24/2008	30	-0.715335097	N/A	0.323773319	0.000015355	0.003258584	N/A	0.019496070	126813.28
5	2/26/2008-4/7/2008	30	-0.667501066	N/A	0.329275456	0.000033234	0.002918198	N/A	0.019282809	124052.04
6	3/11/2008-4/21/2008	30	-0.813369078	N/A	0.329133880	-0.000031281	0.002502705	N/A	0.014458263	116858.61
7	3/25/2008-5/25/2008	30	-0.765444203	N/A	0.307878896	-0.000080278	0.001844008	N/A	0.011004508	95795.31
8	4/8/2008-5/19/2008	30	-0.709957193	N/A	0.302364949	0.000056169	0.001694214	N/A	0.010433344	64771.94
9	4/22/2008-6/2/2008	30	-0.759658991	N/A	0.327370261	0.000010803	0.001748899	N/A	0.010397530	6561.89
10	5/6/2008-6/16/2008	30	-0.799857786	N/A	0.300030383	-0.000073822	0.002078928	N/A	0.011981521	54726.07
11	5/20/2008-6/30/2008	30	-0.723797588	N/A	0.325061304	-0.000033146	0.002223810	N/A	0.013344589	53875.41
12	6/3/2008-7/14/2008	30	-0.801772352	N/A	0.328327773	-0.000060815	0.002574244	N/A	0.015307405	46100.93
13	6/17/2008-7/28/2008	30	-0.696793337	N/A	0.341483359	-0.000099436	0.002365048	N/A	0.014712900	36209.51
14	7/1/2008-8/11/2008	30	-0.794724348	N/A	0.327684187	-0.000025462	0.002303176	N/A	0.013264142	38870.78
15	7/15/2008-8/25/2008	30	-0.653302423	N/A	0.327021263	-0.000089484	0.001976984	N/A	0.011499710	52789.57
16	7/29/2008-9/8/2008	30	-0.793661767	N/A	0.317919468	0.000071329	0.001838121	N/A	0.011643501	53540.45
17	8/12/2008-9/22/2008	30	-0.654431469	N/A	0.319407331	0.000083948	0.002089808	N/A	0.012941921	45095.68
18	8/26/2008-10/6/2008	30	-0.796983533	N/A	0.351965714	-0.000041068	0.002188200	N/A	0.014269338	14854.79
19	9/9/2008-10/20/2008	30	-0.789610949	N/A	0.335003360	-0.000011889	0.002904100	N/A	0.016436854	76828.14
20	9/23/2008-11/3/2008	30	-0.837680820	N/A	0.345115928	-0.000077163	0.003422252	N/A	0.020150847	97091.37
21	10/7/2008-11/17/2008	30	-0.709768551	N/A	0.336534378	0.000000071	0.003715225	N/A	0.021823536	69666.18
22	10/21/2008-12/1/2008	30	-0.715458787	N/A	0.338127582	0.000091335	0.004542345	N/A	0.027343980	26396.65
23	11/4/2008-12/15/2008	30	-0.742219300	N/A	0.329432355	0.000020046	0.005029621	N/A	0.030703574	71005.01
24	11/18/2008-12/29/2008	30	-0.788853055	N/A	0.341204281	-0.000089183	0.005891720	N/A	0.036534240	30571.71
25	12/2/2008-1/12/2009	30	-0.753828387	N/A	0.352066287	0.000051901	0.005440563	N/A	0.032635456	52277.23
26	12/16/2008-1/26/2009	30	-0.676272728	N/A	0.356629005	-0.000039295	0.004440607	N/A	0.027424988	25393.73
27	12/30/2008-2/9/2009	30	-0.816533354	N/A	0.340894513	-0.000058126	0.004336527	N/A	0.025652332	15004.15
28	1/13/2009-2/23/2009	30	-0.699733960	N/A	0.361823809	-0.000023128	0.004345865	N/A	0.025337789	51663.68
29	1/27/2009-3/9/2009	30	-0.834611496	N/A	0.370577070	-0.000010505	0.004426940	N/A	0.025021086	31351.69
30	2/10/2009-3/23/2009	30	-0.723413492	N/A	0.349420013	0.000038321	0.004486378	N/A	0.025154916	18392.14
31	2/24/2009-4/6/2009	30	-0.649331416	N/A	0.340214499	0.000079056	0.004263224	N/A	0.024156482	12326.40
32	3/10/2009-4/20/2009	30	-0.742777874	N/A	0.334433658	-0.000003549	0.003761102	N/A	0.022793617	4924.83
33	3/24/2009-5/4/2009	30	-0.761363752	N/A	0.361447556	0.000054237	0.003309751	N/A	0.020248041	8218.34
34	4/7/2009-5/18/2009	30	-0.698254902	N/A	0.351667305	-0.000077688	0.003108249	N/A	0.019212291	4512.85
35	4/21/2009-6/1/2009	30	-0.776135341	N/A	0.344272323	-0.000038964	0.002951171	N/A	0.018139402	16369.25
36	5/5/2009-6/15/2009	30	-0.795622203	N/A	0.353282548	-0.000063998	0.002888418	N/A	0.017759834	2845.66
37	5/19/2009-6/29/2009	30	-0.739521983	N/A	0.355736341	0.000036741	0.003117667	N/A	0.018778447	3304.82
38	6/2/2009-7/13/2009	30	-0.757478981	N/A	0.334398297	0.000037271	0.002916472	N/A	0.018762487	10905.42
39	6/16/2009-7/27/2009	30	-0.716508180	N/A	0.362256242	0.000039579	0.002755041	N/A	0.016769823	11330.60
40	6/30/2009-8/10/2009	30	-0.769251483	N/A	0.353603048	-0.000088154	0.002256019	N/A	0.013930436	1836.43
41	7/14/2009-8/24/2009	30	-0.640524316	N/A	0.335320231	-0.000035590	0.001817036	N/A	0.011164099	13395.41
42	7/28/2009-9/7/2009	30	-0.658132717	N/A	0.331198478	-0.000072338	0.001566813	N/A	0.009662012	6594.65
43	8/11/2009-9/21/2009	30	-0.709345589	N/A	0.342963357	-0.000054185	0.001486144	N/A	0.008984202	5833.89
44	9/8/2009-10/6/2009	30	-0.686276914	N/A	0.344153259	-0.000094087	0.001373640	N/A	0.008986733	5981.78

Average Sum of Squared Errors   41,564.22

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	AT&T Inc.	NYSE:	T	Industry:	Telecom

Model 5 Default Intensity: $\xi[i,j]=c_0+c_1t$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0+a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.026332349	-141.373196260	N/A	N/A	0.000645948	0.000065772	N/A	4080.48
2	1/15/2008-2/25/2008	30	0.025215329	-126.736695405	N/A	N/A	0.000968252	0.000067714	N/A	10905.10
3	1/29/2008-3/10/2008	30	0.091211415	-142.576571271	N/A	N/A	0.001747333	0.000088378	N/A	36633.97
4	2/12/2008-3/24/2008	30	0.021840749	-142.435770466	N/A	N/A	0.002523700	0.000129403	N/A	34996.97
5	2/26/2008-4/7/2008	30	0.001083487	-120.054788357	N/A	N/A	0.002884432	0.000125061	N/A	27338.57
6	3/11/2008-4/21/2008	30	0.052610527	-135.676093349	N/A	N/A	0.002299580	0.000133190	N/A	36184.77
7	3/25/2008-5/25/2008	30	-0.074952671	-123.733820393	N/A	N/A	0.001668503	0.000105626	N/A	21323.50
8	4/8/2008-5/19/2008	30	-0.056919711	-119.296654990	N/A	N/A	0.001231571	0.000109427	N/A	4456.33
9	4/22/2008-6/2/2008	30	0.022446179	-126.047038104	N/A	N/A	0.000892964	0.000118397	N/A	1652.95
10	5/6/2008-6/16/2008	30	-0.042522913	-122.987560808	N/A	N/A	0.000792270	0.000119760	N/A	942.16
11	5/20/2008-6/30/2008	30	-0.073833488	-137.739206979	N/A	N/A	0.000841846	0.000130384	N/A	1628.51
12	6/3/2008-7/14/2008	30	0.014232431	-124.592272900	N/A	N/A	0.001349602	0.000129369	N/A	3150.71
13	6/17/2008-7/28/2008	30	0.071714576	-119.130257301	N/A	N/A	0.001697698	0.000114120	N/A	3454.57
14	7/1/2008-8/11/2008	30	-0.061494202	-121.270447438	N/A	N/A	0.001554257	0.000127738	N/A	4426.29
15	7/15/2008-8/25/2008	30	0.046361043	-129.651644939	N/A	N/A	0.001119051	0.000147501	N/A	5573.41
16	7/29/2008-9/8/2008	30	0.065241692	-143.888239767	N/A	N/A	0.001054006	0.000150070	N/A	8251.83
17	8/12/2008-9/22/2008	30	0.011658133	-126.046471930	N/A	N/A	0.001493371	0.000123964	N/A	8094.13
18	8/26/2008-10/6/2008	30	0.059459387	-139.764627182	N/A	N/A	0.002220506	0.000123834	N/A	23306.45
19	9/9/2008-10/20/2008	30	0.035413632	-126.694744502	N/A	N/A	0.002940058	0.000140910	N/A	49505.43
20	9/23/2008-11/3/2008	30	0.035980038	-141.083671227	N/A	N/A	0.003832772	0.000173401	N/A	43472.54
21	10/7/2008-11/17/2008	30	-0.026282204	-138.803041525	N/A	N/A	0.005269623	0.000165332	N/A	24101.32
22	10/21/2008-12/1/2008	30	-0.046164804	-131.022733362	N/A	N/A	0.007550095	0.000136317	N/A	37040.84
23	11/4/2008-12/15/2008	30	0.068575453	-139.300766401	N/A	N/A	0.010277217	0.000118894	N/A	60165.95
24	11/18/2008-12/29/2008	30	0.012014020	-135.684459924	N/A	N/A	0.010556709	0.000114731	N/A	41983.60
25	12/2/2008-1/12/2009	30	-0.086744731	-135.862559467	N/A	N/A	0.010171054	0.000104392	N/A	49363.31
26	12/16/2008-1/26/2009	30	-0.003879896	-127.449887525	N/A	N/A	0.010075583	0.000085123	N/A	21114.28
27	12/30/2008-2/9/2009	30	-0.029405393	-144.203180354	N/A	N/A	0.009409529	0.000080548	N/A	22536.30
28	1/13/2009-2/23/2009	30	-0.033872952	-138.351467172	N/A	N/A	0.009314355	0.000075502	N/A	57576.88
29	1/27/2009-3/9/2009	30	-0.008645336	-134.646825899	N/A	N/A	0.008077504	0.000070252	N/A	30656.16
30	2/10/2009-3/23/2009	30	-0.050091879	-121.772206607	N/A	N/A	0.006858595	0.000069626	N/A	20672.47
31	2/24/2009-4/6/2009	30	-0.078257864	-134.973562249	N/A	N/A	0.006462918	0.000075513	N/A	22094.26
32	3/10/2009-4/20/2009	30	0.069412569	-131.256112188	N/A	N/A	0.005545531	0.000076727	N/A	8591.08
33	3/24/2009-5/4/2009	30	0.008938700	-143.815635955	N/A	N/A	0.004918867	0.000078162	N/A	9737.27
34	4/7/2009-5/18/2009	30	0.091057151	-140.918720535	N/A	N/A	0.004478524	0.000072537	N/A	10593.25
35	4/21/2009-6/1/2009	30	-0.073816330	-145.406035183	N/A	N/A	0.004112636	0.000066433	N/A	5087.07
36	5/5/2009-6/15/2009	30	0.024158883	-134.527957184	N/A	N/A	0.003805949	0.000061208	N/A	4466.34
37	5/19/2009-6/29/2009	30	0.094481360	-141.243014442	N/A	N/A	0.003694369	0.000062020	N/A	3392.87
38	6/2/2009-7/13/2009	30	0.085391662	-140.360501329	N/A	N/A	0.003860041	0.000059570	N/A	2847.99
39	6/16/2009-7/27/2009	30	-0.094506738	-140.906124208	N/A	N/A	0.003822310	0.000059937	N/A	2641.10
40	6/30/2009-8/10/2009	30	-0.011283314	-136.813745136	N/A	N/A	0.003205159	0.000056655	N/A	14621.67
41	7/14/2009-8/24/2009	30	0.068504597	-123.844140988	N/A	N/A	0.002855882	0.000049088	N/A	10235.36
42	7/28/2009-9/7/2009	30	-0.035111558	-134.286587365	N/A	N/A	0.002597779	0.000043258	N/A	2609.23
43	8/11/2009-9/21/2009	30	-0.068501623	-143.787196243	N/A	N/A	0.002525827	0.000044114	N/A	2123.62
44	9/8/2009-10/6/2009	30	0.050166427	-124.337275608	N/A	N/A	0.002503432	0.000039062	N/A	2332.89

Average Sum of Squared Errors 18,090.09

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>AT&T Inc.</u>   NYSE: <u>T</u>   Industry: <u>Telecom</u>

Model 6 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.025870314	-126.847283198	0.316639088	N/A	0.001844413	N/A	0.010611225	48805.90
2	1/15/2008-2/25/2008	30	-0.004187342	-126.800560050	0.306152166	N/A	0.002027545	N/A	0.013071058	58985.79
3	1/29/2008-3/10/2008	30	0.023593079	-144.251874802	0.331923893	N/A	0.002636928	N/A	0.015613495	91391.43
4	2/12/2008-3/24/2008	30	0.037707816	-119.989084660	0.335496037	N/A	0.003003598	N/A	0.017527932	107576.46
5	2/26/2008-4/7/2008	30	-0.066689622	-130.081007726	0.326102911	N/A	0.002983127	N/A	0.019110452	106609.99
6	3/11/2008-4/21/2008	30	-0.072095018	-134.933034629	0.328947448	N/A	0.002995794	N/A	0.017590073	100404.19
7	3/25/2008-5/25/2008	30	0.075672611	-136.556527506	0.300997845	N/A	0.002351452	N/A	0.014634863	81912.63
8	4/8/2008-5/19/2008	30	0.072392427	-126.120833864	0.302469499	N/A	0.002158648	N/A	0.012271278	54198.66
9	4/22/2008-6/2/2008	30	0.087099436	-140.520450883	0.310195716	N/A	0.001891006	N/A	0.012093200	5896.47
10	5/6/2008-6/16/2008	30	-0.031502176	-136.390378982	0.329205249	N/A	0.001935789	N/A	0.011485709	48259.13
11	5/20/2008-6/30/2008	30	0.049899291	-137.634418789	0.320772296	N/A	0.001852227	N/A	0.011434744	46350.29
12	6/3/2008-7/14/2008	30	0.022811662	-123.627417376	0.316645849	N/A	0.001885533	N/A	0.011409309	37294.00
13	6/17/2008-7/28/2008	30	-0.058666715	-121.133396275	0.344088402	N/A	0.001822744	N/A	0.011294412	29263.10
14	7/1/2008-8/11/2008	30	-0.063114844	-127.717086728	0.348625248	N/A	0.001741679	N/A	0.011300147	32574.77
15	7/15/2008-8/25/2008	30	0.070799985	-142.300924851	0.316479193	N/A	0.001819730	N/A	0.010772394	45075.50
16	7/29/2008-9/8/2008	30	-0.053357045	-129.624298145	0.317860133	N/A	0.001829530	N/A	0.011654715	46720.37
17	8/12/2008-9/22/2008	30	0.001942996	-123.126183262	0.338462019	N/A	0.001790679	N/A	0.011260545	37345.88
18	8/26/2008-10/6/2008	30	-0.009984661	-139.157162503	0.333922478	N/A	0.001926418	N/A	0.011622823	12834.94
19	9/9/2008-10/20/2008	30	-0.080122757	-141.208905717	0.344263060	N/A	0.002431524	N/A	0.014329283	66845.67
20	9/23/2008-11/3/2008	30	-0.076489753	-131.704762706	0.354489793	N/A	0.003211247	N/A	0.018456424	85313.06
21	10/7/2008-11/17/2008	30	0.011332369	-131.862709063	0.351615619	N/A	0.003394271	N/A	0.021251771	57297.15
22	10/21/2008-12/1/2008	30	0.054726560	-135.898714180	0.332347609	N/A	0.004083062	N/A	0.023117180	23114.09
23	11/4/2008-12/15/2008	30	0.047808955	-122.151498860	0.358755255	N/A	0.004451159	N/A	0.026547881	58336.23
24	11/18/2008-12/29/2008	30	0.057355346	-142.099900779	0.331868605	N/A	0.004837624	N/A	0.027714827	25615.09
25	12/2/2008-1/12/2009	30	-0.064274080	-120.259671797	0.350259999	N/A	0.004692631	N/A	0.028219092	44676.49
26	12/16/2008-1/26/2009	30	0.017410120	-140.269427931	0.357219229	N/A	0.004254545	N/A	0.025446360	20473.76
27	12/30/2008-2/9/2009	30	0.057056241	-145.214558297	0.357462815	N/A	0.004056438	N/A	0.023664418	12868.60
28	1/13/2009-2/23/2009	30	0.035484817	-125.826561621	0.352612235	N/A	0.003789927	N/A	0.022335075	40413.87
29	1/27/2009-3/9/2009	30	-0.042748220	-131.068169012	0.351407824	N/A	0.003534941	N/A	0.021760387	28055.90
30	2/10/2009-3/23/2009	30	-0.071289474	-142.927210873	0.337935838	N/A	0.003307034	N/A	0.018286660	15749.01
31	2/24/2009-4/6/2009	30	0.035746985	-141.168545466	0.342838023	N/A	0.003047599	N/A	0.019015120	9756.52
32	3/10/2009-4/20/2009	30	0.042585166	-122.691347624	0.363009218	N/A	0.002812026	N/A	0.017351784	4135.03
33	3/24/2009-5/4/2009	30	-0.049016735	-132.502283270	0.355528765	N/A	0.002522054	N/A	0.015425456	7051.99
34	4/7/2009-5/18/2009	30	0.098669894	-123.110468770	0.359812730	N/A	0.002220560	N/A	0.014214149	4218.42
35	4/21/2009-6/1/2009	30	-0.027622335	-140.039685710	0.337690876	N/A	0.002161449	N/A	0.012898542	13104.11
36	5/5/2009-6/15/2009	30	0.043545102	-129.831882532	0.338722533	N/A	0.001978809	N/A	0.011352840	2348.18
37	5/19/2009-6/29/2009	30	-0.084927048	-136.797976132	0.338193184	N/A	0.001862585	N/A	0.012050455	2885.54
38	6/2/2009-7/13/2009	30	-0.073116420	-142.710508238	0.360528253	N/A	0.001884055	N/A	0.011201899	9225.28
39	6/16/2009-7/27/2009	30	0.099058222	-125.675438470	0.365084759	N/A	0.001940648	N/A	0.011691797	10322.40
40	6/30/2009-8/10/2009	30	0.065660919	-136.914573644	0.357277946	N/A	0.001584233	N/A	0.009420117	1449.94
41	7/14/2009-8/24/2009	30	0.002046328	-142.332461453	0.338725536	N/A	0.001427588	N/A	0.008433957	11620.67
42	7/28/2009-9/7/2009	30	-0.079567846	-119.212196996	0.342653781	N/A	0.001377572	N/A	0.007927617	5644.03
43	8/11/2009-9/21/2009	30	-0.016232572	-135.717763218	0.326482782	N/A	0.001328346	N/A	0.008337882	5200.38
44	9/8/2009-10/6/2009	30	0.031302217	-134.977931625	0.344180662	N/A	0.001333931	N/A	0.007384265	5175.67

Average Sum of Squared Errors   35,509.01

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __AT&T Inc.__   NYSE: __T__   Industry: __Telecom__

Model 7   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.020662260	-139.242364937	0.308311759	-0.000065259	0.001853019	N/A	0.011303459	43590.58
2	1/15/2008-2/25/2008	30	-0.072548020	-125.604140706	0.320056402	0.000092991	0.002092190	N/A	0.012303921	54263.75
3	1/29/2008-3/10/2008	30	-0.021786489	-126.349485828	0.333783583	0.000015515	0.002395186	N/A	0.014468614	80816.02
4	2/12/2008-3/24/2008	30	-0.073416006	-134.940773486	0.327737058	-0.000016975	0.003013373	N/A	0.018233489	104696.87
5	2/26/2008-4/7/2008	30	-0.048904863	-136.466966938	0.334128850	0.000054230	0.002970261	N/A	0.019691381	100019.40
6	3/11/2008-4/21/2008	30	-0.090040749	-124.768156711	0.318076829	0.000074284	0.002801562	N/A	0.016541316	97389.76
7	3/25/2008-5/25/2008	30	-0.063664151	-126.836539250	0.316377618	0.000042978	0.002340450	N/A	0.014366345	79861.34
8	4/8/2008-5/19/2008	30	-0.021324922	-122.758757090	0.301857425	-0.000055625	0.002049274	N/A	0.013014679	48650.04
9	4/22/2008-6/2/2008	30	-0.094562945	-136.567727927	0.303355918	-0.000032973	0.002013639	N/A	0.011384347	5708.88
10	5/6/2008-6/16/2008	30	0.051015261	-120.615288288	0.309815619	0.000082446	0.001826681	N/A	0.012038380	45782.00
11	5/20/2008-6/30/2008	30	0.007622084	-131.209548699	0.319642033	0.000011224	0.001980068	N/A	0.011097522	44422.75
12	6/3/2008-7/14/2008	30	-0.032813869	-135.538488162	0.332492435	0.000089790	0.001925940	N/A	0.011285448	34155.92
13	6/17/2008-7/28/2008	30	-0.004852979	-139.746921131	0.343865455	0.000082328	0.001838694	N/A	0.011372253	28464.85
14	7/1/2008-8/11/2008	30	-0.051646560	-130.974171020	0.334594902	-0.000064002	0.001873773	N/A	0.010827249	31295.87
15	7/15/2008-8/25/2008	30	0.053660204	-140.369963676	0.333784844	0.000080974	0.001897980	N/A	0.011701800	42543.30
16	7/29/2008-9/8/2008	30	-0.071660537	-143.155598026	0.337636635	0.000021328	0.001796441	N/A	0.011255144	42342.60
17	8/12/2008-9/22/2008	30	-0.039295344	-124.321776606	0.326492089	0.000023969	0.001901527	N/A	0.010993814	33595.97
18	8/26/2008-10/6/2008	30	0.052394203	-125.405956434	0.351169796	0.000090731	0.002018996	N/A	0.012207180	12027.23
19	9/9/2008-10/20/2008	30	0.085511806	-134.375702327	0.353932838	0.000033209	0.002588268	N/A	0.014640699	65201.02
20	9/23/2008-11/3/2008	30	0.016183615	-125.110712745	0.366643988	-0.000069138	0.002995640	N/A	0.019281791	80834.84
21	10/7/2008-11/17/2008	30	-0.085696134	-133.627818644	0.345822931	-0.000003500	0.003681845	N/A	0.020803654	53913.29
22	10/21/2008-12/1/2008	30	-0.097604207	-139.446076072	0.336002437	-0.000049490	0.004088905	N/A	0.023330852	22059.83
23	11/4/2008-12/15/2008	30	0.022650932	-127.061214576	0.331859446	-0.000028913	0.004658873	N/A	0.028274427	54753.07
24	11/18/2008-12/29/2008	30	0.088110084	-142.018352324	0.327235124	0.000048270	0.004745573	N/A	0.027730532	24774.74
25	12/2/2008-1/12/2009	30	0.057814997	-140.501548192	0.335186446	0.000049836	0.004485890	N/A	0.028072561	42179.35
26	12/16/2008-1/26/2009	30	-0.028772468	-142.253192772	0.355095940	0.000022126	0.004336888	N/A	0.025535480	19932.28
27	12/30/2008-2/9/2009	30	-0.032546273	-144.359825406	0.347099616	0.000020165	0.004289620	N/A	0.024680846	11410.76
28	1/13/2009-2/23/2009	30	0.012421175	-121.526036101	0.365701130	0.000063089	0.003723228	N/A	0.022834639	37168.22
29	1/27/2009-3/9/2009	30	-0.060270208	-120.045282674	0.343588768	0.000078725	0.003561581	N/A	0.021642595	27000.99
30	2/10/2009-3/23/2009	30	-0.013920879	-120.491710248	0.366271725	-0.000009743	0.003068778	N/A	0.019416481	15362.91
31	2/24/2009-4/6/2009	30	0.022234818	-133.627395463	0.355119755	-0.000062064	0.003112343	N/A	0.018716264	9276.93
32	3/10/2009-4/20/2009	30	0.053836455	-138.058656073	0.350519167	0.000086326	0.002806454	N/A	0.016538999	3926.50
33	3/24/2009-5/4/2009	30	0.021234462	-143.317123257	0.353421537	-0.000016315	0.002412678	N/A	0.014912804	6787.15
34	4/7/2009-5/18/2009	30	0.033953262	-142.739469049	0.360123586	-0.000020784	0.002296908	N/A	0.013993170	3744.47
35	4/21/2009-6/1/2009	30	-0.097721016	-141.671962010	0.339122266	-0.000072891	0.002140861	N/A	0.012353460	12155.94
36	5/5/2009-6/15/2009	30	-0.091250860	-134.539714261	0.341946642	-0.000059171	0.001897134	N/A	0.011759451	2089.21
37	5/19/2009-6/29/2009	30	0.080606870	-121.092274705	0.347113388	0.000016439	0.001926165	N/A	0.011093631	2625.53
38	6/2/2009-7/13/2009	30	0.067172850	-123.223739447	0.354601795	-0.000051131	0.001932451	N/A	0.010757310	8362.53
39	6/16/2009-7/27/2009	30	0.082527343	-145.384142559	0.363622253	-0.000030863	0.001846840	N/A	0.011015599	9527.77
40	6/30/2009-8/10/2009	30	-0.078208744	-128.758480286	0.359651657	-0.000027073	0.001621979	N/A	0.009881356	1393.73
41	7/14/2009-8/24/2009	30	0.068150540	-132.198735735	0.350719349	0.000043992	0.001496437	N/A	0.008828091	11171.38
42	7/28/2009-9/7/2009	30	-0.097660535	-119.371869992	0.345954332	-0.000069270	0.001275503	N/A	0.007611523	5032.59
43	8/11/2009-9/21/2009	30	-0.022933111	-124.815328265	0.354547080	-0.000054606	0.001326993	N/A	0.008393380	4820.47
44	9/8/2009-10/6/2009	30	-0.060125116	-133.904631801	0.356878692	0.000051260	0.001317534	N/A	0.007498194	4735.40

Average Sum of Squared Errors   33,406.09

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __AT&T Inc.__   NYSE: __T__   Industry: __Telecom__

Model 8   Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{j_0}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.833348263	N/A	0.331593251	N/A	0.000678093	0.000039179	0.004541714	3076.36
2	1/15/2008-2/25/2008	30	-0.652818842	N/A	0.320840156	N/A	0.000996041	0.000040574	0.004977100	7776.39
3	1/29/2008-3/10/2008	30	-0.715254236	N/A	0.335458323	N/A	0.001756991	0.000052778	0.006231380	26071.63
4	2/12/2008-3/24/2008	30	-0.795868410	N/A	0.333191977	N/A	0.002643555	0.000076587	0.007009992	25628.84
5	2/26/2008-4/7/2008	30	-0.824041097	N/A	0.323299356	N/A	0.002710953	0.000075412	0.007205697	21539.44
6	3/11/2008-4/21/2008	30	-0.818576537	N/A	0.328076187	N/A	0.002303413	0.000076113	0.006936607	27715.83
7	3/25/2008-5/25/2008	30	-0.806372873	N/A	0.301874520	N/A	0.001650161	0.000068335	0.005662835	15751.21
8	4/8/2008-5/19/2008	30	-0.698231007	N/A	0.311431449	N/A	0.001229739	0.000068038	0.004896720	3327.36
9	4/22/2008-6/2/2008	30	-0.668056469	N/A	0.323749981	N/A	0.000860102	0.000067405	0.004747853	1275.94
10	5/6/2008-6/16/2008	30	-0.814795375	N/A	0.306347746	N/A	0.000802953	0.000067486	0.004657981	714.25
11	5/20/2008-6/30/2008	30	-0.706962982	N/A	0.304256220	N/A	0.000837808	0.000075006	0.004750178	1162.19
12	6/3/2008-7/14/2008	30	-0.716790788	N/A	0.341117378	N/A	0.001345205	0.000081164	0.004420068	2318.66
13	6/17/2008-7/28/2008	30	-0.640290697	N/A	0.326049453	N/A	0.001661565	0.000071771	0.004341106	2557.86
14	7/1/2008-8/11/2008	30	-0.717043539	N/A	0.339498961	N/A	0.001590578	0.000074847	0.004211234	3350.83
15	7/15/2008-8/25/2008	30	-0.678979101	N/A	0.329741197	N/A	0.001124101	0.000082146	0.004381709	4340.57
16	7/29/2008-9/8/2008	30	-0.794788189	N/A	0.346655959	N/A	0.000983326	0.000085616	0.004519041	6107.68
17	8/12/2008-9/22/2008	30	-0.784492977	N/A	0.328933985	N/A	0.001595467	0.000076005	0.004537759	6146.30
18	8/26/2008-10/6/2008	30	-0.727776615	N/A	0.350721437	N/A	0.002288285	0.000075344	0.004936601	14600.41
19	9/9/2008-10/20/2008	30	-0.730639684	N/A	0.351011797	N/A	0.002811009	0.000090814	0.006109469	36533.86
20	9/23/2008-11/3/2008	30	-0.717163643	N/A	0.359620656	N/A	0.003759005	0.000107047	0.007694477	32154.87
21	10/7/2008-11/17/2008	30	-0.688705242	N/A	0.337361146	N/A	0.005452306	0.000092268	0.008397586	18437.20
22	10/21/2008-12/1/2008	30	-0.801674328	N/A	0.346262371	N/A	0.007703963	0.000085050	0.009307739	27500.17
23	11/4/2008-12/15/2008	30	-0.668288548	N/A	0.329315890	N/A	0.009536081	0.000067354	0.010791639	43129.63
24	11/18/2008-12/29/2008	30	-0.767274307	N/A	0.354560031	N/A	0.010654226	0.000066366	0.011648005	31298.90
25	12/2/2008-1/12/2009	30	-0.686521068	N/A	0.352684269	N/A	0.010284220	0.000059484	0.010591770	39099.85
26	12/16/2008-1/26/2009	30	-0.660186515	N/A	0.365041014	N/A	0.009573214	0.000054328	0.010366946	14731.30
27	12/30/2008-2/9/2009	30	-0.747430231	N/A	0.346309715	N/A	0.009352080	0.000048115	0.009434032	16647.88
28	1/13/2009-2/23/2009	30	-0.667916797	N/A	0.341296612	N/A	0.009255446	0.000048708	0.009333671	42388.72
29	1/27/2009-3/9/2009	30	-0.812462558	N/A	0.348491269	N/A	0.008092775	0.000040597	0.008173739	22320.33
30	2/10/2009-3/23/2009	30	-0.833756967	N/A	0.363622510	N/A	0.006872238	0.000041912	0.007254565	14666.38
31	2/24/2009-4/6/2009	30	-0.704145644	N/A	0.366795354	N/A	0.006812795	0.000044340	0.007499668	12261.80
32	3/10/2009-4/20/2009	30	-0.752206278	N/A	0.346458507	N/A	0.005736354	0.000047782	0.006931774	5349.79
33	3/24/2009-5/4/2009	30	-0.713827483	N/A	0.337982241	N/A	0.005037784	0.000046553	0.006117918	7604.33
34	4/7/2009-5/18/2009	30	-0.822112323	N/A	0.343912930	N/A	0.004484928	0.000040570	0.005260746	4436.35
35	4/21/2009-6/1/2009	30	-0.740287653	N/A	0.345875813	N/A	0.004364882	0.000041657	0.005174771	3734.36
36	5/5/2009-6/15/2009	30	-0.822454598	N/A	0.366489687	N/A	0.003728277	0.000038090	0.004539373	2473.78
37	5/19/2009-6/29/2009	30	-0.717416717	N/A	0.345681826	N/A	0.003805573	0.000036316	0.004582828	2432.68
38	6/2/2009-7/13/2009	30	-0.763902529	N/A	0.349960102	N/A	0.003608286	0.000037466	0.004376164	2164.31
39	6/16/2009-7/27/2009	30	-0.706586969	N/A	0.356742410	N/A	0.003771442	0.000037885	0.004484790	2019.32
40	6/30/2009-8/10/2009	30	-0.758574365	N/A	0.341938567	N/A	0.003044316	0.000032168	0.003920750	1872.44
41	7/14/2009-8/24/2009	30	-0.700038990	N/A	0.353805132	N/A	0.002869869	0.000027371	0.003443406	7502.30
42	7/28/2009-9/7/2009	30	-0.712481295	N/A	0.344334059	N/A	0.002655301	0.000025490	0.003001219	1986.67
43	8/11/2009-9/21/2009	30	-0.831056958	N/A	0.353631468	N/A	0.002568450	0.000026536	0.003187730	1609.04
44	9/8/2009-10/6/2009	30	-0.741009631	N/A	0.332542944	N/A	0.002478483	0.000023743	0.003053346	1724.08

Average Sum of Squared Errors   12,944.14

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **AT&T Inc.**   NYSE: **T**   Industry: **Telecom**

Model9   Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.726615550	N/A	0.320063443	-0.000036550	0.000690845	0.000039196	0.004439679	2792.98
2	1/15/2008-2/25/2008	30	-0.649814568	N/A	0.319062608	-0.000032718	0.000984748	0.000040818	0.004811825	6917.98
3	1/29/2008-3/10/2008	30	-0.835466029	N/A	0.333201743	-0.000032526	0.001826010	0.000050391	0.006211476	22757.95
4	2/12/2008-3/24/2008	30	-0.828418571	N/A	0.332595229	-0.000061949	0.002467842	0.000075790	0.007411786	21733.94
5	2/26/2008-4/7/2008	30	-0.758692963	N/A	0.312611357	0.000064838	0.002875009	0.000073352	0.007432245	19174.77
6	3/11/2008-4/21/2008	30	-0.704730500	N/A	0.325055852	-0.000083786	0.002339778	0.000072852	0.006635161	25397.77
7	3/25/2008-5/25/2008	30	-0.761746511	N/A	0.301521896	-0.000058996	0.001695872	0.000064250	0.005974058	13266.11
8	4/8/2008-5/19/2008	30	-0.766906015	N/A	0.302900034	0.000045020	0.001322348	0.000071469	0.005330644	2916.54
9	4/22/2008-6/2/2008	30	-0.746147497	N/A	0.312907228	0.000092449	0.000862053	0.000070971	0.004682423	1111.48
10	5/6/2008-6/16/2008	30	-0.767267055	N/A	0.306358865	0.000051514	0.000804077	0.000071779	0.004420626	610.56
11	5/20/2008-6/30/2008	30	-0.814577140	N/A	0.327565998	-0.000051399	0.000900371	0.000077409	0.004637860	1054.62
12	6/3/2008-7/14/2008	30	-0.661074720	N/A	0.317053874	0.000014946	0.001272948	0.000083525	0.004612753	2009.90
13	6/17/2008-7/28/2008	30	-0.801652388	N/A	0.335760821	-0.000027855	0.001767603	0.000067746	0.004217697	2340.17
14	7/1/2008-8/11/2008	30	-0.644820892	N/A	0.334444632	-0.000026582	0.001582891	0.000072556	0.004501202	2870.09
15	7/15/2008-8/25/2008	30	-0.834190000	N/A	0.334219124	0.000037328	0.001132243	0.000088439	0.004498071	3667.69
16	7/29/2008-9/8/2008	30	-0.738551167	N/A	0.349241927	0.000022241	0.000973863	0.000087506	0.004597110	5546.47
17	8/12/2008-9/22/2008	30	-0.794931016	N/A	0.328849987	-0.000069287	0.001501385	0.000076842	0.004633897	5648.38
18	8/26/2008-10/6/2008	30	-0.827251831	N/A	0.348079082	-0.000057676	0.002117827	0.000074743	0.004953867	12938.51
19	9/9/2008-10/20/2008	30	-0.703151215	N/A	0.332381828	0.000036372	0.002924564	0.000083876	0.006239060	30713.85
20	9/23/2008-11/3/2008	30	-0.647082262	N/A	0.355182995	-0.000041449	0.003849610	0.000110294	0.007539091	29371.71
21	10/7/2008-11/17/2008	30	-0.766649721	N/A	0.343896337	-0.000047224	0.005502468	0.000093734	0.008481345	16781.38
22	10/21/2008-12/1/2008	30	-0.682213219	N/A	0.348156112	0.000044931	0.007331345	0.000082750	0.009351887	23516.31
23	11/4/2008-12/15/2008	30	-0.756618593	N/A	0.332322456	-0.000041757	0.010028002	0.000068236	0.011324276	36488.26
24	11/18/2008-12/29/2008	30	-0.796064703	N/A	0.335340584	0.000093117	0.010976499	0.000064976	0.010737222	28465.69
25	12/2/2008-1/12/2009	30	-0.677754419	N/A	0.345870012	-0.000039508	0.010561307	0.000058002	0.011085397	35241.20
26	12/16/2008-1/26/2009	30	-0.695321154	N/A	0.363212315	0.000047662	0.010173817	0.000050765	0.010330115	12526.58
27	12/30/2008-2/9/2009	30	-0.658145849	N/A	0.350464415	-0.000047162	0.009645337	0.000052567	0.010036589	14024.20
28	1/13/2009-2/23/2009	30	-0.721085474	N/A	0.360492127	-0.000010783	0.009263180	0.000046763	0.009411928	36177.22
29	1/27/2009-3/9/2009	30	-0.752630689	N/A	0.341971772	-0.000056468	0.008146300	0.000042214	0.008066229	19747.93
30	2/10/2009-3/23/2009	30	-0.744138779	N/A	0.343085189	-0.000030711	0.007370202	0.000042614	0.007861823	13040.93
31	2/24/2009-4/6/2009	30	-0.751881278	N/A	0.348944592	0.000033786	0.006764826	0.000044670	0.007024286	11618.56
32	3/10/2009-4/20/2009	30	-0.783583641	N/A	0.334701763	-0.000038579	0.005984104	0.000047967	0.006705868	4818.13
33	3/24/2009-5/4/2009	30	-0.650763331	N/A	0.346904933	0.000028940	0.004910456	0.000043263	0.006064220	6793.09
34	4/7/2009-5/18/2009	30	-0.821408224	N/A	0.335555699	-0.000012985	0.004572844	0.000040237	0.005746985	3981.94
35	4/21/2009-6/1/2009	30	-0.754391081	N/A	0.348941047	0.000032119	0.004410814	0.000040651	0.005270590	3263.88
36	5/5/2009-6/15/2009	30	-0.797758590	N/A	0.360898170	0.000066245	0.003727812	0.000037855	0.004919109	2468.83
37	5/19/2009-6/29/2009	30	-0.759596740	N/A	0.340918480	0.000068775	0.003946470	0.000035339	0.004815451	2223.37
38	6/2/2009-7/13/2009	30	-0.766124303	N/A	0.356980532	-0.000003943	0.003691705	0.000035032	0.004604995	1946.12
39	6/16/2009-7/27/2009	30	-0.678350915	N/A	0.332601085	0.000013681	0.003770032	0.000038226	0.004398781	1755.45
40	6/30/2009-8/10/2009	30	-0.809032531	N/A	0.335166978	-0.000048745	0.003272207	0.000031041	0.003770915	1085.95
41	7/14/2009-8/24/2009	30	-0.765536840	N/A	0.343753674	-0.000030056	0.002728602	0.000028319	0.003539268	6649.59
42	7/28/2009-9/7/2009	30	-0.735074969	N/A	0.348715238	0.000001900	0.002587168	0.000026803	0.002999050	1713.16
43	8/11/2009-9/21/2009	30	-0.692461971	N/A	0.356054640	0.000013567	0.002689395	0.000025567	0.003159135	1465.67
44	9/8/2009-10/6/2009	30	-0.749000720	N/A	0.341081836	-0.000007697	0.002604975	0.000024204	0.003199743	1577.48

Average Sum of Squared Errors   11,368.46

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __AT&T Inc.__   NYSE: __T__   Industry: __Telecom__

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.096755344	-137.537218193	0.319386412	N/A	0.000689817	0.000040042	0.004494333	2135.39
2	1/15/2008-2/25/2008	30	-0.016879645	-140.183082799	0.305791161	N/A	0.000975020	0.000042404	0.005261052	5535.38
3	1/29/2008-3/10/2008	30	-0.041924679	-129.645681016	0.320979870	N/A	0.001787120	0.000049126	0.005975336	19968.48
4	2/12/2008-3/24/2008	30	-0.007572597	-133.381826064	0.331740821	N/A	0.002416751	0.000072887	0.007009392	18761.34
5	2/26/2008-4/7/2008	30	0.042812640	-139.208514148	0.332775314	N/A	0.002721180	0.000077713	0.007851264	16397.27
6	3/11/2008-4/21/2008	30	-0.004133017	-128.163620280	0.328346992	N/A	0.002358284	0.000077099	0.007195344	19783.98
7	3/25/2008-5/25/2008	30	0.076014090	-127.541506257	0.321894244	N/A	0.001664868	0.000064219	0.006026981	11579.54
8	4/8/2008-5/19/2008	30	0.084430732	-130.344690257	0.326278644	N/A	0.001307728	0.000070254	0.004923382	2311.76
9	4/22/2008-6/2/2008	30	-0.077194429	-135.230025118	0.316877916	N/A	0.000925593	0.000071667	0.004866614	976.57
10	5/6/2008-6/16/2008	30	-0.069776969	-140.564943353	0.300619736	N/A	0.000798285	0.000069981	0.004516669	519.49
11	5/20/2008-6/30/2008	30	-0.068159560	-124.300031194	0.305281593	N/A	0.000896438	0.000080418	0.004697251	862.85
12	6/3/2008-7/14/2008	30	-0.047402244	-141.979902332	0.312430015	N/A	0.001276091	0.000077201	0.004542939	1626.69
13	6/17/2008-7/28/2008	30	-0.072345769	-144.774423658	0.345404393	N/A	0.001667419	0.000069063	0.004335911	1948.98
14	7/1/2008-8/11/2008	30	0.001145671	-130.899592477	0.324508193	N/A	0.001513050	0.000075986	0.004176881	2414.72
15	7/15/2008-8/25/2008	30	0.086615277	-130.914363053	0.333148549	N/A	0.001095736	0.000086526	0.004349248	3025.42
16	7/29/2008-9/8/2008	30	0.098529463	-144.162822869	0.345740313	N/A	0.001015801	0.000088645	0.004579226	4388.06
17	8/12/2008-9/22/2008	30	-0.021036947	-139.880693912	0.349412227	N/A	0.001486557	0.000077976	0.004635746	4407.29
18	8/26/2008-10/6/2008	30	-0.068230088	-119.812715377	0.345704717	N/A	0.002279865	0.000075202	0.004946685	12280.71
19	9/9/2008-10/20/2008	30	0.054585741	-127.378845223	0.354132709	N/A	0.002753593	0.000085780	0.006260351	26817.33
20	9/23/2008-11/3/2008	30	-0.066339857	-131.574181536	0.356009698	N/A	0.003582051	0.000107641	0.007208524	23122.02
21	10/7/2008-11/17/2008	30	0.069616765	-135.084350303	0.339578971	N/A	0.005478201	0.000093306	0.008116352	13440.94
22	10/21/2008-12/1/2008	30	0.027425395	-130.743672764	0.342633787	N/A	0.007178732	0.000080363	0.009668212	20656.47
23	11/4/2008-12/15/2008	30	-0.046933564	-127.641656239	0.330565193	N/A	0.010151907	0.000069928	0.010729290	30983.49
24	11/18/2008-12/29/2008	30	0.029707166	-141.945235175	0.351228945	N/A	0.010284914	0.000068285	0.011052973	23951.45
25	12/2/2008-1/12/2009	30	-0.020485562	-124.515797238	0.345723557	N/A	0.010334316	0.000058084	0.011012021	28997.45
26	12/16/2008-1/26/2009	30	-0.000459828	-126.474460509	0.348287982	N/A	0.010245653	0.000051638	0.010391620	10366.13
27	12/30/2008-2/9/2009	30	0.020639746	-120.572044133	0.340349962	N/A	0.009774684	0.000048981	0.009876195	12757.58
28	1/13/2009-2/23/2009	30	0.016383357	-134.379433021	0.365351759	N/A	0.008540069	0.000046031	0.008800333	30686.39
29	1/27/2009-3/9/2009	30	-0.069346813	-124.342293075	0.354350273	N/A	0.008425350	0.000040249	0.008186247	16297.23
30	2/10/2009-3/23/2009	30	-0.040187844	-123.926175983	0.351726130	N/A	0.007131983	0.000042246	0.007407004	10896.00
31	2/24/2009-4/6/2009	30	-0.075599164	-144.372889183	0.346680915	N/A	0.006815900	0.000046173	0.006987440	8913.46
32	3/10/2009-4/20/2009	30	0.062277861	-139.398893744	0.340099207	N/A	0.005770057	0.000045993	0.006594484	4090.44
33	3/24/2009-5/4/2009	30	0.020249972	-123.655133026	0.353030144	N/A	0.005156266	0.000044423	0.006001956	5377.57
34	4/7/2009-5/18/2009	30	-0.066240131	-122.428973022	0.348702358	N/A	0.004689683	0.000043559	0.005748627	4128.13
35	4/21/2009-6/1/2009	30	0.034400862	-129.281958541	0.361738278	N/A	0.004156219	0.000041072	0.005118317	2640.16
36	5/5/2009-6/15/2009	30	0.028353095	-129.964986842	0.363466892	N/A	0.003737379	0.000037093	0.004859780	2287.19
37	5/19/2009-6/29/2009	30	-0.073726512	-139.622954034	0.340278967	N/A	0.003700701	0.000038151	0.004397710	1765.98
38	6/2/2009-7/13/2009	30	-0.052766738	-130.813322320	0.365207219	N/A	0.003719933	0.000035229	0.004328685	1532.67
39	6/16/2009-7/27/2009	30	0.070283009	-122.940022708	0.354378423	N/A	0.003661665	0.000036728	0.004356631	1431.59
40	6/30/2009-8/10/2009	30	-0.029884782	-128.394346037	0.332424118	N/A	0.003052940	0.000030895	0.003884418	1290.34
41	7/14/2009-8/24/2009	30	-0.033642803	-145.399092736	0.344516607	N/A	0.002832493	0.000027694	0.003528895	5699.06
42	7/28/2009-9/7/2009	30	-0.080207381	-138.759325202	0.343884637	N/A	0.002497894	0.000025193	0.003251608	1453.46
43	8/11/2009-9/21/2009	30	0.026081869	-124.525603163	0.338239176	N/A	0.002656266	0.000024642	0.003314578	1218.71
44	9/8/2009-10/6/2009	30	0.009006034	-123.739432283	0.332188165	N/A	0.002499532	0.000024351	0.002972118	1197.19

Average Sum of Squared Errors   9,566.42

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: AT&T Inc.   NYSE: T   Industry: Telecom

Model11 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.086862994	-144.745192407	0.306315124	-0.000010278	0.000657701	0.000040650	0.004381414	2074.59
2	1/15/2008-2/25/2008	30	0.039778759	-130.256055570	0.307463546	-0.000064699	0.001001006	0.000039636	0.004900574	5181.96
3	1/29/2008-3/10/2008	30	0.099961525	-136.969006814	0.333112790	0.000006579	0.001727820	0.000051099	0.006275222	19005.99
4	2/12/2008-3/24/2008	30	0.048032761	-121.191403509	0.317277706	0.000063819	0.002548513	0.000075904	0.006960921	17646.79
5	2/26/2008-4/7/2008	30	0.063376976	-137.740376791	0.327854331	-0.000071594	0.002680710	0.000074012	0.007205898	15658.40
6	3/11/2008-4/21/2008	30	0.036801417	-143.248249978	0.314572851	-0.000043392	0.002340789	0.000079521	0.006903605	18742.43
7	3/25/2008-5/25/2008	30	-0.013290259	-138.078127820	0.315471835	0.000074499	0.001729480	0.000062334	0.005525992	11422.67
8	4/8/2008-5/19/2008	30	-0.016238601	-122.135564813	0.325696606	-0.000092101	0.001277130	0.000068974	0.005018175	2251.11
9	4/22/2008-6/2/2008	30	0.033820795	-135.378115245	0.304654360	-0.000070544	0.000917133	0.000071698	0.004547205	927.78
10	5/6/2008-6/16/2008	30	0.001090878	-135.180486148	0.320675044	0.000014267	0.000829123	0.000071348	0.004804557	511.02
11	5/20/2008-6/30/2008	30	-0.003636768	-138.126663017	0.307127833	-0.000041131	0.000884825	0.000074730	0.004728961	825.77
12	6/3/2008-7/14/2008	30	0.010140184	-141.097685131	0.320434126	-0.000016500	0.001302133	0.000078008	0.004674941	1583.82
13	6/17/2008-7/28/2008	30	-0.054997527	-122.502327848	0.332302676	-0.000085578	0.001803856	0.000068851	0.004214155	1691.93
14	7/1/2008-8/11/2008	30	0.017805839	-121.458043897	0.331247118	0.000099362	0.001594170	0.000072910	0.004555227	2250.86
15	7/15/2008-8/25/2008	30	0.023322137	-128.928084187	0.328224514	0.000013532	0.001118576	0.000082712	0.004495703	3007.63
16	7/29/2008-9/8/2008	30	0.052841485	-138.133092788	0.327964168	-0.000092066	0.000998563	0.000087528	0.004655496	4196.33
17	8/12/2008-9/22/2008	30	0.028286913	-144.827978156	0.325308473	0.000065405	0.001449777	0.000076237	0.004212571	4217.78
18	8/26/2008-10/6/2008	30	0.014416399	-126.217998759	0.333316930	0.000036599	0.002143780	0.000075318	0.004757245	11626.86
19	9/9/2008-10/20/2008	30	0.099419257	-141.794887287	0.347513434	0.000054298	0.002815161	0.000084903	0.005879882	26088.57
20	9/23/2008-11/3/2008	30	-0.081928688	-139.977284726	0.342526359	-0.000016216	0.003563686	0.000106244	0.007430530	21690.16
21	10/7/2008-11/17/2008	30	-0.032286594	-121.400304813	0.355508966	-0.000000228	0.005623569	0.000092743	0.008344216	12749.73
22	10/21/2008-12/1/2008	30	-0.085291948	-136.913377625	0.341883265	-0.000001966	0.007733681	0.000078208	0.009000634	19914.67
23	11/4/2008-12/15/2008	30	-0.047775017	-130.898333243	0.329771568	-0.000073448	0.009904532	0.000071364	0.011294922	30656.17
24	11/18/2008-12/29/2008	30	-0.006084787	-141.885778971	0.349203946	0.000084592	0.011027213	0.000066554	0.011411560	22795.43
25	12/2/2008-1/12/2009	30	0.043455961	-143.542792563	0.342123120	0.000084956	0.010081478	0.000062484	0.010425869	27866.47
26	12/16/2008-1/26/2009	30	0.087337105	-130.157162057	0.348420722	0.000067479	0.010008490	0.000051947	0.009944410	9924.13
27	12/30/2008-2/9/2009	30	-0.029235635	-137.100312611	0.368667027	0.000080254	0.009421962	0.000050687	0.009775597	10680.47
28	1/13/2009-2/23/2009	30	0.097999228	-119.777451545	0.352858364	0.000021119	0.009395801	0.000046265	0.008730582	29962.77
29	1/27/2009-3/9/2009	30	0.075028194	-120.822231350	0.360079485	-0.000016230	0.008476315	0.000042485	0.007943708	15942.05
30	2/10/2009-3/23/2009	30	-0.030022455	-143.033026403	0.342720330	-0.000000908	0.007468540	0.000044561	0.007224840	10172.88
31	2/24/2009-4/6/2009	30	-0.091433095	-137.104874005	0.363988779	-0.000076238	0.006882162	0.000044021	0.007002203	8244.80
32	3/10/2009-4/20/2009	30	-0.014142865	-124.341646604	0.344619069	-0.000033176	0.005784139	0.000046343	0.006695506	3828.54
33	3/24/2009-5/4/2009	30	0.002563171	-138.207652271	0.355427176	-0.000029758	0.004917967	0.000046588	0.006203246	5167.25
34	4/7/2009-5/18/2009	30	0.048397552	-125.874070394	0.346337273	-0.000097787	0.004652780	0.000040890	0.005530985	3202.01
35	4/21/2009-6/1/2009	30	-0.030305421	-126.085291466	0.351570216	0.000066112	0.004172499	0.000039637	0.004997209	2486.64
36	5/5/2009-6/15/2009	30	-0.038663480	-145.397773247	0.365503366	-0.000097412	0.003682132	0.000039034	0.004636770	2033.17
37	5/19/2009-6/29/2009	30	0.048262795	-121.163779636	0.338137637	-0.000038094	0.003640135	0.000036286	0.004652928	1672.67
38	6/2/2009-7/13/2009	30	0.027543512	-136.193610140	0.359977684	0.000050748	0.003581909	0.000037111	0.004526259	1532.15
39	6/16/2009-7/27/2009	30	0.055565640	-121.240399648	0.347919798	-0.000030381	0.003890396	0.000037082	0.004521792	1429.24
40	6/30/2009-8/10/2009	30	-0.023413686	-122.313165046	0.332381689	-0.000086353	0.003254322	0.000031248	0.004133478	1003.60
41	7/14/2009-8/24/2009	30	0.087793804	-142.677117789	0.351054423	0.000038704	0.002739982	0.000027916	0.003638484	5631.87
42	7/28/2009-9/7/2009	30	-0.070544318	-129.446839138	0.359134017	0.000019858	0.002531315	0.000026147	0.003109423	1354.46
43	8/11/2009-9/21/2009	30	-0.048956290	-130.414947333	0.334598156	0.000062866	0.002721660	0.000024929	0.003311688	1136.16
44	9/8/2009-10/6/2009	30	-0.098896317	-136.171988418	0.354747707	-0.000027191	0.002629117	0.000025525	0.003226997	1124.69

Average Sum of Squared Errors 9,116.24

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Bank of America Corp.   NYSE: BAC   Industry: Finance and Banking

Model 1   Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.411627621	N/A	N/A	N/A	0.012134267	N/A	N/A	38385.47
2	1/15/2008-2/25/2008	30	-0.309336971	N/A	N/A	N/A	0.013349953	N/A	N/A	40371.19
3	1/29/2008-3/10/2008	30	-0.264552424	N/A	N/A	N/A	0.015168928	N/A	N/A	133377.00
4	2/12/2008-3/24/2008	30	-0.361989355	N/A	N/A	N/A	0.018480934	N/A	N/A	198921.40
5	2/26/2008-4/7/2008	30	-0.420859284	N/A	N/A	N/A	0.018168258	N/A	N/A	218544.70
6	3/11/2008-4/21/2008	30	-0.419866429	N/A	N/A	N/A	0.016741466	N/A	N/A	213723.38
7	3/25/2008-5/25/2008	30	-0.357536279	N/A	N/A	N/A	0.013540833	N/A	N/A	67559.31
8	4/8/2008-5/19/2008	30	-0.450176458	N/A	N/A	N/A	0.012266502	N/A	N/A	73671.42
9	4/22/2008-6/2/2008	30	-0.395252576	N/A	N/A	N/A	0.011242341	N/A	N/A	49514.75
10	5/6/2008-6/16/2008	30	-0.285127763	N/A	N/A	N/A	0.011922383	N/A	N/A	61289.85
11	5/20/2008-6/30/2008	30	-0.298227058	N/A	N/A	N/A	0.013516468	N/A	N/A	87167.44
12	6/3/2008-7/14/2008	30	-0.280533366	N/A	N/A	N/A	0.015922596	N/A	N/A	125442.11
13	6/17/2008-7/28/2008	30	-0.282135255	N/A	N/A	N/A	0.017828190	N/A	N/A	131676.43
14	7/1/2008-8/11/2008	30	-0.330461904	N/A	N/A	N/A	0.018837632	N/A	N/A	93511.60
15	7/15/2008-8/25/2008	30	-0.253901616	N/A	N/A	N/A	0.019168835	N/A	N/A	86685.36
16	7/29/2008-9/8/2008	30	-0.289277062	N/A	N/A	N/A	0.019680811	N/A	N/A	78179.14
17	8/12/2008-9/22/2008	30	-0.437901335	N/A	N/A	N/A	0.022606603	N/A	N/A	255822.77
18	8/26/2008-10/6/2008	30	-0.360341655	N/A	N/A	N/A	0.024421440	N/A	N/A	237199.06
19	9/9/2008-10/20/2008	30	-0.278457122	N/A	N/A	N/A	0.024679742	N/A	N/A	306970.20
20	9/23/2008-11/3/2008	30	-0.261382469	N/A	N/A	N/A	0.022458224	N/A	N/A	209296.21
21	10/7/2008-11/17/2008	30	-0.412110614	N/A	N/A	N/A	0.021223603	N/A	N/A	171342.70
22	10/21/2008-12/1/2008	30	-0.28071194	N/A	N/A	N/A	0.023919839	N/A	N/A	280808.66
23	11/4/2008-12/15/2008	30	-0.280197706	N/A	N/A	N/A	0.027455236	N/A	N/A	261749.14
24	11/18/2008-12/29/2008	30	-0.394685459	N/A	N/A	N/A	0.028405339	N/A	N/A	187256.28
25	12/2/2008-1/12/2009	30	-0.30845952	N/A	N/A	N/A	0.025460262	N/A	N/A	213395.06
26	12/16/2008-1/26/2009	30	-0.270961169	N/A	N/A	N/A	0.026236659	N/A	N/A	278495.71
27	12/30/2008-2/9/2009	30	-0.428376822	N/A	N/A	N/A	0.022694824	N/A	N/A	369624.10
28	1/13/2009-2/23/2009	30	-0.445507847	N/A	N/A	N/A	0.027115191	N/A	N/A	376923.54
29	1/27/2009-3/9/2009	30	-0.283520038	N/A	N/A	N/A	0.033188284	N/A	N/A	1737681.83
30	2/10/2009-3/23/2009	30	-0.307160363	N/A	N/A	N/A	0.039758493	N/A	N/A	1798457.33
31	2/24/2009-4/6/2009	30	-0.376245293	N/A	N/A	N/A	0.046552833	N/A	N/A	1836408.82
32	3/10/2009-4/20/2009	30	-0.338853624	N/A	N/A	N/A	0.045432664	N/A	N/A	1793719.62
33	3/24/2009-5/4/2009	30	-0.328290788	N/A	N/A	N/A	0.044126438	N/A	N/A	1613899.98
34	4/7/2009-5/18/2009	30	-0.382898839	N/A	N/A	N/A	0.036823603	N/A	N/A	1104029.68
35	4/21/2009-6/1/2009	30	-0.30427602	N/A	N/A	N/A	0.031331693	N/A	N/A	1237896.68
36	5/5/2009-6/15/2009	30	-0.251777877	N/A	N/A	N/A	0.025587353	N/A	N/A	492676.15
37	5/19/2009-6/29/2009	30	-0.316090203	N/A	N/A	N/A	0.026879090	N/A	N/A	568092.82
38	6/2/2009-7/13/2009	30	-0.396380775	N/A	N/A	N/A	0.029051312	N/A	N/A	403974.62
39	6/16/2009-7/27/2009	30	-0.399357485	N/A	N/A	N/A	0.028908589	N/A	N/A	431994.38
40	6/30/2009-8/10/2009	30	-0.379878104	N/A	N/A	N/A	0.024104686	N/A	N/A	278885.76
41	7/14/2009-8/24/2009	30	-0.443825646	N/A	N/A	N/A	0.022067861	N/A	N/A	96013.45
42	7/28/2009-9/7/2009	30	-0.311936729	N/A	N/A	N/A	0.021791110	N/A	N/A	39868.62
43	8/11/2009-9/21/2009	30	-0.28577657	N/A	N/A	N/A	0.026738830	N/A	N/A	96484.86
44	9/8/2009-10/6/2009	30	-0.371525438	N/A	N/A	N/A	0.023828092	N/A	N/A	143568.39

Average Sum of Squared Errors   420,921.75

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Bank of America Corp. NYSE: BAC   Industry: Finance and Banking

Model 2   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.275409523	N/A	N/A	N/A	0.0099834751	0.000067886	N/A	18270.38
2	1/15/2008-2/25/2008	30	-0.436062973	N/A	N/A	N/A	0.0111594180	0.000069222	N/A	19851.40
3	1/29/2008-3/10/2008	30	-0.420407817	N/A	N/A	N/A	0.0124771427	0.000085272	N/A	77900.83
4	2/12/2008-3/24/2008	30	-0.332054754	N/A	N/A	N/A	0.0145262000	0.000125784	N/A	104160.42
5	2/26/2008-4/7/2008	30	-0.399648131	N/A	N/A	N/A	0.0142420203	0.000124726	N/A	125233.52
6	3/11/2008-4/21/2008	30	-0.432300461	N/A	N/A	N/A	0.0127200858	0.000127575	N/A	110485.79
7	3/25/2008-5/25/2008	30	-0.287549279	N/A	N/A	N/A	0.0100915777	0.000109176	N/A	25983.53
8	4/8/2008-5/19/2008	30	-0.267980659	N/A	N/A	N/A	0.0086757593	0.000113674	N/A	29550.49
9	4/22/2008-6/2/2008	30	-0.424233827	N/A	N/A	N/A	0.0076270865	0.000114487	N/A	13076.72
10	5/6/2008-6/16/2008	30	-0.383233936	N/A	N/A	N/A	0.0082609023	0.000116193	N/A	21134.49
11	5/20/2008-6/30/2008	30	-0.260539552	N/A	N/A	N/A	0.0094523533	0.000143557	N/A	30456.12
12	6/3/2008-7/14/2008	30	-0.424570002	N/A	N/A	N/A	0.0111402189	0.000152824	N/A	50250.30
13	6/17/2008-7/28/2008	30	-0.285631025	N/A	N/A	N/A	0.0126190298	0.000166853	N/A	49424.73
14	7/1/2008-8/11/2008	30	-0.377761198	N/A	N/A	N/A	0.0135457112	0.000169583	N/A	21030.82
15	7/15/2008-8/25/2008	30	-0.389043639	N/A	N/A	N/A	0.0144751619	0.000150348	N/A	24274.63
16	7/29/2008-9/8/2008	30	-0.304684252	N/A	N/A	N/A	0.0151833282	0.000143928	N/A	23198.00
17	8/12/2008-9/22/2008	30	-0.29211086	N/A	N/A	N/A	0.0184286585	0.000133928	N/A	140655.44
18	8/26/2008-10/6/2008	30	-0.326086206	N/A	N/A	N/A	0.0203810282	0.000129726	N/A	132672.90
19	9/9/2008-10/20/2008	30	-0.353686959	N/A	N/A	N/A	0.0207653295	0.000125740	N/A	173667.17
20	9/23/2008-11/3/2008	30	-0.390260957	N/A	N/A	N/A	0.0181192154	0.000139078	N/A	114747.76
21	10/7/2008-11/17/2008	30	-0.370927382	N/A	N/A	N/A	0.0163614438	0.000155561	N/A	78177.50
22	10/21/2008-12/1/2008	30	-0.31836115	N/A	N/A	N/A	0.0182204414	0.000182465	N/A	143843.29
23	11/4/2008-12/15/2008	30	-0.295371189	N/A	N/A	N/A	0.0215652915	0.000188440	N/A	126865.76
24	11/18/2008-12/29/2008	30	-0.366310384	N/A	N/A	N/A	0.0236705839	0.000150716	N/A	94142.06
25	12/2/2008-1/12/2009	30	-0.270364262	N/A	N/A	N/A	0.0222555637	0.000101307	N/A	123913.54
26	12/16/2008-1/26/2009	30	-0.422046548	N/A	N/A	N/A	0.0252673524	0.000030606	N/A	181339.85
27	12/30/2008-2/9/2009	30	-0.331808538	N/A	N/A	N/A	0.0303792530	-0.000057173	N/A	239825.96
28	1/13/2009-2/23/2009	30	-0.320000475	N/A	N/A	N/A	0.0391803857	-0.000160264	N/A	217541.96
29	1/27/2009-3/9/2009	30	-0.439756494	N/A	N/A	N/A	0.0526912013	-0.000349089	N/A	975365.68
30	2/10/2009-3/23/2009	30	-0.306613198	N/A	N/A	N/A	0.0666868422	-0.000535248	N/A	782591.64
31	2/24/2009-4/6/2009	30	-0.268989691	N/A	N/A	N/A	0.0800457069	-0.000694324	N/A	567769.02
32	3/10/2009-4/20/2009	30	-0.271605353	N/A	N/A	N/A	0.0786931387	-0.000694991	N/A	557416.85
33	3/24/2009-5/4/2009	30	-0.447523589	N/A	N/A	N/A	0.0750649458	-0.000631126	N/A	523959.42
34	4/7/2009-5/18/2009	30	-0.405172438	N/A	N/A	N/A	0.0611955045	-0.000477446	N/A	417242.60
35	4/21/2009-6/1/2009	30	-0.274470833	N/A	N/A	N/A	0.0507020887	-0.000361334	N/A	625940.70
36	5/5/2009-6/15/2009	30	-0.44127143	N/A	N/A	N/A	0.0396883753	-0.000239630	N/A	243192.33
37	5/19/2009-6/29/2009	30	-0.399317235	N/A	N/A	N/A	0.0397599978	-0.000190735	N/A	315320.29
38	6/2/2009-7/13/2009	30	-0.373624065	N/A	N/A	N/A	0.0332821109	-0.000135977	N/A	218308.04
39	6/16/2009-7/27/2009	30	-0.373891537	N/A	N/A	N/A	0.0415518442	-0.000166349	N/A	246235.94
40	6/30/2009-8/10/2009	30	-0.431645445	N/A	N/A	N/A	0.0346819985	-0.000139218	N/A	161246.62
41	7/14/2009-8/24/2009	30	-0.394526273	N/A	N/A	N/A	0.0243389025	-0.000072446	N/A	52103.64
42	7/28/2009-9/7/2009	30	-0.445894173	N/A	N/A	N/A	0.0227258997	-0.000029819	N/A	23883.12
43	8/11/2009-9/21/2009	30	-0.299708042	N/A	N/A	N/A	0.0263726783	0.000011743	N/A	65431.43
44	9/8/2009-10/6/2009	30	-0.410057403	N/A	N/A	N/A	0.0222407072	0.000050725	N/A	90450.52

Average Sum of Squared Errors   190,412.12

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Bank of America Corp.</u> NYSE: <u>BAC</u> Industry: <u>Finance and Banking</u>

Model 3 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.289002658	N/A	0.289865211	N/A	0.003889572	N/A	0.025198781	22123.45
2	1/15/2008-2/25/2008	30	-0.303091557	N/A	0.294535730	N/A	0.004453251	N/A	0.026068215	24205.39
3	1/29/2008-3/10/2008	30	-0.286451787	N/A	0.299403797	N/A	0.005101381	N/A	0.031464767	77209.42
4	2/12/2008-3/24/2008	30	-0.385697478	N/A	0.300768189	N/A	0.005942388	N/A	0.038756247	124445.68
5	2/26/2008-4/7/2008	30	-0.410631155	N/A	0.301116313	N/A	0.006144838	N/A	0.038108356	129245.00
6	3/11/2008-4/21/2008	30	-0.441547606	N/A	0.301831538	N/A	0.005451007	N/A	0.034276347	122317.40
7	3/25/2008-5/25/2008	30	-0.35242809	N/A	0.308945258	N/A	0.004379837	N/A	0.026706204	40338.49
8	4/8/2008-5/19/2008	30	-0.300014065	N/A	0.302104038	N/A	0.004288635	N/A	0.024469551	46086.68
9	4/22/2008-6/2/2008	30	-0.347513261	N/A	0.317814236	N/A	0.003614712	N/A	0.021540014	29253.64
10	5/6/2008-6/16/2008	30	-0.375654111	N/A	0.322682373	N/A	0.003848886	N/A	0.024737569	37553.06
11	5/20/2008-6/30/2008	30	-0.306208752	N/A	0.341588306	N/A	0.004578857	N/A	0.02707517	51382.44
12	6/3/2008-7/14/2008	30	-0.445448621	N/A	0.330387614	N/A	0.005513945	N/A	0.031836413	75055.49
13	6/17/2008-7/28/2008	30	-0.323761145	N/A	0.355592688	N/A	0.006055546	N/A	0.034769429	75461.82
14	7/1/2008-8/11/2008	30	-0.410240004	N/A	0.333475383	N/A	0.006249838	N/A	0.03833688	55859.84
15	7/15/2008-8/25/2008	30	-0.37833136	N/A	0.309981099	N/A	0.006704269	N/A	0.036882461	53394.18
16	7/29/2008-9/8/2008	30	-0.310307717	N/A	0.324752099	N/A	0.006642318	N/A	0.037741481	45972.44
17	8/12/2008-9/22/2008	30	-0.313852223	N/A	0.330966166	N/A	0.007878291	N/A	0.043651856	151757.19
18	8/26/2008-10/6/2008	30	-0.272593239	N/A	0.308746722	N/A	0.008011592	N/A	0.04731952	138271.20
19	9/9/2008-10/20/2008	30	-0.441878749	N/A	0.349494046	N/A	0.008323387	N/A	0.050912141	182852.73
20	9/23/2008-11/3/2008	30	-0.413873793	N/A	0.357907199	N/A	0.007770752	N/A	0.0448775	126119.22
21	10/7/2008-11/17/2008	30	-0.399012749	N/A	0.356707076	N/A	0.007280056	N/A	0.044190114	99269.31
22	10/21/2008-12/1/2008	30	-0.427029915	N/A	0.387642136	N/A	0.007963736	N/A	0.046184479	169311.77
23	11/4/2008-12/15/2008	30	-0.29260141	N/A	0.395418533	N/A	0.009183124	N/A	0.052395393	150226.49
24	11/18/2008-12/29/2008	30	-0.25713099	N/A	0.402993756	N/A	0.009409995	N/A	0.059615664	107664.59
25	12/2/2008-1/12/2009	30	-0.321588932	N/A	0.454012381	N/A	0.008701276	N/A	0.048546556	125546.17
26	12/16/2008-1/26/2009	30	-0.411498058	N/A	0.516876924	N/A	0.008674262	N/A	0.054554586	163760.04
27	12/30/2008-2/9/2009	30	-0.450200716	N/A	0.633977983	N/A	0.007924711	N/A	0.043138539	223979.92
28	1/13/2009-2/23/2009	30	-0.355393952	N/A	0.690768870	N/A	0.008822273	N/A	0.05528182	215411.02
29	1/27/2009-3/9/2009	30	-0.40581317	N/A	0.668234441	N/A	0.010843468	N/A	0.064834945	1082139.88
30	2/10/2009-3/23/2009	30	-0.3378428	N/A	0.602958593	N/A	0.013782668	N/A	0.077033792	1131421.28
31	2/24/2009-4/6/2009	30	-0.397804458	N/A	0.538366268	N/A	0.016147336	N/A	0.096792407	1138927.80
32	3/10/2009-4/20/2009	30	-0.312888967	N/A	0.488993061	N/A	0.014624952	N/A	0.087545422	1028616.76
33	3/24/2009-5/4/2009	30	-0.393157559	N/A	0.484087772	N/A	0.015246803	N/A	0.087985734	922631.71
34	4/7/2009-5/18/2009	30	-0.359322013	N/A	0.453691203	N/A	0.012731356	N/A	0.071603084	668979.90
35	4/21/2009-6/1/2009	30	-0.446535979	N/A	0.463146877	N/A	0.010491232	N/A	0.060611257	770766.31
36	5/5/2009-6/15/2009	30	-0.2546221	N/A	0.432108747	N/A	0.00894752	N/A	0.04955152	292399.02
37	5/19/2009-6/29/2009	30	-0.387954217	N/A	0.418735956	N/A	0.008751076	N/A	0.056118765	336617.36
38	6/2/2009-7/13/2009	30	-0.369183166	N/A	0.443584500	N/A	0.010127451	N/A	0.058165386	243903.90
39	6/16/2009-7/27/2009	30	-0.278684087	N/A	0.399498215	N/A	0.009627628	N/A	0.055456811	247220.09
40	6/30/2009-8/10/2009	30	-0.424880927	N/A	0.397706362	N/A	0.00796343	N/A	0.04725344	174005.32
41	7/14/2009-8/24/2009	30	-0.257364318	N/A	0.388220504	N/A	0.007113191	N/A	0.043478186	55684.02
42	7/28/2009-9/7/2009	30	-0.362688252	N/A	0.380098031	N/A	0.00699762	N/A	0.044933961	24905.19
43	8/11/2009-9/21/2009	30	-0.387903901	N/A	0.406356070	N/A	0.008930198	N/A	0.053692226	57723.66
44	9/8/2009-10/6/2009	30	-0.309630883	N/A	0.403902331	N/A	0.007963163	N/A	0.049153857	90386.53

Average Sum of Squared Errors 252,963.70

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Bank of America Corp.</u> NYSE: <u>BAC</u> Industry: <u>Finance and Banking</u>

Model 4 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 - b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.410384294	N/A	0.317049749	0.000088600	0.003986797	N/A	0.025427620	20692.40
2	1/15/2008-2/25/2008	30	-0.333412531	N/A	0.297014156	-0.000086283	0.004310105	N/A	0.025370756	22349.01
3	1/29/2008-3/10/2008	30	-0.314738551	N/A	0.295876016	-0.000064873	0.004964716	N/A	0.029394203	72091.94
4	2/12/2008-3/24/2008	30	-0.267383038	N/A	0.293857990	-0.000024833	0.006272565	N/A	0.037683839	108210.23
5	2/26/2008-4/7/2008	30	-0.289626500	N/A	0.300866326	-0.000002260	0.006225059	N/A	0.036290545	119025.00
6	3/11/2008-4/21/2008	30	-0.321071769	N/A	0.303785339	0.000036840	0.005384472	N/A	0.033106583	115362.72
7	3/25/2008-5/25/2008	30	-0.439934272	N/A	0.311769445	0.000091467	0.004444220	N/A	0.027649719	37092.90
8	4/8/2008-5/19/2008	30	-0.359044283	N/A	0.317839501	0.000033273	0.003944074	N/A	0.023575523	40405.78
9	4/22/2008-6/2/2008	30	-0.263026660	N/A	0.297624832	-0.000070016	0.003829740	N/A	0.022962647	26940.69
10	5/6/2008-6/16/2008	30	-0.275441299	N/A	0.336527543	-0.000031573	0.003859389	N/A	0.022864359	33966.55
11	5/20/2008-6/30/2008	30	-0.424634360	N/A	0.336739923	0.000024106	0.004709693	N/A	0.026720898	48851.76
12	6/3/2008-7/14/2008	30	-0.414246415	N/A	0.352531724	-0.000058201	0.005254654	N/A	0.032407428	68944.57
13	6/17/2008-7/28/2008	30	-0.393227758	N/A	0.352175118	-0.000040240	0.005749314	N/A	0.036096542	71036.16
14	7/1/2008-8/11/2008	30	-0.418532762	N/A	0.319000686	0.000020944	0.006206796	N/A	0.037968500	52010.30
15	7/15/2008-8/25/2008	30	-0.317024576	N/A	0.309802575	0.000045677	0.006195324	N/A	0.036945498	47200.07
16	7/29/2008-9/8/2008	30	-0.330783472	N/A	0.323071799	0.000020099	0.006307885	N/A	0.037530025	43672.10
17	8/12/2008-9/22/2008	30	-0.445779748	N/A	0.332126920	0.000026124	0.007310031	N/A	0.044592178	141199.20
18	8/26/2008-10/6/2008	30	-0.282948864	N/A	0.308198119	0.000044060	0.008176342	N/A	0.048681285	132468.90
19	9/9/2008-10/20/2008	30	-0.449959263	N/A	0.332863366	-0.000023464	0.008532088	N/A	0.047214729	169739.82
20	9/23/2008-11/3/2008	30	-0.359526583	N/A	0.342230183	-0.000022885	0.007401536	N/A	0.046060469	116051.82
21	10/7/2008-11/17/2008	30	-0.258681887	N/A	0.360391582	0.000082825	0.007000960	N/A	0.040681595	94971.99
22	10/21/2008-12/1/2008	30	-0.353165425	N/A	0.385463960	0.000056839	0.007783659	N/A	0.048919212	155455.86
23	11/4/2008-12/15/2008	30	-0.266267632	N/A	0.405776756	0.000057549	0.008918615	N/A	0.054904237	142772.17
24	11/18/2008-12/29/2008	30	-0.352176936	N/A	0.398164199	-0.000049955	0.009327470	N/A	0.054515237	103186.96
25	12/2/2008-1/12/2009	30	-0.391989370	N/A	0.444888196	-0.000029476	0.008108078	N/A	0.050997322	115076.09
26	12/16/2008-1/26/2009	30	-0.374717788	N/A	0.503490678	0.000081170	0.008917620	N/A	0.051096731	151725.54
27	12/30/2008-2/9/2009	30	-0.261993762	N/A	0.631930023	0.000015103	0.007586876	N/A	0.043414654	199877.75
28	1/13/2009-2/23/2009	30	-0.346870469	N/A	0.703557611	-0.000082397	0.009476273	N/A	0.054911215	210883.84
29	1/27/2009-3/9/2009	30	-0.360791309	N/A	0.648306669	0.000095207	0.010660018	N/A	0.063638461	951957.85
30	2/10/2009-3/23/2009	30	-0.306661621	N/A	0.589930169	-0.000051289	0.013413403	N/A	0.081003050	982837.17
31	2/24/2009-4/6/2009	30	-0.419515143	N/A	0.534158002	0.000051220	0.015807393	N/A	0.091341571	1017500.71
32	3/10/2009-4/20/2009	30	-0.279705610	N/A	0.515707048	0.000019371	0.014518896	N/A	0.088191005	993606.33
33	3/24/2009-5/4/2009	30	-0.329229701	N/A	0.447081601	0.000061704	0.014307602	N/A	0.088696307	905040.57
34	4/7/2009-5/18/2009	30	-0.255328777	N/A	0.447226866	0.000010275	0.012038859	N/A	0.071927838	599151.12
35	4/21/2009-6/1/2009	30	-0.374296459	N/A	0.464633516	-0.000026304	0.010567194	N/A	0.061486762	693586.57
36	5/5/2009-6/15/2009	30	-0.444068833	N/A	0.455520956	0.000053210	0.008512111	N/A	0.052644773	267755.59
37	5/19/2009-6/29/2009	30	-0.259651342	N/A	0.425941739	0.000044215	0.008993184	N/A	0.052338873	310137.09
38	6/2/2009-7/13/2009	30	-0.448101428	N/A	0.440030427	-0.000006475	0.009479341	N/A	0.056967696	221003.23
39	6/16/2009-7/27/2009	30	-0.290069100	N/A	0.407113485	0.000048006	0.009515163	N/A	0.055430107	234678.35
40	6/30/2009-8/10/2009	30	-0.396878278	N/A	0.414659390	-0.000019146	0.008203769	N/A	0.048916415	154259.34
41	7/14/2009-8/24/2009	30	-0.258316025	N/A	0.377027379	0.000047798	0.007616431	N/A	0.044187840	52493.69
42	7/28/2009-9/7/2009	30	-0.345475170	N/A	0.369376893	-0.000041708	0.007605003	N/A	0.043592946	22341.18
43	8/11/2009-9/21/2009	30	-0.346229976	N/A	0.394701418	-0.000077535	0.008590704	N/A	0.051158278	52062.15
44	9/8/2009-10/6/2009	30	-0.323398480	N/A	0.380196743	0.000003832	0.007808874	N/A	0.045346057	78163.38

Average Sum of Squared Errors 231,769.01

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Bank of America Corp. NYSE: BAC Industry: Finance and Banking

Model 5 Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.001601887	-30.107101997	N/A	N/A	0.009493415	0.000065961	N/A	15451.87
2	1/15/2008-2/25/2008	30	-0.087659099	-29.302321149	N/A	N/A	0.011187439	0.000067718	N/A	16817.77
3	1/29/2008-3/10/2008	30	0.024192644	-29.449601435	N/A	N/A	0.012082605	0.000082294	N/A	63568.16
4	2/12/2008-3/24/2008	30	-0.012963916	-27.529248894	N/A	N/A	0.014798715	0.000126618	N/A	87860.43
5	2/26/2008-4/7/2008	30	0.081761671	-30.153683608	N/A	N/A	0.014736315	0.000124717	N/A	89485.19
6	3/11/2008-4/21/2008	30	0.008843406	-29.299731633	N/A	N/A	0.012781205	0.000123596	N/A	92786.67
7	3/25/2008-5/25/2008	30	-0.053286954	-28.764192817	N/A	N/A	0.009773342	0.000110620	N/A	21874.80
8	4/8/2008-5/19/2008	30	0.070235536	-29.807959988	N/A	N/A	0.008902375	0.000113590	N/A	23375.91
9	4/22/2008-6/2/2008	30	-0.061439448	-29.709243278	N/A	N/A	0.007974277	0.000116520	N/A	10406.02
10	5/6/2008-6/16/2008	30	-0.006010857	-29.177472769	N/A	N/A	0.008188443	0.000112422	N/A	17239.08
11	5/20/2008-6/30/2008	30	-0.089182243	-31.052264144	N/A	N/A	0.009005396	0.000143514	N/A	24960.45
12	6/3/2008-7/14/2008	30	-0.083467014	-26.122854795	N/A	N/A	0.011230949	0.000147756	N/A	42330.37
13	6/17/2008-7/28/2008	30	0.077562251	-30.984686864	N/A	N/A	0.012690058	0.000164472	N/A	41114.23
14	7/1/2008-8/11/2008	30	-0.067777124	-29.193537397	N/A	N/A	0.014219305	0.000161686	N/A	17212.69
15	7/15/2008-8/25/2008	30	-0.071949168	-26.878134654	N/A	N/A	0.014983736	0.000147215	N/A	20380.68
16	7/29/2008-9/8/2008	30	-0.075386993	-28.687114737	N/A	N/A	0.015766880	0.000142030	N/A	19069.24
17	8/12/2008-9/22/2008	30	0.086929261	-29.284118278	N/A	N/A	0.017819061	0.000128471	N/A	114973.55
18	8/26/2008-10/6/2008	30	0.012962647	-27.593761741	N/A	N/A	0.019662309	0.000126781	N/A	109682.83
19	9/9/2008-10/20/2008	30	-0.026189260	-29.547406467	N/A	N/A	0.021403693	0.000130008	N/A	140985.02
20	9/23/2008-11/3/2008	30	-0.072590798	-31.433752388	N/A	N/A	0.017580143	0.000143168	N/A	89727.11
21	10/7/2008-11/17/2008	30	0.072995943	-27.108205030	N/A	N/A	0.016778580	0.000154847	N/A	66031.25
22	10/21/2008-12/1/2008	30	0.001987425	-31.480387501	N/A	N/A	0.017385111	0.000189372	N/A	115054.82
23	11/4/2008-12/15/2008	30	-0.047640112	-30.525709681	N/A	N/A	0.020806428	0.000179427	N/A	100396.75
24	11/18/2008-12/29/2008	30	0.042348407	-27.015924785	N/A	N/A	0.023788495	0.000154765	N/A	78551.85
25	12/2/2008-1/12/2009	30	0.016011152	-30.725472372	N/A	N/A	0.021774543	0.000104941	N/A	104699.58
26	12/16/2008-1/26/2009	30	0.077121234	-27.752848725	N/A	N/A	0.026409559	0.000030658	N/A	150241.34
27	12/30/2008-2/9/2009	30	0.083105003	-30.831762604	N/A	N/A	0.031142089	-0.000058906	N/A	201235.28
28	1/13/2009-2/23/2009	30	0.013022815	-31.103485069	N/A	N/A	0.037419654	-0.000153385	N/A	181752.49
29	1/27/2009-3/9/2009	30	0.009515892	-30.250228699	N/A	N/A	0.051674417	-0.000356177	N/A	827736.91
30	2/10/2009-3/23/2009	30	0.084492721	-29.437302697	N/A	N/A	0.068499541	-0.000560986	N/A	659486.19
31	2/24/2009-4/6/2009	30	0.005154237	-28.298825546	N/A	N/A	0.083303628	-0.000710308	N/A	478086.11
32	3/10/2009-4/20/2009	30	-0.075644334	-30.405285983	N/A	N/A	0.077685130	-0.000673556	N/A	465169.38
33	3/24/2009-5/4/2009	30	-0.041783796	-27.384231806	N/A	N/A	0.078618159	-0.000659968	N/A	443084.85
34	4/7/2009-5/18/2009	30	0.088696352	-30.824585084	N/A	N/A	0.058294714	-0.000455561	N/A	351204.41
35	4/21/2009-6/1/2009	30	0.096636148	-27.074285314	N/A	N/A	0.048536928	-0.000354876	N/A	531004.98
36	5/5/2009-6/15/2009	30	0.024928136	-30.963923106	N/A	N/A	0.038629794	-0.000247280	N/A	205756.06
37	5/19/2009-6/29/2009	30	-0.020187399	-29.510000689	N/A	N/A	0.040133854	-0.000188744	N/A	259965.18
38	6/2/2009-7/13/2009	30	0.019676199	-31.424767359	N/A	N/A	0.032931384	-0.000131023	N/A	183717.09
39	6/16/2009-7/27/2009	30	0.025231049	-26.178321685	N/A	N/A	0.042803299	-0.000161567	N/A	209257.09
40	6/30/2009-8/10/2009	30	0.001533115	-30.639884809	N/A	N/A	0.035229688	-0.000138719	N/A	136769.76
41	7/14/2009-8/24/2009	30	-0.077887535	-27.663454329	N/A	N/A	0.025283840	-0.000069192	N/A	42225.67
42	7/28/2009-9/7/2009	30	-0.027450295	-29.945798511	N/A	N/A	0.022751834	-0.000030387	N/A	17071.72
43	8/11/2009-9/21/2009	30	0.048753757	-27.761550137	N/A	N/A	0.025191241	0.000011974	N/A	52896.27
44	9/8/2009-10/6/2009	30	-0.029635623	-26.666479494	N/A	N/A	0.023075385	0.000052048	N/A	75300.02

Average Sum of Squared Errors 158,999.93

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

| | Reference Entity: | Bank of America Corp. | NYSE: | | BAC | | Industry: | Finance and Banking | |

Model 6   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

| Time window | Period of time | The number of trading days | Extracted Parameters | | | | | | | Sum of squared errors |
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.001441399	-26.883781777	0.296071880	N/A	0.003883469	N/A	0.023300879	18803.52
2	1/15/2008-2/25/2008	30	-0.040480146	-31.279008717	0.297715942	N/A	0.004298038	N/A	0.027524709	20261.14
3	1/29/2008-3/10/2008	30	0.051658733	-26.696558896	0.298938023	N/A	0.005106991	N/A	0.030041670	60889.53
4	2/12/2008-3/24/2008	30	-0.038433526	-30.262396716	0.316733220	N/A	0.006374176	N/A	0.035925283	90994.07
5	2/26/2008-4/7/2008	30	-0.038878763	-30.588744205	0.310776103	N/A	0.006331534	N/A	0.037566004	104922.94
6	3/11/2008-4/21/2008	30	-0.037195148	-27.390855683	0.306944402	N/A	0.005329811	N/A	0.032923340	106252.51
7	3/25/2008-5/25/2008	30	0.048997153	-31.664608905	0.319407536	N/A	0.004390945	N/A	0.027587699	31734.51
8	4/8/2008-5/19/2008	30	-0.040895796	-29.022918435	0.310415943	N/A	0.003889587	N/A	0.025034287	35924.81
9	4/22/2008-6/2/2008	30	-0.044552557	-31.213627465	0.304754271	N/A	0.003592290	N/A	0.021588882	22947.68
10	5/6/2008-6/16/2008	30	0.086972009	-28.712828327	0.326755455	N/A	0.004045664	N/A	0.024254984	29809.90
11	5/20/2008-6/30/2008	30	0.089540159	-28.539171450	0.334009888	N/A	0.004594005	N/A	0.028263554	40920.93
12	6/3/2008-7/14/2008	30	-0.058244083	-30.650899921	0.327986858	N/A	0.005477267	N/A	0.033411561	60933.89
13	6/17/2008-7/28/2008	30	-0.053354875	-27.212458558	0.340076137	N/A	0.005794730	N/A	0.036276369	61922.01
14	7/1/2008-8/11/2008	30	0.010306989	-26.487968373	0.337436033	N/A	0.006295409	N/A	0.039342107	44455.41
15	7/15/2008-8/25/2008	30	-0.025537038	-26.253722721	0.335541877	N/A	0.006618384	N/A	0.040076684	42858.49
16	7/29/2008-9/8/2008	30	-0.036329452	-27.703675364	0.321151493	N/A	0.006683752	N/A	0.037614050	38437.20
17	8/12/2008-9/22/2008	30	0.010529521	-30.409226643	0.306452644	N/A	0.007803344	N/A	0.046884260	122427.41
18	8/26/2008-10/6/2008	30	0.004981986	-31.637435249	0.315210150	N/A	0.008095280	N/A	0.047065674	116754.72
19	9/9/2008-10/20/2008	30	-0.055039098	-31.290829020	0.336829554	N/A	0.008303935	N/A	0.048543843	143213.58
20	9/23/2008-11/3/2008	30	-0.006310644	-28.886818552	0.351683526	N/A	0.007414055	N/A	0.043631322	98116.36
21	10/7/2008-11/17/2008	30	-0.097727401	-30.143660372	0.369733979	N/A	0.006822302	N/A	0.041371014	81667.55
22	10/21/2008-12/1/2008	30	-0.032918218	-30.887742797	0.377874316	N/A	0.008195042	N/A	0.049656920	131718.72
23	11/4/2008-12/15/2008	30	0.008643903	-29.032838837	0.431646998	N/A	0.008855465	N/A	0.055717053	120993.21
24	11/18/2008-12/29/2008	30	0.040686016	-28.409764294	0.425967630	N/A	0.009833990	N/A	0.054546778	85886.25
25	12/2/2008-1/12/2009	30	0.009774317	-30.521682725	0.439213426	N/A	0.008824512	N/A	0.050575056	105990.71
26	12/16/2008-1/26/2009	30	-0.040873598	-29.032148015	0.488387185	N/A	0.009099109	N/A	0.050571148	136138.16
27	12/30/2008-2/9/2009	30	0.095065905	-27.327135792	0.603535121	N/A	0.007539699	N/A	0.044309430	182577.56
28	1/13/2009-2/23/2009	30	-0.067185724	-28.491898544	0.675407450	N/A	0.008701024	N/A	0.055130646	180552.58
29	1/27/2009-3/9/2009	30	-0.055779397	-31.443134314	0.669709681	N/A	0.011223268	N/A	0.068768887	816514.18
30	2/10/2009-3/23/2009	30	0.045381263	-28.307728183	0.633781832	N/A	0.013045776	N/A	0.082702669	836451.10
31	2/24/2009-4/6/2009	30	0.045703944	-29.998746941	0.558563800	N/A	0.015794032	N/A	0.090208520	901108.39
32	3/10/2009-4/20/2009	30	0.068205523	-27.586546747	0.508921687	N/A	0.015408618	N/A	0.089327115	892722.93
33	3/24/2009-5/4/2009	30	-0.008578576	-27.326081535	0.490415839	N/A	0.015159689	N/A	0.090992386	794026.09
34	4/7/2009-5/18/2009	30	-0.081610533	-27.982335339	0.472270936	N/A	0.011810518	N/A	0.071104187	543154.96
35	4/21/2009-6/1/2009	30	0.005090674	-29.000270347	0.434079483	N/A	0.010463439	N/A	0.063092332	620701.60
36	5/5/2009-6/15/2009	30	0.055904247	-29.514339031	0.456578545	N/A	0.008840058	N/A	0.050752322	237284.80
37	5/19/2009-6/29/2009	30	-0.023803039	-26.690849197	0.423925641	N/A	0.009253284	N/A	0.055508093	277851.34
38	6/2/2009-7/13/2009	30	0.064054264	-29.207344298	0.442414867	N/A	0.009993120	N/A	0.057216256	189660.96
39	6/16/2009-7/27/2009	30	0.002100484	-29.612439499	0.394646718	N/A	0.009373057	N/A	0.056760583	204263.12
40	6/30/2009-8/10/2009	30	0.034453730	-27.445480753	0.396561990	N/A	0.008294298	N/A	0.047194378	137783.17
41	7/14/2009-8/24/2009	30	-0.091504651	-27.143323714	0.404990989	N/A	0.007280393	N/A	0.042788845	45634.89
42	7/28/2009-9/7/2009	30	0.059458304	-30.776652032	0.386061697	N/A	0.007289493	N/A	0.042565291	19640.96
43	8/11/2009-9/21/2009	30	0.071624952	-26.607799062	0.388574549	N/A	0.009108252	N/A	0.051622195	46947.37
44	9/8/2009-10/6/2009	30	-0.070640194	-27.435717624	0.386018615	N/A	0.007641138	N/A	0.048041108	67786.47

Average Sum of Squared Errors   203,400.86

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Bank of America Corp.</u> NYSE: <u>BAC</u> Industry: <u>Finance and Banking</u>

Model 7 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.048839758	-26.873164306	0.317304762	-0.000072947	0.004034396	N/A	0.024844817	15857.16
2	1/15/2008-2/25/2008	30	-0.089359996	-28.004123614	0.330598501	0.000050856	0.004587537	N/A	0.025782375	16568.06
3	1/29/2008-3/10/2008	30	-0.063566490	-28.971790887	0.306267114	-0.000096083	0.005092167	N/A	0.030702166	59410.34
4	2/12/2008-3/24/2008	30	-0.017409057	-29.032400295	0.311746945	0.000024802	0.006156681	N/A	0.037485166	83276.90
5	2/26/2008-4/7/2008	30	0.054805038	-28.923750863	0.294707259	0.000078318	0.006086086	N/A	0.035510699	94934.09
6	3/11/2008-4/21/2008	30	0.049309874	-28.247929393	0.315241628	0.000089356	0.005523879	N/A	0.034610558	94564.42
7	3/25/2008-5/25/2008	30	0.085632111	-27.489908359	0.313119756	0.000007286	0.004605827	N/A	0.026609939	29239.77
8	4/8/2008-5/19/2008	30	0.002596485	-30.500754352	0.293264727	-0.000076032	0.004220307	N/A	0.025105568	32652.58
9	4/22/2008-6/2/2008	30	-0.037607918	-29.842852278	0.302892632	-0.000029010	0.003789793	N/A	0.023549629	22019.89
10	5/6/2008-6/16/2008	30	-0.067435420	-26.412199659	0.294116568	0.000049019	0.004080977	N/A	0.023107344	25108.15
11	5/20/2008-6/30/2008	30	-0.052366830	-28.279065841	0.311908657	0.000056762	0.004419692	N/A	0.026500433	39118.51
12	6/3/2008-7/14/2008	30	0.021255292	-31.718661441	0.304480541	-0.000032049	0.005321852	N/A	0.031448624	53004.21
13	6/17/2008-7/28/2008	30	-0.037886197	-27.811242875	0.301755758	0.000012998	0.006051575	N/A	0.036318873	59007.72
14	7/1/2008-8/11/2008	30	-0.068316683	-30.034950211	0.311999656	0.000013240	0.006517837	N/A	0.036457618	39246.97
15	7/15/2008-8/25/2008	30	-0.079806890	-31.357043677	0.333041620	0.000070408	0.006182510	N/A	0.038336084	38979.57
16	7/29/2008-9/8/2008	30	0.065253931	-31.689863931	0.332313324	-0.000081353	0.006863809	N/A	0.038453663	34437.06
17	8/12/2008-9/22/2008	30	-0.077322159	-28.719478939	0.343175168	0.000040435	0.007902681	N/A	0.046793466	105666.48
18	8/26/2008-10/6/2008	30	0.038479388	-26.802333588	0.372830676	-0.000064561	0.008155206	N/A	0.049998146	103827.07
19	9/9/2008-10/20/2008	30	0.079659630	-29.641276321	0.392089030	0.000094448	0.008622498	N/A	0.048227084	129179.31
20	9/23/2008-11/3/2008	30	0.011161488	-27.601670527	0.446858595	-0.000028500	0.007123694	N/A	0.045613033	92831.01
21	10/7/2008-11/17/2008	30	-0.097379118	-30.887949418	0.490167521	-0.000029054	0.007259342	N/A	0.043851261	76572.50
22	10/21/2008-12/1/2008	30	-0.030125074	-29.843722426	0.460350053	0.000038207	0.007847601	N/A	0.043415102	118852.10
23	11/4/2008-12/15/2008	30	-0.040095401	-29.780608870	0.483600842	-0.000086478	0.008966539	N/A	0.054726792	117037.18
24	11/18/2008-12/29/2008	30	-0.004816510	-31.554543936	0.504776772	0.000015452	0.009050996	N/A	0.057559830	81952.52
25	12/2/2008-1/12/2009	30	0.000634076	-31.065997852	0.481422048	-0.000080032	0.008271135	N/A	0.052913352	94644.66
26	12/16/2008-1/26/2009	30	0.094784576	-28.218919678	0.504719514	-0.000008425	0.008997476	N/A	0.053433487	116704.87
27	12/30/2008-2/9/2009	30	-0.009407254	-27.340691931	0.524393835	-0.000093125	0.007814550	N/A	0.045680905	159427.20
28	1/13/2009-2/23/2009	30	-0.070513331	-30.449898333	0.601363976	-0.000068358	0.009338034	N/A	0.053960950	169716.01
29	1/27/2009-3/9/2009	30	-0.087989348	-29.860677214	0.602455001	-0.000010265	0.011231417	N/A	0.067630084	736269.80
30	2/10/2009-3/23/2009	30	0.036677292	-30.122662149	0.612236160	-0.000036305	0.013701049	N/A	0.081761275	763992.04
31	2/24/2009-4/6/2009	30	-0.027300578	-29.461937638	0.553683463	-0.000028242	0.014806527	N/A	0.092825182	809337.47
32	3/10/2009-4/20/2009	30	-0.066345424	-29.828195674	0.517116046	0.000041272	0.015478346	N/A	0.092826754	772589.49
33	3/24/2009-5/4/2009	30	0.044924936	-31.278569097	0.505884500	-0.000035796	0.014740567	N/A	0.089539510	721539.76
34	4/7/2009-5/18/2009	30	-0.055824467	-30.739559929	0.470788487	0.000087836	0.012569490	N/A	0.076238377	494267.85
35	4/21/2009-6/1/2009	30	0.055949383	-26.001543371	0.465755529	0.000003282	0.010818323	N/A	0.059630129	523153.70
36	5/5/2009-6/15/2009	30	0.089001858	-26.222896782	0.481082923	0.000033419	0.008584537	N/A	0.049585862	219198.57
37	5/19/2009-6/29/2009	30	0.062416202	-30.339260341	0.482535255	-0.000049245	0.009292518	N/A	0.052966060	254376.02
38	6/2/2009-7/13/2009	30	0.008719374	-31.513048344	0.483136360	-0.000088657	0.009465422	N/A	0.056393765	179233.10
39	6/16/2009-7/27/2009	30	-0.009426213	-31.337020189	0.473653279	0.000030746	0.009512317	N/A	0.058841604	178343.60
40	6/30/2009-8/10/2009	30	0.065790724	-31.720861278	0.457807881	0.000056728	0.007678615	N/A	0.048564034	116367.03
41	7/14/2009-8/24/2009	30	0.081196245	-31.017603696	0.415671843	-0.000095640	0.007017561	N/A	0.042976082	41896.55
42	7/28/2009-9/7/2009	30	-0.060862733	-30.467851184	0.434612963	0.000020032	0.007310803	N/A	0.044882246	16707.02
43	8/11/2009-9/21/2009	30	-0.077899284	-28.275634442	0.429696258	-0.000004307	0.008780742	N/A	0.055093085	40040.60
44	9/8/2009-10/6/2009	30	-0.041200524	-31.665308877	0.402642837	-0.000071706	0.008109184	N/A	0.048078791	62207.67

Average Sum of Squared Errors   182,576.29

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __Bank of America Corp.__ NYSE: __BAC__ Industry: __Finance and Banking__

Model 8 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{1}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.382241457	N/A	0.312845505	N/A	0.010482214	0.000039411	0.006586829	13960.90
2	1/15/2008-2/25/2008	30	-0.283908289	N/A	0.304803084	N/A	0.010936097	0.000040022	0.007586494	15412.27
3	1/29/2008-3/10/2008	30	-0.345083057	N/A	0.323608622	N/A	0.012233334	0.000049871	0.008503405	60570.95
4	2/12/2008-3/24/2008	30	-0.302350035	N/A	0.309487572	N/A	0.014814736	0.000073094	0.009538257	79883.04
5	2/26/2008-4/7/2008	30	-0.332304535	N/A	0.317345799	N/A	0.013841206	0.000071638	0.007963605	96403.03
6	3/11/2008-4/21/2008	30	-0.256856073	N/A	0.323763644	N/A	0.012744614	0.000078959	0.007228131	86734.37
7	3/25/2008-5/25/2008	30	-0.319802918	N/A	0.319362906	N/A	0.009594205	0.000065417	0.006036612	20488.92
8	4/8/2008-5/19/2008	30	-0.364485088	N/A	0.299801978	N/A	0.009087959	0.000066077	0.005613794	22995.25
9	4/22/2008-6/2/2008	30	-0.300041676	N/A	0.317828419	N/A	0.007625465	0.000067174	0.005860895	10178.75
10	5/6/2008-6/16/2008	30	-0.258991794	N/A	0.300073854	N/A	0.008219974	0.000067978	0.007455178	15758.69
11	5/20/2008-6/30/2008	30	-0.299176929	N/A	0.310601578	N/A	0.009842543	0.000083688	0.008374122	22204.64
12	6/3/2008-7/14/2008	30	-0.254305238	N/A	0.306305143	N/A	0.011203081	0.000090194	0.009189056	39009.39
13	6/17/2008-7/28/2008	30	-0.343475160	N/A	0.327797148	N/A	0.012659102	0.000101027	0.009741419	38268.60
14	7/1/2008-8/11/2008	30	-0.319577804	N/A	0.329205800	N/A	0.013660532	0.000100454	0.009014589	17681.39
15	7/15/2008-8/25/2008	30	-0.367802875	N/A	0.331828710	N/A	0.014981956	0.000091220	0.008151480	19835.52
16	7/29/2008-9/8/2008	30	-0.385476431	N/A	0.331164285	N/A	0.015904563	0.000084996	0.008146747	17025.85
17	8/12/2008-9/22/2008	30	-0.447657702	N/A	0.336580514	N/A	0.018105028	0.000081575	0.010053137	110259.98
18	8/26/2008-10/6/2008	30	-0.375688370	N/A	0.357881061	N/A	0.020295680	0.000079063	0.012568565	99065.18
19	9/9/2008-10/20/2008	30	-0.388289764	N/A	0.395077215	N/A	0.020556444	0.000074811	0.015258681	133540.11
20	9/23/2008-11/3/2008	30	-0.439049846	N/A	0.422980283	N/A	0.017822724	0.000086352	0.020060808	84210.35
21	10/7/2008-11/17/2008	30	-0.433929392	N/A	0.455804504	N/A	0.016969795	0.000090757	0.021426213	59911.94
22	10/21/2008-12/1/2008	30	-0.252637317	N/A	0.468257264	N/A	0.018227819	0.000106831	0.023330153	107231.50
23	11/4/2008-12/15/2008	30	-0.368479611	N/A	0.518204440	N/A	0.020976243	0.000111256	0.027927666	94743.85
24	11/18/2008-12/29/2008	30	-0.338526428	N/A	0.464529707	N/A	0.024821739	0.000087812	0.031702578	69840.39
25	12/2/2008-1/12/2009	30	-0.381924927	N/A	0.493555232	N/A	0.023257905	0.000061941	0.029285536	100104.71
26	12/16/2008-1/26/2009	30	-0.374101709	N/A	0.485480883	N/A	0.026486236	0.000019198	0.026534227	137253.86
27	12/30/2008-2/9/2009	30	-0.268175726	N/A	0.564347123	N/A	0.030924218	-0.000033312	0.024184509	189688.36
28	1/13/2009-2/23/2009	30	-0.408654069	N/A	0.600455319	N/A	0.037479358	-0.000098648	0.021855260	163858.25
29	1/27/2009-3/9/2009	30	-0.431599266	N/A	0.577498174	N/A	0.050321421	-0.000211476	0.024087731	752436.13
30	2/10/2009-3/23/2009	30	-0.390808373	N/A	0.610954600	N/A	0.067906483	-0.000314659	0.028344322	594108.30
31	2/24/2009-4/6/2009	30	-0.291183582	N/A	0.521477253	N/A	0.080895878	-0.000405878	0.029583131	443871.31
32	3/10/2009-4/20/2009	30	-0.363551683	N/A	0.504606244	N/A	0.078796431	-0.000435109	0.028389220	405380.37
33	3/24/2009-5/4/2009	30	-0.322058529	N/A	0.497761479	N/A	0.078542210	-0.000385880	0.026413853	409469.43
34	4/7/2009-5/18/2009	30	-0.446426866	N/A	0.470069324	N/A	0.058317249	-0.000289565	0.023170129	319187.30
35	4/21/2009-6/1/2009	30	-0.305498561	N/A	0.466085373	N/A	0.051014290	-0.000222230	0.021720403	501170.61
36	5/5/2009-6/15/2009	30	-0.415792702	N/A	0.452034581	N/A	0.040077143	-0.000147970	0.016783389	189439.57
37	5/19/2009-6/29/2009	30	-0.429092755	N/A	0.474097862	N/A	0.038421042	-0.000114288	0.015164944	247669.86
38	6/2/2009-7/13/2009	30	-0.283373513	N/A	0.478881253	N/A	0.032453535	-0.000083151	0.013940224	173019.28
39	6/16/2009-7/27/2009	30	-0.264939557	N/A	0.457124301	N/A	0.041122596	-0.000100937	0.016083296	182429.03
40	6/30/2009-8/10/2009	30	-0.266086643	N/A	0.437308053	N/A	0.035885879	-0.000083796	0.014541951	119597.49
41	7/14/2009-8/24/2009	30	-0.433233801	N/A	0.453686401	N/A	0.023584012	-0.000041839	0.013069771	39755.08
42	7/28/2009-9/7/2009	30	-0.364860147	N/A	0.414982973	N/A	0.023506372	-0.000017248	0.012591082	17665.98
43	8/11/2009-9/21/2009	30	-0.253686180	N/A	0.405488927	N/A	0.026604838	0.000006905	0.012984356	46933.02
44	9/8/2009-10/6/2009	30	-0.438988817	N/A	0.435541809	N/A	0.022998151	0.000029814	0.012686344	67876.45

Average Sum of Squared Errors 146,275.66

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Bank of America Corp.</u> NYSE: <u>BAC</u> Industry: <u>Finance and Banking</u>

Model9 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.316195936	N/A	0.328817148	-0.000051945	0.010126072	0.000039374	0.009795148	12474.33
2	1/15/2008-2/25/2008	30	-0.284124032	N/A	0.331067609	-0.000068404	0.011258204	0.000042518	0.011148642	14217.01
3	1/29/2008-3/10/2008	30	-0.396644178	N/A	0.312445456	0.000046647	0.011919459	0.000052485	0.012130607	51048.09
4	2/12/2008-3/24/2008	30	-0.278650148	N/A	0.301518575	0.000025436	0.014158307	0.000076641	0.014458880	78698.19
5	2/26/2008-4/7/2008	30	-0.403878646	N/A	0.308823345	0.000028534	0.013982742	0.000073396	0.014171893	82375.44
6	3/11/2008-4/21/2008	30	-0.403268364	N/A	0.304482105	-0.000015763	0.013003437	0.000078605	0.013660761	83462.10
7	3/25/2008-5/25/2008	30	-0.373682954	N/A	0.320844966	-0.000089088	0.010391425	0.000062331	0.010706588	18286.31
8	4/8/2008-5/19/2008	30	-0.403462066	N/A	0.307233370	-0.000056326	0.008681743	0.000067496	0.009581225	20558.14
9	4/22/2008-6/2/2008	30	-0.432474343	N/A	0.313245875	0.000005575	0.007801067	0.000068137	0.009350495	9140.27
10	5/6/2008-6/16/2008	30	-0.302123904	N/A	0.296999366	0.000027879	0.007874305	0.000067842	0.009742412	14671.14
11	5/20/2008-6/30/2008	30	-0.399929135	N/A	0.317239535	0.000093931	0.009912779	0.000081977	0.010635164	20722.80
12	6/3/2008-7/14/2008	30	-0.399204688	N/A	0.304322243	0.000015332	0.010617739	0.000087993	0.013161282	35607.18
13	6/17/2008-7/28/2008	30	-0.440436583	N/A	0.324104896	-0.000036703	0.012978111	0.000100932	0.014362737	33075.04
14	7/1/2008-8/11/2008	30	-0.361402004	N/A	0.313111872	0.000078136	0.013118853	0.000103628	0.015502868	16143.42
15	7/15/2008-8/25/2008	30	-0.344035495	N/A	0.312012397	-0.000043547	0.015154299	0.000092858	0.015383689	17180.29
16	7/29/2008-9/8/2008	30	-0.317617171	N/A	0.314485952	0.000023336	0.015510738	0.000083445	0.015366557	15242.64
17	8/12/2008-9/22/2008	30	-0.393850254	N/A	0.318948209	-0.000012129	0.018817467	0.000078724	0.017327497	101788.92
18	8/26/2008-10/6/2008	30	-0.320039741	N/A	0.364583107	0.000071157	0.020869643	0.000078349	0.019462316	95336.01
19	9/9/2008-10/20/2008	30	-0.261295572	N/A	0.378915644	-0.000046794	0.021540023	0.000076290	0.019106770	125837.26
20	9/23/2008-11/3/2008	30	-0.406152774	N/A	0.451307001	0.000093142	0.017967069	0.000080212	0.017677929	80264.21
21	10/7/2008-11/17/2008	30	-0.405736251	N/A	0.467707909	-0.000035996	0.016184613	0.000096376	0.017000602	53704.89
22	10/21/2008-12/1/2008	30	-0.370949534	N/A	0.473538727	-0.000080236	0.018960483	0.000106522	0.018313164	93501.62
23	11/4/2008-12/15/2008	30	-0.391131539	N/A	0.475825340	-0.000030690	0.022090577	0.000113188	0.021041040	85203.49
24	11/18/2008-12/29/2008	30	-0.290790458	N/A	0.502390170	-0.000012894	0.023604196	0.000087554	0.023782543	64342.86
25	12/2/2008-1/12/2009	30	-0.319693347	N/A	0.501110978	0.000058278	0.023342688	0.000058181	0.019536084	84927.38
26	12/16/2008-1/26/2009	30	-0.350154219	N/A	0.494227806	0.000094621	0.024449803	0.000018951	0.020992106	131382.80
27	12/30/2008-2/9/2009	30	-0.289706664	N/A	0.522408650	-0.000091596	0.029821141	-0.000035347	0.017340768	157062.36
28	1/13/2009-2/23/2009	30	-0.347239060	N/A	0.549407062	-0.000008629	0.039093524	-0.000100661	0.022673283	149986.13
29	1/27/2009-3/9/2009	30	-0.421586928	N/A	0.618075797	0.000028202	0.051664269	-0.000202508	0.026384972	641361.88
30	2/10/2009-3/23/2009	30	-0.326061527	N/A	0.601245553	0.000041896	0.067628782	-0.000313260	0.032118712	575228.72
31	2/24/2009-4/6/2009	30	-0.418856711	N/A	0.536718303	0.000091139	0.079348401	-0.000432473	0.038800845	374978.14
32	3/10/2009-4/20/2009	30	-0.436226163	N/A	0.520716491	0.000014646	0.075933828	-0.000404831	0.037968602	363053.73
33	3/24/2009-5/4/2009	30	-0.333985992	N/A	0.482618194	0.000039489	0.072187369	-0.000366659	0.034606076	380757.38
34	4/7/2009-5/18/2009	30	-0.444798741	N/A	0.486907953	0.000006577	0.060659176	-0.000292329	0.030105716	296886.51
35	4/21/2009-6/1/2009	30	-0.366444372	N/A	0.498169867	0.000038086	0.050513475	-0.000214472	0.025714096	457396.15
36	5/5/2009-6/15/2009	30	-0.286642425	N/A	0.457511588	-0.000086795	0.040240293	-0.000146654	0.019783792	172021.79
37	5/19/2009-6/29/2009	30	-0.442384366	N/A	0.478570882	-0.000069362	0.039348623	-0.000111409	0.021359659	234584.55
38	6/2/2009-7/13/2009	30	-0.374414151	N/A	0.463324279	0.000099082	0.033802281	-0.000079583	0.024201551	151372.17
39	6/16/2009-7/27/2009	30	-0.335005593	N/A	0.451300343	0.000097856	0.041040409	-0.000104197	0.023530802	164624.58
40	6/30/2009-8/10/2009	30	-0.402514306	N/A	0.429015169	-0.000044489	0.033642294	-0.000086192	0.019949260	111185.42
41	7/14/2009-8/24/2009	30	-0.422812653	N/A	0.439929107	-0.000091977	0.024170869	-0.000044230	0.017134892	36808.12
42	7/28/2009-9/7/2009	30	-0.303734754	N/A	0.425338665	0.000069491	0.021711143	-0.000017985	0.017878748	17071.54
43	8/11/2009-9/21/2009	30	-0.349698130	N/A	0.427419038	-0.000051547	0.027279547	0.000007246	0.021162142	46024.81
44	9/8/2009-10/6/2009	30	-0.299274801	N/A	0.436394409	-0.000050707	0.022300800	0.000029090	0.019804272	59813.23

Average Sum of Squared Errors   132,486.57

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __Bank of America Corp.__ NYSE: __BAC__ Industry: __Finance and Banking__

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{h}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.087690508	-28.585839712	0.322763348	N/A	0.009589712	0.000041525	0.009739802	11821.45
2	1/15/2008-2/25/2008	30	0.043090308	-30.163948671	0.307456833	N/A	0.011220834	0.000039531	0.010163103	12877.97
3	1/29/2008-3/10/2008	30	0.005717513	-26.957404441	0.300681106	N/A	0.012652336	0.000051901	0.011613261	50956.05
4	2/12/2008-3/24/2008	30	-0.053222770	-30.117830626	0.301392835	N/A	0.014693752	0.000075680	0.014504401	70143.54
5	2/26/2008-4/7/2008	30	-0.051490137	-28.027649520	0.313285983	N/A	0.013631901	0.000077544	0.014097265	73675.77
6	3/11/2008-4/21/2008	30	0.071641272	-27.396540662	0.317237036	N/A	0.012508623	0.000074945	0.013421062	74097.33
7	3/25/2008-5/25/2008	30	0.043497666	-29.608382826	0.325468871	N/A	0.010236775	0.000062815	0.011175805	16467.46
8	4/8/2008-5/19/2008	30	0.044199992	-28.771886802	0.319344514	N/A	0.008547795	0.000070168	0.009780622	18974.78
9	4/22/2008-6/2/2008	30	0.086815098	-28.311997944	0.290624139	N/A	0.007618158	0.000069560	0.008773031	8490.23
10	5/6/2008-6/16/2008	30	-0.058013107	-31.697177519	0.286136649	N/A	0.007879990	0.000070729	0.009072675	13200.22
11	5/20/2008-6/30/2008	30	0.042903788	-29.503381079	0.321866434	N/A	0.009272719	0.000081832	0.011286191	17867.15
12	6/3/2008-7/14/2008	30	0.092555389	-27.216973322	0.307139995	N/A	0.011674086	0.000087396	0.013247078	31986.04
13	6/17/2008-7/28/2008	30	0.024080817	-29.665980787	0.310423351	N/A	0.012413000	0.000098354	0.014895239	31960.25
14	7/1/2008-8/11/2008	30	0.040601492	-26.090294404	0.315809745	N/A	0.014121653	0.000104842	0.015208630	13699.70
15	7/15/2008-8/25/2008	30	-0.029134059	-26.943584901	0.316161512	N/A	0.014376261	0.000089363	0.015566601	16467.44
16	7/29/2008-9/8/2008	30	0.013995509	-30.852272681	0.317161649	N/A	0.015278685	0.000089565	0.016487581	13910.84
17	8/12/2008-9/22/2008	30	-0.045224376	-29.046040358	0.330790140	N/A	0.017614231	0.000084039	0.017441597	87720.33
18	8/26/2008-10/6/2008	30	-0.021448089	-28.001549774	0.354088514	N/A	0.020004705	0.000079415	0.019999957	86541.70
19	9/9/2008-10/20/2008	30	-0.024070475	-27.687080339	0.395090991	N/A	0.020446889	0.000074759	0.019691214	110143.89
20	9/23/2008-11/3/2008	30	0.017267471	-30.218909308	0.427482159	N/A	0.018911331	0.000083250	0.017763735	71413.93
21	10/7/2008-11/17/2008	30	-0.035341494	-29.628063549	0.454303240	N/A	0.016628320	0.000093730	0.016583152	53224.34
22	10/21/2008-12/1/2008	30	-0.080586567	-27.530585410	0.485708236	N/A	0.018390178	0.000108397	0.019333489	88201.60
23	11/4/2008-12/15/2008	30	0.080068052	-28.467773317	0.506638538	N/A	0.021919388	0.000114257	0.021282146	76218.98
24	11/18/2008-12/29/2008	30	0.092203115	-26.016202692	0.489020292	N/A	0.022790102	0.000092830	0.023133412	55716.31
25	12/2/2008-1/12/2009	30	0.007277803	-29.132529013	0.499954849	N/A	0.022131823	0.000057920	0.019519132	77912.63
26	12/16/2008-1/26/2009	30	0.033379760	-28.782801022	0.492501796	N/A	0.024988258	0.000017828	0.021202570	117686.73
27	12/30/2008-2/9/2009	30	0.076295149	-28.763500506	0.566198420	N/A	0.029252278	-0.000034862	0.017615325	144856.07
28	1/13/2009-2/23/2009	30	-0.069600325	-27.245944289	0.547765351	N/A	0.038244101	-0.000092685	0.022762283	131435.38
29	1/27/2009-3/9/2009	30	-0.079325550	-29.365216916	0.584270514	N/A	0.054745500	-0.000213875	0.025280255	600473.92
30	2/10/2009-3/23/2009	30	-0.053933379	-27.092176394	0.604633744	N/A	0.064575768	-0.000324654	0.031205732	504609.55
31	2/24/2009-4/6/2009	30	-0.007592245	-26.660386381	0.520484431	N/A	0.078796024	-0.000407325	0.038648845	358074.02
32	3/10/2009-4/20/2009	30	0.083515557	-30.934396308	0.511283817	N/A	0.076053280	-0.000400402	0.034824979	355422.87
33	3/24/2009-5/4/2009	30	0.088610866	-28.974010982	0.477667443	N/A	0.074057492	-0.000361915	0.035224571	357035.51
34	4/7/2009-5/18/2009	30	0.070306722	-27.042459016	0.485690486	N/A	0.062684812	-0.000283469	0.028804055	272043.07
35	4/21/2009-6/1/2009	30	0.042388724	-26.349556850	0.470334767	N/A	0.051195003	-0.000219402	0.025274479	409636.88
36	5/5/2009-6/15/2009	30	0.013673972	-26.504508196	0.461203985	N/A	0.038845261	-0.000146490	0.020427275	160034.71
37	5/19/2009-6/29/2009	30	0.044185875	-30.252647519	0.475253546	N/A	0.040382285	-0.000119193	0.022053566	193619.47
38	6/2/2009-7/13/2009	30	0.006574579	-28.049205431	0.461958422	N/A	0.034716697	-0.000077548	0.023050561	139828.89
39	6/16/2009-7/27/2009	30	0.040964083	-29.387540845	0.472395278	N/A	0.041038081	-0.000103046	0.022352533	160877.43
40	6/30/2009-8/10/2009	30	0.012623244	-27.732349504	0.459489594	N/A	0.034196593	-0.000086433	0.018633590	95918.47
41	7/14/2009-8/24/2009	30	-0.085809646	-31.025106832	0.426071822	N/A	0.025498393	-0.000045556	0.018053011	31977.04
42	7/28/2009-9/7/2009	30	-0.019705815	-29.278908412	0.450950176	N/A	0.022773043	-0.000017811	0.017452099	15017.76
43	8/11/2009-9/21/2009	30	-0.065627505	-28.580684554	0.406788224	N/A	0.027478119	0.000006768	0.022366073	38726.17
44	9/8/2009-10/6/2009	30	-0.078853646	-27.174395957	0.406732578	N/A	0.022945492	0.000030250	0.018202100	57510.38

Average Sum of Squared Errors 121,101.69

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **Bank of America Corp.** NYSE: **BAC** Industry: **Finance and Banking**

Model11 Default Intensity: $\xi[i,j]=c_0+c_1t+\dfrac{c_2}{s^{\frac{z}{z_1}+\lambda t}}$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0+a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.099808619	-29.687935820	0.331626486	0.000094458	0.009700224	0.000038934	0.009565187	11524.94
2	1/15/2008-2/25/2008	30	0.083552655	-29.860856164	0.321122795	-0.000096278	0.011165456	0.000043179	0.010833744	11582.67
3	1/29/2008-3/10/2008	30	0.018392130	-31.365595085	0.324007951	-0.000047947	0.012203636	0.000049284	0.011680999	48397.01
4	2/12/2008-3/24/2008	30	-0.023348913	-26.711316923	0.316345579	-0.000017330	0.015059349	0.000074150	0.015128043	67140.08
5	2/26/2008-4/7/2008	30	0.055353078	-31.045977394	0.308897430	-0.000081676	0.013657924	0.000078258	0.014515777	72138.49
6	3/11/2008-4/21/2008	30	-0.018833692	-30.511218006	0.315715955	-0.000077639	0.012908765	0.000074902	0.013530155	69097.67
7	3/25/2008-5/25/2008	30	0.032922656	-28.789504622	0.296503580	0.000012152	0.010420606	0.000064566	0.011145704	14501.01
8	4/8/2008-5/19/2008	30	0.076670325	-28.239205325	0.301146477	0.000026157	0.008247880	0.000070055	0.009792658	18210.07
9	4/22/2008-6/2/2008	30	-0.098113070	-26.966157913	0.288272012	0.000075308	0.007408067	0.000069835	0.009215516	8071.14
10	5/6/2008-6/16/2008	30	0.077011674	-31.099913669	0.311138109	0.000069963	0.008085970	0.000068152	0.009726371	12923.44
11	5/20/2008-6/30/2008	30	-0.055040431	-28.167058396	0.298274093	-0.000085097	0.009895837	0.000086709	0.010834212	16730.22
12	6/3/2008-7/14/2008	30	-0.089507375	-29.340658189	0.318841372	0.000025820	0.010710347	0.000087118	0.012744942	30209.01
13	6/17/2008-7/28/2008	30	-0.054392097	-26.639033901	0.330803030	0.000043310	0.012095867	0.000102464	0.014216546	28802.67
14	7/1/2008-8/11/2008	30	-0.025973542	-27.479807526	0.306008155	-0.000091637	0.013288292	0.000103335	0.015245773	11710.65
15	7/15/2008-8/25/2008	30	0.083489235	-27.626276769	0.319598904	-0.000065479	0.013768999	0.000086405	0.015119111	15002.35
16	7/29/2008-9/8/2008	30	0.051606083	-31.083424621	0.322127063	0.000003266	0.015933619	0.000086013	0.016239767	13712.44
17	8/12/2008-9/22/2008	30	-0.085238262	-27.536057039	0.325121589	0.000016500	0.017647769	0.000078205	0.017975641	80387.47
18	8/26/2008-10/6/2008	30	0.065346370	-31.328663908	0.360950135	0.000018204	0.020124396	0.000080872	0.020072870	78625.37
19	9/9/2008-10/20/2008	30	0.044533507	-27.704680165	0.393101603	0.000010490	0.020180555	0.000078048	0.019298824	106847.95
20	9/23/2008-11/3/2008	30	-0.085740226	-26.700863300	0.447950790	-0.000068722	0.017807043	0.000083360	0.018004934	70113.52
21	10/7/2008-11/17/2008	30	-0.018960310	-29.907255048	0.484704681	0.000061605	0.016773009	0.000095393	0.017667444	48688.06
22	10/21/2008-12/1/2008	30	0.085657301	-31.743615373	0.470574619	0.000014689	0.018305130	0.000103261	0.013643161	85588.67
23	11/4/2008-12/15/2008	30	-0.042760868	-30.616308511	0.502608685	0.000066564	0.021048011	0.000109257	0.021731833	74011.53
24	11/18/2008-12/29/2008	30	0.061214014	-27.815752029	0.480547494	-0.000064548	0.024214435	0.000094170	0.022130141	53635.10
25	12/2/2008-1/12/2009	30	0.033248454	-30.240694311	0.479020639	0.000079576	0.021432288	0.000061902	0.020374266	72450.32
26	12/16/2008-1/26/2009	30	0.081967495	-26.443386133	0.484002936	0.000064279	0.024461628	0.000018879	0.020047438	112126.72
27	12/30/2008-2/9/2009	30	0.031182208	-26.975137941	0.530861308	0.000050929	0.030430686	-0.000035433	0.018633895	140983.78
28	1/13/2009-2/23/2009	30	-0.045697922	-27.419495302	0.580208213	0.000099855	0.039454900	-0.000092508	0.022022501	114475.40
29	1/27/2009-3/9/2009	30	0.021370006	-26.057037107	0.623626261	0.000044207	0.052229833	-0.000208779	0.026293639	587264.64
30	2/10/2009-3/23/2009	30	0.081508237	-29.429580609	0.603906540	-0.000024074	0.064980206	-0.000307231	0.031650285	481950.85
31	2/24/2009-4/6/2009	30	-0.095141354	-27.486636898	0.535474128	0.000058149	0.083508849	-0.000426051	0.038931395	337638.57
32	3/10/2009-4/20/2009	30	0.052425889	-30.006951670	0.515579623	0.000049035	0.076547542	-0.000414951	0.035269631	325214.76
33	3/24/2009-5/4/2009	30	0.072547399	-31.385196492	0.497301323	0.000048286	0.071698534	-0.000367333	0.036012802	327212.63
34	4/7/2009-5/18/2009	30	0.009897969	-29.255600664	0.485418828	0.000043103	0.062045924	-0.000279856	0.029060210	266415.67
35	4/21/2009-6/1/2009	30	0.041236550	-26.933783056	0.496776558	-0.000091423	0.048837173	-0.000219743	0.024975772	385119.82
36	5/5/2009-6/15/2009	30	-0.035957198	-29.668258873	0.454873382	0.000099187	0.038773633	-0.000146399	0.020963755	146782.27
37	5/19/2009-6/29/2009	30	-0.071847103	-31.220471305	0.494663610	0.000086928	0.038304786	-0.000113965	0.021209135	181615.60
38	6/2/2009-7/13/2009	30	-0.062915440	-29.071789121	0.492290181	0.000066736	0.031656844	-0.000078149	0.024360032	139117.12
39	6/16/2009-7/27/2009	30	0.021289195	-29.386327072	0.470693227	0.000066314	0.040995575	-0.000097686	0.022314981	146431.18
40	6/30/2009-8/10/2009	30	-0.006502286	-29.289336683	0.451787957	0.000083898	0.034311886	-0.000084679	0.018335787	94476.70
41	7/14/2009-8/24/2009	30	-0.080670975	-29.988605187	0.435784956	-0.000059136	0.024627987	-0.000042876	0.017833161	28526.23
42	7/28/2009-9/7/2009	30	0.030917999	-29.666293446	0.435220376	0.000049189	0.021668010	-0.000018097	0.017086220	13846.53
43	8/11/2009-9/21/2009	30	-0.066237980	-31.431272518	0.417624686	0.000008122	0.025438376	0.000006982	0.021271352	33451.55
44	9/8/2009-10/6/2009	30	0.042369642	-26.489436097	0.415810463	0.000032030	0.023048154	0.000031747	0.018624921	53527.58

Average Sum of Squared Errors   114,460.90

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Boeing Co.</u> NYSE: <u>BA</u> Industry: <u>Industrial</u>

Model 1 Default Intensity: $\xi[i, j] = c_0$ Default Probability: $\lambda[i, j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i, j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.277075892	N/A	N/A	N/A	0.007972003	N/A	N/A	40677.28
2	1/15/2008-2/25/2008	30	-0.276317667	N/A	N/A	N/A	0.009610165	N/A	N/A	63483.45
3	1/29/2008-3/10/2008	30	-0.419329898	N/A	N/A	N/A	0.010287733	N/A	N/A	67063.51
4	2/12/2008-3/24/2008	30	-0.422736163	N/A	N/A	N/A	0.011506217	N/A	N/A	63994.48
5	2/26/2008-4/7/2008	30	-0.437182961	N/A	N/A	N/A	0.010434523	N/A	N/A	77570.69
6	3/11/2008-4/21/2008	30	-0.285116365	N/A	N/A	N/A	0.009164421	N/A	N/A	92272.92
7	3/25/2008-5/25/2008	30	-0.283889312	N/A	N/A	N/A	0.007227572	N/A	N/A	44866.75
8	4/8/2008-5/19/2008	30	-0.37223212	N/A	N/A	N/A	0.006739177	N/A	N/A	26562.26
9	4/22/2008-6/2/2008	30	-0.368131711	N/A	N/A	N/A	0.007648982	N/A	N/A	55001.63
10	5/6/2008-6/16/2008	30	-0.469467029	N/A	N/A	N/A	0.009266502	N/A	N/A	60607.96
11	5/20/2008-6/30/2008	30	-0.423600577	N/A	N/A	N/A	0.010745712	N/A	N/A	54486.08
12	6/3/2008-7/14/2008	30	-0.351113549	N/A	N/A	N/A	0.012007101	N/A	N/A	74912.47
13	6/17/2008-7/28/2008	30	-0.316617799	N/A	N/A	N/A	0.012218650	N/A	N/A	75443.84
14	7/1/2008-8/11/2008	30	-0.455844207	N/A	N/A	N/A	0.011754570	N/A	N/A	80572.38
15	7/15/2008-8/25/2008	30	-0.373802209	N/A	N/A	N/A	0.010704779	N/A	N/A	49555.16
16	7/29/2008-9/8/2008	30	-0.423480036	N/A	N/A	N/A	0.010642100	N/A	N/A	41899.11
17	8/12/2008-9/22/2008	30	-0.299422715	N/A	N/A	N/A	0.012382788	N/A	N/A	100569.24
18	8/26/2008-10/6/2008	30	-0.472649911	N/A	N/A	N/A	0.015210865	N/A	N/A	206824.57
19	9/9/2008-10/20/2008	30	-0.317932651	N/A	N/A	N/A	0.019394439	N/A	N/A	291948.38
20	9/23/2008-11/3/2008	30	-0.346601374	N/A	N/A	N/A	0.024130451	N/A	N/A	352864.72
21	10/7/2008-11/17/2008	30	-0.348514215	N/A	N/A	N/A	0.026570793	N/A	N/A	203372.65
22	10/21/2008-12/1/2008	30	-0.328267383	N/A	N/A	N/A	0.030566412	N/A	N/A	473779.41
23	11/4/2008-12/15/2008	30	-0.277034048	N/A	N/A	N/A	0.035641265	N/A	N/A	815992.22
24	11/18/2008-12/29/2008	30	-0.352093393	N/A	N/A	N/A	0.039636206	N/A	N/A	483299.39
25	12/2/2008-1/12/2009	30	-0.399343642	N/A	N/A	N/A	0.037895396	N/A	N/A	603885.71
26	12/16/2008-1/26/2009	30	-0.3926353	N/A	N/A	N/A	0.033007904	N/A	N/A	434207.67
27	12/30/2008-2/9/2009	30	-0.344928634	N/A	N/A	N/A	0.029042664	N/A	N/A	246474.33
28	1/13/2009-2/23/2009	30	-0.441091731	N/A	N/A	N/A	0.027695820	N/A	N/A	90083.18
29	1/27/2009-3/9/2009	30	-0.447821858	N/A	N/A	N/A	0.031238602	N/A	N/A	505288.80
30	2/10/2009-3/23/2009	30	-0.340747149	N/A	N/A	N/A	0.034222639	N/A	N/A	512367.80
31	2/24/2009-4/6/2009	30	-0.281061298	N/A	N/A	N/A	0.035828005	N/A	N/A	420827.57
32	3/10/2009-4/20/2009	30	-0.401299319	N/A	N/A	N/A	0.033995049	N/A	N/A	244912.75
33	3/24/2009-5/4/2009	30	-0.284080406	N/A	N/A	N/A	0.032571810	N/A	N/A	190061.54
34	4/7/2009-5/18/2009	30	-0.414743748	N/A	N/A	N/A	0.029823980	N/A	N/A	271260.39
35	4/21/2009-6/1/2009	30	-0.35523803	N/A	N/A	N/A	0.026381152	N/A	N/A	250620.65
36	5/5/2009-6/15/2009	30	-0.308480174	N/A	N/A	N/A	0.021259488	N/A	N/A	199523.87
37	5/19/2009-6/29/2009	30	-0.460423766	N/A	N/A	N/A	0.018940155	N/A	N/A	100099.40
38	6/2/2009-7/13/2009	30	-0.30454993	N/A	N/A	N/A	0.018139857	N/A	N/A	49653.67
39	6/16/2009-7/27/2009	30	-0.430219853	N/A	N/A	N/A	0.019173119	N/A	N/A	59506.81
40	6/30/2009-8/10/2009	30	-0.281036895	N/A	N/A	N/A	0.017369901	N/A	N/A	146504.86
41	7/14/2009-8/24/2009	30	-0.328358469	N/A	N/A	N/A	0.015919623	N/A	N/A	119723.93
42	7/28/2009-9/7/2009	30	-0.412295624	N/A	N/A	N/A	0.015214198	N/A	N/A	63710.08
43	8/11/2009-9/21/2009	30	-0.349022317	N/A	N/A	N/A	0.016225994	N/A	N/A	46620.67
44	9/8/2009-10/6/2009	30	-0.447120532	N/A	N/A	N/A	0.015991612	N/A	N/A	55321.95

Average Sum of Squared Errors 193,369.91

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __The Boeing Co.__   NYSE: __BA__   Industry: __Industrial__

Model 2   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.370048187	N/A	N/A	N/A	0.0043498351	0.000210581	N/A	7580.15
2	1/15/2008-2/25/2008	30	-0.378311778	N/A	N/A	N/A	0.0054503102	0.000205516	N/A	16997.90
3	1/29/2008-3/10/2008	30	-0.335857375	N/A	N/A	N/A	0.0058638223	0.000171636	N/A	14486.31
4	2/12/2008-3/24/2008	30	-0.385596438	N/A	N/A	N/A	0.0066971388	0.000145127	N/A	8513.58
5	2/26/2008-4/7/2008	30	-0.429915533	N/A	N/A	N/A	0.0059611810	0.000118126	N/A	19834.49
6	3/11/2008-4/21/2008	30	-0.443099876	N/A	N/A	N/A	0.0050796134	0.000108407	N/A	34026.46
7	3/25/2008-5/25/2008	30	-0.392024415	N/A	N/A	N/A	0.0038209285	0.000108124	N/A	10782.83
8	4/8/2008-5/19/2008	30	-0.424054362	N/A	N/A	N/A	0.0037371633	0.000120688	N/A	3369.58
9	4/22/2008-6/2/2008	30	-0.452292874	N/A	N/A	N/A	0.0045160393	0.000135715	N/A	20966.75
10	5/6/2008-6/16/2008	30	-0.457831091	N/A	N/A	N/A	0.0056917880	0.000147475	N/A	21182.85
11	5/20/2008-6/30/2008	30	-0.308986486	N/A	N/A	N/A	0.0065701003	0.000157895	N/A	10034.64
12	6/3/2008-7/14/2008	30	-0.279590266	N/A	N/A	N/A	0.0074010012	0.000171821	N/A	17480.73
13	6/17/2008-7/28/2008	30	-0.369561653	N/A	N/A	N/A	0.0075755251	0.000189983	N/A	17177.17
14	7/1/2008-8/11/2008	30	-0.406746184	N/A	N/A	N/A	0.0072430434	0.000199242	N/A	23036.19
15	7/15/2008-8/25/2008	30	-0.352544643	N/A	N/A	N/A	0.0066620288	0.000209762	N/A	7044.79
16	7/29/2008-9/8/2008	30	-0.429440284	N/A	N/A	N/A	0.0067280978	0.000221881	N/A	4569.43
17	8/12/2008-9/22/2008	30	-0.280659774	N/A	N/A	N/A	0.0083378413	0.000246440	N/A	42955.38
18	8/26/2008-10/6/2008	30	-0.28374408	N/A	N/A	N/A	0.0105830303	0.000272034	N/A	98952.92
19	9/9/2008-10/20/2008	30	-0.434421754	N/A	N/A	N/A	0.0137038402	0.000330284	N/A	142140.87
20	9/23/2008-11/3/2008	30	-0.363549449	N/A	N/A	N/A	0.0169506169	0.000320582	N/A	159332.92
21	10/7/2008-11/17/2008	30	-0.456147676	N/A	N/A	N/A	0.0185967756	0.000292430	N/A	45981.67
22	10/21/2008-12/1/2008	30	-0.380283793	N/A	N/A	N/A	0.0212856360	0.000261322	N/A	188604.91
23	11/4/2008-12/15/2008	30	-0.306080484	N/A	N/A	N/A	0.0246395966	0.000332997	N/A	355287.32
24	11/18/2008-12/29/2008	30	-0.318120429	N/A	N/A	N/A	0.0275627669	0.000378821	N/A	116229.89
25	12/2/2008-1/12/2009	30	-0.383981754	N/A	N/A	N/A	0.0266629104	0.000389418	N/A	225836.71
26	12/16/2008-1/26/2009	30	-0.390025917	N/A	N/A	N/A	0.0235704945	0.000408759	N/A	158777.66
27	12/30/2008-2/9/2009	30	-0.435004177	N/A	N/A	N/A	0.0226507839	0.000253169	N/A	105911.83
28	1/13/2009-2/23/2009	30	-0.387728479	N/A	N/A	N/A	0.0237090997	-0.000148703	N/A	37658.20
29	1/27/2009-3/9/2009	30	-0.301424907	N/A	N/A	N/A	0.0293681958	-0.000612801	N/A	314000.18
30	2/10/2009-3/23/2009	30	-0.425602308	N/A	N/A	N/A	0.0311187420	-0.001293106	N/A	325581.99
31	2/24/2009-4/6/2009	30	-0.303415625	N/A	N/A	N/A	0.0309196337	-0.001234046	N/A	246007.47
32	3/10/2009-4/20/2009	30	-0.274978005	N/A	N/A	N/A	0.0273268514	-0.000878085	N/A	93409.19
33	3/24/2009-5/4/2009	30	-0.435206403	N/A	N/A	N/A	0.0259531081	-0.000272245	N/A	64717.12
34	4/7/2009-5/18/2009	30	-0.333757726	N/A	N/A	N/A	0.0244310845	-0.000057881	N/A	134692.54
35	4/21/2009-6/1/2009	30	-0.313022272	N/A	N/A	N/A	0.0223100028	-0.000058561	N/A	143287.39
36	5/5/2009-6/15/2009	30	-0.444681769	N/A	N/A	N/A	0.0188983694	-0.000057961	N/A	117652.57
37	5/19/2009-6/29/2009	30	-0.464445686	N/A	N/A	N/A	0.0170576359	-0.000049387	N/A	57524.84
38	6/2/2009-7/13/2009	30	-0.461860084	N/A	N/A	N/A	0.0160712996	-0.000001029	N/A	27340.94
39	6/16/2009-7/27/2009	30	-0.380106662	N/A	N/A	N/A	0.0160710890	0.000061037	N/A	25191.26
40	6/30/2009-8/10/2009	30	-0.44020374	N/A	N/A	N/A	0.0140951545	0.000121469	N/A	76748.57
41	7/14/2009-8/24/2009	30	-0.38177168	N/A	N/A	N/A	0.0128230160	0.000147709	N/A	60648.06
42	7/28/2009-9/7/2009	30	-0.274793366	N/A	N/A	N/A	0.0124599218	0.000174423	N/A	30867.71
43	8/11/2009-9/21/2009	30	-0.468146987	N/A	N/A	N/A	0.0131417297	0.000225332	N/A	16444.87
44	9/8/2009-10/6/2009	30	-0.365884362	N/A	N/A	N/A	0.0123089945	0.000308158	N/A	15680.71

Average Sum of Squared Errors   83,285.22

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Boeing Co.</u> NYSE: <u>BA</u> Industry: <u>Industrial</u>

Model 3 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.40710073	N/A	0.262506959	N/A	0.002572592	N/A	0.015238058	28385.34
2	1/15/2008-2/25/2008	30	-0.402891758	N/A	0.255648479	N/A	0.003106226	N/A	0.019832735	45358.56
3	1/29/2008-3/10/2008	30	-0.433053421	N/A	0.262112182	N/A	0.00326628	N/A	0.021494122	48605.19
4	2/12/2008-3/24/2008	30	-0.448007983	N/A	0.245235147	N/A	0.004000579	N/A	0.022189499	46628.94
5	2/26/2008-4/7/2008	30	-0.335347199	N/A	0.259719471	N/A	0.003578324	N/A	0.021863084	55136.17
6	3/11/2008-4/21/2008	30	-0.315754792	N/A	0.251981351	N/A	0.002907065	N/A	0.017598181	33378.98
7	3/25/2008-5/25/2008	30	-0.37067626	N/A	0.255719158	N/A	0.002333074	N/A	0.014412867	5758.24
8	4/8/2008-5/19/2008	30	-0.468748573	N/A	0.252996605	N/A	0.002182315	N/A	0.013856906	5807.69
9	4/22/2008-6/2/2008	30	-0.340431289	N/A	0.261834662	N/A	0.002614161	N/A	0.014612818	39401.43
10	5/6/2008-6/16/2008	30	-0.312741486	N/A	0.249627029	N/A	0.002968575	N/A	0.018913817	43637.32
11	5/20/2008-6/30/2008	30	-0.277536407	N/A	0.249353533	N/A	0.003541094	N/A	0.021111182	38118.99
12	6/3/2008-7/14/2008	30	-0.352040457	N/A	0.252503958	N/A	0.004008268	N/A	0.023749478	51819.91
13	6/17/2008-7/28/2008	30	-0.311455086	N/A	0.280481481	N/A	0.004144856	N/A	0.024118567	53125.96
14	7/1/2008-8/11/2008	30	-0.446930256	N/A	0.258079952	N/A	0.003787623	N/A	0.023276081	40232.58
15	7/15/2008-8/25/2008	30	-0.336882236	N/A	0.271106684	N/A	0.003702492	N/A	0.021480757	34905.30
16	7/29/2008-9/8/2008	30	-0.472948344	N/A	0.262908008	N/A	0.003590959	N/A	0.020494235	30502.40
17	8/12/2008-9/22/2008	30	-0.445890514	N/A	0.284246521	N/A	0.0042565	N/A	0.024807789	7603.65
18	8/26/2008-10/6/2008	30	-0.298286924	N/A	0.270646510	N/A	0.005251344	N/A	0.029270315	13586.84
19	9/9/2008-10/20/2008	30	-0.433932714	N/A	0.282575042	N/A	0.006306628	N/A	0.039412425	39884.89
20	9/23/2008-11/3/2008	30	-0.360572795	N/A	0.288979707	N/A	0.008070505	N/A	0.048203861	38408.40
21	10/7/2008-11/17/2008	30	-0.447924968	N/A	0.303751613	N/A	0.008943371	N/A	0.053068805	144197.92
22	10/21/2008-12/1/2008	30	-0.331003893	N/A	0.299442312	N/A	0.009924822	N/A	0.059914999	345827.40
23	11/4/2008-12/15/2008	30	-0.421287388	N/A	0.293995275	N/A	0.011941914	N/A	0.069204122	547674.58
24	11/18/2008-12/29/2008	30	-0.448817019	N/A	0.289245653	N/A	0.012827958	N/A	0.078128334	347063.51
25	12/2/2008-1/12/2009	30	-0.342859663	N/A	0.290188835	N/A	0.013242207	N/A	0.073093887	430033.91
26	12/16/2008-1/26/2009	30	-0.456727053	N/A	0.304262489	N/A	0.011029679	N/A	0.066759903	174428.10
27	12/30/2008-2/9/2009	30	-0.455498238	N/A	0.296122611	N/A	0.009754484	N/A	0.059867517	117137.20
28	1/13/2009-2/23/2009	30	-0.30044984	N/A	0.308876023	N/A	0.00901448	N/A	0.053433315	37726.95
29	1/27/2009-3/9/2009	30	-0.424807879	N/A	0.301813892	N/A	0.010551622	N/A	0.062116934	309200.58
30	2/10/2009-3/23/2009	30	-0.382120352	N/A	0.323597702	N/A	0.011732351	N/A	0.068256598	376461.93
31	2/24/2009-4/6/2009	30	-0.401558984	N/A	0.321583089	N/A	0.01187987	N/A	0.06886147	282501.27
32	3/10/2009-4/20/2009	30	-0.401426561	N/A	0.319360190	N/A	0.011816082	N/A	0.067117607	168881.43
33	3/24/2009-5/4/2009	30	-0.359212501	N/A	0.307299844	N/A	0.010453998	N/A	0.062119789	138681.13
34	4/7/2009-5/18/2009	30	-0.29336325	N/A	0.285600042	N/A	0.009504563	N/A	0.06168384	180394.30
35	4/21/2009-6/1/2009	30	-0.463105535	N/A	0.297829403	N/A	0.008724112	N/A	0.050568331	174002.34
36	5/5/2009-6/15/2009	30	-0.417827242	N/A	0.287321145	N/A	0.007436776	N/A	0.041821691	74577.56
37	5/19/2009-6/29/2009	30	-0.460130244	N/A	0.299743412	N/A	0.006596966	N/A	0.036854843	48385.69
38	6/2/2009-7/13/2009	30	-0.448885913	N/A	0.283177789	N/A	0.006011426	N/A	0.035316269	36179.29
39	6/16/2009-7/27/2009	30	-0.356144995	N/A	0.292339083	N/A	0.006514385	N/A	0.040062137	42160.91
40	6/30/2009-8/10/2009	30	-0.306190315	N/A	0.302033470	N/A	0.005812101	N/A	0.03606772	35931.57
41	7/14/2009-8/24/2009	30	-0.3883915	N/A	0.277920375	N/A	0.005383764	N/A	0.031134387	80539.35
42	7/28/2009-9/7/2009	30	-0.360584512	N/A	0.279156058	N/A	0.005193581	N/A	0.030873205	43771.13
43	8/11/2009-9/21/2009	30	-0.314717423	N/A	0.288928089	N/A	0.005635949	N/A	0.031385864	31934.47
44	9/8/2009-10/6/2009	30	-0.328918897	N/A	0.291813743	N/A	0.005456991	N/A	0.032383635	37373.16

Average Sum of Squared Errors 111,485.28

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __The Boeing Co.__ NYSE: __BA__ Industry: __Industrial__

Model 4 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 - b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.373293119	N/A	0.258767479	-0.000005866	0.004300128	N/A	0.027937579	26188.88
2	1/15/2008-2/25/2008	30	-0.426603756	N/A	0.262159637	0.000044628	0.005607027	N/A	0.033499591	42030.19
3	1/29/2008-3/10/2008	30	-0.438369855	N/A	0.264712455	-0.000085761	0.006165175	N/A	0.037937609	43410.95
4	2/12/2008-3/24/2008	30	-0.332870485	N/A	0.248404930	0.000075656	0.006950849	N/A	0.042496810	42105.80
5	2/26/2008-4/7/2008	30	-0.390907974	N/A	0.251105807	-0.000032148	0.006221268	N/A	0.035213600	51403.29
6	3/11/2008-4/21/2008	30	-0.327420189	N/A	0.248829027	0.000048125	0.005473637	N/A	0.033900874	31350.49
7	3/25/2008-5/25/2008	30	-0.349024722	N/A	0.249090362	0.000033893	0.004968131	N/A	0.028549834	5242.51
8	4/8/2008-5/19/2008	30	-0.449782619	N/A	0.258502503	0.000004418	0.004233242	N/A	0.027095307	5395.61
9	4/22/2008-6/2/2008	30	-0.425129639	N/A	0.260484219	0.000077930	0.003990911	N/A	0.023491711	36047.21
10	5/6/2008-6/16/2008	30	-0.364034957	N/A	0.254295274	-0.000065829	0.004338353	N/A	0.025216702	39737.28
11	5/20/2008-6/30/2008	30	-0.403566212	N/A	0.259953743	0.000025332	0.004421312	N/A	0.027760031	36108.25
12	6/3/2008-7/14/2008	30	-0.285938857	N/A	0.254664476	-0.000084434	0.004785687	N/A	0.027375185	48460.33
13	6/17/2008-7/28/2008	30	-0.428919286	N/A	0.273676554	0.000066512	0.004783400	N/A	0.029888039	48255.23
14	7/1/2008-8/11/2008	30	-0.377046654	N/A	0.275915929	0.000008761	0.005328303	N/A	0.030366894	36160.36
15	7/15/2008-8/25/2008	30	-0.361025317	N/A	0.274798801	-0.000089835	0.005424562	N/A	0.033859028	32206.41
16	7/29/2008-9/8/2008	30	-0.467474712	N/A	0.265227808	0.000098498	0.006133424	N/A	0.034891499	27111.97
17	8/12/2008-9/22/2008	30	-0.393678757	N/A	0.275642548	-0.000019023	0.006408575	N/A	0.039184787	7264.30
18	8/26/2008-10/6/2008	30	-0.296344329	N/A	0.274573918	0.000025529	0.006486658	N/A	0.042223659	12739.13
19	9/9/2008-10/20/2008	30	-0.389702816	N/A	0.291322327	0.000029840	0.009075032	N/A	0.056853935	37256.62
20	9/23/2008-11/3/2008	30	-0.297712531	N/A	0.300091001	0.000056227	0.014531097	N/A	0.089881892	37555.71
21	10/7/2008-11/17/2008	30	-0.370332483	N/A	0.288064201	0.000043317	0.018831661	N/A	0.104812542	134726.83
22	10/21/2008-12/1/2008	30	-0.439542753	N/A	0.285483564	0.000064128	0.022399172	N/A	0.135316081	306177.74
23	11/4/2008-12/15/2008	30	-0.473358724	N/A	0.299460229	-0.000067298	0.024399268	N/A	0.147168283	528561.44
24	11/18/2008-12/29/2008	30	-0.414337047	N/A	0.298651110	-0.000004812	0.031046764	N/A	0.179502858	308923.64
25	12/2/2008-1/12/2009	30	-0.387334897	N/A	0.288942133	0.000064488	0.031192688	N/A	0.194200599	394391.81
26	12/16/2008-1/26/2009	30	-0.294421591	N/A	0.300212951	-0.000006593	0.031703687	N/A	0.195153524	159989.75
27	12/30/2008-2/9/2009	30	-0.359623519	N/A	0.306335474	0.000090401	0.035988322	N/A	0.217846534	102875.23
28	1/13/2009-2/23/2009	30	-0.445212457	N/A	0.309761067	-0.000023145	0.034237505	N/A	0.195024432	34697.36
29	1/27/2009-3/9/2009	30	-0.379402666	N/A	0.308880158	0.000073066	0.037502171	N/A	0.221350519	307370.00
30	2/10/2009-3/23/2009	30	-0.295597948	N/A	0.328764167	-0.000049848	0.040209503	N/A	0.232110670	332907.37
31	2/24/2009-4/6/2009	30	-0.385333806	N/A	0.300209776	-0.000069503	0.039385641	N/A	0.240369486	274712.23
32	3/10/2009-4/20/2009	30	-0.379143288	N/A	0.314326686	0.000040254	0.035818703	N/A	0.204518779	161350.53
33	3/24/2009-5/4/2009	30	-0.331343465	N/A	0.309866803	0.000008989	0.027911319	N/A	0.175646950	121386.62
34	4/7/2009-5/18/2009	30	-0.449505922	N/A	0.288225989	0.000016811	0.025824869	N/A	0.143692477	178831.59
35	4/21/2009-6/1/2009	30	-0.470575363	N/A	0.276476660	0.000031670	0.022507113	N/A	0.128658616	166097.79
36	5/5/2009-6/15/2009	30	-0.450222226	N/A	0.279370544	-0.000099857	0.018611067	N/A	0.110229869	71796.08
37	5/19/2009-6/29/2009	30	-0.355101325	N/A	0.301271810	-0.000053427	0.017957536	N/A	0.103841646	44039.55
38	6/2/2009-7/13/2009	30	-0.351275776	N/A	0.304726532	-0.000029802	0.018341169	N/A	0.105060145	32568.45
39	6/16/2009-7/27/2009	30	-0.423812268	N/A	0.298406471	0.000037816	0.021128410	N/A	0.118291773	38974.82
40	6/30/2009-8/10/2009	30	-0.337146204	N/A	0.284444417	0.000007661	0.018329287	N/A	0.109622801	33546.12
41	7/14/2009-8/24/2009	30	-0.329087098	N/A	0.278726179	-0.000019915	0.015880389	N/A	0.094814354	77243.94
42	7/28/2009-9/7/2009	30	-0.341262014	N/A	0.273539061	-0.000025923	0.014166294	N/A	0.088202985	41470.05
43	8/11/2009-9/21/2009	30	-0.460292986	N/A	0.293195750	0.000060834	0.012913005	N/A	0.077689478	30696.61
44	9/8/2009-10/6/2009	30	-0.433758396	N/A	0.290053314	-0.000097188	0.011806738	N/A	0.073652442	35779.38

Average Sum of Squared Errors 103,753.31

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: The Boeing Co.   NYSE: BA   Industry: Industrial

Model 5 Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.087199090	-43.158396143	N/A	N/A	0.004133292	0.000217338	N/A	6376.96
2	1/15/2008-2/25/2008	30	-0.006919037	-46.579487571	N/A	N/A	0.005515173	0.000205662	N/A	13092.27
3	1/29/2008-3/10/2008	30	0.017908979	-49.034126366	N/A	N/A	0.005797508	0.000176357	N/A	11645.94
4	2/12/2008-3/24/2008	30	0.088595775	-51.395369067	N/A	N/A	0.006683791	0.000140231	N/A	6914.11
5	2/26/2008-4/7/2008	30	-0.047469913	-42.434858505	N/A	N/A	0.006215958	0.000123668	N/A	17058.71
6	3/11/2008-4/21/2008	30	0.084830855	-44.312190912	N/A	N/A	0.004932911	0.000109834	N/A	27821.78
7	3/25/2008-5/25/2008	30	0.021994294	-49.824330576	N/A	N/A	0.003684943	0.000104676	N/A	9297.94
8	4/8/2008-5/19/2008	30	-0.042182639	-48.314254897	N/A	N/A	0.003836966	0.000117929	N/A	2842.14
9	4/22/2008-6/2/2008	30	-0.053289429	-42.310999958	N/A	N/A	0.004608316	0.000140903	N/A	18049.25
10	5/6/2008-6/16/2008	30	-0.077416988	-43.047612172	N/A	N/A	0.005534018	0.000141062	N/A	16428.71
11	5/20/2008-6/30/2008	30	0.002114893	-42.701876408	N/A	N/A	0.006706686	0.000152422	N/A	8271.05
12	6/3/2008-7/14/2008	30	0.091556732	-48.468041484	N/A	N/A	0.007568217	0.000171829	N/A	14375.88
13	6/17/2008-7/28/2008	30	-0.014017349	-44.631820813	N/A	N/A	0.007818803	0.000196161	N/A	14950.70
14	7/1/2008-8/11/2008	30	-0.044519192	-48.673847415	N/A	N/A	0.007602882	0.000199139	N/A	18436.08
15	7/15/2008-8/25/2008	30	-0.037343696	-47.144569582	N/A	N/A	0.006381237	0.000213647	N/A	5977.16
16	7/29/2008-9/8/2008	30	-0.034469305	-45.324034875	N/A	N/A	0.006856411	0.000217076	N/A	3918.61
17	8/12/2008-9/22/2008	30	0.093627172	-50.560720182	N/A	N/A	0.008600331	0.000239910	N/A	32678.15
18	8/26/2008-10/6/2008	30	-0.035603044	-45.904421663	N/A	N/A	0.010537263	0.000274426	N/A	81497.01
19	9/9/2008-10/20/2008	30	0.019473258	-42.404222656	N/A	N/A	0.014085201	0.000338782	N/A	119425.96
20	9/23/2008-11/3/2008	30	-0.001325922	-50.362987061	N/A	N/A	0.016533447	0.000306979	N/A	128650.13
21	10/7/2008-11/17/2008	30	0.048140272	-42.657027173	N/A	N/A	0.019160539	0.000285552	N/A	38725.05
22	10/21/2008-12/1/2008	30	0.004891036	-48.715741959	N/A	N/A	0.021673533	0.000256657	N/A	154904.94
23	11/4/2008-12/15/2008	30	0.053444048	-48.265697824	N/A	N/A	0.023477874	0.000340685	N/A	312632.06
24	11/18/2008-12/29/2008	30	0.020513461	-48.476253688	N/A	N/A	0.028217244	0.000368223	N/A	98289.51
25	12/2/2008-1/12/2009	30	-0.038747117	-47.380907595	N/A	N/A	0.026652954	0.000385660	N/A	188234.18
26	12/16/2008-1/26/2009	30	0.084269896	-47.118389984	N/A	N/A	0.023150116	0.000390688	N/A	139930.98
27	12/30/2008-2/9/2009	30	0.007178225	-43.506620276	N/A	N/A	0.022062953	0.000266244	N/A	85300.83
28	1/13/2009-2/23/2009	30	-0.017417493	-45.647759814	N/A	N/A	0.023845011	-0.000153019	N/A	30633.39
29	1/27/2009-3/9/2009	30	-0.039713592	-43.141919966	N/A	N/A	0.029991622	-0.000630874	N/A	271337.98
30	2/10/2009-3/23/2009	30	-0.003108698	-50.677531481	N/A	N/A	0.032391989	-0.001280148	N/A	257560.95
31	2/24/2009-4/6/2009	30	0.044294886	-48.601063118	N/A	N/A	0.031475173	-0.001252441	N/A	203941.12
32	3/10/2009-4/20/2009	30	-0.096910444	-51.546999481	N/A	N/A	0.026372306	-0.000912515	N/A	78248.60
33	3/24/2009-5/4/2009	30	0.051002434	-45.141803122	N/A	N/A	0.025729125	-0.000273975	N/A	50720.87
34	4/7/2009-5/18/2009	30	0.046387153	-44.640849572	N/A	N/A	0.023421127	-0.000059615	N/A	115711.82
35	4/21/2009-6/1/2009	30	-0.033506740	-50.598574442	N/A	N/A	0.022968927	-0.000057107	N/A	120694.01
36	5/5/2009-6/15/2009	30	-0.080790581	-45.458968963	N/A	N/A	0.018036157	-0.000060120	N/A	99255.59
37	5/19/2009-6/29/2009	30	-0.065452573	-49.035566373	N/A	N/A	0.016381434	-0.000051051	N/A	49803.74
38	6/2/2009-7/13/2009	30	0.030994520	-46.804121686	N/A	N/A	0.015967125	-0.000001067	N/A	20978.99
39	6/16/2009-7/27/2009	30	0.076992041	-47.588936560	N/A	N/A	0.016342601	0.000061840	N/A	19980.28
40	6/30/2009-8/10/2009	30	0.049986756	-46.028677150	N/A	N/A	0.013948394	0.000121766	N/A	67043.55
41	7/14/2009-8/24/2009	30	0.019885700	-43.477400673	N/A	N/A	0.012191755	0.000146272	N/A	50416.45
42	7/28/2009-9/7/2009	30	-0.000008518	-51.320019132	N/A	N/A	0.012181260	0.000172132	N/A	24816.27
43	8/11/2009-9/21/2009	30	-0.049751930	-47.307658002	N/A	N/A	0.013112998	0.000235747	N/A	13734.83
44	9/8/2009-10/6/2009	30	-0.092686627	-51.074287062	N/A	N/A	0.012406755	0.000313005	N/A	13786.95

Average Sum of Squared Errors   69,645.26

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Boeing Co.</u> NYSE: <u>BA</u> Industry: <u>Industrial</u>

Model 6 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.012034071	-50.429860889	0.242530433	N/A	0.002616356	N/A	0.016389964	24680.69
2	1/15/2008-2/25/2008	30	-0.041069546	-50.979989866	0.255067549	N/A	0.003132564	N/A	0.019270247	36016.30
3	1/29/2008-3/10/2008	30	-0.064743323	-43.450595751	0.259812568	N/A	0.003456049	N/A	0.020604896	39614.63
4	2/12/2008-3/24/2008	30	-0.092130513	-44.783606764	0.254777098	N/A	0.003858362	N/A	0.022773664	38742.82
5	2/26/2008-4/7/2008	30	-0.035722879	-44.068418472	0.265123252	N/A	0.003399387	N/A	0.020132954	43443.92
6	3/11/2008-4/21/2008	30	0.007356744	-49.039802296	0.257694742	N/A	0.003056598	N/A	0.019111945	27432.92
7	3/25/2008-5/25/2008	30	0.073967215	-43.518962767	0.248669386	N/A	0.002487980	N/A	0.014611063	4568.37
8	4/8/2008-5/19/2008	30	0.070708813	-47.967756903	0.263595146	N/A	0.002136725	N/A	0.013350409	4561.02
9	4/22/2008-6/2/2008	30	0.022790989	-47.168282275	0.264596731	N/A	0.002571822	N/A	0.014953117	32211.17
10	5/6/2008-6/16/2008	30	0.069296497	-51.671274612	0.250080752	N/A	0.003007483	N/A	0.018330128	36128.24
11	5/20/2008-6/30/2008	30	-0.098611681	-50.260492522	0.268293830	N/A	0.003496029	N/A	0.021421147	31271.43
12	6/3/2008-7/14/2008	30	0.054146902	-49.375453846	0.257132947	N/A	0.003931232	N/A	0.023945147	45236.07
13	6/17/2008-7/28/2008	30	-0.088971122	-44.275008821	0.269544224	N/A	0.004043524	N/A	0.024743386	45185.95
14	7/1/2008-8/11/2008	30	0.053386161	-48.736443174	0.281114125	N/A	0.003840041	N/A	0.023111388	31218.89
15	7/15/2008-8/25/2008	30	-0.081901038	-47.572686698	0.269100312	N/A	0.003673225	N/A	0.022398842	28179.95
16	7/29/2008-9/8/2008	30	0.036345826	-50.175017280	0.278739651	N/A	0.003589802	N/A	0.021824002	23818.40
17	8/12/2008-9/22/2008	30	0.034923846	-43.547351408	0.274553662	N/A	0.004321686	N/A	0.025605898	6834.83
18	8/26/2008-10/6/2008	30	-0.082399136	-43.614299909	0.270111193	N/A	0.005034288	N/A	0.030949227	11136.12
19	9/9/2008-10/20/2008	30	-0.041003018	-50.669989731	0.274520142	N/A	0.006436554	N/A	0.040015915	34419.38
20	9/23/2008-11/3/2008	30	0.094117406	-43.914001408	0.285719189	N/A	0.007744923	N/A	0.046473009	32977.72
21	10/7/2008-11/17/2008	30	-0.028031635	-50.956393880	0.301265128	N/A	0.009023337	N/A	0.053475506	121062.62
22	10/21/2008-12/1/2008	30	0.065381521	-48.913932852	0.292969445	N/A	0.010456867	N/A	0.058240591	267704.05
23	11/4/2008-12/15/2008	30	-0.021098991	-46.487160310	0.305872767	N/A	0.011334347	N/A	0.074404770	451477.47
24	11/18/2008-12/29/2008	30	0.041790337	-43.773956779	0.286716672	N/A	0.013205579	N/A	0.082299223	268051.82
25	12/2/2008-1/12/2009	30	0.028882603	-42.658247630	0.310244996	N/A	0.012440499	N/A	0.078603216	353358.75
26	12/16/2008-1/26/2009	30	0.098175355	-49.780962561	0.284666998	N/A	0.010505520	N/A	0.064732520	134894.57
27	12/30/2008-2/9/2009	30	0.067228209	-46.580134772	0.311128205	N/A	0.009926507	N/A	0.060539684	94943.66
28	1/13/2009-2/23/2009	30	0.048018558	-45.361904886	0.312942628	N/A	0.009047183	N/A	0.054966892	29355.67
29	1/27/2009-3/9/2009	30	-0.099017440	-51.649474912	0.307556632	N/A	0.010106629	N/A	0.060888206	268175.86
30	2/10/2009-3/23/2009	30	0.016025450	-50.089864623	0.321993577	N/A	0.011937776	N/A	0.066550211	285932.74
31	2/24/2009-4/6/2009	30	-0.003362442	-50.138970626	0.309617044	N/A	0.011723321	N/A	0.072641571	238717.31
32	3/10/2009-4/20/2009	30	-0.031742195	-50.131532669	0.303812927	N/A	0.011195130	N/A	0.068659627	137277.58
33	3/24/2009-5/4/2009	30	0.034526559	-50.915064632	0.292491006	N/A	0.010673511	N/A	0.064606263	104771.15
34	4/7/2009-5/18/2009	30	0.010530748	-46.238914109	0.306524532	N/A	0.009809825	N/A	0.060174755	159157.94
35	4/21/2009-6/1/2009	30	-0.055421274	-44.322238571	0.275981700	N/A	0.008840644	N/A	0.050361284	139262.29
36	5/5/2009-6/15/2009	30	-0.068662913	-45.733447520	0.277387348	N/A	0.006985618	N/A	0.040925043	64125.30
37	5/19/2009-6/29/2009	30	-0.099140021	-50.848870369	0.284089818	N/A	0.006149062	N/A	0.037171789	39748.71
38	6/2/2009-7/13/2009	30	-0.082915259	-50.604386850	0.293525421	N/A	0.005788332	N/A	0.035285852	30041.41
39	6/16/2009-7/27/2009	30	0.065304162	-47.451603218	0.284300184	N/A	0.006126702	N/A	0.038795709	32902.05
40	6/30/2009-8/10/2009	30	0.033388302	-44.427489877	0.289850101	N/A	0.005983796	N/A	0.035509903	30990.73
41	7/14/2009-8/24/2009	30	0.093407100	-46.262572511	0.276002465	N/A	0.005119554	N/A	0.031335247	72276.56
42	7/28/2009-9/7/2009	30	-0.017867484	-50.241600303	0.282489220	N/A	0.005053274	N/A	0.029108505	37572.59
43	8/11/2009-9/21/2009	30	-0.026423865	-45.628283734	0.294372699	N/A	0.005144204	N/A	0.031540740	27713.44
44	9/8/2009-10/6/2009	30	0.053871511	-51.215645859	0.275252878	N/A	0.005357931	N/A	0.031463193	32805.04

Average Sum of Squared Errors 90,909.05

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __The Boeing Co.__   NYSE: __BA__   Industry: __Industrial__

Model 7   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.038784773	-50.274641489	0.245096934	-0.000018473	0.002788417	N/A	0.015630443	24255.58
2	1/15/2008-2/25/2008	30	-0.000824672	-46.649511954	0.242276521	-0.000068526	0.003165184	N/A	0.018586767	33474.38
3	1/29/2008-3/10/2008	30	0.040010033	-47.559368799	0.264022908	0.000039841	0.003443947	N/A	0.021109309	35737.25
4	2/12/2008-3/24/2008	30	-0.091296920	-51.054184435	0.267206972	-0.000052087	0.003883174	N/A	0.023109637	33512.74
5	2/26/2008-4/7/2008	30	0.073123264	-49.411833029	0.266568980	-0.000091320	0.003560838	N/A	0.020151814	39474.27
6	3/11/2008-4/21/2008	30	0.058432092	-42.314894025	0.246853737	-0.000040389	0.003109589	N/A	0.017995548	26802.31
7	3/25/2008-5/25/2008	30	0.029298261	-44.297129228	0.250907725	0.000076005	0.002489377	N/A	0.013930930	4301.56
8	4/8/2008-5/19/2008	30	-0.052220683	-51.025364201	0.259569322	-0.000049256	0.002216888	N/A	0.012857198	4179.08
9	4/22/2008-6/2/2008	30	-0.072762276	-42.444958949	0.264819391	0.000072983	0.002423269	N/A	0.014701642	30295.53
10	5/6/2008-6/16/2008	30	0.035349886	-47.131223189	0.263524213	0.000059056	0.003016968	N/A	0.018263977	32390.05
11	5/20/2008-6/30/2008	30	-0.045723131	-42.666342167	0.253319542	-0.000047480	0.003735141	N/A	0.022127115	28481.24
12	6/3/2008-7/14/2008	30	0.033181384	-49.438869929	0.256258287	0.000021580	0.003954240	N/A	0.024631585	38558.63
13	6/17/2008-7/28/2008	30	0.044798445	-47.529776261	0.255809693	-0.000079769	0.004016838	N/A	0.023531613	41768.66
14	7/1/2008-8/11/2008	30	-0.096277556	-48.490334466	0.275082493	0.000099964	0.003914055	N/A	0.024184998	28521.89
15	7/15/2008-8/25/2008	30	0.066011469	-42.659954203	0.259190290	0.000054233	0.003691399	N/A	0.020598114	25518.00
16	7/29/2008-9/8/2008	30	0.095381864	-44.309052712	0.264498428	-0.000034978	0.003467989	N/A	0.020610015	22401.33
17	8/12/2008-9/22/2008	30	-0.026900480	-50.597434442	0.275533777	0.000048427	0.004271421	N/A	0.024323664	6045.09
18	8/26/2008-10/6/2008	30	0.054804604	-49.371897037	0.279319058	-0.000087440	0.005098878	N/A	0.030924100	10691.74
19	9/9/2008-10/20/2008	30	-0.076903952	-51.060593700	0.289879636	0.000070371	0.006522026	N/A	0.038283604	31295.51
20	9/23/2008-11/3/2008	30	0.032069982	-50.308380414	0.296315631	-0.000087361	0.008301410	N/A	0.046123056	30130.35
21	10/7/2008-11/17/2008	30	-0.089923050	-51.103999606	0.281074090	0.000063974	0.009206776	N/A	0.051782825	110588.13
22	10/21/2008-12/1/2008	30	0.003779320	-45.333636753	0.284837346	-0.000064316	0.010248975	N/A	0.061084144	256652.28
23	11/4/2008-12/15/2008	30	-0.096123335	-42.575522755	0.303897322	-0.000086073	0.011919209	N/A	0.069271925	432903.12
24	11/18/2008-12/29/2008	30	0.038320784	-42.518774711	0.302261074	0.000054976	0.013047959	N/A	0.079606558	247057.44
25	12/2/2008-1/12/2009	30	0.063326225	-50.514392883	0.291387508	0.000072353	0.012028501	N/A	0.074027426	313412.02
26	12/16/2008-1/26/2009	30	-0.041937512	-49.617761833	0.293139657	0.000073878	0.011183616	N/A	0.064759052	123633.23
27	12/30/2008-2/9/2009	30	0.092369311	-51.298011490	0.311610054	-0.000071240	0.009769179	N/A	0.059196647	83902.07
28	1/13/2009-2/23/2009	30	-0.042340433	-47.843450479	0.323355655	0.000010451	0.009099289	N/A	0.057847839	29125.72
29	1/27/2009-3/9/2009	30	-0.052282143	-48.681246936	0.313150164	0.000007524	0.010629361	N/A	0.059576567	246652.38
30	2/10/2009-3/23/2009	30	0.024234463	-48.853540042	0.301607225	-0.000013392	0.011730479	N/A	0.066567919	259864.49
31	2/24/2009-4/6/2009	30	0.020114047	-50.719303911	0.310146504	-0.000041631	0.012261589	N/A	0.072044317	221015.68
32	3/10/2009-4/20/2009	30	-0.042807537	-51.320208476	0.307253483	0.000044774	0.011186407	N/A	0.068764837	128563.09
33	3/24/2009-5/4/2009	30	-0.017152523	-45.429941973	0.292158052	0.000023408	0.010582358	N/A	0.067652514	97822.08
34	4/7/2009-5/18/2009	30	-0.046602028	-43.237271862	0.289540532	0.000053140	0.009486487	N/A	0.062550462	143061.01
35	4/21/2009-6/1/2009	30	0.006502704	-50.312684587	0.293737620	-0.000084658	0.008467442	N/A	0.051081162	137080.63
36	5/5/2009-6/15/2009	30	-0.018464213	-51.394471273	0.280829963	0.000026251	0.007027925	N/A	0.042652274	58565.25
37	5/19/2009-6/29/2009	30	-0.049057693	-45.222038853	0.304420531	-0.000050082	0.006316207	N/A	0.038991492	35845.76
38	6/2/2009-7/13/2009	30	0.076811966	-45.041477468	0.305611599	0.000011221	0.005902230	N/A	0.037878435	26606.72
39	6/16/2009-7/27/2009	30	0.097128223	-43.932500225	0.305560430	-0.000013159	0.006249365	N/A	0.040241564	30254.14
40	6/30/2009-8/10/2009	30	-0.010723201	-44.728841264	0.282932748	0.000076789	0.006071176	N/A	0.035529620	26337.80
41	7/14/2009-8/24/2009	30	0.018049129	-44.575130482	0.285984648	0.000079525	0.005428645	N/A	0.032087778	64289.67
42	7/28/2009-9/7/2009	30	-0.084492846	-43.967673018	0.279504284	-0.000028036	0.005141723	N/A	0.029381922	32865.05
43	8/11/2009-9/21/2009	30	-0.032047052	-46.333889700	0.272925680	-0.000064873	0.005477001	N/A	0.032585214	25176.21
44	9/8/2009-10/6/2009	30	0.049390010	-44.926809858	0.282422177	0.000068874	0.005172018	N/A	0.032885231	28731.69

Average Sum of Squared Errors   83,814.57

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: The Boeing Co.   NYSE: BA   Industry: Industrial

Model 8   Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.330689232	N/A	0.265264856	N/A	0.004231691	0.000128574	0.006142162	5293.16
2	1/15/2008-2/25/2008	30	-0.342177309	N/A	0.263823801	N/A	0.005457470	0.000118888	0.007673237	12428.68
3	1/29/2008-3/10/2008	30	-0.389488266	N/A	0.243511024	N/A	0.005731411	0.000107527	0.008163399	10403.99
4	2/12/2008-3/24/2008	30	-0.448256796	N/A	0.268061581	N/A	0.006426266	0.000089383	0.009428672	6376.57
5	2/26/2008-4/7/2008	30	-0.413000206	N/A	0.256131509	N/A	0.006093894	0.000070291	0.008295040	15468.06
6	3/11/2008-4/21/2008	30	-0.315387036	N/A	0.260308392	N/A	0.005308032	0.000066389	0.007320206	24869.43
7	3/25/2008-5/25/2008	30	-0.321595347	N/A	0.245633780	N/A	0.003911584	0.000063460	0.005523551	5329.67
8	4/8/2008-5/19/2008	30	-0.348633607	N/A	0.259514879	N/A	0.003675208	0.000071940	0.005212750	2488.16
9	4/22/2008-6/2/2008	30	-0.431964951	N/A	0.258143830	N/A	0.004658509	0.000084327	0.005981849	15736.22
10	5/6/2008-6/16/2008	30	-0.412404967	N/A	0.243430979	N/A	0.005468557	0.000090332	0.007192359	14237.88
11	5/20/2008-6/30/2008	30	-0.456727814	N/A	0.269602619	N/A	0.006344166	0.000094809	0.008678093	7214.00
12	6/3/2008-7/14/2008	30	-0.296916190	N/A	0.258143289	N/A	0.007579561	0.000099921	0.009156563	13300.40
13	6/17/2008-7/28/2008	30	-0.429653338	N/A	0.277938740	N/A	0.007909706	0.000110374	0.009999893	13185.14
14	7/1/2008-8/11/2008	30	-0.378080926	N/A	0.262448870	N/A	0.007514349	0.000123178	0.009767275	16516.65
15	7/15/2008-8/25/2008	30	-0.320072013	N/A	0.266115809	N/A	0.006737832	0.000127550	0.008644038	5419.51
16	7/29/2008-9/8/2008	30	-0.462310234	N/A	0.272619085	N/A	0.006927415	0.000136843	0.008239291	3149.90
17	8/12/2008-9/22/2008	30	-0.446482485	N/A	0.262745767	N/A	0.007981098	0.000144954	0.009434230	7012.80
18	8/26/2008-10/6/2008	30	-0.349443617	N/A	0.269288238	N/A	0.010127023	0.000162748	0.011668507	10510.82
19	9/9/2008-10/20/2008	30	-0.325760554	N/A	0.296214464	N/A	0.014201564	0.000188904	0.016190260	34162.88
20	9/23/2008-11/3/2008	30	-0.306834780	N/A	0.294893685	N/A	0.016487600	0.000193100	0.019987176	35169.95
21	10/7/2008-11/17/2008	30	-0.427669778	N/A	0.296079852	N/A	0.018894973	0.000181388	0.021229410	34466.50
22	10/21/2008-12/1/2008	30	-0.311949997	N/A	0.298782966	N/A	0.021333310	0.000163717	0.025551817	145790.31
23	11/4/2008-12/15/2008	30	-0.349124869	N/A	0.305867320	N/A	0.025621514	0.000201916	0.027871836	279138.68
24	11/18/2008-12/29/2008	30	-0.399621393	N/A	0.299604544	N/A	0.028279926	0.000221679	0.031239717	85137.88
25	12/2/2008-1/12/2009	30	-0.286305208	N/A	0.297607709	N/A	0.026979223	0.000240711	0.030163293	169170.71
26	12/16/2008-1/26/2009	30	-0.462530726	N/A	0.310877241	N/A	0.024214637	0.000254684	0.025642284	117271.60
27	12/30/2008-2/9/2009	30	-0.384861062	N/A	0.312497059	N/A	0.021783718	0.000159089	0.022133114	74215.90
28	1/13/2009-2/23/2009	30	-0.388255345	N/A	0.310993966	N/A	0.022534228	-0.000090253	0.022376100	25733.52
29	1/27/2009-3/9/2009	30	-0.438557551	N/A	0.301003351	N/A	0.029692333	-0.000369920	0.024629784	245597.45
30	2/10/2009-3/23/2009	30	-0.472648846	N/A	0.311855152	N/A	0.031141703	-0.000771137	0.026713960	237218.63
31	2/24/2009-4/6/2009	30	-0.337277470	N/A	0.313807897	N/A	0.030529223	-0.000735702	0.027428523	172737.94
32	3/10/2009-4/20/2009	30	-0.391772801	N/A	0.317236968	N/A	0.026603789	-0.000548719	0.026844090	73114.23
33	3/24/2009-5/4/2009	30	-0.368773946	N/A	0.291721220	N/A	0.026759578	-0.000165580	0.024995966	46309.69
34	4/7/2009-5/18/2009	30	-0.308722506	N/A	0.304156616	N/A	0.025369545	-0.000034897	0.024947542	98517.01
35	4/21/2009-6/1/2009	30	-0.409336747	N/A	0.290386490	N/A	0.023148215	-0.000033586	0.021765047	98371.22
36	5/5/2009-6/15/2009	30	-0.321967136	N/A	0.279307573	N/A	0.019038032	-0.000035707	0.017159768	65650.76
37	5/19/2009-6/29/2009	30	-0.363300976	N/A	0.283452543	N/A	0.017680474	-0.000030811	0.015777850	42749.71
38	6/2/2009-7/13/2009	30	-0.361174637	N/A	0.296746878	N/A	0.016605905	-0.000000593	0.014581105	19711.41
39	6/16/2009-7/27/2009	30	-0.377394458	N/A	0.284135289	N/A	0.015609804	0.000035891	0.015314873	17900.07
40	6/30/2009-8/10/2009	30	-0.434492855	N/A	0.291071600	N/A	0.014666740	0.000070878	0.013628082	35006.44
41	7/14/2009-8/24/2009	30	-0.426588695	N/A	0.299194235	N/A	0.013344456	0.000092336	0.013344867	46621.24
42	7/28/2009-9/7/2009	30	-0.451528132	N/A	0.273554576	N/A	0.012553666	0.000105800	0.011848313	21232.81
43	8/11/2009-9/21/2009	30	-0.413810266	N/A	0.277220296	N/A	0.013455517	0.000130133	0.012596362	12463.08
44	9/8/2009-10/6/2009	30	-0.377994786	N/A	0.288609783	N/A	0.012405946	0.000186871	0.012602509	11606.44

Average Sum of Squared Errors   55,318.34

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Boeing Co.</u>   NYSE: <u>BA</u>   Industry: <u>Industrial</u>

Model9   Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{\frac{1}{b_0}+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.353029662	N/A	0.250421089	-0.000008850	0.004185467	0.000126125	0.006360073	5077.32
2	1/15/2008-2/25/2008	30	-0.318704603	N/A	0.262422071	-0.000081486	0.005410210	0.000118206	0.007364652	11402.41
3	1/29/2008-3/10/2008	30	-0.291220982	N/A	0.247942439	-0.000024836	0.005884244	0.000104234	0.008313542	10094.23
4	2/12/2008-3/24/2008	30	-0.444699664	N/A	0.247072763	0.000011330	0.006426296	0.000089133	0.009642147	6059.95
5	2/26/2008-4/7/2008	30	-0.314973950	N/A	0.249396259	-0.000056781	0.005982703	0.000069189	0.008484456	14381.60
6	3/11/2008-4/21/2008	30	-0.464509172	N/A	0.251708164	0.000086502	0.005281746	0.000063815	0.007330901	20405.36
7	3/25/2008-5/25/2008	30	-0.279000911	N/A	0.247855496	0.000019193	0.003775573	0.000066476	0.005999018	4957.64
8	4/8/2008-5/19/2008	30	-0.355198973	N/A	0.246212368	-0.000041123	0.003658311	0.000072868	0.005283016	2288.00
9	4/22/2008-6/2/2008	30	-0.457056322	N/A	0.246772289	0.000030803	0.004610392	0.000078959	0.006205327	15547.64
10	5/6/2008-6/16/2008	30	-0.282655193	N/A	0.249813346	-0.000075341	0.005833396	0.000091877	0.007488647	13392.18
11	5/20/2008-6/30/2008	30	-0.290629155	N/A	0.268135484	0.000085161	0.006833180	0.000091139	0.009024427	6897.11
12	6/3/2008-7/14/2008	30	-0.428957486	N/A	0.274677401	-0.000068264	0.007330080	0.000098770	0.009589936	13120.53
13	6/17/2008-7/28/2008	30	-0.285004066	N/A	0.271089512	-0.000008241	0.007798513	0.000111633	0.009517982	12185.99
14	7/1/2008-8/11/2008	30	-0.394040664	N/A	0.281070799	0.000024376	0.007262825	0.000114118	0.009604564	16164.06
15	7/15/2008-8/25/2008	30	-0.341833963	N/A	0.265835810	-0.000044339	0.006597649	0.000129129	0.008253745	5371.83
16	7/29/2008-9/8/2008	30	-0.428422927	N/A	0.263596548	0.000083937	0.006563124	0.000127484	0.008225363	2860.61
17	8/12/2008-9/22/2008	30	-0.467041032	N/A	0.276156284	0.000068911	0.008435267	0.000152343	0.010247179	6906.49
18	8/26/2008-10/6/2008	30	-0.337829900	N/A	0.268900681	-0.000036716	0.010995562	0.000158578	0.012630160	7010.80
19	9/9/2008-10/20/2008	30	-0.396480250	N/A	0.297276817	-0.000046762	0.013115385	0.000204513	0.016111667	32895.87
20	9/23/2008-11/3/2008	30	-0.366102395	N/A	0.283087055	-0.000027973	0.016682302	0.000200390	0.019532786	32236.28
21	10/7/2008-11/17/2008	30	-0.349790475	N/A	0.288910708	0.000053789	0.018879753	0.000173670	0.020971627	31734.15
22	10/21/2008-12/1/2008	30	-0.276386090	N/A	0.301699199	-0.000088031	0.021414063	0.000153638	0.025027768	136341.13
23	11/4/2008-12/15/2008	30	-0.405820512	N/A	0.294589374	0.000094361	0.023981759	0.000197219	0.027586288	259383.68
24	11/18/2008-12/29/2008	30	-0.345781691	N/A	0.285887424	0.000089687	0.028369105	0.000233736	0.030757099	81729.69
25	12/2/2008-1/12/2009	30	-0.378827105	N/A	0.298819838	0.000044746	0.027581733	0.000222499	0.031463185	165252.12
26	12/16/2008-1/26/2009	30	-0.350066605	N/A	0.285964623	0.000039916	0.023059684	0.000234481	0.026645188	112712.72
27	12/30/2008-2/9/2009	30	-0.356433599	N/A	0.314038203	-0.000044864	0.022309255	0.000156595	0.023174004	70280.76
28	1/13/2009-2/23/2009	30	-0.370121123	N/A	0.306681182	0.000019004	0.024572121	-0.000090149	0.022744867	22962.33
29	1/27/2009-3/9/2009	30	-0.282587954	N/A	0.323967937	0.000035743	0.028710567	-0.000358794	0.023964384	205741.66
30	2/10/2009-3/23/2009	30	-0.359759498	N/A	0.320431646	0.000068319	0.030768717	-0.000814481	0.027254473	222304.76
31	2/24/2009-4/6/2009	30	-0.347371069	N/A	0.301783532	0.000053326	0.031848696	-0.000742422	0.028818326	169169.52
32	3/10/2009-4/20/2009	30	-0.302689673	N/A	0.315601592	-0.000020971	0.027834581	-0.000527870	0.026225856	70527.80
33	3/24/2009-5/4/2009	30	-0.360908881	N/A	0.289194349	0.000023869	0.024834902	-0.000171469	0.027081937	45488.66
34	4/7/2009-5/18/2009	30	-0.356633003	N/A	0.295088807	0.000079233	0.025297249	-0.000033385	0.023352169	92505.10
35	4/21/2009-6/1/2009	30	-0.331488137	N/A	0.290677733	0.000094879	0.022573681	-0.000035216	0.020242936	96127.69
36	5/5/2009-6/15/2009	30	-0.427194069	N/A	0.282723307	-0.000014221	0.019591815	-0.000034506	0.017307970	65143.81
37	5/19/2009-6/29/2009	30	-0.365570374	N/A	0.293386652	0.000053294	0.016889063	-0.000030319	0.014929609	42536.65
38	6/2/2009-7/13/2009	30	-0.301811857	N/A	0.306163816	0.000079781	0.016601685	-0.000000594	0.014581966	17797.82
39	6/16/2009-7/27/2009	30	-0.430058189	N/A	0.282875221	0.000014950	0.016184948	0.000035835	0.015334543	17832.34
40	6/30/2009-8/10/2009	30	-0.463285352	N/A	0.300556047	0.000095734	0.014463027	0.000072178	0.013245256	30975.50
41	7/14/2009-8/24/2009	30	-0.330158397	N/A	0.299166688	-0.000097784	0.013203049	0.000089149	0.013164699	40359.11
42	7/28/2009-9/7/2009	30	-0.396979307	N/A	0.271465890	0.000075383	0.012795694	0.000107241	0.011776221	19678.06
43	8/11/2009-9/21/2009	30	-0.408501342	N/A	0.282891118	0.000019157	0.013066569	0.000136020	0.012965041	12215.26
44	9/8/2009-10/6/2009	30	-0.431934427	N/A	0.282572213	0.000057869	0.012043191	0.000186543	0.012396234	11547.91

Average Sum of Squared Errors   51,809.19

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Boeing Co.</u> NYSE: <u>BA</u> Industry: <u>Industrial</u>

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{b_0}{}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.078407168	-50.419022482	0.264280079	N/A	0.004338171	0.000123320	0.006153223	3847.94
2	1/15/2008-2/25/2008	30	0.027545002	-47.401572933	0.266522796	N/A	0.005474458	0.000122253	0.007456200	8912.07
3	1/29/2008-3/10/2008	30	0.098343574	-46.503274869	0.258008169	N/A	0.006027429	0.000104034	0.008608531	7840.26
4	2/12/2008-3/24/2008	30	-0.016531017	-45.005345405	0.246873092	N/A	0.006365230	0.000086259	0.009292108	4612.75
5	2/26/2008-4/7/2008	30	0.037580157	-47.628425271	0.256665680	N/A	0.005957223	0.000072547	0.008039201	11241.24
6	3/11/2008-4/21/2008	30	-0.001259468	-43.717983253	0.267717722	N/A	0.005154411	0.000067619	0.007116971	18251.17
7	3/25/2008-5/25/2008	30	-0.046413213	-43.199191984	0.266994190	N/A	0.003937268	0.000064161	0.005980396	4388.52
8	4/8/2008-5/19/2008	30	0.033585778	-43.308238999	0.251448532	N/A	0.003568637	0.000070338	0.005419669	1653.00
9	4/22/2008-6/2/2008	30	0.089087410	-43.050735238	0.262489107	N/A	0.004659496	0.000079108	0.006289201	10549.45
10	5/6/2008-6/16/2008	30	0.019393918	-44.208527484	0.252767135	N/A	0.005639299	0.000088855	0.007129521	10256.61
11	5/20/2008-6/30/2008	30	-0.017429541	-47.897769354	0.250440854	N/A	0.006396433	0.000091524	0.008800530	5179.78
12	6/3/2008-7/14/2008	30	0.001812573	-49.691156998	0.267112233	N/A	0.007414396	0.000102358	0.009619638	9194.67
13	6/17/2008-7/28/2008	30	-0.093225645	-48.216572390	0.267043101	N/A	0.007919696	0.000116255	0.009812113	9558.15
14	7/1/2008-8/11/2008	30	0.003833445	-47.134837295	0.273082722	N/A	0.007057403	0.000116948	0.009304972	11826.63
15	7/15/2008-8/25/2008	30	-0.097106261	-46.028020275	0.278129610	N/A	0.006600123	0.000126367	0.008511147	3651.84
16	7/29/2008-9/8/2008	30	0.086963678	-44.899614067	0.278465066	N/A	0.006399220	0.000131439	0.008655156	2424.59
17	8/12/2008-9/22/2008	30	-0.052462095	-43.984410486	0.268970785	N/A	0.008371623	0.000154060	0.009534957	6815.24
18	8/26/2008-10/6/2008	30	-0.081974830	-50.384937745	0.274607672	N/A	0.011082018	0.000170821	0.011758877	10510.12
19	9/9/2008-10/20/2008	30	-0.051950888	-45.136691778	0.288816195	N/A	0.013784893	0.000198948	0.016082009	33725.73
20	9/23/2008-11/3/2008	30	0.018176832	-43.597754228	0.276881876	N/A	0.017694180	0.000196916	0.019276561	32191.99
21	10/7/2008-11/17/2008	30	0.004391555	-43.525556616	0.301421645	N/A	0.019120905	0.000174618	0.021133269	23005.27
22	10/21/2008-12/1/2008	30	-0.045086365	-43.557541047	0.290763639	N/A	0.020292741	0.000154184	0.025285347	102989.04
23	11/4/2008-12/15/2008	30	0.067800597	-42.687297080	0.303903907	N/A	0.023547061	0.000202754	0.028795799	187864.93
24	11/18/2008-12/29/2008	30	-0.093717191	-42.515582643	0.307639270	N/A	0.028890788	0.000238103	0.032535360	60347.43
25	12/2/2008-1/12/2009	30	0.081682940	-48.460569129	0.294002326	N/A	0.027389597	0.000238725	0.030532703	122641.75
26	12/16/2008-1/26/2009	30	0.044590559	-50.489330898	0.292528448	N/A	0.023722105	0.000241233	0.026866723	82108.22
27	12/30/2008-2/9/2009	30	0.095183475	-48.808587305	0.294191860	N/A	0.022819806	0.000156284	0.022422639	55141.51
28	1/13/2009-2/23/2009	30	0.008005890	-45.318948058	0.319661713	N/A	0.024892270	-0.000089829	0.022430582	19957.66
29	1/27/2009-3/9/2009	30	0.082802574	-47.147716295	0.310514399	N/A	0.028249328	-0.000381065	0.024040706	178931.54
30	2/10/2009-3/23/2009	30	0.061970144	-43.896645997	0.315927587	N/A	0.029702374	-0.000753150	0.028698954	164574.80
31	2/24/2009-4/6/2009	30	0.093806129	-51.014956037	0.294529929	N/A	0.031487374	-0.000712213	0.029512088	131602.54
32	3/10/2009-4/20/2009	30	0.023302918	-46.994258549	0.296165025	N/A	0.026030966	-0.000531094	0.027247159	51169.92
33	3/24/2009-5/4/2009	30	0.061931119	-48.450813403	0.301058646	N/A	0.025813668	-0.000159006	0.025195824	31254.12
34	4/7/2009-5/18/2009	30	0.059111191	-48.903071871	0.287725207	N/A	0.025423860	-0.000033489	0.024083198	73093.79
35	4/21/2009-6/1/2009	30	0.099048877	-47.608779628	0.285584571	N/A	0.023039386	-0.000036387	0.022117603	74194.15
36	5/5/2009-6/15/2009	30	-0.026926020	-50.469192227	0.288094041	N/A	0.018299130	-0.000036478	0.017653631	61753.03
37	5/19/2009-6/29/2009	30	0.066828196	-46.818702030	0.280063971	N/A	0.017556169	-0.000029699	0.014473677	32467.46
38	6/2/2009-7/13/2009	30	0.006645841	-46.307799696	0.297159693	N/A	0.016369418	-0.000000608	0.014709380	13539.28
39	6/16/2009-7/27/2009	30	0.089294547	-50.180329518	0.284002604	N/A	0.016586144	0.000036983	0.015472391	13279.44
40	6/30/2009-8/10/2009	30	0.028314338	-51.593591349	0.298578935	N/A	0.014255243	0.000072639	0.013566733	30162.15
41	7/14/2009-8/24/2009	30	0.028408656	-49.958794695	0.300125741	N/A	0.012465027	0.000090802	0.013274837	32698.94
42	7/28/2009-9/7/2009	30	-0.033778120	-51.592815737	0.278594737	N/A	0.011984506	0.000103382	0.011782418	16568.98
43	8/11/2009-9/21/2009	30	-0.025347646	-46.551539307	0.282521357	N/A	0.013621105	0.000140878	0.012613037	8472.83
44	9/8/2009-10/6/2009	30	-0.085679224	-44.103457763	0.266260150	N/A	0.011959075	0.000188026	0.012535059	8152.02

Average Sum of Squared Errors 40,513.70

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Boeing Co.</u>   NYSE: <u>BA</u>   Industry: <u>Industrial</u>

Model11 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.044142667	-47.618087207	0.249635961	-0.000093343	0.004181381	0.000129941	0.006553811	3770.47
2	1/15/2008-2/25/2008	30	-0.039405116	-49.492459312	0.264155834	-0.000075100	0.005350665	0.000124580	0.007334994	8166.12
3	1/29/2008-3/10/2008	30	0.004910234	-47.032651654	0.255612731	-0.000080121	0.005992750	0.000103478	0.008512418	7408.57
4	2/12/2008-3/24/2008	30	0.050268606	-50.439441236	0.263977245	-0.000075134	0.006727618	0.000090433	0.009152349	4287.49
5	2/26/2008-4/7/2008	30	-0.038508640	-43.262610477	0.264173932	0.000089181	0.006210997	0.000069470	0.008068492	10937.93
6	3/11/2008-4/21/2008	30	0.055197598	-47.123356108	0.269427019	0.000084506	0.004829921	0.000067815	0.007587763	17401.54
7	3/25/2008-5/25/2008	30	0.037909866	-43.297786936	0.243657126	0.000075927	0.003825496	0.000064521	0.005580500	4234.07
8	4/8/2008-5/19/2008	30	-0.014153840	-50.843437855	0.254948652	-0.000057586	0.003882154	0.000074783	0.005409290	1612.87
9	4/22/2008-6/2/2008	30	-0.025076393	-42.907116668	0.240194222	0.000067266	0.004536801	0.000083429	0.006136924	10014.52
10	5/6/2008-6/16/2008	30	0.023479999	-48.978858193	0.262804481	0.000064269	0.005949009	0.000091939	0.007754273	9944.13
11	5/20/2008-6/30/2008	30	0.061330522	-50.120266124	0.259303668	0.000022765	0.006897156	0.000095474	0.008366113	4959.11
12	6/3/2008-7/14/2008	30	-0.000608954	-48.788145906	0.251076976	0.000096876	0.007099181	0.000098243	0.009826046	8941.77
13	6/17/2008-7/28/2008	30	-0.053111141	-46.321715102	0.273288287	-0.000018298	0.007478196	0.000109588	0.010163498	9311.18
14	7/1/2008-8/11/2008	30	-0.025014433	-43.103350093	0.264161080	-0.000075267	0.007117535	0.000122895	0.009858477	11553.05
15	7/15/2008-8/25/2008	30	0.059971084	-51.636265810	0.278898676	-0.000028079	0.006386815	0.000129957	0.008241839	3616.43
16	7/29/2008-9/8/2008	30	-0.097685235	-49.090172611	0.258325595	-0.000038783	0.006835890	0.000136279	0.008566116	2395.35
17	8/12/2008-9/22/2008	30	0.007358054	-44.583138005	0.265404413	0.000088795	0.008471745	0.000148650	0.009723049	6010.76
18	8/26/2008-10/6/2008	30	0.039092808	-44.767559146	0.264152122	0.000071929	0.010651904	0.000166651	0.012225018	6087.12
19	9/9/2008-10/20/2008	30	-0.027459052	-51.134818529	0.272981876	-0.000099010	0.014375258	0.000188697	0.015683138	31052.94
20	9/23/2008-11/3/2008	30	0.035898344	-47.737490227	0.289398141	-0.000002810	0.016562334	0.000196808	0.019946320	29172.02
21	10/7/2008-11/17/2008	30	0.091643661	-44.101087982	0.301653507	0.000008974	0.019322080	0.000169601	0.020285440	22145.67
22	10/21/2008-12/1/2008	30	0.067184779	-49.082565397	0.289019421	0.000070312	0.021563342	0.000150261	0.024693213	96781.86
23	11/4/2008-12/15/2008	30	0.083170095	-45.293096708	0.311855415	-0.000030931	0.025403368	0.000205124	0.029677267	186307.83
24	11/18/2008-12/29/2008	30	-0.005955158	-46.107360819	0.284624808	-0.000034911	0.028269309	0.000227499	0.031115220	58416.01
25	12/2/2008-1/12/2009	30	-0.038404593	-46.260577123	0.305840792	-0.000074817	0.026596174	0.000239373	0.030356519	110831.82
26	12/16/2008-1/26/2009	30	0.011804017	-43.540227479	0.296499662	-0.000085444	0.024312536	0.000257326	0.025700825	77512.33
27	12/30/2008-2/9/2009	30	-0.050346665	-49.927769121	0.297200965	0.000023072	0.022723301	0.000153750	0.022473619	52817.24
28	1/13/2009-2/23/2009	30	-0.091450189	-46.783589530	0.299387966	0.000058113	0.023355898	-0.000087234	0.023016606	18320.38
29	1/27/2009-3/9/2009	30	0.097833069	-42.803516625	0.306965619	0.000040702	0.029411280	-0.000353076	0.024300470	150586.47
30	2/10/2009-3/23/2009	30	0.016508291	-44.189479410	0.317985217	-0.000060887	0.029769975	-0.000778853	0.026450474	148347.21
31	2/24/2009-4/6/2009	30	-0.070086865	-48.672627822	0.313210806	-0.000031382	0.031802819	-0.000721853	0.028973682	124385.29
32	3/10/2009-4/20/2009	30	0.067087167	-46.493748355	0.306765894	0.000065042	0.027386400	-0.000533991	0.028246106	48996.01
33	3/24/2009-5/4/2009	30	0.028352189	-47.940660286	0.301679079	-0.000062362	0.025149975	-0.000162301	0.025025046	30022.60
34	4/7/2009-5/18/2009	30	0.087779283	-50.862597268	0.301571918	-0.000029992	0.024142614	-0.000036297	0.025045458	72800.68
35	4/21/2009-6/1/2009	30	0.012216478	-48.404019850	0.287722481	0.000073103	0.021797809	-0.000033976	0.021477430	70819.03
36	5/5/2009-6/15/2009	30	0.034796021	-46.126135486	0.290616093	-0.000041978	0.017995676	-0.000036116	0.016842559	55504.10
37	5/19/2009-6/29/2009	30	-0.078950926	-47.809218670	0.306146002	0.000061155	0.016467183	-0.000030733	0.015067542	29491.74
38	6/2/2009-7/13/2009	30	0.067762578	-48.265403594	0.294548969	0.000011976	0.015980064	-0.000000594	0.013858627	12760.96
39	6/16/2009-7/27/2009	30	0.087512827	-45.471587316	0.306573704	-0.000078152	0.016684837	0.000037083	0.014771018	13268.90
40	6/30/2009-8/10/2009	30	0.003776801	-49.246651920	0.296547804	0.000010432	0.014137517	0.000071046	0.014286083	25986.43
41	7/14/2009-8/24/2009	30	-0.060254164	-49.140041209	0.294269636	0.000043446	0.012679788	0.000089322	0.012745404	32374.44
42	7/28/2009-9/7/2009	30	0.009500352	-50.151872844	0.271259713	0.000080683	0.012160509	0.000100674	0.011934958	14935.53
43	8/11/2009-9/21/2009	30	-0.085258902	-45.575488469	0.268710597	0.000091235	0.012725405	0.000134713	0.012973233	8094.67
44	9/8/2009-10/6/2009	30	-0.021212162	-50.108231288	0.271963660	0.000082641	0.012214474	0.000185943	0.013386474	8084.92

Average Sum of Squared Errors   37,737.95

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 11 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Exxon Mobile Corp.</u>   NYSE: <u>XOM</u>   Industry: <u>Oil & Oil Service</u>

Model 1   Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.124589169	N/A	N/A	N/A	0.005500380	N/A	N/A	41852.53
2	1/15/2008-2/25/2008	30	-0.129146422	N/A	N/A	N/A	0.005983450	N/A	N/A	34995.58
3	1/29/2008-3/10/2008	30	-0.23651506	N/A	N/A	N/A	0.006299407	N/A	N/A	26457.63
4	2/12/2008-3/24/2008	30	-0.087324995	N/A	N/A	N/A	0.006743953	N/A	N/A	21376.02
5	2/26/2008-4/7/2008	30	-0.094760848	N/A	N/A	N/A	0.006576473	N/A	N/A	22073.04
6	3/11/2008-4/21/2008	30	-0.074010905	N/A	N/A	N/A	0.006180710	N/A	N/A	21870.52
7	3/25/2008-5/25/2008	30	-0.054450084	N/A	N/A	N/A	0.005329619	N/A	N/A	18753.76
8	4/8/2008-5/19/2008	30	-0.077887937	N/A	N/A	N/A	0.004832828	N/A	N/A	15069.85
9	4/22/2008-6/2/2008	30	-0.08880157	N/A	N/A	N/A	0.004580885	N/A	N/A	12073.46
10	5/6/2008-6/16/2008	30	-0.109711804	N/A	N/A	N/A	0.004688923	N/A	N/A	12337.31
11	5/20/2008-6/30/2008	30	-0.112891311	N/A	N/A	N/A	0.004801922	N/A	N/A	12506.00
12	6/3/2008-7/14/2008	30	-0.235719128	N/A	N/A	N/A	0.004893291	N/A	N/A	11879.60
13	6/17/2008-7/28/2008	30	-0.123461094	N/A	N/A	N/A	0.004914574	N/A	N/A	10898.87
14	7/1/2008-8/11/2008	30	-0.071607656	N/A	N/A	N/A	0.004930087	N/A	N/A	10083.78
15	7/15/2008-8/25/2008	30	-0.051382318	N/A	N/A	N/A	0.005121012	N/A	N/A	12182.53
16	7/29/2008-9/8/2008	30	-0.150889046	N/A	N/A	N/A	0.005501866	N/A	N/A	13841.94
17	8/12/2008-9/22/2008	30	-0.117248957	N/A	N/A	N/A	0.006079462	N/A	N/A	17664.85
18	8/26/2008-10/6/2008	30	-0.074523116	N/A	N/A	N/A	0.006543740	N/A	N/A	20804.19
19	9/9/2008-10/20/2008	30	-0.064221849	N/A	N/A	N/A	0.007481675	N/A	N/A	33476.05
20	9/23/2008-11/3/2008	30	-0.080590813	N/A	N/A	N/A	0.008771419	N/A	N/A	41952.08
21	10/7/2008-11/17/2008	30	-0.065577138	N/A	N/A	N/A	0.010269817	N/A	N/A	38115.49
22	10/21/2008-12/1/2008	30	-0.087033308	N/A	N/A	N/A	0.013126652	N/A	N/A	114424.79
23	11/4/2008-12/15/2008	30	-0.072574788	N/A	N/A	N/A	0.017365333	N/A	N/A	207491.08
24	11/18/2008-12/29/2008	30	-0.167680698	N/A	N/A	N/A	0.021184161	N/A	N/A	152238.64
25	12/2/2008-1/12/2009	30	-0.044578333	N/A	N/A	N/A	0.022024284	N/A	N/A	141320.58
26	12/16/2008-1/26/2009	30	-0.068950348	N/A	N/A	N/A	0.021728436	N/A	N/A	126714.22
27	12/30/2008-2/9/2009	30	-0.040550558	N/A	N/A	N/A	0.019140127	N/A	N/A	134725.97
28	1/13/2009-2/23/2009	30	-0.168721849	N/A	N/A	N/A	0.016980166	N/A	N/A	122991.10
29	1/27/2009-3/9/2009	30	-0.136151358	N/A	N/A	N/A	0.014876112	N/A	N/A	39660.77
30	2/10/2009-3/23/2009	30	-0.159650275	N/A	N/A	N/A	0.013807792	N/A	N/A	24439.82
31	2/24/2009-4/6/2009	30	-0.065822858	N/A	N/A	N/A	0.012915824	N/A	N/A	33409.37
32	3/10/2009-4/20/2009	30	-0.199148317	N/A	N/A	N/A	0.011554810	N/A	N/A	21863.57
33	3/24/2009-5/4/2009	30	-0.116917954	N/A	N/A	N/A	0.010604192	N/A	N/A	14406.45
34	4/7/2009-5/18/2009	30	-0.058252561	N/A	N/A	N/A	0.009798228	N/A	N/A	15162.14
35	4/21/2009-6/1/2009	30	-0.1027042	N/A	N/A	N/A	0.009135757	N/A	N/A	12840.39
36	5/5/2009-6/15/2009	30	-0.05352959	N/A	N/A	N/A	0.008583010	N/A	N/A	8939.08
37	5/19/2009-6/29/2009	30	-0.107891583	N/A	N/A	N/A	0.008596656	N/A	N/A	8857.66
38	6/2/2009-7/13/2009	30	-0.222016518	N/A	N/A	N/A	0.008677519	N/A	N/A	8949.94
39	6/16/2009-7/27/2009	30	-0.110334212	N/A	N/A	N/A	0.008664560	N/A	N/A	9302.06
40	6/30/2009-8/10/2009	30	-0.171324828	N/A	N/A	N/A	0.008116133	N/A	N/A	10845.45
41	7/14/2009-8/24/2009	30	-0.161755365	N/A	N/A	N/A	0.007521388	N/A	N/A	10065.08
42	7/28/2009-9/7/2009	30	-0.106228411	N/A	N/A	N/A	0.006976608	N/A	N/A	6224.37
43	8/11/2009-9/21/2009	30	-0.131441985	N/A	N/A	N/A	0.006723788	N/A	N/A	5752.88
44	9/8/2009-10/6/2009	30	-0.16647198	N/A	N/A	N/A	0.006468528	N/A	N/A	5517.50

Average Sum of Squared Errors   38,327.45

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Exxon Mobile Corp.   NYSE: XOM   Industry: Oil & Oil Service

Model 2   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.046495335	N/A	N/A	N/A	0.0002692741	0.000116040	N/A	3069.60
2	1/15/2008-2/25/2008	30	-0.064952538	N/A	N/A	N/A	0.0014231940	0.000143039	N/A	4521.16
3	1/29/2008-3/10/2008	30	-0.135670127	N/A	N/A	N/A	0.0024619428	0.000120360	N/A	4120.89
4	2/12/2008-3/24/2008	30	-0.167115334	N/A	N/A	N/A	0.0031913868	0.000111382	N/A	2890.85
5	2/26/2008-4/7/2008	30	-0.122406684	N/A	N/A	N/A	0.0030946715	0.000109043	N/A	3637.53
6	3/11/2008-4/21/2008	30	-0.157984906	N/A	N/A	N/A	0.0028529644	0.000104191	N/A	4998.30
7	3/25/2008-5/25/2008	30	-0.168921896	N/A	N/A	N/A	0.0023273399	0.000094073	N/A	4530.28
8	4/8/2008-5/19/2008	30	-0.089123546	N/A	N/A	N/A	0.0020229168	0.000088119	N/A	2611.78
9	4/22/2008-6/2/2008	30	-0.095249638	N/A	N/A	N/A	0.0018706988	0.000085089	N/A	880.54
10	5/6/2008-6/16/2008	30	-0.18617317	N/A	N/A	N/A	0.0019352250	0.000086573	N/A	804.50
11	5/20/2008-6/30/2008	30	-0.175827606	N/A	N/A	N/A	0.0020323414	0.000087212	N/A	864.41
12	6/3/2008-7/14/2008	30	-0.198370471	N/A	N/A	N/A	0.0022117650	0.000084438	N/A	967.36
13	6/17/2008-7/28/2008	30	-0.055488321	N/A	N/A	N/A	0.0023659789	0.000080233	N/A	1038.66
14	7/1/2008-8/11/2008	30	-0.151914217	N/A	N/A	N/A	0.0024888015	0.000076791	N/A	1028.66
15	7/15/2008-8/25/2008	30	-0.193297628	N/A	N/A	N/A	0.0025834422	0.000079809	N/A	2063.44
16	7/29/2008-9/8/2008	30	-0.21189966	N/A	N/A	N/A	0.0027754991	0.000085674	N/A	2545.58
17	8/12/2008-9/22/2008	30	-0.042548011	N/A	N/A	N/A	0.0030568132	0.000094910	N/A	3776.36
18	8/26/2008-10/6/2008	30	-0.088125784	N/A	N/A	N/A	0.0032691445	0.000102842	N/A	4524.90
19	9/9/2008-10/20/2008	30	-0.207153236	N/A	N/A	N/A	0.0038032790	0.000115714	N/A	13015.74
20	9/23/2008-11/3/2008	30	-0.117516351	N/A	N/A	N/A	0.0048099007	0.000124874	N/A	18357.46
21	10/7/2008-11/17/2008	30	-0.058984425	N/A	N/A	N/A	0.0059575264	0.000136112	N/A	11245.42
22	10/21/2008-12/1/2008	30	-0.214865329	N/A	N/A	N/A	0.0078552147	0.000166535	N/A	74443.75
23	11/4/2008-12/15/2008	30	-0.174465447	N/A	N/A	N/A	0.0103348318	0.000222359	N/A	136750.80
24	11/18/2008-12/29/2008	30	-0.214442623	N/A	N/A	N/A	0.0126776274	0.000269066	N/A	48954.13
25	12/2/2008-1/12/2009	30	-0.095918117	N/A	N/A	N/A	0.0132770334	0.000276363	N/A	31919.77
26	12/16/2008-1/26/2009	30	-0.136221459	N/A	N/A	N/A	0.0131808824	0.000269756	N/A	25734.34
27	12/30/2008-2/9/2009	30	-0.183173194	N/A	N/A	N/A	0.0118536218	0.000229646	N/A	58286.56
28	1/13/2009-2/23/2009	30	-0.096014574	N/A	N/A	N/A	0.0113017659	0.000178522	N/A	76241.48
29	1/27/2009-3/9/2009	30	-0.168268577	N/A	N/A	N/A	0.0108233568	0.000127257	N/A	14917.15
30	2/10/2009-3/23/2009	30	-0.090821995	N/A	N/A	N/A	0.0106104120	0.000100237	N/A	8957.66
31	2/24/2009-4/6/2009	30	-0.17015893	N/A	N/A	N/A	0.0098054137	0.000097431	N/A	18230.22
32	3/10/2009-4/20/2009	30	-0.172463077	N/A	N/A	N/A	0.0086672889	0.000090255	N/A	9165.07
33	3/24/2009-5/4/2009	30	-0.208760276	N/A	N/A	N/A	0.0079498751	0.000082941	N/A	3662.02
34	4/7/2009-5/18/2009	30	-0.219093582	N/A	N/A	N/A	0.0073475837	0.000076621	N/A	6007.77
35	4/21/2009-6/1/2009	30	-0.116356149	N/A	N/A	N/A	0.0068489725	0.000071609	N/A	4887.66
36	5/5/2009-6/15/2009	30	-0.158540242	N/A	N/A	N/A	0.0064362526	0.000067425	N/A	1959.29
37	5/19/2009-6/29/2009	30	-0.084144169	N/A	N/A	N/A	0.0064490490	0.000067641	N/A	1901.36
38	6/2/2009-7/13/2009	30	-0.139818647	N/A	N/A	N/A	0.0065108947	0.000068256	N/A	1871.10
39	6/16/2009-7/27/2009	30	-0.109684226	N/A	N/A	N/A	0.0065022189	0.000068044	N/A	2242.71
40	6/30/2009-8/10/2009	30	-0.229419011	N/A	N/A	N/A	0.0060859450	0.000063847	N/A	4612.55
41	7/14/2009-8/24/2009	30	-0.042029144	N/A	N/A	N/A	0.0056438357	0.000059030	N/A	4543.02
42	7/28/2009-9/7/2009	30	-0.197602208	N/A	N/A	N/A	0.0052389478	0.000054560	N/A	1638.91
43	8/11/2009-9/21/2009	30	-0.152236305	N/A	N/A	N/A	0.0050454884	0.000052612	N/A	1463.84
44	9/8/2009-10/6/2009	30	-0.138310693	N/A	N/A	N/A	0.0048525255	0.000050531	N/A	1531.54

Average Sum of Squared Errors   14,350.37

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **Exxon Mobile Corp.**   NYSE: **XOM**   Industry: **Oil & Oil Service**

Model 3   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.145859482	N/A	0.246915927	N/A	0.001752968	N/A	0.010928402	41852.53
2	1/15/2008-2/25/2008	30	-0.177150121	N/A	0.258491660	N/A	0.002069046	N/A	0.011656584	11350.34
3	1/29/2008-3/10/2008	30	-0.070753875	N/A	0.247415604	N/A	0.002104499	N/A	0.012863828	8371.21
4	2/12/2008-3/24/2008	30	-0.134464716	N/A	0.258750927	N/A	0.002178416	N/A	0.01351197	3451.63
5	2/26/2008-4/7/2008	30	-0.097234565	N/A	0.238569965	N/A	0.002166914	N/A	0.013769181	3346.16
6	3/11/2008-4/21/2008	30	-0.22571281	N/A	0.240935449	N/A	0.002116243	N/A	0.011816511	2977.42
7	3/25/2008-5/25/2008	30	-0.119525186	N/A	0.235139606	N/A	0.001717351	N/A	0.010142818	18753.76
8	4/8/2008-5/19/2008	30	-0.040786084	N/A	0.244648645	N/A	0.001623106	N/A	0.009245629	15069.85
9	4/22/2008-6/2/2008	30	-0.125616817	N/A	0.245506340	N/A	0.001460401	N/A	0.009086065	12073.46
10	5/6/2008-6/16/2008	30	-0.192387513	N/A	0.240398047	N/A	0.001496801	N/A	0.008979151	12337.31
11	5/20/2008-6/30/2008	30	-0.102706134	N/A	0.250217949	N/A	0.001643061	N/A	0.009541761	12506.00
12	6/3/2008-7/14/2008	30	-0.097110936	N/A	0.240040190	N/A	0.001607136	N/A	0.009662555	11879.60
13	6/17/2008-7/28/2008	30	-0.19143206	N/A	0.241605380	N/A	0.001581347	N/A	0.009640254	10898.87
14	7/1/2008-8/11/2008	30	-0.164326207	N/A	0.265704523	N/A	0.001658485	N/A	0.009389927	10083.78
15	7/15/2008-8/25/2008	30	-0.083980471	N/A	0.253880409	N/A	0.001730624	N/A	0.010628961	12182.53
16	7/29/2008-9/8/2008	30	-0.193787838	N/A	0.261747147	N/A	0.0017396	N/A	0.011222614	13841.94
17	8/12/2008-9/22/2008	30	-0.123532417	N/A	0.254315495	N/A	0.001951073	N/A	0.012369372	4339.57
18	8/26/2008-10/6/2008	30	-0.041610942	N/A	0.249270810	N/A	0.002223815	N/A	0.013338477	5511.00
19	9/9/2008-10/20/2008	30	-0.091754646	N/A	0.251053954	N/A	0.002381694	N/A	0.014441477	14338.62
20	9/23/2008-11/3/2008	30	-0.159880945	N/A	0.269367051	N/A	0.002989853	N/A	0.01824809	11609.87
21	10/7/2008-11/17/2008	30	-0.148674398	N/A	0.249294309	N/A	0.003388549	N/A	0.020164752	7591.78
22	10/21/2008-12/1/2008	30	-0.223583547	N/A	0.260477234	N/A	0.004562626	N/A	0.026077311	52789.26
23	11/4/2008-12/15/2008	30	-0.202337933	N/A	0.267952762	N/A	0.005873751	N/A	0.033246619	111742.27
24	11/18/2008-12/29/2008	30	-0.100002718	N/A	0.263814900	N/A	0.006806393	N/A	0.042205468	42711.10
25	12/2/2008-1/12/2009	30	-0.04949006	N/A	0.265194999	N/A	0.007325165	N/A	0.042037924	32447.49
26	12/16/2008-1/26/2009	30	-0.193033051	N/A	0.263545453	N/A	0.006972819	N/A	0.042863292	24226.31
27	12/30/2008-2/9/2009	30	-0.129860797	N/A	0.245429398	N/A	0.006454944	N/A	0.037932643	51642.91
28	1/13/2009-2/23/2009	30	-0.140084989	N/A	0.271831551	N/A	0.005683284	N/A	0.033413535	68837.87
29	1/27/2009-3/9/2009	30	-0.175563849	N/A	0.250550748	N/A	0.004943758	N/A	0.028527295	16946.56
30	2/10/2009-3/23/2009	30	-0.13771243	N/A	0.250856113	N/A	0.004512229	N/A	0.026285293	12450.00
31	2/24/2009-4/6/2009	30	-0.158535477	N/A	0.264917651	N/A	0.004148637	N/A	0.025461001	10110.81
32	3/10/2009-4/20/2009	30	-0.054579346	N/A	0.257444721	N/A	0.003837757	N/A	0.02389421	4134.44
33	3/24/2009-5/4/2009	30	-0.130320335	N/A	0.269261804	N/A	0.003529447	N/A	0.021507702	3275.49
34	4/7/2009-5/18/2009	30	-0.091125143	N/A	0.262134850	N/A	0.003105256	N/A	0.020560069	1266.72
35	4/21/2009-6/1/2009	30	-0.163809044	N/A	0.257833326	N/A	0.003156534	N/A	0.018012412	920.21
36	5/5/2009-6/15/2009	30	-0.145631452	N/A	0.252609139	N/A	0.002944846	N/A	0.017881322	1913.02
37	5/19/2009-6/29/2009	30	-0.154550557	N/A	0.262705095	N/A	0.002982765	N/A	0.018003645	2317.47
38	6/2/2009-7/13/2009	30	-0.118884158	N/A	0.272258793	N/A	0.00296436	N/A	0.017157082	1601.96
39	6/16/2009-7/27/2009	30	-0.169503152	N/A	0.273506533	N/A	0.002974219	N/A	0.017338026	2179.13
40	6/30/2009-8/10/2009	30	-0.050790065	N/A	0.251692336	N/A	0.002663453	N/A	0.015978177	2850.50
41	7/14/2009-8/24/2009	30	-0.182486742	N/A	0.254070489	N/A	0.002554042	N/A	0.014578182	1947.30
42	7/28/2009-9/7/2009	30	-0.208457512	N/A	0.248774752	N/A	0.002355134	N/A	0.013727081	6224.37
43	8/11/2009-9/21/2009	30	-0.213746513	N/A	0.261972914	N/A	0.002307788	N/A	0.013000636	5752.88
44	9/8/2009-10/6/2009	30	-0.085471624	N/A	0.258798573	N/A	0.002108132	N/A	0.012298616	5517.50

Average Sum of Squared Errors   16,094.84

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **Exxon Mobile Corp.**   NYSE: **XOM**   Industry: **Oil & Oil Service**

Model 4   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 - b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.227764249	N/A	0.240291871	-0.000011039	0.001924241	N/A	0.011463088	38878.35
2	1/15/2008-2/25/2008	30	-0.224519206	N/A	0.239400297	0.000095166	0.001946388	N/A	0.011555778	11011.95
3	1/29/2008-3/10/2008	30	-0.164217806	N/A	0.243099762	-0.000007085	0.002029445	N/A	0.012495034	7562.34
4	2/12/2008-3/24/2008	30	-0.193150448	N/A	0.253821584	-0.000079401	0.002317709	N/A	0.013684802	3391.01
5	2/26/2008-4/7/2008	30	-0.180831967	N/A	0.247843543	0.000043328	0.002249173	N/A	0.013130046	3137.70
6	3/11/2008-4/21/2008	30	-0.202675580	N/A	0.246682020	0.000096842	0.002005806	N/A	0.012134112	2791.55
7	3/25/2008-5/25/2008	30	-0.131880344	N/A	0.243106362	-0.000092532	0.001760905	N/A	0.010154762	17912.57
8	4/8/2008-5/19/2008	30	-0.047575891	N/A	0.255213192	0.000039219	0.001628671	N/A	0.009854439	14853.54
9	4/22/2008-6/2/2008	30	-0.178542054	N/A	0.258763301	0.000093575	0.001529873	N/A	0.009242310	10839.79
10	5/6/2008-6/16/2008	30	-0.219748420	N/A	0.237229498	0.000011616	0.001581111	N/A	0.009374765	11454.21
11	5/20/2008-6/30/2008	30	-0.165694532	N/A	0.236422578	0.000099730	0.001625508	N/A	0.009609614	11766.65
12	6/3/2008-7/14/2008	30	-0.127327283	N/A	0.244233406	0.000065839	0.001710452	N/A	0.009967205	10709.77
13	6/17/2008-7/28/2008	30	-0.186172482	N/A	0.246369926	0.000007159	0.001707261	N/A	0.009540079	10497.21
14	7/1/2008-8/11/2008	30	-0.051865075	N/A	0.258394314	0.000075572	0.001648667	N/A	0.009510337	9607.75
15	7/15/2008-8/25/2008	30	-0.162576073	N/A	0.243176087	0.000017076	0.001744169	N/A	0.009777268	11178.90
16	7/29/2008-9/8/2008	30	-0.165205605	N/A	0.246128982	0.000069028	0.001924353	N/A	0.011097241	13413.09
17	8/12/2008-9/22/2008	30	-0.067745282	N/A	0.248653570	0.000000892	0.002103539	N/A	0.012059859	4021.16
18	8/26/2008-10/6/2008	30	-0.158664609	N/A	0.265309719	0.000071284	0.002252520	N/A	0.013083714	4973.33
19	9/9/2008-10/20/2008	30	-0.081409712	N/A	0.268878802	-0.000066191	0.002546251	N/A	0.015052186	13818.79
20	9/23/2008-11/3/2008	30	-0.186850745	N/A	0.256510948	-0.000090199	0.002940690	N/A	0.016938838	10996.88
21	10/7/2008-11/17/2008	30	-0.176246936	N/A	0.269525245	-0.000047169	0.003295120	N/A	0.020938781	7395.23
22	10/21/2008-12/1/2008	30	-0.162820276	N/A	0.246250842	-0.000076065	0.004500460	N/A	0.026577794	47438.65
23	11/4/2008-12/15/2008	30	-0.138209748	N/A	0.257160897	-0.000017965	0.005515532	N/A	0.035016032	102134.58
24	11/18/2008-12/29/2008	30	-0.123691231	N/A	0.248826834	0.000012452	0.006993615	N/A	0.042830861	41418.20
25	12/2/2008-1/12/2009	30	-0.223626690	N/A	0.263361784	-0.000048084	0.007568171	N/A	0.046063190	31182.66
26	12/16/2008-1/26/2009	30	-0.123015787	N/A	0.264662964	0.000058691	0.007361708	N/A	0.041896899	23292.96
27	12/30/2008-2/9/2009	30	-0.056543167	N/A	0.248943732	-0.000024655	0.006104469	N/A	0.038340078	48422.41
28	1/13/2009-2/23/2009	30	-0.177712869	N/A	0.258141559	-0.000015273	0.005808145	N/A	0.033438852	63876.00
29	1/27/2009-3/9/2009	30	-0.228743514	N/A	0.269605616	0.000083073	0.005068888	N/A	0.028603867	15618.97
30	2/10/2009-3/23/2009	30	-0.091256822	N/A	0.269020002	-0.000059963	0.004661529	N/A	0.028445019	11126.75
31	2/24/2009-4/6/2009	30	-0.208644895	N/A	0.252072975	0.000009423	0.004095849	N/A	0.024801286	9150.59
32	3/10/2009-4/20/2009	30	-0.146490544	N/A	0.254266413	0.000058894	0.003803394	N/A	0.022947183	3693.82
33	3/24/2009-5/4/2009	30	-0.078899091	N/A	0.269236422	0.000059215	0.003436735	N/A	0.021934427	3190.79
34	4/7/2009-5/18/2009	30	-0.091547301	N/A	0.258930928	-0.000000033	0.003248572	N/A	0.019663622	1151.84
35	4/21/2009-6/1/2009	30	-0.168197228	N/A	0.268119754	0.000037549	0.003036551	N/A	0.018441017	829.81
36	5/5/2009-6/15/2009	30	-0.207393117	N/A	0.271186577	-0.000077792	0.002908815	N/A	0.017780405	1758.56
37	5/19/2009-6/29/2009	30	-0.125213148	N/A	0.261761242	-0.000039228	0.002836698	N/A	0.017278944	2126.82
38	6/2/2009-7/13/2009	30	-0.135956872	N/A	0.260558729	0.000012959	0.002783890	N/A	0.017562221	1570.08
39	6/16/2009-7/27/2009	30	-0.042109043	N/A	0.270285810	-0.000035899	0.002785780	N/A	0.017121632	1974.05
40	6/30/2009-8/10/2009	30	-0.077280001	N/A	0.251534985	0.000055158	0.002606398	N/A	0.016437668	2563.71
41	7/14/2009-8/24/2009	30	-0.082290501	N/A	0.265068958	-0.000072021	0.002404708	N/A	0.015216761	1860.11
42	7/28/2009-9/7/2009	30	-0.128023457	N/A	0.261680656	0.000073519	0.002296330	N/A	0.013634059	5710.30
43	8/11/2009-9/21/2009	30	-0.213819724	N/A	0.268758779	0.000031467	0.002169045	N/A	0.013235406	5676.40
44	9/8/2009-10/6/2009	30	-0.136766862	N/A	0.253644695	-0.000093889	0.002198870	N/A	0.012368159	5119.68

Average Sum of Squared Errors   15,024.99

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __Exxon Mobile Corp.__ NYSE: __XOM__ Industry: __Oil & Oil Service__

Model 5   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.004309733	-25.272927028	N/A	N/A	0.000272242	0.000115818	N/A	2187.28
2	1/15/2008-2/25/2008	30	0.044573831	-24.743675398	N/A	N/A	0.001485645	0.000140012	N/A	3081.80
3	1/29/2008-3/10/2008	30	0.006568648	-27.793602104	N/A	N/A	0.002501378	0.000115257	N/A	2871.84
4	2/12/2008-3/24/2008	30	-0.039420544	-27.845199817	N/A	N/A	0.003274253	0.000107068	N/A	1915.92
5	2/26/2008-4/7/2008	30	-0.068560749	-25.070816226	N/A	N/A	0.003034342	0.000103992	N/A	2520.16
6	3/11/2008-4/21/2008	30	0.053637307	-26.701281256	N/A	N/A	0.002911445	0.000107289	N/A	3507.80
7	3/25/2008-5/25/2008	30	-0.018795544	-25.751138678	N/A	N/A	0.002247931	0.000089912	N/A	3037.61
8	4/8/2008-5/19/2008	30	-0.014376081	-28.850856429	N/A	N/A	0.001925914	0.000083784	N/A	1705.60
9	4/22/2008-6/2/2008	30	0.027952000	-26.799438701	N/A	N/A	0.001785887	0.000081046	N/A	583.57
10	5/6/2008-6/16/2008	30	-0.075697259	-26.640591996	N/A	N/A	0.001905069	0.000084233	N/A	538.39
11	5/20/2008-6/30/2008	30	-0.081997153	-27.912936873	N/A	N/A	0.002104085	0.000086888	N/A	585.90
12	6/3/2008-7/14/2008	30	-0.044499340	-28.016641774	N/A	N/A	0.002276022	0.000083563	N/A	632.22
13	6/17/2008-7/28/2008	30	-0.084137728	-25.378613166	N/A	N/A	0.002277841	0.000077814	N/A	712.18
14	7/1/2008-8/11/2008	30	0.012395975	-28.817889385	N/A	N/A	0.002559599	0.000073302	N/A	726.24
15	7/15/2008-8/25/2008	30	-0.089036327	-24.368568314	N/A	N/A	0.002457255	0.000077794	N/A	1334.43
16	7/29/2008-9/8/2008	30	0.053853135	-26.336100299	N/A	N/A	0.002769157	0.000082477	N/A	1763.49
17	8/12/2008-9/22/2008	30	-0.008323151	-27.087447899	N/A	N/A	0.003124217	0.000095792	N/A	2545.64
18	8/26/2008-10/6/2008	30	-0.042333020	-25.626650381	N/A	N/A	0.003390028	0.000098607	N/A	3159.46
19	9/9/2008-10/20/2008	30	0.092672992	-28.287423838	N/A	N/A	0.003654262	0.000117141	N/A	9093.52
20	9/23/2008-11/3/2008	30	0.001436006	-24.769717171	N/A	N/A	0.004979289	0.000119108	N/A	12203.01
21	10/7/2008-11/17/2008	30	0.047559789	-26.254764070	N/A	N/A	0.005821526	0.000135217	N/A	7477.45
22	10/21/2008-12/1/2008	30	0.066751164	-25.816116137	N/A	N/A	0.008233924	0.000172092	N/A	51680.11
23	11/4/2008-12/15/2008	30	0.085293133	-28.360165166	N/A	N/A	0.010072681	0.000224771	N/A	90069.65
24	11/18/2008-12/29/2008	30	-0.091190052	-26.550293622	N/A	N/A	0.012868700	0.000255632	N/A	34566.27
25	12/2/2008-1/12/2009	30	-0.041683893	-26.456047493	N/A	N/A	0.013729602	0.000276722	N/A	22749.19
26	12/16/2008-1/26/2009	30	-0.079799225	-26.748298364	N/A	N/A	0.013015224	0.000276436	N/A	17641.31
27	12/30/2008-2/9/2009	30	0.058408162	-25.205575912	N/A	N/A	0.012428378	0.000232639	N/A	38716.80
28	1/13/2009-2/23/2009	30	-0.017871291	-28.140332906	N/A	N/A	0.011657111	0.000169827	N/A	53635.72
29	1/27/2009-3/9/2009	30	0.094525457	-29.035639513	N/A	N/A	0.010507749	0.000131699	N/A	10190.73
30	2/10/2009-3/23/2009	30	0.070567919	-25.162969537	N/A	N/A	0.010699633	0.000097631	N/A	6293.78
31	2/24/2009-4/6/2009	30	0.040432948	-25.469074975	N/A	N/A	0.010212494	0.000097088	N/A	12683.93
32	3/10/2009-4/20/2009	30	-0.074514661	-24.381795316	N/A	N/A	0.009075941	0.000086646	N/A	6154.67
33	3/24/2009-5/4/2009	30	0.067340259	-27.551876882	N/A	N/A	0.008177576	0.000086615	N/A	2549.87
34	4/7/2009-5/18/2009	30	-0.003292999	-24.244069874	N/A	N/A	0.007043042	0.000073678	N/A	4244.93
35	4/21/2009-6/1/2009	30	0.069022665	-27.598634868	N/A	N/A	0.006546162	0.000070828	N/A	3218.06
36	5/5/2009-6/15/2009	30	-0.079735389	-28.151236849	N/A	N/A	0.006364827	0.000064064	N/A	1342.89
37	5/19/2009-6/29/2009	30	-0.033268815	-28.135955990	N/A	N/A	0.006623616	0.000067331	N/A	1248.44
38	6/2/2009-7/13/2009	30	0.089437835	-27.155947533	N/A	N/A	0.006538711	0.000067183	N/A	1321.69
39	6/16/2009-7/27/2009	30	-0.063196150	-26.309171785	N/A	N/A	0.006440519	0.000065003	N/A	1464.42
40	6/30/2009-8/10/2009	30	-0.038390501	-26.031499173	N/A	N/A	0.006247708	0.000066454	N/A	3021.19
41	7/14/2009-8/24/2009	30	0.025136763	-29.246779089	N/A	N/A	0.005885272	0.000060914	N/A	3138.32
42	7/28/2009-9/7/2009	30	0.053809430	-27.378673451	N/A	N/A	0.005448750	0.000057124	N/A	1085.20
43	8/11/2009-9/21/2009	30	-0.066177808	-23.995038079	N/A	N/A	0.005270141	0.000053309	N/A	998.88
44	9/8/2009-10/6/2009	30	0.071467180	-26.043420008	N/A	N/A	0.004685992	0.000052039	N/A	1001.49

Average Sum of Squared Errors   9,800.02

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	Exxon Mobile Corp.	NYSE:	XOM	Industry:	Oil & Oil Service

Model 6 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.029453562	-29.108519948	0.256607995	N/A	0.001788697	N/A	0.010573704	31172.55
2	1/15/2008-2/25/2008	30	-0.031241255	-29.209506839	0.238614833	N/A	0.002087572	N/A	0.011810662	8305.02
3	1/29/2008-3/10/2008	30	0.030803617	-28.889429692	0.244850664	N/A	0.002126405	N/A	0.012093401	5958.79
4	2/12/2008-3/24/2008	30	0.050138317	-27.202035124	0.254074820	N/A	0.002264494	N/A	0.013149608	2409.30
5	2/26/2008-4/7/2008	30	-0.094591562	-28.205534213	0.249589540	N/A	0.002126207	N/A	0.012763681	2313.26
6	3/11/2008-4/21/2008	30	-0.048265258	-27.153922125	0.254717523	N/A	0.002078878	N/A	0.012950156	2018.39
7	3/25/2008-5/25/2008	30	-0.094570270	-24.198965893	0.244830460	N/A	0.001727079	N/A	0.010430300	13477.46
8	4/8/2008-5/19/2008	30	-0.091427026	-26.688040059	0.255332955	N/A	0.001616530	N/A	0.010051894	11181.18
9	4/22/2008-6/2/2008	30	-0.096979492	-24.997635812	0.235352398	N/A	0.001595039	N/A	0.008712085	8729.40
10	5/6/2008-6/16/2008	30	0.042133963	-24.960926190	0.248550108	N/A	0.001555685	N/A	0.009251911	8468.45
11	5/20/2008-6/30/2008	30	0.005086449	-25.301284546	0.236300313	N/A	0.001577111	N/A	0.009506126	8657.24
12	6/3/2008-7/14/2008	30	0.086303403	-25.793497270	0.240585174	N/A	0.001685163	N/A	0.010057773	8467.27
13	6/17/2008-7/28/2008	30	0.064354512	-27.861717970	0.253347955	N/A	0.001692843	N/A	0.009698871	7450.93
14	7/1/2008-8/11/2008	30	0.087908121	-24.090997480	0.265550557	N/A	0.001659493	N/A	0.009737733	7107.33
15	7/15/2008-8/25/2008	30	0.026042904	-23.970741401	0.263288097	N/A	0.001710458	N/A	0.010062943	8550.85
16	7/29/2008-9/8/2008	30	-0.025475115	-27.184255738	0.262282828	N/A	0.001765526	N/A	0.011537527	9365.60
17	8/12/2008-9/22/2008	30	-0.051137728	-26.199467945	0.259982222	N/A	0.002100665	N/A	0.011729937	2981.33
18	8/26/2008-10/6/2008	30	0.048403752	-24.475656987	0.259924926	N/A	0.002137750	N/A	0.013628429	3831.87
19	9/9/2008-10/20/2008	30	-0.030503856	-24.374754019	0.250093182	N/A	0.002470869	N/A	0.014342132	10007.90
20	9/23/2008-11/3/2008	30	-0.025391550	-25.929014748	0.266629126	N/A	0.003014548	N/A	0.017631273	8490.59
21	10/7/2008-11/17/2008	30	0.019509362	-28.668523660	0.248965142	N/A	0.003344086	N/A	0.021281196	5198.24
22	10/21/2008-12/1/2008	30	-0.001972578	-26.311355357	0.248232266	N/A	0.004428547	N/A	0.026634854	38147.22
23	11/4/2008-12/15/2008	30	-0.034152310	-25.421195717	0.245238002	N/A	0.005791560	N/A	0.036081565	76660.79
24	11/18/2008-12/29/2008	30	0.021978840	-28.826669776	0.243483763	N/A	0.007236892	N/A	0.041373197	30996.59
25	12/2/2008-1/12/2009	30	0.000390563	-24.013429527	0.266793744	N/A	0.007234151	N/A	0.044832524	24001.56
26	12/16/2008-1/26/2009	30	0.097808710	-25.355974828	0.261385488	N/A	0.007167971	N/A	0.043450115	16562.20
27	12/30/2008-2/9/2009	30	0.019644435	-25.867154895	0.243851276	N/A	0.006455359	N/A	0.039512238	35232.18
28	1/13/2009-2/23/2009	30	-0.089138360	-28.772755396	0.247507703	N/A	0.005674107	N/A	0.035388492	49154.47
29	1/27/2009-3/9/2009	30	-0.046919848	-27.809505016	0.250841939	N/A	0.005189688	N/A	0.029936780	12512.43
30	2/10/2009-3/23/2009	30	0.099926641	-26.382061420	0.272464651	N/A	0.004582204	N/A	0.028292252	8934.74
31	2/24/2009-4/6/2009	30	-0.024203667	-28.595722380	0.268917109	N/A	0.004223928	N/A	0.025797366	7482.37
32	3/10/2009-4/20/2009	30	-0.077720359	-25.583816054	0.254553148	N/A	0.003792172	N/A	0.024072642	2895.68
33	3/24/2009-5/4/2009	30	0.006483252	-28.014332246	0.260988171	N/A	0.003570196	N/A	0.021436285	2210.86
34	4/7/2009-5/18/2009	30	-0.046128222	-25.135626072	0.250079165	N/A	0.003111398	N/A	0.018985890	885.43
35	4/21/2009-6/1/2009	30	-0.095866533	-27.870754162	0.250731518	N/A	0.002924597	N/A	0.017364043	624.26
36	5/5/2009-6/15/2009	30	0.094548898	-27.606765548	0.268479484	N/A	0.002966183	N/A	0.016976326	1339.51
37	5/19/2009-6/29/2009	30	0.077264202	-28.095924233	0.259403662	N/A	0.002944826	N/A	0.016674552	1682.19
38	6/2/2009-7/13/2009	30	-0.067033875	-28.944419146	0.261291079	N/A	0.002848524	N/A	0.017060875	1081.63
39	6/16/2009-7/27/2009	30	-0.032608918	-25.829326120	0.252217635	N/A	0.002775588	N/A	0.016627690	1567.29
40	6/30/2009-8/10/2009	30	-0.045648216	-25.451703392	0.267692938	N/A	0.002725552	N/A	0.016518463	2028.83
41	7/14/2009-8/24/2009	30	-0.063710961	-24.582574510	0.254213075	N/A	0.002489050	N/A	0.014933955	1401.43
42	7/28/2009-9/7/2009	30	0.090782813	-28.820123215	0.259226591	N/A	0.002297771	N/A	0.013775222	4459.47
43	8/11/2009-9/21/2009	30	0.063828427	-26.825644273	0.253126950	N/A	0.002261457	N/A	0.013806775	4110.36
44	9/8/2009-10/6/2009	30	-0.030939125	-28.492726791	0.249679512	N/A	0.002144015	N/A	0.013155612	3991.99

Average Sum of Squared Errors 11,411.51

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Exxon Mobile Corp.</u> NYSE: <u>XOM</u> Industry: <u>Oil & Oil Service</u>

Model 7 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.070065656	-25.393666170	0.245032082	-0.000084977	0.252389226	N/A	0.000051203	27122.33
2	1/15/2008-2/25/2008	30	0.041763371	-27.304778003	0.249833533	0.000020924	0.252463653	N/A	0.000007871	7387.37
3	1/29/2008-3/10/2008	30	-0.063820259	-29.205542185	0.254746656	-0.000074066	0.238319089	N/A	0.000037836	5199.72
4	2/12/2008-3/24/2008	30	0.019028474	-26.753764387	0.240739809	0.000039852	0.240150321	N/A	-0.000005141	2117.69
5	2/26/2008-4/7/2008	30	-0.046613531	-28.164183531	0.239162206	0.000066573	0.238333201	N/A	-0.000019627	2099.77
6	3/11/2008-4/21/2008	30	0.025952215	-28.722957394	0.253315041	-0.000022934	0.246018315	N/A	-0.000050189	1822.57
7	3/25/2008-5/25/2008	30	0.086857035	-25.460159979	0.255519113	0.000009104	0.241330533	N/A	-0.000051438	12435.74
8	4/8/2008-5/19/2008	30	0.004539400	-28.473424295	0.240460056	-0.000040912	0.239872664	N/A	-0.000052809	10165.00
9	4/22/2008-6/2/2008	30	-0.059968366	-27.756011280	0.237808596	0.000066643	0.241230198	N/A	-0.000033859	7922.05
10	5/6/2008-6/16/2008	30	0.016388961	-24.843649611	0.238522105	0.000015073	0.242592737	N/A	-0.000087014	7748.60
11	5/20/2008-6/30/2008	30	0.046895001	-26.007767340	0.257719229	-0.000043665	0.249703244	N/A	0.000059000	7695.21
12	6/3/2008-7/14/2008	30	0.069291457	-24.105382552	0.248078115	0.000085027	0.258775842	N/A	-0.000083617	7802.75
13	6/17/2008-7/28/2008	30	-0.082751578	-26.063062194	0.239549039	0.000017849	0.246127953	N/A	0.000067686	6304.53
14	7/1/2008-8/11/2008	30	0.010820843	-27.553014619	0.248875408	-0.000064195	0.251550737	N/A	-0.000064429	6321.11
15	7/15/2008-8/25/2008	30	-0.070775333	-24.213355999	0.241681310	0.000087710	0.246915851	N/A	-0.000001396	7636.87
16	7/29/2008-9/8/2008	30	-0.086526772	-24.610687569	0.251780791	-0.000082483	0.261140095	N/A	0.000045024	8630.30
17	8/12/2008-9/22/2008	30	-0.057931377	-27.184536114	0.244973838	0.000045900	0.250379978	N/A	0.000004453	2574.91
18	8/26/2008-10/6/2008	30	0.099804683	-26.958034452	0.244307979	0.000063828	0.266300762	N/A	0.000071954	3474.51
19	9/9/2008-10/20/2008	30	-0.083723375	-26.983915351	0.262145276	0.000084680	0.263985439	N/A	0.000069990	9081.65
20	9/23/2008-11/3/2008	30	-0.058978644	-24.279277059	0.259752963	-0.000088224	0.249762933	N/A	0.000023041	7756.08
21	10/7/2008-11/17/2008	30	0.042353098	-24.450712073	0.269680450	-0.000010533	0.256371770	N/A	-0.000067368	4471.13
22	10/21/2008-12/1/2008	30	-0.047940222	-25.162805057	0.255333705	0.000052632	0.264639114	N/A	0.000027889	32944.73
23	11/4/2008-12/15/2008	30	0.007980586	-28.001239800	0.263466266	0.000085244	0.263632043	N/A	-0.000090379	69694.68
24	11/18/2008-12/29/2008	30	0.097036257	-27.899542265	0.266926551	-0.000047805	0.247744889	N/A	-0.000027108	27935.27
25	12/2/2008-1/12/2009	30	0.060670602	-28.993310045	0.247062718	0.000002333	0.254395521	N/A	-0.000017555	21497.25
26	12/16/2008-1/26/2009	30	0.002873241	-25.024182784	0.265955126	-0.000020036	0.252610520	N/A	-0.000012280	14592.27
27	12/30/2008-2/9/2009	30	-0.018489718	-29.092133527	0.254208348	0.000081225	0.251816511	N/A	-0.000086644	30038.21
28	1/13/2009-2/23/2009	30	-0.089120008	-25.586645276	0.268578981	0.000067013	0.257597147	N/A	0.000017080	42160.88
29	1/27/2009-3/9/2009	30	-0.058198050	-27.752762271	0.253819096	0.000060406	0.272945364	N/A	0.000046154	10741.27
30	2/10/2009-3/23/2009	30	-0.075672122	-25.815881387	0.266165882	0.000081448	0.262657833	N/A	0.000000318	7487.91
31	2/24/2009-4/6/2009	30	-0.055525956	-24.684546277	0.272516057	0.000050919	0.275038461	N/A	0.000065087	6407.07
32	3/10/2009-4/20/2009	30	-0.045681549	-28.249307362	0.265747689	-0.000094097	0.270343608	N/A	-0.000021881	2462.12
33	3/24/2009-5/4/2009	30	0.042011132	-25.511275639	0.269798255	0.000078422	0.268707950	N/A	0.000037407	2023.87
34	4/7/2009-5/18/2009	30	-0.018043421	-25.806910564	0.250068758	0.000096966	0.262914576	N/A	-0.000024798	748.53
35	4/21/2009-6/1/2009	30	-0.035960414	-27.477095962	0.270707101	0.000041472	0.256785327	N/A	0.000063770	559.09
36	5/5/2009-6/15/2009	30	0.043926405	-26.478446236	0.251170762	-0.000054910	0.270726677	N/A	-0.000021114	1183.38
37	5/19/2009-6/29/2009	30	-0.054923517	-28.052413590	0.252508618	0.000059980	0.266035805	N/A	-0.000019984	1417.99
38	6/2/2009-7/13/2009	30	0.027608399	-26.218555787	0.270063064	-0.000073248	0.265352564	N/A	-0.000066933	968.86
39	6/16/2009-7/27/2009	30	-0.009304144	-28.129764526	0.274304447	-0.000053352	0.268814578	N/A	-0.000066375	1311.16
40	6/30/2009-8/10/2009	30	0.083836548	-27.751384336	0.250006650	-0.000055601	0.252779045	N/A	0.000071328	1742.32
41	7/14/2009-8/24/2009	30	-0.070458615	-24.568442170	0.271493721	-0.000061565	0.272136128	N/A	-0.000067612	1195.28
42	7/28/2009-9/7/2009	30	0.004201122	-24.737045253	0.261810855	-0.000067832	0.265479251	N/A	0.000065176	3856.62
43	8/11/2009-9/21/2009	30	0.067751305	-26.487336292	0.257836296	-0.000000888	0.266250788	N/A	-0.000068584	3456.81
44	9/8/2009-10/6/2009	30	-0.027649419	-25.377900287	0.254575478	-0.000057960	0.252366770	N/A	0.000091774	3462.91

Average Sum of Squared Errors 10,083.14

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Exxon Mobile Corp. NYSE: XOM Industry: Oil & Oil Service

Model 8 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{2}{3}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.040203002	N/A	0.250344965	N/A	0.000257438	0.000071586	0.004443964	1602.16
2	1/15/2008-2/25/2008	30	-0.080989979	N/A	0.253991992	N/A	0.001449993	0.000081531	0.004744113	2398.07
3	1/29/2008-3/10/2008	30	-0.061989517	N/A	0.245302830	N/A	0.002468207	0.000070919	0.004811385	2124.80
4	2/12/2008-3/24/2008	30	-0.162969488	N/A	0.258173757	N/A	0.003149497	0.000064456	0.005544429	1436.83
5	2/26/2008-4/7/2008	30	-0.230078599	N/A	0.258748196	N/A	0.002988669	0.000067086	0.005475696	1982.36
6	3/11/2008-4/21/2008	30	-0.150254963	N/A	0.243327887	N/A	0.002818674	0.000060941	0.004858552	2623.87
7	3/25/2008-5/25/2008	30	-0.144209597	N/A	0.246748074	N/A	0.002410147	0.000057249	0.004460897	2459.20
8	4/8/2008-5/19/2008	30	-0.120424624	N/A	0.253417249	N/A	0.001938058	0.000053735	0.003904106	1339.71
9	4/22/2008-6/2/2008	30	-0.169278137	N/A	0.244118879	N/A	0.001926809	0.000052300	0.003560917	444.32
10	5/6/2008-6/16/2008	30	-0.197744713	N/A	0.257935782	N/A	0.001839998	0.000052805	0.003747159	426.48
11	5/20/2008-6/30/2008	30	-0.103913323	N/A	0.242618883	N/A	0.002063548	0.000050389	0.003851579	464.88
12	6/3/2008-7/14/2008	30	-0.082019895	N/A	0.262067855	N/A	0.002159235	0.000052823	0.003779198	485.91
13	6/17/2008-7/28/2008	30	-0.187999812	N/A	0.247230170	N/A	0.002311490	0.000046344	0.003882523	545.28
14	7/1/2008-8/11/2008	30	-0.148736521	N/A	0.246909854	N/A	0.002492029	0.000046054	0.003821952	539.62
15	7/15/2008-8/25/2008	30	-0.095158982	N/A	0.266013043	N/A	0.002510689	0.000049590	0.004016501	1071.97
16	7/29/2008-9/8/2008	30	-0.046517313	N/A	0.254100481	N/A	0.002654572	0.000053075	0.004603592	1275.43
17	8/12/2008-9/22/2008	30	-0.120424985	N/A	0.261196887	N/A	0.003129621	0.000055707	0.005069011	1941.34
18	8/26/2008-10/6/2008	30	-0.235977422	N/A	0.261353909	N/A	0.003126081	0.000064427	0.005366894	2418.68
19	9/9/2008-10/20/2008	30	-0.200840308	N/A	0.254716300	N/A	0.003658162	0.000066182	0.005761867	7049.83
20	9/23/2008-11/3/2008	30	-0.179403707	N/A	0.250788043	N/A	0.004944075	0.000073010	0.007020649	9602.69
21	10/7/2008-11/17/2008	30	-0.097497434	N/A	0.258140443	N/A	0.005757854	0.000081291	0.008614374	6005.43
22	10/21/2008-12/1/2008	30	-0.103490912	N/A	0.248957289	N/A	0.008036825	0.000097287	0.010163228	40157.41
23	11/4/2008-12/15/2008	30	-0.111838243	N/A	0.257367190	N/A	0.010023459	0.000132224	0.013580667	68807.29
24	11/18/2008-12/29/2008	30	-0.104627017	N/A	0.264000851	N/A	0.012095395	0.000163525	0.016873780	25780.90
25	12/2/2008-1/12/2009	30	-0.086836987	N/A	0.265876057	N/A	0.013895700	0.000172270	0.018159271	16815.17
26	12/16/2008-1/26/2009	30	-0.185212035	N/A	0.253173880	N/A	0.013588186	0.000154997	0.018213227	13130.36
27	12/30/2008-2/9/2009	30	-0.228722445	N/A	0.254532678	N/A	0.011970533	0.000142432	0.015773728	29933.33
28	1/13/2009-2/23/2009	30	-0.195382764	N/A	0.264895705	N/A	0.011446915	0.000103368	0.014258444	40587.52
29	1/27/2009-3/9/2009	30	-0.130702420	N/A	0.264793628	N/A	0.010578941	0.000074814	0.012335428	7767.64
30	2/10/2009-3/23/2009	30	-0.046176624	N/A	0.262490655	N/A	0.010410066	0.000057833	0.011555478	4543.34
31	2/24/2009-4/6/2009	30	-0.123236729	N/A	0.261117861	N/A	0.009692439	0.000057771	0.010255642	9283.77
32	3/10/2009-4/20/2009	30	-0.062729425	N/A	0.266560376	N/A	0.008718766	0.000053779	0.009082400	3965.31
33	3/24/2009-5/4/2009	30	-0.188058970	N/A	0.261998274	N/A	0.007785683	0.000052206	0.008565438	1946.37
34	4/7/2009-5/18/2009	30	-0.196699360	N/A	0.250550060	N/A	0.007042555	0.000047737	0.007580057	1195.95
35	4/21/2009-6/1/2009	30	-0.205231545	N/A	0.269613811	N/A	0.006636921	0.000042613	0.006953497	893.30
36	5/5/2009-6/15/2009	30	-0.053998780	N/A	0.262423245	N/A	0.006706421	0.000041199	0.007016990	978.20
37	5/19/2009-6/29/2009	30	-0.122511728	N/A	0.253398045	N/A	0.006160547	0.000039354	0.007179620	1027.57
38	6/2/2009-7/13/2009	30	-0.230288924	N/A	0.274126915	N/A	0.006775946	0.000042734	0.007058514	943.22
39	6/16/2009-7/27/2009	30	-0.190336244	N/A	0.258332383	N/A	0.006342105	0.000041275	0.007024756	1130.29
40	6/30/2009-8/10/2009	30	-0.044577808	N/A	0.271573214	N/A	0.005956172	0.000037245	0.006186205	2422.06
41	7/14/2009-8/24/2009	30	-0.234867167	N/A	0.266512558	N/A	0.005698178	0.000034607	0.005980844	1750.95
42	7/28/2009-9/7/2009	30	-0.196071763	N/A	0.266821758	N/A	0.005211435	0.000032850	0.005452676	877.14
43	8/11/2009-9/21/2009	30	-0.046806718	N/A	0.249320332	N/A	0.004799493	0.000031572	0.005490791	759.45
44	9/8/2009-10/6/2009	30	-0.226005730	N/A	0.269494296	N/A	0.005058410	0.000031286	0.005132640	783.99

Average Sum of Squared Errors 7,357.26

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __Exxon Mobile Corp.__ NYSE: __XOM__ Industry: __Oil & Oil Service__

Model9 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.196703554	N/A	0.256713913	0.000080342	0.000266524	0.000069127	0.004487402	1394.72
2	1/15/2008-2/25/2008	30	-0.190834894	N/A	0.257021006	-0.000054718	0.001407658	0.000084533	0.004971078	2149.46
3	1/29/2008-3/10/2008	30	-0.101869948	N/A	0.262486114	-0.000073561	0.002364452	0.000070583	0.004861723	1930.57
4	2/12/2008-3/24/2008	30	-0.061933621	N/A	0.257642866	-0.000073161	0.003331043	0.000069057	0.005191952	1336.82
5	2/26/2008-4/7/2008	30	-0.224727782	N/A	0.237349007	0.000069755	0.002965592	0.000067863	0.005404984	1819.34
6	3/11/2008-4/21/2008	30	-0.097872583	N/A	0.259678760	0.000028486	0.002828392	0.000062957	0.004865509	2304.73
7	3/25/2008-5/25/2008	30	-0.217555216	N/A	0.244517997	-0.000066958	0.002222869	0.000059108	0.004187325	2111.70
8	4/8/2008-5/19/2008	30	-0.096450830	N/A	0.251560389	0.000098170	0.001937686	0.000055160	0.003887078	1254.37
9	4/22/2008-6/2/2008	30	-0.198782889	N/A	0.254056947	0.000084349	0.001830664	0.000051818	0.003728163	383.50
10	5/6/2008-6/16/2008	30	-0.170153824	N/A	0.252323316	-0.000041484	0.001862668	0.000053655	0.003815635	385.58
11	5/20/2008-6/30/2008	30	-0.221075094	N/A	0.258403825	0.000042563	0.001992066	0.000053434	0.003677293	406.16
12	6/3/2008-7/14/2008	30	-0.171427390	N/A	0.257281566	0.000094125	0.002183999	0.000052006	0.004040784	425.68
13	6/17/2008-7/28/2008	30	-0.142550102	N/A	0.256528712	0.000038455	0.002476719	0.000048957	0.004106678	500.12
14	7/1/2008-8/11/2008	30	-0.178005742	N/A	0.251706316	-0.000095492	0.002483334	0.000046401	0.003951109	462.87
15	7/15/2008-8/25/2008	30	-0.148367571	N/A	0.256719575	0.000002165	0.002601272	0.000048350	0.004086393	942.14
16	7/29/2008-9/8/2008	30	-0.041706909	N/A	0.246502352	-0.000059634	0.002784011	0.000051951	0.004410539	1176.90
17	8/12/2008-9/22/2008	30	-0.095784810	N/A	0.252700795	0.000060945	0.003003498	0.000059232	0.004972811	1666.59
18	8/26/2008-10/6/2008	30	-0.234917202	N/A	0.259890903	-0.000064138	0.003310254	0.000059807	0.005422396	2150.78
19	9/9/2008-10/20/2008	30	-0.080392314	N/A	0.254157264	0.000012929	0.003777453	0.000066384	0.006033701	6151.78
20	9/23/2008-11/3/2008	30	-0.228132030	N/A	0.262457904	-0.000096213	0.004883637	0.000074066	0.006989085	8386.63
21	10/7/2008-11/17/2008	30	-0.053809731	N/A	0.269504070	-0.000066473	0.005817185	0.000082721	0.007838117	5289.89
22	10/21/2008-12/1/2008	30	-0.047529115	N/A	0.254239679	-0.000034378	0.008169304	0.000103137	0.010373372	37624.37
23	11/4/2008-12/15/2008	30	-0.198601335	N/A	0.257343469	-0.000001832	0.010000211	0.000128457	0.014334802	59108.50
24	11/18/2008-12/29/2008	30	-0.086456852	N/A	0.243560717	-0.000029269	0.012058846	0.000159044	0.016960570	23199.34
25	12/2/2008-1/12/2009	30	-0.081230511	N/A	0.252552293	0.000009469	0.013803826	0.000173111	0.017545615	15729.47
26	12/16/2008-1/26/2009	30	-0.191772990	N/A	0.265610874	-0.000014930	0.013250003	0.000156613	0.016364383	11989.26
27	12/30/2008-2/9/2009	30	-0.179963924	N/A	0.265010698	0.000046359	0.011791388	0.000141073	0.014884102	27017.85
28	1/13/2009-2/23/2009	30	-0.095197216	N/A	0.257374715	-0.000005345	0.010989681	0.000111678	0.013875984	34723.76
29	1/27/2009-3/9/2009	30	-0.096341249	N/A	0.257112737	0.000035723	0.011024718	0.000072554	0.012322597	6654.79
30	2/10/2009-3/23/2009	30	-0.207897591	N/A	0.263115553	0.000033396	0.011138574	0.000058810	0.011165939	4045.82
31	2/24/2009-4/6/2009	30	-0.185709130	N/A	0.270553602	0.000046501	0.009934878	0.000057183	0.010784542	8372.38
32	3/10/2009-4/20/2009	30	-0.082939403	N/A	0.253585866	0.000051075	0.008835453	0.000056410	0.008845242	3612.24
33	3/24/2009-5/4/2009	30	-0.190278096	N/A	0.253952744	0.000000783	0.008120832	0.000048448	0.008825672	1696.31
34	4/7/2009-5/18/2009	30	-0.129067584	N/A	0.250454186	0.000051596	0.007668979	0.000047325	0.007957397	1096.95
35	4/21/2009-6/1/2009	30	-0.056312289	N/A	0.258230102	-0.000005471	0.006823501	0.000042734	0.007595518	816.57
36	5/5/2009-6/15/2009	30	-0.199990502	N/A	0.271327335	-0.000002660	0.006756918	0.000039292	0.006650385	860.75
37	5/19/2009-6/29/2009	30	-0.065615009	N/A	0.265432699	-0.000073629	0.006394444	0.000038865	0.006988507	937.77
38	6/2/2009-7/13/2009	30	-0.130708494	N/A	0.254698108	-0.000033889	0.006475810	0.000040334	0.007261363	833.65
39	6/16/2009-7/27/2009	30	-0.186988919	N/A	0.256253415	0.000033316	0.006682600	0.000038853	0.007128412	1020.26
40	6/30/2009-8/10/2009	30	-0.232859223	N/A	0.255170910	-0.000088911	0.005926414	0.000039806	0.006554201	2078.07
41	7/14/2009-8/24/2009	30	-0.148782735	N/A	0.265187825	0.000029795	0.005560565	0.000036267	0.006162282	1685.86
42	7/28/2009-9/7/2009	30	-0.237850592	N/A	0.259084184	-0.000036545	0.005080048	0.000034112	0.005828261	803.84
43	8/11/2009-9/21/2009	30	-0.112857607	N/A	0.266450986	-0.000021799	0.005017095	0.000030774	0.005462490	665.72
44	9/8/2009-10/6/2009	30	-0.226887957	N/A	0.248271669	0.000025440	0.004786716	0.000031086	0.005432165	690.26

Average Sum of Squared Errors 6,543.05

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __Exxon Mobile Corp.__   NYSE: __XOM__   Industry: __Oil & Oil Service__

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{2}{3}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.095973326	-25.886790028	0.240368789	N/A	0.000281708	0.000067408	0.004507552	1253.17
2	1/15/2008-2/25/2008	30	0.024347454	-28.761126520	0.261745558	N/A	0.001489141	0.000087972	0.004819724	1869.57
3	1/29/2008-3/10/2008	30	-0.056704741	-27.072460521	0.241167145	N/A	0.002492464	0.000074728	0.005078039	1593.44
4	2/12/2008-3/24/2008	30	-0.000551190	-28.963337913	0.241844124	N/A	0.003076910	0.000069125	0.005484404	1128.89
5	2/26/2008-4/7/2008	30	0.085959516	-29.120015077	0.252819839	N/A	0.002947598	0.000066201	0.005136504	1478.37
6	3/11/2008-4/21/2008	30	0.015120229	-28.776796344	0.244679130	N/A	0.002874153	0.000064753	0.004934088	1950.68
7	3/25/2008-5/25/2008	30	0.023527261	-27.046898248	0.239497483	N/A	0.002224268	0.000055187	0.004179943	1958.52
8	4/8/2008-5/19/2008	30	-0.004361194	-24.948612902	0.240679631	N/A	0.002068083	0.000054539	0.003673424	1061.01
9	4/22/2008-6/2/2008	30	-0.042325502	-28.232253102	0.254831803	N/A	0.001878205	0.000052768	0.003701409	343.16
10	5/6/2008-6/16/2008	30	-0.083381196	-26.763148603	0.236764776	N/A	0.001976982	0.000050319	0.003785104	320.46
11	5/20/2008-6/30/2008	30	-0.082073452	-24.578341535	0.239857725	N/A	0.002015844	0.000052245	0.003710211	366.44
12	6/3/2008-7/14/2008	30	-0.003552119	-26.863774136	0.252895952	N/A	0.002271677	0.000049224	0.003924609	365.65
13	6/17/2008-7/28/2008	30	-0.016505374	-27.348733975	0.240872868	N/A	0.002394983	0.000049506	0.003849945	409.63
14	7/1/2008-8/11/2008	30	-0.018265342	-27.584234056	0.263566029	N/A	0.002485939	0.000045576	0.003906861	401.24
15	7/15/2008-8/25/2008	30	0.009319490	-27.165633197	0.241975208	N/A	0.002682827	0.000048440	0.004081089	833.70
16	7/29/2008-9/8/2008	30	0.018244332	-25.007389505	0.245070702	N/A	0.002772165	0.000051637	0.004294423	1017.49
17	8/12/2008-9/22/2008	30	0.087132641	-24.711849150	0.245754791	N/A	0.002957272	0.000058246	0.004937751	1423.47
18	8/26/2008-10/6/2008	30	-0.049733907	-24.117277278	0.246807609	N/A	0.003240906	0.000059952	0.005102156	1818.48
19	9/9/2008-10/20/2008	30	0.077824107	-27.978963742	0.247020002	N/A	0.003812503	0.000072818	0.005890397	5247.84
20	9/23/2008-11/3/2008	30	0.058532971	-24.377247075	0.253550367	N/A	0.004838038	0.000075285	0.007116730	7672.75
21	10/7/2008-11/17/2008	30	-0.051965673	-26.258004955	0.268033033	N/A	0.005859625	0.000078828	0.008075259	4656.99
22	10/21/2008-12/1/2008	30	0.076413107	-26.038505936	0.255587061	N/A	0.007463072	0.000099654	0.010591793	30719.38
23	11/4/2008-12/15/2008	30	0.078988589	-26.125404994	0.254283170	N/A	0.010781967	0.000134208	0.013781316	51610.95
24	11/18/2008-12/29/2008	30	-0.014274186	-28.286991780	0.250355699	N/A	0.013216515	0.000168686	0.016791318	20839.32
25	12/2/2008-1/12/2009	30	0.031661682	-24.645551933	0.249234607	N/A	0.013264762	0.000171774	0.018017131	12450.22
26	12/16/2008-1/26/2009	30	0.046795123	-24.917325567	0.244733772	N/A	0.013253996	0.000159637	0.018070663	10315.75
27	12/30/2008-2/9/2009	30	0.082966871	-29.110081107	0.250915130	N/A	0.011448731	0.000136565	0.014745024	22635.57
28	1/13/2009-2/23/2009	30	0.051812374	-27.093097148	0.269027755	N/A	0.011765878	0.000110202	0.013429362	30020.46
29	1/27/2009-3/9/2009	30	-0.010401195	-27.969087559	0.257974133	N/A	0.010395102	0.000074786	0.012405654	6257.30
30	2/10/2009-3/23/2009	30	-0.088725728	-28.319376326	0.272785366	N/A	0.010616850	0.000057770	0.011205762	3482.97
31	2/24/2009-4/6/2009	30	0.092481498	-25.648872552	0.256132957	N/A	0.009796896	0.000056418	0.010085460	7354.67
32	3/10/2009-4/20/2009	30	-0.067915870	-25.118044746	0.253126279	N/A	0.009056909	0.000053371	0.008918500	2857.11
33	3/24/2009-5/4/2009	30	-0.042987726	-26.454652960	0.253297241	N/A	0.008205000	0.000049899	0.008605406	1468.57
34	4/7/2009-5/18/2009	30	-0.052482842	-25.527381877	0.263003708	N/A	0.006997242	0.000045268	0.007689895	113.13
35	4/21/2009-6/1/2009	30	-0.062509875	-24.514181804	0.265433037	N/A	0.006533932	0.000042143	0.007302717	624.07
36	5/5/2009-6/15/2009	30	0.030392020	-27.087088272	0.272398329	N/A	0.006351549	0.000039141	0.007096979	735.12
37	5/19/2009-6/29/2009	30	0.028055778	-24.252001306	0.269160141	N/A	0.006297073	0.000039599	0.006826117	768.76
38	6/2/2009-7/13/2009	30	0.073130968	-25.287679594	0.251489249	N/A	0.006548675	0.000039706	0.006678110	706.80
39	6/16/2009-7/27/2009	30	0.058345528	-27.154892534	0.266586123	N/A	0.006573209	0.000039638	0.006764949	839.61
40	6/30/2009-8/10/2009	30	-0.018592986	-26.881473849	0.263896220	N/A	0.006182322	0.000037921	0.006178397	1926.22
41	7/14/2009-8/24/2009	30	0.042578969	-25.275058675	0.249350770	N/A	0.005467842	0.000034535	0.005868426	1292.43
42	7/28/2009-9/7/2009	30	-0.006389575	-26.753053062	0.253133117	N/A	0.005043123	0.000034275	0.005649390	679.54
43	8/11/2009-9/21/2009	30	-0.036511061	-24.365944906	0.261597716	N/A	0.004946432	0.000030315	0.005404447	598.91
44	9/8/2009-10/6/2009	30	-0.064910525	-27.505673204	0.257513032	N/A	0.004962260	0.000031818	0.004988437	612.51

Average Sum of Squared Errors   5,592.73

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **Exxon Mobile Corp.** NYSE: **XOM** Industry: **Oil & Oil Service**

Model11 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{\frac{b_0}{b_1 + b_1 t}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.093055035	-26.603097543	0.241207338	0.000076701	0.000261278	0.000072850	0.004389333	1143.24
2	1/15/2008-2/25/2008	30	-0.055501022	-24.536919828	0.242677651	-0.000016101	0.001437828	0.000083993	0.004911457	1722.04
3	1/29/2008-3/10/2008	30	0.096341975	-27.505374109	0.248800984	-0.000032337	0.002377649	0.000069592	0.004944284	1510.32
4	2/12/2008-3/24/2008	30	0.075487214	-25.605394364	0.253475961	0.000060512	0.003235931	0.000066090	0.005297001	1069.27
5	2/26/2008-4/7/2008	30	0.061390346	-26.515947407	0.258954293	-0.000087775	0.003028388	0.000063318	0.005110039	1398.54
6	3/11/2008-4/21/2008	30	-0.005307523	-25.535814250	0.241326530	-0.000022873	0.002920409	0.000064918	0.005088849	1726.16
7	3/25/2008-5/25/2008	30	0.058112500	-27.084771033	0.245186492	0.000015085	0.002282417	0.000054855	0.004080465	1823.64
8	4/8/2008-5/19/2008	30	-0.015727357	-27.967765469	0.245274965	0.000021256	0.002076123	0.000053028	0.004018177	1021.85
9	4/22/2008-6/2/2008	30	0.027162008	-24.212644559	0.247213039	0.000004219	0.001957321	0.000050839	0.003801616	320.60
10	5/6/2008-6/16/2008	30	-0.003765626	-27.910989543	0.244940476	-0.000004874	0.001375419	0.000049603	0.003620502	281.31
11	5/20/2008-6/30/2008	30	-0.038089671	-26.908294206	0.249796286	-0.000044443	0.002019448	0.000050183	0.003799144	337.79
12	6/3/2008-7/14/2008	30	-0.001682225	-26.311141183	0.240372710	0.000054833	0.002233472	0.000048867	0.003935817	341.48
13	6/17/2008-7/28/2008	30	0.077206634	-28.749303758	0.259067307	-0.000001359	0.002429824	0.000048307	0.003865149	384.83
14	7/1/2008-8/11/2008	30	-0.083269046	-27.028710333	0.244779392	-0.000050283	0.002526505	0.000047268	0.003945266	353.40
15	7/15/2008-8/25/2008	30	-0.022863624	-26.249338855	0.249692119	0.000075300	0.002579692	0.000046466	0.004074446	735.74
16	7/29/2008-9/8/2008	30	0.025129822	-27.931403602	0.265484523	0.000084353	0.002675060	0.000053966	0.004350838	942.14
17	8/12/2008-9/22/2008	30	0.038360572	-25.504290615	0.253746524	-0.000040766	0.003065932	0.000054751	0.004847748	1348.34
18	8/26/2008-10/6/2008	30	0.061570914	-28.129212074	0.258139316	-0.000074520	0.003151239	0.000063476	0.005013523	1711.48
19	9/9/2008-10/20/2008	30	-0.033407244	-24.571612528	0.268861282	-0.000066418	0.003943285	0.000068926	0.005780241	4946.54
20	9/23/2008-11/3/2008	30	-0.078655527	-25.627462515	0.252270245	-0.000011719	0.004912302	0.000077855	0.006808734	6809.84
21	10/7/2008-11/17/2008	30	0.023256834	-27.040388067	0.257458055	0.000046803	0.005829780	0.000082377	0.007977482	4457.66
22	10/21/2008-12/1/2008	30	-0.036837323	-27.926278135	0.261001275	-0.000047211	0.007430245	0.000102205	0.010360808	29392.30
23	11/4/2008-12/15/2008	30	0.092320071	-25.138151074	0.267602291	0.000075046	0.010040615	0.000128371	0.014528611	48033.54
24	11/18/2008-12/29/2008	30	-0.085428136	-27.081023923	0.242862903	-0.000097332	0.012977157	0.000159332	0.016472928	20076.19
25	12/2/2008-1/12/2009	30	-0.098259115	-27.670724402	0.264562944	0.000028665	0.013639404	0.000173016	0.017004697	11946.32
26	12/16/2008-1/26/2009	30	0.012694711	-27.730299422	0.245699727	0.000001594	0.013055763	0.000164920	0.017528892	9962.53
27	12/30/2008-2/9/2009	30	-0.009442304	-26.474733558	0.250813024	-0.000096148	0.011967792	0.000137946	0.015386199	19934.93
28	1/13/2009-2/23/2009	30	-0.018937984	-26.661515136	0.261268927	0.000056292	0.011555351	0.000108382	0.013234913	26742.50
29	1/27/2009-3/9/2009	30	-0.002057486	-26.986857646	0.253829348	-0.000071310	0.010571288	0.000079669	0.012195559	5685.70
30	2/10/2009-3/23/2009	30	-0.090817006	-27.928730433	0.271628311	0.000000544	0.010600933	0.000061534	0.010723338	3214.62
31	2/24/2009-4/6/2009	30	-0.056418588	-26.647049423	0.260258328	-0.000011910	0.010003282	0.000057965	0.009819179	6104.16
32	3/10/2009-4/20/2009	30	-0.095610948	-26.641695077	0.268356271	-0.000099919	0.008945581	0.000051973	0.009031232	2192.44
33	3/24/2009-5/4/2009	30	-0.031082744	-28.159417778	0.264748577	-0.000019002	0.007713644	0.000049683	0.008554593	1373.82
34	4/7/2009-5/18/2009	30	0.095629814	-26.045152758	0.249379911	-0.000098764	0.007658314	0.000046126	0.008143836	110.54
35	4/21/2009-6/1/2009	30	0.070001450	-25.697894628	0.265352487	0.000071817	0.006697743	0.000041010	0.007512135	530.98
36	5/5/2009-6/15/2009	30	-0.070655844	-26.584582202	0.265352430	0.000071795	0.006590637	0.000041448	0.006532695	685.59
37	5/19/2009-6/29/2009	30	-0.049033607	-24.744402478	0.250948150	-0.000049174	0.006480167	0.000039516	0.006621517	718.82
38	6/2/2009-7/13/2009	30	0.060642364	-27.705851900	0.272305775	-0.000026779	0.006491504	0.000042343	0.006880903	638.86
39	6/16/2009-7/27/2009	30	-0.021158465	-26.753047933	0.250786653	-0.000094787	0.006386093	0.000040224	0.007122449	741.25
40	6/30/2009-8/10/2009	30	0.098525618	-28.504474507	0.255988633	0.000099623	0.005925698	0.000038471	0.006240279	1738.99
41	7/14/2009-8/24/2009	30	-0.008198396	-27.631052984	0.254805987	0.000051680	0.005499151	0.000033791	0.005943837	1178.43
42	7/28/2009-9/7/2009	30	-0.036333843	-25.848731817	0.253349941	-0.000046277	0.005439279	0.000032429	0.005529164	638.22
43	8/11/2009-9/21/2009	30	-0.045868756	-27.472732935	0.254824649	0.000003113	0.004921518	0.000033127	0.005467483	535.65
44	9/8/2009-10/6/2009	30	-0.031384919	-27.404078286	0.254962343	0.000032100	0.004654377	0.000030385	0.005308633	547.45

Average Sum of Squared Errors 5,161.59

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __IBM__   NYSE: __IBM__   Industry: __Technology__

Model 1   Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.513679074	N/A	N/A	N/A	0.005199646	N/A	N/A	43933.03
2	1/15/2008-2/25/2008	30	-0.44667523	N/A	N/A	N/A	0.006710861	N/A	N/A	91334.80
3	1/29/2008-3/10/2008	30	-0.453904509	N/A	N/A	N/A	0.008598619	N/A	N/A	125327.06
4	2/12/2008-3/24/2008	30	-0.530692916	N/A	N/A	N/A	0.010029224	N/A	N/A	95177.32
5	2/26/2008-4/7/2008	30	-0.632169197	N/A	N/A	N/A	0.009199593	N/A	N/A	116062.10
6	3/11/2008-4/21/2008	30	-0.510698636	N/A	N/A	N/A	0.007434174	N/A	N/A	101477.79
7	3/25/2008-5/25/2008	30	-0.557475746	N/A	N/A	N/A	0.005611623	N/A	N/A	45379.76
8	4/8/2008-5/19/2008	30	-0.606503319	N/A	N/A	N/A	0.005052752	N/A	N/A	27009.15
9	4/22/2008-6/2/2008	30	-0.516521692	N/A	N/A	N/A	0.005203629	N/A	N/A	31506.57
10	5/6/2008-6/16/2008	30	-0.515697147	N/A	N/A	N/A	0.005984636	N/A	N/A	38018.41
11	5/20/2008-6/30/2008	30	-0.608152937	N/A	N/A	N/A	0.006838936	N/A	N/A	44507.45
12	6/3/2008-7/14/2008	30	-0.56412948	N/A	N/A	N/A	0.007645443	N/A	N/A	45813.16
13	6/17/2008-7/28/2008	30	-0.48089329	N/A	N/A	N/A	0.007405639	N/A	N/A	47656.36
14	7/1/2008-8/11/2008	30	-0.622418727	N/A	N/A	N/A	0.006628609	N/A	N/A	47203.55
15	7/15/2008-8/25/2008	30	-0.456964264	N/A	N/A	N/A	0.005793197	N/A	N/A	20751.64
16	7/29/2008-9/8/2008	30	-0.45283606	N/A	N/A	N/A	0.005720512	N/A	N/A	18187.03
17	8/12/2008-9/22/2008	30	-0.61807651	N/A	N/A	N/A	0.006191233	N/A	N/A	26510.36
18	8/26/2008-10/6/2008	30	-0.497944468	N/A	N/A	N/A	0.006873297	N/A	N/A	46289.02
19	9/9/2008-10/20/2008	30	-0.576886122	N/A	N/A	N/A	0.008438247	N/A	N/A	89550.95
20	9/23/2008-11/3/2008	30	-0.583230203	N/A	N/A	N/A	0.009781434	N/A	N/A	85297.37
21	10/7/2008-11/17/2008	30	-0.589510286	N/A	N/A	N/A	0.011159972	N/A	N/A	50418.86
22	10/21/2008-12/1/2008	30	-0.601442146	N/A	N/A	N/A	0.014061160	N/A	N/A	225147.87
23	11/4/2008-12/15/2008	30	-0.506250646	N/A	N/A	N/A	0.014911908	N/A	N/A	198973.24
24	11/18/2008-12/29/2008	30	-0.513182546	N/A	N/A	N/A	0.018602517	N/A	N/A	107282.81
25	12/2/2008-1/12/2009	30	-0.609526605	N/A	N/A	N/A	0.016171015	N/A	N/A	172167.53
26	12/16/2008-1/26/2009	30	-0.588000275	N/A	N/A	N/A	0.013979419	N/A	N/A	41692.47
27	12/30/2008-2/9/2009	30	-0.504105607	N/A	N/A	N/A	0.013153312	N/A	N/A	31316.41
28	1/13/2009-2/23/2009	30	-0.459328511	N/A	N/A	N/A	0.013124560	N/A	N/A	24520.98
29	1/27/2009-3/9/2009	30	-0.446563292	N/A	N/A	N/A	0.012726880	N/A	N/A	12629.07
30	2/10/2009-3/23/2009	30	-0.609056504	N/A	N/A	N/A	0.012903594	N/A	N/A	12753.94
31	2/24/2009-4/6/2009	30	-0.457048447	N/A	N/A	N/A	0.012694346	N/A	N/A	17129.76
32	3/10/2009-4/20/2009	30	-0.526134572	N/A	N/A	N/A	0.011706244	N/A	N/A	26129.79
33	3/24/2009-5/4/2009	30	-0.488639535	N/A	N/A	N/A	0.010196486	N/A	N/A	25326.24
34	4/7/2009-5/18/2009	30	-0.605370123	N/A	N/A	N/A	0.009178501	N/A	N/A	13742.92
35	4/21/2009-6/1/2009	30	-0.568821292	N/A	N/A	N/A	0.008688212	N/A	N/A	7017.59
36	5/5/2009-6/15/2009	30	-0.608489875	N/A	N/A	N/A	0.008680592	N/A	N/A	9172.56
37	5/19/2009-6/29/2009	30	-0.508851043	N/A	N/A	N/A	0.009071896	N/A	N/A	15734.19
38	6/2/2009-7/13/2009	30	-0.566632722	N/A	N/A	N/A	0.009193852	N/A	N/A	17479.49
39	6/16/2009-7/27/2009	30	-0.552111706	N/A	N/A	N/A	0.008591974	N/A	N/A	36894.90
40	6/30/2009-8/10/2009	30	-0.449625693	N/A	N/A	N/A	0.006769512	N/A	N/A	54652.31
41	7/14/2009-8/24/2009	30	-0.480964902	N/A	N/A	N/A	0.005576177	N/A	N/A	25870.49
42	7/28/2009-9/7/2009	30	-0.509525527	N/A	N/A	N/A	0.004832650	N/A	N/A	9123.46
43	8/11/2009-9/21/2009	30	-0.565266521	N/A	N/A	N/A	0.004626412	N/A	N/A	15185.14
44	9/8/2009-10/6/2009	30	-0.491174486	N/A	N/A	N/A	0.004294306	N/A	N/A	21472.91

Average Sum of Squared Errors   53,609.72

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __IBM__ NYSE: __IBM__ Industry: __Technology__

Model 2 Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.554262441	N/A	N/A	N/A	0.0019070279	0.000103141	N/A	13317.43
2	1/15/2008-2/25/2008	30	-0.589019148	N/A	N/A	N/A	0.0028706353	0.000120522	N/A	49908.71
3	1/29/2008-3/10/2008	30	-0.450692984	N/A	N/A	N/A	0.0041694380	0.000139362	N/A	68632.74
4	2/12/2008-3/24/2008	30	-0.45731376	N/A	N/A	N/A	0.0052187098	0.000151540	N/A	30844.93
5	2/26/2008-4/7/2008	30	-0.602846448	N/A	N/A	N/A	0.0049780443	0.000132694	N/A	64481.52
6	3/11/2008-4/21/2008	30	-0.573176258	N/A	N/A	N/A	0.0039919403	0.000107943	N/A	66946.99
7	3/25/2008-5/25/2008	30	-0.576462649	N/A	N/A	N/A	0.0029373626	0.000083811	N/A	23720.40
8	4/8/2008-5/19/2008	30	-0.505974602	N/A	N/A	N/A	0.0025503368	0.000078485	N/A	8037.89
9	4/22/2008-6/2/2008	30	-0.4701006	N/A	N/A	N/A	0.0024666723	0.000086000	N/A	9621.50
10	5/6/2008-6/16/2008	30	-0.60325082	N/A	N/A	N/A	0.0028751583	0.000097936	N/A	9896.57
11	5/20/2008-6/30/2008	30	-0.539600651	N/A	N/A	N/A	0.0035775218	0.000102988	N/A	13709.39
12	6/3/2008-7/14/2008	30	-0.634846356	N/A	N/A	N/A	0.0045180164	0.000098838	N/A	17550.09
13	6/17/2008-7/28/2008	30	-0.562414584	N/A	N/A	N/A	0.0046713196	0.000086351	N/A	26014.63
14	7/1/2008-8/11/2008	30	-0.500988235	N/A	N/A	N/A	0.0042213916	0.000075873	N/A	30367.23
15	7/15/2008-8/25/2008	30	-0.499204488	N/A	N/A	N/A	0.0036064830	0.000068811	N/A	6335.45
16	7/29/2008-9/8/2008	30	-0.578868309	N/A	N/A	N/A	0.0035014652	0.000069731	N/A	3806.38
17	8/12/2008-9/22/2008	30	-0.449937177	N/A	N/A	N/A	0.0037179449	0.000077646	N/A	8639.38
18	8/26/2008-10/6/2008	30	-0.606562218	N/A	N/A	N/A	0.0040357232	0.000089132	N/A	22819.87
19	9/9/2008-10/20/2008	30	-0.513662593	N/A	N/A	N/A	0.0049670618	0.000109308	N/A	54664.38
20	9/23/2008-11/3/2008	30	-0.607358077	N/A	N/A	N/A	0.0061555052	0.000114414	N/A	47447.58
21	10/7/2008-11/17/2008	30	-0.55823527	N/A	N/A	N/A	0.0083673140	0.000088162	N/A	28769.53
22	10/21/2008-12/1/2008	30	-0.636543684	N/A	N/A	N/A	0.0122138324	0.000058300	N/A	215669.84
23	11/4/2008-12/15/2008	30	-0.498995005	N/A	N/A	N/A	0.0165345186	0.000035082	N/A	195525.08
24	11/18/2008-12/29/2008	30	-0.612847001	N/A	N/A	N/A	0.0175405393	0.000033329	N/A	104118.82
25	12/2/2008-1/12/2009	30	-0.458032356	N/A	N/A	N/A	0.0149873707	0.000036959	N/A	168198.01
26	12/16/2008-1/26/2009	30	-0.632724248	N/A	N/A	N/A	0.0125355252	0.000044952	N/A	35961.09
27	12/30/2008-2/9/2009	30	-0.503982327	N/A	N/A	N/A	0.0114365308	0.000053538	N/A	22940.10
28	1/13/2009-2/23/2009	30	-0.528870695	N/A	N/A	N/A	0.0115405643	0.000049447	N/A	17405.71
29	1/27/2009-3/9/2009	30	-0.623202665	N/A	N/A	N/A	0.0113774543	0.000042196	N/A	7295.03
30	2/10/2009-3/23/2009	30	-0.597435054	N/A	N/A	N/A	0.0116877189	0.000038031	N/A	8426.64
31	2/24/2009-4/6/2009	30	-0.557370095	N/A	N/A	N/A	0.0114407072	0.000039215	N/A	12372.02
32	3/10/2009-4/20/2009	30	-0.580843921	N/A	N/A	N/A	0.0105186065	0.000037090	N/A	21988.42
33	3/24/2009-5/4/2009	30	-0.549743127	N/A	N/A	N/A	0.0091511806	0.000032616	N/A	22109.84
34	4/7/2009-5/18/2009	30	-0.528490759	N/A	N/A	N/A	0.0081714910	0.000031434	N/A	10758.94
35	4/21/2009-6/1/2009	30	-0.439975787	N/A	N/A	N/A	0.0076817232	0.000031476	N/A	4046.52
36	5/5/2009-6/15/2009	30	-0.591392886	N/A	N/A	N/A	0.0074345210	0.000039120	N/A	4647.22
37	5/19/2009-6/29/2009	30	-0.468908733	N/A	N/A	N/A	0.0075174656	0.000048968	N/A	8732.61
38	6/2/2009-7/13/2009	30	-0.484407553	N/A	N/A	N/A	0.0073533486	0.000058006	N/A	7672.18
39	6/16/2009-7/27/2009	30	-0.537438694	N/A	N/A	N/A	0.0067961352	0.000056497	N/A	27530.41
40	6/30/2009-8/10/2009	30	-0.571730426	N/A	N/A	N/A	0.0053127697	0.000045725	N/A	48458.47
41	7/14/2009-8/24/2009	30	-0.480704271	N/A	N/A	N/A	0.0043997890	0.000036886	N/A	21678.52
42	7/28/2009-9/7/2009	30	-0.537285901	N/A	N/A	N/A	0.0036553512	0.000036861	N/A	5052.13
43	8/11/2009-9/21/2009	30	-0.580334542	N/A	N/A	N/A	0.0029914442	0.000051126	N/A	7321.08
44	9/8/2009-10/6/2009	30	-0.623067568	N/A	N/A	N/A	0.0019682444	0.000072667	N/A	5538.72

Average Sum of Squared Errors 36,113.18

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

| Reference Entity: | IBM | NYSE: | IBM | Industry: | Technology |

Model 3 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.598405492	N/A	0.239022824	N/A	0.00170192	N/A	0.01015819	43933.03
2	1/15/2008-2/25/2008	30	-0.476525298	N/A	0.230905883	N/A	0.002348362	N/A	0.013523561	91334.80
3	1/29/2008-3/10/2008	30	-0.598354784	N/A	0.229469224	N/A	0.002766473	N/A	0.016432665	125327.06
4	2/12/2008-3/24/2008	30	-0.455020759	N/A	0.230433184	N/A	0.003422319	N/A	0.020537851	95177.32
5	2/26/2008-4/7/2008	30	-0.623519593	N/A	0.243710895	N/A	0.003168375	N/A	0.018462252	116062.10
6	3/11/2008-4/21/2008	30	-0.573091379	N/A	0.243704429	N/A	0.002440162	N/A	0.014857294	14144.80
7	3/25/2008-5/25/2008	30	-0.573367542	N/A	0.235997552	N/A	0.001816947	N/A	0.011108422	17755.44
8	4/8/2008-5/19/2008	30	-0.529124749	N/A	0.218826388	N/A	0.001611107	N/A	0.010203181	27009.15
9	4/22/2008-6/2/2008	30	-0.557659516	N/A	0.236051150	N/A	0.001801865	N/A	0.010470438	31506.57
10	5/6/2008-6/16/2008	30	-0.481263645	N/A	0.238320562	N/A	0.002062582	N/A	0.011565703	38018.41
11	5/20/2008-6/30/2008	30	-0.499055792	N/A	0.240640805	N/A	0.002392385	N/A	0.01317787	44507.45
12	6/3/2008-7/14/2008	30	-0.537523495	N/A	0.241189460	N/A	0.002532619	N/A	0.014687088	45813.16
13	6/17/2008-7/28/2008	30	-0.44877251	N/A	0.222397299	N/A	0.002417208	N/A	0.014134803	47656.36
14	7/1/2008-8/11/2008	30	-0.574814219	N/A	0.224791628	N/A	0.002199052	N/A	0.013264916	47203.55
15	7/15/2008-8/25/2008	30	-0.481975868	N/A	0.219191588	N/A	0.001930687	N/A	0.011608026	20751.64
16	7/29/2008-9/8/2008	30	-0.524042223	N/A	0.222280589	N/A	0.001936616	N/A	0.011546847	18187.03
17	8/12/2008-9/22/2008	30	-0.579292203	N/A	0.238742789	N/A	0.002007865	N/A	0.012794765	26510.36
18	8/26/2008-10/6/2008	30	-0.583063953	N/A	0.240403134	N/A	0.002372783	N/A	0.014052468	46289.02
19	9/9/2008-10/20/2008	30	-0.545584458	N/A	0.240828238	N/A	0.002724153	N/A	0.017304031	23827.43
20	9/23/2008-11/3/2008	30	-0.484165748	N/A	0.244368359	N/A	0.003120759	N/A	0.018690232	38038.76
21	10/7/2008-11/17/2008	30	-0.450015286	N/A	0.261888327	N/A	0.003699921	N/A	0.022715093	50418.86
22	10/21/2008-12/1/2008	30	-0.613160601	N/A	0.251437252	N/A	0.004497361	N/A	0.028574589	108640.71
23	11/4/2008-12/15/2008	30	-0.449771419	N/A	0.259175681	N/A	0.004852225	N/A	0.029245884	134124.39
24	11/18/2008-12/29/2008	30	-0.474547219	N/A	0.239990053	N/A	0.00641228	N/A	0.037201811	107282.81
25	12/2/2008-1/12/2009	30	-0.575302499	N/A	0.240138808	N/A	0.005499965	N/A	0.033447622	172167.53
26	12/16/2008-1/26/2009	30	-0.538216327	N/A	0.253619844	N/A	0.004629213	N/A	0.027110225	35167.11
27	12/30/2008-2/9/2009	30	-0.552005162	N/A	0.241310150	N/A	0.004228488	N/A	0.025960328	22622.68
28	1/13/2009-2/23/2009	30	-0.44758463	N/A	0.243274358	N/A	0.004345766	N/A	0.025322526	14386.68
29	1/27/2009-3/9/2009	30	-0.560355055	N/A	0.251329640	N/A	0.004270005	N/A	0.026710033	6752.04
30	2/10/2009-3/23/2009	30	-0.569220541	N/A	0.242866428	N/A	0.004293805	N/A	0.025364759	8327.25
31	2/24/2009-4/6/2009	30	-0.500239253	N/A	0.248931386	N/A	0.004059032	N/A	0.025196102	7767.88
32	3/10/2009-4/20/2009	30	-0.572143604	N/A	0.244365066	N/A	0.003861675	N/A	0.02320517	12037.38
33	3/24/2009-5/4/2009	30	-0.493886469	N/A	0.232710767	N/A	0.003487812	N/A	0.020767632	12759.43
34	4/7/2009-5/18/2009	30	-0.513490087	N/A	0.235332744	N/A	0.003136279	N/A	0.018022504	7140.58
35	4/21/2009-6/1/2009	30	-0.622415249	N/A	0.248289939	N/A	0.002962314	N/A	0.017270797	4980.24
36	5/5/2009-6/15/2009	30	-0.5715421	N/A	0.227625549	N/A	0.002750588	N/A	0.017734858	9172.56
37	5/19/2009-6/29/2009	30	-0.538385938	N/A	0.243002541	N/A	0.002949605	N/A	0.017669096	15734.19
38	6/2/2009-7/13/2009	30	-0.629522188	N/A	0.244394045	N/A	0.00313592	N/A	0.01773482	17479.49
39	6/16/2009-7/27/2009	30	-0.474271687	N/A	0.239723774	N/A	0.00281674	N/A	0.017618875	4975.35
40	6/30/2009-8/10/2009	30	-0.503885344	N/A	0.239450135	N/A	0.002282046	N/A	0.013410192	3804.29
41	7/14/2009-8/24/2009	30	-0.631541178	N/A	0.239720979	N/A	0.001796629	N/A	0.011029434	6079.80
42	7/28/2009-9/7/2009	30	-0.529360371	N/A	0.234888707	N/A	0.00166888	N/A	0.009530098	9123.46
43	8/11/2009-9/21/2009	30	-0.518109344	N/A	0.218938507	N/A	0.001550622	N/A	0.00933067	15185.14
44	9/8/2009-10/6/2009	30	-0.5427907	N/A	0.239858253	N/A	0.001373747	N/A	0.008188224	21472.91

Average Sum of Squared Errors   40,151.28

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __IBM__ NYSE: __IBM__ Industry: __Technology__

Model 4 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 - b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.466570471	N/A	0.245214987	0.000051278	0.001787512	N/A	0.010912305	38362.06
2	1/15/2008-2/25/2008	30	-0.520563670	N/A	0.242953848	0.000062131	0.002200985	N/A	0.013321832	84643.07
3	1/29/2008-3/10/2008	30	-0.616663128	N/A	0.226492883	-0.000034545	0.002798957	N/A	0.016481178	116802.70
4	2/12/2008-3/24/2008	30	-0.591831469	N/A	0.240747538	-0.000087533	0.003233680	N/A	0.019153815	85007.64
5	2/26/2008-4/7/2008	30	-0.583370037	N/A	0.241032704	-0.000061291	0.003104347	N/A	0.018015314	103085.01
6	3/11/2008-4/21/2008	30	-0.484047658	N/A	0.235917188	0.000007899	0.002422776	N/A	0.015138858	13297.57
7	3/25/2008-5/25/2008	30	-0.468244132	N/A	0.240216921	-0.000034274	0.001843839	N/A	0.011671056	15408.10
8	4/8/2008-5/19/2008	30	-0.509555531	N/A	0.229645077	0.000067669	0.001719304	N/A	0.009793504	24039.20
9	4/22/2008-6/2/2008	30	-0.575512016	N/A	0.222058235	-0.000067250	0.001689367	N/A	0.010402800	28735.26
10	5/6/2008-6/16/2008	30	-0.567312909	N/A	0.235375781	0.000021305	0.001970569	N/A	0.012018117	34555.04
11	5/20/2008-6/30/2008	30	-0.482099898	N/A	0.227704571	-0.000038845	0.002271893	N/A	0.013819877	40657.81
12	6/3/2008-7/14/2008	30	-0.534358789	N/A	0.229282398	0.000047210	0.002433351	N/A	0.015702727	42711.26
13	6/17/2008-7/28/2008	30	-0.632866254	N/A	0.227833707	-0.000042067	0.002371614	N/A	0.014506267	41972.89
14	7/1/2008-8/11/2008	30	-0.560844091	N/A	0.238170143	0.000021958	0.002292447	N/A	0.013337252	41291.44
15	7/15/2008-8/25/2008	30	-0.560175151	N/A	0.217860521	0.000058765	0.001967743	N/A	0.011254197	19238.82
16	7/29/2008-9/8/2008	30	-0.514830826	N/A	0.226746935	-0.000012692	0.001833360	N/A	0.011859692	16663.05
17	8/12/2008-9/22/2008	30	-0.609548146	N/A	0.225993079	0.000083061	0.002001976	N/A	0.012804828	23929.36
18	8/26/2008-10/6/2008	30	-0.479574579	N/A	0.225661092	0.000016681	0.002403829	N/A	0.014207939	41158.79
19	9/9/2008-10/20/2008	30	-0.518034888	N/A	0.245169634	-0.000021979	0.002785644	N/A	0.016530915	21326.08
20	9/23/2008-11/3/2008	30	-0.472553618	N/A	0.249847605	-0.000076440	0.003265719	N/A	0.019204388	35922.56
21	10/7/2008-11/17/2008	30	-0.452524515	N/A	0.253166612	-0.000006985	0.003773811	N/A	0.022709664	43717.10
22	10/21/2008-12/1/2008	30	-0.492884745	N/A	0.261851542	-0.000042989	0.004692882	N/A	0.026786055	102948.62
23	11/4/2008-12/15/2008	30	-0.627982164	N/A	0.263309453	0.000093852	0.005011553	N/A	0.029476950	127043.67
24	11/18/2008-12/29/2008	30	-0.461609528	N/A	0.247296802	0.000050128	0.006358654	N/A	0.036271722	100143.92
25	12/2/2008-1/12/2009	30	-0.490696604	N/A	0.250448546	0.000012487	0.005246636	N/A	0.031570825	152346.71
26	12/16/2008-1/26/2009	30	-0.461997707	N/A	0.242903447	0.000074774	0.004540053	N/A	0.027978935	31868.79
27	12/30/2008-2/9/2009	30	-0.627821041	N/A	0.255659283	-0.000046740	0.004573005	N/A	0.026524817	20554.30
28	1/13/2009-2/23/2009	30	-0.481779040	N/A	0.244330466	0.000028064	0.004479792	N/A	0.025849288	13027.78
29	1/27/2009-3/9/2009	30	-0.605362759	N/A	0.235971019	-0.000006339	0.004388678	N/A	0.024660481	6165.13
30	2/10/2009-3/23/2009	30	-0.560389204	N/A	0.239290213	-0.000040301	0.004515178	N/A	0.025578785	7559.86
31	2/24/2009-4/6/2009	30	-0.560254283	N/A	0.241258251	-0.000015424	0.004297055	N/A	0.025369558	6855.06
32	3/10/2009-4/20/2009	30	-0.499598392	N/A	0.240725430	-0.000088612	0.003833754	N/A	0.023519638	10436.51
33	3/24/2009-5/4/2009	30	-0.633978180	N/A	0.230421762	0.000073254	0.003248738	N/A	0.020473969	11148.12
34	4/7/2009-5/18/2009	30	-0.449464026	N/A	0.236365737	-0.000036353	0.003204470	N/A	0.018994767	6333.39
35	4/21/2009-6/1/2009	30	-0.534039070	N/A	0.243666787	0.000089114	0.002884011	N/A	0.017487092	4325.55
36	5/5/2009-6/15/2009	30	-0.468653267	N/A	0.237767831	0.000098403	0.002781878	N/A	0.016932652	8007.25
37	5/19/2009-6/29/2009	30	-0.559139000	N/A	0.247939753	-0.000082480	0.003073354	N/A	0.018853371	13934.02
38	6/2/2009-7/13/2009	30	-0.635898351	N/A	0.239435962	-0.000086213	0.002939782	N/A	0.018267494	16274.42
39	6/16/2009-7/27/2009	30	-0.606868483	N/A	0.236779587	0.000066400	0.002856946	N/A	0.017659157	4429.64
40	6/30/2009-8/10/2009	30	-0.475302678	N/A	0.232289194	0.000002611	0.002156659	N/A	0.013352053	3622.88
41	7/14/2009-8/24/2009	30	-0.602899827	N/A	0.237462377	-0.000042375	0.001818912	N/A	0.011043162	5351.88
42	7/28/2009-9/7/2009	30	-0.505167373	N/A	0.222533350	0.000072734	0.001653324	N/A	0.009276649	8209.91
43	8/11/2009-9/21/2009	30	-0.556877816	N/A	0.225772295	0.000019448	0.001497774	N/A	0.009601230	14236.99
44	9/8/2009-10/6/2009	30	-0.527761737	N/A	0.227266220	0.000003209	0.001379540	N/A	0.008763788	19679.20

Average Sum of Squared Errors 36,523.37

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	IBM	NYSE:	IBM	Industry:	Technology

Model 5   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.087530235	-108.580067317	N/A	N/A	0.001984010	0.000103585	N/A	10441.37
2	1/15/2008-2/25/2008	30	0.016097332	-105.233875632	N/A	N/A	0.002914312	0.000125970	N/A	42232.48
3	1/29/2008-3/10/2008	30	-0.037331795	-99.911167079	N/A	N/A	0.004161697	0.000135724	N/A	56479.11
4	2/12/2008-3/24/2008	30	0.062167958	-99.298746204	N/A	N/A	0.005349390	0.000158005	N/A	24438.53
5	2/26/2008-4/7/2008	30	0.091134678	-111.688806543	N/A	N/A	0.004744357	0.000126610	N/A	52876.08
6	3/11/2008-4/21/2008	30	0.070294547	-103.362513989	N/A	N/A	0.004185963	0.000106344	N/A	56556.22
7	3/25/2008-5/25/2008	30	-0.013296358	-95.286553075	N/A	N/A	0.003037590	0.000081037	N/A	19844.64
8	4/8/2008-5/19/2008	30	-0.042953414	-95.114406895	N/A	N/A	0.002539829	0.000075072	N/A	6704.79
9	4/22/2008-6/2/2008	30	0.093902619	-112.539764647	N/A	N/A	0.002437082	0.000085304	N/A	7925.87
10	5/6/2008-6/16/2008	30	-0.002009018	-94.203393028	N/A	N/A	0.002847711	0.000102649	N/A	8075.78
11	5/20/2008-6/30/2008	30	0.050335867	-106.482355844	N/A	N/A	0.003745974	0.000102026	N/A	11033.07
12	6/3/2008-7/14/2008	30	0.084446355	-99.905748515	N/A	N/A	0.004584092	0.000097352	N/A	14573.09
13	6/17/2008-7/28/2008	30	-0.079762289	-98.689341047	N/A	N/A	0.004703528	0.000082457	N/A	20446.51
14	7/1/2008-8/11/2008	30	0.080556199	-107.685304690	N/A	N/A	0.004278255	0.000078957	N/A	25716.47
15	7/15/2008-8/25/2008	30	-0.052048580	-94.371535437	N/A	N/A	0.003488085	0.000069999	N/A	5121.45
16	7/29/2008-9/8/2008	30	0.094745306	-104.007234828	N/A	N/A	0.003535476	0.000066537	N/A	3219.26
17	8/12/2008-9/22/2008	30	0.041189393	-102.495694908	N/A	N/A	0.003607919	0.000074959	N/A	7161.76
18	8/26/2008-10/6/2008	30	-0.096895694	-107.175333294	N/A	N/A	0.004237339	0.000088177	N/A	18809.75
19	9/9/2008-10/20/2008	30	0.062784606	-106.322757057	N/A	N/A	0.004859129	0.000110440	N/A	45964.46
20	9/23/2008-11/3/2008	30	0.014367462	-105.457169754	N/A	N/A	0.006228613	0.000114663	N/A	38624.20
21	10/7/2008-11/17/2008	30	-0.051568288	-108.999954577	N/A	N/A	0.008554625	0.000089735	N/A	22947.56
22	10/21/2008-12/1/2008	30	0.075003103	-105.572442585	N/A	N/A	0.012467129	0.000060696	N/A	169374.55
23	11/4/2008-12/15/2008	30	0.034579894	-98.632896572	N/A	N/A	0.016606719	0.000035637	N/A	158126.49
24	11/18/2008-12/29/2008	30	0.029958479	-106.781495153	N/A	N/A	0.017999563	0.000031667	N/A	86764.94
25	12/2/2008-1/12/2009	30	-0.006754011	-113.511357035	N/A	N/A	0.015711185	0.000038355	N/A	140775.77
26	12/16/2008-1/26/2009	30	-0.009529309	-93.578803184	N/A	N/A	0.011986181	0.000046055	N/A	30364.87
27	12/30/2008-2/9/2009	30	0.057656099	-94.257407017	N/A	N/A	0.011500973	0.000054043	N/A	19451.71
28	1/13/2009-2/23/2009	30	0.016606589	-103.723144863	N/A	N/A	0.011435545	0.000050252	N/A	13952.65
29	1/27/2009-3/9/2009	30	0.068619888	-95.477514264	N/A	N/A	0.010937594	0.000040434	N/A	6279.96
30	2/10/2009-3/23/2009	30	0.028961445	-97.922626031	N/A	N/A	0.011977841	0.000036613	N/A	6795.65
31	2/24/2009-4/6/2009	30	-0.084630556	-111.131961834	N/A	N/A	0.011546393	0.000038264	N/A	10293.47
32	3/10/2009-4/20/2009	30	-0.014407983	-108.873257412	N/A	N/A	0.010485001	0.000038415	N/A	18507.28
33	3/24/2009-5/4/2009	30	-0.033147582	-112.386818706	N/A	N/A	0.008939083	0.000032401	N/A	18847.30
34	4/7/2009-5/18/2009	30	0.077803106	-94.912266508	N/A	N/A	0.008507671	0.000031910	N/A	8536.69
35	4/21/2009-6/1/2009	30	0.005384190	-111.448541995	N/A	N/A	0.007662776	0.000032845	N/A	3447.43
36	5/5/2009-6/15/2009	30	0.028719570	-105.699721676	N/A	N/A	0.007534755	0.000038706	N/A	3661.97
37	5/19/2009-6/29/2009	30	0.010878060	-104.013444033	N/A	N/A	0.007548705	0.000048139	N/A	7400.42
38	6/2/2009-7/13/2009	30	0.070635799	-112.732044324	N/A	N/A	0.007368404	0.000058433	N/A	6557.54
39	6/16/2009-7/27/2009	30	0.036225421	-113.811270353	N/A	N/A	0.006894330	0.000054266	N/A	21889.77
40	6/30/2009-8/10/2009	30	-0.065882072	-96.234921391	N/A	N/A	0.005092780	0.000044369	N/A	39025.45
41	7/14/2009-8/24/2009	30	0.004774320	-100.578465355	N/A	N/A	0.004476323	0.000037295	N/A	17000.83
42	7/28/2009-9/7/2009	30	-0.085843286	-109.830650346	N/A	N/A	0.003736667	0.000037705	N/A	4033.96
43	8/11/2009-9/21/2009	30	0.088322919	-107.619798370	N/A	N/A	0.003087916	0.000052615	N/A	6245.27
44	9/8/2009-10/6/2009	30	-0.004856995	-108.180146369	N/A	N/A	0.002010368	0.000070452	N/A	4367.69

Average Sum of Squared Errors   29,565.78

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

| | Reference Entity: | IBM | | NYSE: | IBM | | Industry: | Technology |

Model 6　Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$　Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$　Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.052534963	-93.767666777	0.243690622	N/A	0.001758228	N/A	0.010716289	34262.81
2	1/15/2008-2/25/2008	30	0.002783090	-105.856425475	0.234953781	N/A	0.002133819	N/A	0.013066582	68648.96
3	1/29/2008-3/10/2008	30	-0.057669929	-103.217702191	0.232184142	N/A	0.002897556	N/A	0.016392709	96804.97
4	2/12/2008-3/24/2008	30	0.049304479	-96.878784256	0.231366507	N/A	0.003452109	N/A	0.020198680	73147.33
5	2/26/2008-4/7/2008	30	-0.025015937	-107.461721199	0.223149173	N/A	0.003117735	N/A	0.018353970	94220.19
6	3/11/2008-4/21/2008	30	-0.050030113	-111.671190040	0.234869216	N/A	0.002494763	N/A	0.014702347	10880.52
7	3/25/2008-5/25/2008	30	0.037035923	-105.454983594	0.234132790	N/A	0.001798377	N/A	0.010798905	13861.91
8	4/8/2008-5/19/2008	30	-0.033642149	-106.750139678	0.241540674	N/A	0.001601177	N/A	0.009668503	21513.12
9	4/22/2008-6/2/2008	30	-0.045732838	-101.773482719	0.240732616	N/A	0.001748824	N/A	0.010655198	26022.23
10	5/6/2008-6/16/2008	30	-0.010548234	-102.964130225	0.222253874	N/A	0.002079400	N/A	0.011589020	29292.63
11	5/20/2008-6/30/2008	30	-0.087819192	-103.234026883	0.236379798	N/A	0.002203321	N/A	0.013425628	34355.42
12	6/3/2008-7/14/2008	30	0.013285248	-95.141307783	0.225633289	N/A	0.002504335	N/A	0.015116816	36187.10
13	6/17/2008-7/28/2008	30	0.035275689	-102.471729973	0.229697756	N/A	0.002391952	N/A	0.014325942	38926.96
14	7/1/2008-8/11/2008	30	-0.035447549	-113.712756621	0.235415849	N/A	0.002132043	N/A	0.013470911	36653.19
15	7/15/2008-8/25/2008	30	0.080853503	-113.079958405	0.224118381	N/A	0.001956025	N/A	0.011215184	16062.93
16	7/29/2008-9/8/2008	30	-0.012414429	-107.746399623	0.231378447	N/A	0.001889000	N/A	0.011258209	14885.90
17	8/12/2008-9/22/2008	30	0.088100007	-112.939826239	0.236689363	N/A	0.002137622	N/A	0.012205202	21125.93
18	8/26/2008-10/6/2008	30	-0.099977574	-103.026781785	0.243135946	N/A	0.002269685	N/A	0.013635726	37870.78
19	9/9/2008-10/20/2008	30	0.066937549	-94.192487135	0.242297870	N/A	0.002820889	N/A	0.017422318	18505.86
20	9/23/2008-11/3/2008	30	-0.068006593	-103.685793467	0.245834664	N/A	0.003126478	N/A	0.019713190	30257.30
21	10/7/2008-11/17/2008	30	-0.034182430	-113.932800884	0.244214252	N/A	0.003764742	N/A	0.023294971	40260.61
22	10/21/2008-12/1/2008	30	0.007445755	-100.344261706	0.243726823	N/A	0.004724254	N/A	0.028635747	89364.09
23	11/4/2008-12/15/2008	30	0.023898112	-111.443231430	0.260560238	N/A	0.004870061	N/A	0.029162902	102599.47
24	11/18/2008-12/29/2008	30	-0.002490092	-98.824337561	0.247080208	N/A	0.005966446	N/A	0.037999834	84362.84
25	12/2/2008-1/12/2009	30	0.035897753	-95.833569937	0.241429834	N/A	0.005623744	N/A	0.033795738	137901.84
26	12/16/2008-1/26/2009	30	0.043050194	-101.361326274	0.254095037	N/A	0.004844132	N/A	0.029146275	29047.08
27	12/30/2008-2/9/2009	30	-0.019502109	-93.947002501	0.257834172	N/A	0.004358372	N/A	0.026807329	17841.00
28	1/13/2009-2/23/2009	30	0.041492003	-99.112664906	0.255598849	N/A	0.004158979	N/A	0.027104208	11875.74
29	1/27/2009-3/9/2009	30	0.023448402	-95.537030887	0.237748460	N/A	0.004106938	N/A	0.025134034	5477.37
30	2/10/2009-3/23/2009	30	0.035262112	-110.829201541	0.252052056	N/A	0.004436582	N/A	0.025642595	6730.10
31	2/24/2009-4/6/2009	30	-0.056593567	-108.181741984	0.231716643	N/A	0.004081769	N/A	0.024389912	5920.44
32	3/10/2009-4/20/2009	30	-0.040814637	-106.825060123	0.241741235	N/A	0.003820391	N/A	0.023507142	9647.91
33	3/24/2009-5/4/2009	30	0.080336620	-103.033304682	0.227535947	N/A	0.003350923	N/A	0.021006894	9711.22
34	4/7/2009-5/18/2009	30	0.083816970	-109.873551741	0.238698819	N/A	0.002995868	N/A	0.017704792	5501.40
35	4/21/2009-6/1/2009	30	0.053898183	-104.253234475	0.234501064	N/A	0.003021591	N/A	0.017812369	3909.89
36	5/5/2009-6/15/2009	30	-0.062095129	-109.722085177	0.227603582	N/A	0.002755226	N/A	0.016881062	7543.64
37	5/19/2009-6/29/2009	30	-0.038190013	-96.656641433	0.232954071	N/A	0.002993611	N/A	0.018465513	11876.54
38	6/2/2009-7/13/2009	30	0.040988233	-98.783250359	0.245056921	N/A	0.003074390	N/A	0.019017448	14368.79
39	6/16/2009-7/27/2009	30	-0.037337881	-110.529079094	0.225078170	N/A	0.002997510	N/A	0.016631347	3859.07
40	6/30/2009-8/10/2009	30	0.078013086	-106.813983340	0.237384461	N/A	0.002274017	N/A	0.013697106	2932.38
41	7/14/2009-8/24/2009	30	-0.079896213	-106.030759656	0.234108626	N/A	0.001896178	N/A	0.011222429	4766.35
42	7/28/2009-9/7/2009	30	-0.034054147	-111.871253421	0.235932699	N/A	0.001663875	N/A	0.009264332	7219.27
43	8/11/2009-9/21/2009	30	0.069893788	-113.099945768	0.226816427	N/A	0.001488817	N/A	0.009300775	12565.73
44	9/8/2009-10/6/2009	30	0.007901353	-100.385477671	0.235116367	N/A	0.001461774	N/A	0.008723601	16276.26

Average Sum of Squared Errors　31,705.57

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	IBM	NYSE:	IBM	Industry:	Technology

Model 7 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.012794560	-98.549103394	0.236617851	0.000023461	0.001732767	N/A	0.010465396	31440.33
2	1/15/2008-2/25/2008	30	0.005125586	-97.746061421	0.237839511	-0.000080032	0.002138119	N/A	0.013785352	63162.18
3	1/29/2008-3/10/2008	30	0.034449472	-95.385494417	0.225963108	0.000076654	0.002905352	N/A	0.017712118	95743.32
4	2/12/2008-3/24/2008	30	0.074251090	-108.120511074	0.227015236	-0.000093989	0.003194822	N/A	0.020953102	68513.78
5	2/26/2008-4/7/2008	30	-0.039761538	-107.135818386	0.239238479	-0.000059183	0.003074781	N/A	0.018998044	89700.74
6	3/11/2008-4/21/2008	30	-0.001989396	-95.640020555	0.237715510	0.000044534	0.002599270	N/A	0.014227080	10000.78
7	3/25/2008-5/25/2008	30	-0.091512379	-101.521278456	0.223156844	-0.000019895	0.001803491	N/A	0.010957620	13816.35
8	4/8/2008-5/19/2008	30	-0.017440176	-96.948844518	0.235204654	-0.000095128	0.001707703	N/A	0.010562134	20438.52
9	4/22/2008-6/2/2008	30	-0.035159311	-104.865088377	0.227533672	-0.000001227	0.001712809	N/A	0.010500385	25332.15
10	5/6/2008-6/16/2008	30	0.009885813	-99.460381627	0.229716112	-0.000097130	0.002014831	N/A	0.011423402	28190.87
11	5/20/2008-6/30/2008	30	0.053995057	-98.087401580	0.241153768	-0.000061553	0.002248814	N/A	0.013173517	32672.21
12	6/3/2008-7/14/2008	30	-0.098087644	-113.270709474	0.220112778	-0.000012196	0.002505943	N/A	0.015110595	35896.49
13	6/17/2008-7/28/2008	30	0.060342789	-105.265603708	0.220697878	-0.000055876	0.002447843	N/A	0.014518329	36895.06
14	7/1/2008-8/11/2008	30	0.062210089	-108.923706553	0.217670593	0.000050877	0.002108097	N/A	0.013636824	35711.62
15	7/15/2008-8/25/2008	30	-0.088853591	-94.367606939	0.227784999	-0.000091118	0.002009831	N/A	0.011970338	15284.40
16	7/29/2008-9/8/2008	30	0.027154160	-100.704489731	0.239594328	0.000049404	0.001950594	N/A	0.011679433	13656.05
17	8/12/2008-9/22/2008	30	-0.054171928	-93.367735190	0.234461438	0.000029668	0.002082109	N/A	0.012999045	20203.80
18	8/26/2008-10/6/2008	30	0.091732225	-102.189408268	0.236338543	-0.000000011	0.002400646	N/A	0.014381484	36262.26
19	9/9/2008-10/20/2008	30	-0.028523222	-107.218758482	0.241021578	0.000022855	0.002696671	N/A	0.016410925	18298.17
20	9/23/2008-11/3/2008	30	0.086293662	-103.065640010	0.238396659	0.000099283	0.003378283	N/A	0.018984928	28840.52
21	10/7/2008-11/17/2008	30	-0.090883651	-109.233625087	0.240927852	0.000066114	0.003548020	N/A	0.022490095	37598.31
22	10/21/2008-12/1/2008	30	-0.034483769	-112.169617034	0.246332117	-0.000055045	0.004641728	N/A	0.026773634	86433.15
23	11/4/2008-12/15/2008	30	-0.047665191	-109.661587295	0.241506594	0.000013792	0.004844200	N/A	0.030181345	95616.22
24	11/18/2008-12/29/2008	30	0.067976246	-101.569995563	0.250094137	-0.000044055	0.005901732	N/A	0.038382130	81309.83
25	12/2/2008-1/12/2009	30	0.025596918	-108.197715204	0.239646645	0.000006261	0.005153237	N/A	0.033844828	128138.72
26	12/16/2008-1/26/2009	30	-0.053592030	-98.955577847	0.248041509	0.000092944	0.004486109	N/A	0.028189777	28577.89
27	12/30/2008-2/9/2009	30	-0.083554183	-105.277618250	0.237595357	0.000096525	0.004265929	N/A	0.027546878	16947.21
28	1/13/2009-2/23/2009	30	-0.095324333	-101.577345857	0.253076546	0.000055867	0.004568815	N/A	0.027115679	11609.36
29	1/27/2009-3/9/2009	30	-0.000107785	-104.423023328	0.250462074	-0.000096964	0.004382668	N/A	0.025346129	5412.89
30	2/10/2009-3/23/2009	30	-0.075057199	-102.483772491	0.244769344	0.000048288	0.004485283	N/A	0.026407392	6539.22
31	2/24/2009-4/6/2009	30	-0.045189185	-102.554731642	0.240729762	-0.000013824	0.004287614	N/A	0.025708361	5538.32
32	3/10/2009-4/20/2009	30	-0.064210619	-101.715542583	0.230897715	-0.000082990	0.004060289	N/A	0.022993887	9447.31
33	3/24/2009-5/4/2009	30	0.095281396	-99.812506428	0.227234680	0.000056452	0.003516751	N/A	0.019383394	9159.72
34	4/7/2009-5/18/2009	30	0.093267368	-100.535682249	0.237312040	0.000020670	0.003182282	N/A	0.018435542	5435.19
35	4/21/2009-6/1/2009	30	-0.031556735	-109.875881914	0.232182534	-0.000049764	0.002762189	N/A	0.018007917	3830.31
36	5/5/2009-6/15/2009	30	0.012644433	-103.368671269	0.232415009	-0.000074174	0.003008854	N/A	0.017021271	7247.54
37	5/19/2009-6/29/2009	30	0.087557781	-112.549707855	0.228774056	0.000007519	0.002887154	N/A	0.017845774	11522.60
38	6/2/2009-7/13/2009	30	0.087179210	-107.720549681	0.224327129	0.000075893	0.003200058	N/A	0.017814720	13129.47
39	6/16/2009-7/27/2009	30	-0.077813853	-104.127820042	0.237355483	-0.000034182	0.002811749	N/A	0.016460106	3588.57
40	6/30/2009-8/10/2009	30	0.064981589	-100.352196030	0.223521017	-0.000067423	0.002188643	N/A	0.013932100	2831.16
41	7/14/2009-8/24/2009	30	-0.054614616	-109.249299376	0.223184629	0.000046440	0.001930178	N/A	0.011619787	4685.50
42	7/28/2009-9/7/2009	30	-0.090849661	-104.257316576	0.240370000	0.000003808	0.001654655	N/A	0.009878131	6982.26
43	8/11/2009-9/21/2009	30	-0.078991034	-107.980786416	0.231755053	0.000055219	0.001531150	N/A	0.009181593	11709.47
44	9/8/2009-10/6/2009	30	0.071088894	-103.136675619	0.222587263	-0.000031649	0.001444500	N/A	0.008603001	15165.15

Average Sum of Squared Errors 30,193.52

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	IBM	NYSE:	IBM	Industry:	Technology

Model 8 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{1}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.499952600	N/A	0.240429678	N/A	0.001922801	0.000060334	0.004204247	10429.55
2	1/15/2008-2/25/2008	30	-0.549230728	N/A	0.237769181	N/A	0.002893924	0.000074793	0.005126033	38378.06
3	1/29/2008-3/10/2008	30	-0.620334247	N/A	0.245529195	N/A	0.003962474	0.000084481	0.006714326	52367.79
4	2/12/2008-3/24/2008	30	-0.470019836	N/A	0.224061512	N/A	0.005202080	0.000090275	0.007688117	22849.19
5	2/26/2008-4/7/2008	30	-0.493663018	N/A	0.242553665	N/A	0.004844633	0.000080166	0.007214643	46691.35
6	3/11/2008-4/21/2008	30	-0.496585972	N/A	0.242400277	N/A	0.003804959	0.000062522	0.005773227	12865.87
7	3/25/2008-5/25/2008	30	-0.540443268	N/A	0.220591571	N/A	0.002814008	0.000051767	0.004514190	17551.52
8	4/8/2008-5/19/2008	30	-0.502525026	N/A	0.227336502	N/A	0.002627276	0.000045620	0.004028383	6275.86
9	4/22/2008-6/2/2008	30	-0.634973441	N/A	0.223546306	N/A	0.002348045	0.000052215	0.004159649	7127.87
10	5/6/2008-6/16/2008	30	-0.622305355	N/A	0.222714833	N/A	0.002956576	0.000057959	0.005015767	7172.35
11	5/20/2008-6/30/2008	30	-0.471519877	N/A	0.230352321	N/A	0.003527229	0.000062641	0.005486375	10890.42
12	6/3/2008-7/14/2008	30	-0.460219769	N/A	0.220361911	N/A	0.004477404	0.000060104	0.006047642	13644.87
13	6/17/2008-7/28/2008	30	-0.487395267	N/A	0.219628883	N/A	0.004847784	0.000053466	0.006037165	19760.63
14	7/1/2008-8/11/2008	30	-0.571032447	N/A	0.225178942	N/A	0.004244770	0.000047288	0.005251114	23233.74
15	7/15/2008-8/25/2008	30	-0.488135041	N/A	0.231214986	N/A	0.003467997	0.000043136	0.004577620	4789.43
16	7/29/2008-9/8/2008	30	-0.628731193	N/A	0.242285001	N/A	0.003402656	0.000039986	0.004696816	2975.48
17	8/12/2008-9/22/2008	30	-0.551491370	N/A	0.224834664	N/A	0.003862841	0.000046804	0.004884342	6500.72
18	8/26/2008-10/6/2008	30	-0.506682505	N/A	0.238066403	N/A	0.004074611	0.000055218	0.005759839	17302.50
19	9/9/2008-10/20/2008	30	-0.486361739	N/A	0.234973361	N/A	0.005098342	0.000065186	0.006834005	22936.31
20	9/23/2008-11/3/2008	30	-0.498266414	N/A	0.242663677	N/A	0.006039640	0.000068767	0.007447120	36542.17
21	10/7/2008-11/17/2008	30	-0.545139655	N/A	0.255436093	N/A	0.008028861	0.000054393	0.009214327	22364.18
22	10/21/2008-12/1/2008	30	-0.533005312	N/A	0.256041498	N/A	0.012236657	0.000033274	0.011469115	108301.90
23	11/4/2008-12/15/2008	30	-0.572043112	N/A	0.254935727	N/A	0.016356137	0.000020387	0.012163642	129834.66
24	11/18/2008-12/29/2008	30	-0.511646199	N/A	0.253321363	N/A	0.018410606	0.000019183	0.015463089	81492.21
25	12/2/2008-1/12/2009	30	-0.525258436	N/A	0.238997402	N/A	0.014410516	0.000021509	0.012925650	133825.93
26	12/16/2008-1/26/2009	30	-0.571077079	N/A	0.254338320	N/A	0.012454044	0.000027585	0.010830730	26330.62
27	12/30/2008-2/9/2009	30	-0.543365706	N/A	0.243295008	N/A	0.011625870	0.000031436	0.010580297	16813.42
28	1/13/2009-2/23/2009	30	-0.549955664	N/A	0.252463306	N/A	0.010981007	0.000028609	0.010569287	13326.86
29	1/27/2009-3/9/2009	30	-0.589506455	N/A	0.240246633	N/A	0.011774135	0.000026380	0.010572817	5635.34
30	2/10/2009-3/23/2009	30	-0.499208503	N/A	0.248980745	N/A	0.011906845	0.000022481	0.010597525	6438.57
31	2/24/2009-4/6/2009	30	-0.626100880	N/A	0.244364954	N/A	0.011885450	0.000024437	0.010507999	7328.73
32	3/10/2009-4/20/2009	30	-0.528018719	N/A	0.248090080	N/A	0.010439110	0.000022747	0.009785228	11214.41
33	3/24/2009-5/4/2009	30	-0.638048948	N/A	0.228233061	N/A	0.008870490	0.000018792	0.008186744	12623.19
34	4/7/2009-5/18/2009	30	-0.550971323	N/A	0.229012079	N/A	0.008118466	0.000019110	0.007405104	6987.79
35	4/21/2009-6/1/2009	30	-0.578886868	N/A	0.232707602	N/A	0.007723744	0.000018448	0.007190642	3225.60
36	5/5/2009-6/15/2009	30	-0.444930233	N/A	0.241250487	N/A	0.007562011	0.000022814	0.006898317	3670.34
37	5/19/2009-6/29/2009	30	-0.579646988	N/A	0.243552719	N/A	0.007147637	0.000028801	0.007322919	6690.61
38	6/2/2009-7/13/2009	30	-0.467669085	N/A	0.223632176	N/A	0.007106349	0.000034223	0.007331744	6075.81
39	6/16/2009-7/27/2009	30	-0.600491960	N/A	0.228910759	N/A	0.006831581	0.000032519	0.007059298	4883.26
40	6/30/2009-8/10/2009	30	-0.544045561	N/A	0.240732174	N/A	0.005331520	0.000026815	0.005666749	3715.11
41	7/14/2009-8/24/2009	30	-0.621025135	N/A	0.237223017	N/A	0.004309866	0.000021047	0.004408930	5927.60
42	7/28/2009-9/7/2009	30	-0.604813094	N/A	0.229449507	N/A	0.003531292	0.000022826	0.004045042	3713.33
43	8/11/2009-9/21/2009	30	-0.570212187	N/A	0.238791857	N/A	0.003048885	0.000030764	0.003737772	5810.63
44	9/8/2009-10/6/2009	30	-0.490580682	N/A	0.228417671	N/A	0.001990270	0.000043890	0.003275426	4111.76

Average Sum of Squared Errors 22,968.81

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **IBM**   NYSE: **IBM**   Industry: **Technology**

Model9   Default Intensity: $\xi[i,j]=c_0+c_1t+\dfrac{c_2}{s^{b_0+b_1t}}$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.457946252	N/A	0.231145201	-0.000018441	0.001831937	0.000060632	0.004045060	9954.43
2	1/15/2008-2/25/2008	30	-0.449107821	N/A	0.235149460	0.000039000	0.002946232	0.000073131	0.005403086	35837.40
3	1/29/2008-3/10/2008	30	-0.537822786	N/A	0.247475967	-0.000094050	0.004056820	0.000083062	0.007123979	46593.29
4	2/12/2008-3/24/2008	30	-0.561620572	N/A	0.236678357	-0.000091674	0.005057205	0.000088123	0.007999586	21796.46
5	2/26/2008-4/7/2008	30	-0.631257384	N/A	0.235075196	-0.000012186	0.005095745	0.000075697	0.007506282	42535.99
6	3/11/2008-4/21/2008	30	-0.487916105	N/A	0.241812813	0.000047523	0.004172947	0.000063272	0.005837076	12155.04
7	3/25/2008-5/25/2008	30	-0.547835531	N/A	0.229810796	-0.000087767	0.003027187	0.000049555	0.004522304	14098.11
8	4/8/2008-5/19/2008	30	-0.517871127	N/A	0.241389805	-0.000010535	0.002437578	0.000048482	0.003887610	5917.39
9	4/22/2008-6/2/2008	30	-0.554168670	N/A	0.234032894	-0.000062934	0.002461820	0.000051721	0.003978819	6517.00
10	5/6/2008-6/16/2008	30	-0.470527102	N/A	0.219049232	-0.000036147	0.002793375	0.000056504	0.004558839	6752.88
11	5/20/2008-6/30/2008	30	-0.632439971	N/A	0.225546769	-0.000033925	0.003506581	0.000064558	0.005350666	9772.69
12	6/3/2008-7/14/2008	30	-0.553587748	N/A	0.218922221	-0.000028334	0.004506298	0.000060576	0.005820113	12518.74
13	6/17/2008-7/28/2008	30	-0.512044842	N/A	0.227913281	0.000030169	0.004878317	0.000054229	0.005685241	17606.68
14	7/1/2008-8/11/2008	30	-0.537133970	N/A	0.240188473	-0.000032627	0.004167654	0.000044891	0.005088040	21458.19
15	7/15/2008-8/25/2008	30	-0.636614291	N/A	0.240194105	0.000068987	0.003591008	0.000039938	0.004787886	4570.59
16	7/29/2008-9/8/2008	30	-0.534535497	N/A	0.230184535	0.000031119	0.003455349	0.000040547	0.004737253	2630.32
17	8/12/2008-9/22/2008	30	-0.619748982	N/A	0.239154355	-0.000087101	0.003810927	0.000044428	0.005106073	6178.45
18	8/26/2008-10/6/2008	30	-0.527095686	N/A	0.245142514	0.000054644	0.004137546	0.000052807	0.005772636	15384.51
19	9/9/2008-10/20/2008	30	-0.531557965	N/A	0.231880359	-0.000019718	0.004970760	0.000064453	0.006953774	20997.29
20	9/23/2008-11/3/2008	30	-0.620690756	N/A	0.248422227	0.000000165	0.006354344	0.000067301	0.007848847	32689.01
21	10/7/2008-11/17/2008	30	-0.625851049	N/A	0.256494927	-0.000006317	0.008474373	0.000054146	0.008837785	20743.08
22	10/21/2008-12/1/2008	30	-0.611004535	N/A	0.247120371	-0.000066515	0.012535761	0.000036612	0.010336063	102877.32
23	11/4/2008-12/15/2008	30	-0.635577774	N/A	0.253387938	-0.000000558	0.016340451	0.000021834	0.012202368	109023.76
24	11/18/2008-12/29/2008	30	-0.448854469	N/A	0.240103349	0.000023316	0.017371787	0.000019953	0.014873150	78362.89
25	12/2/2008-1/12/2009	30	-0.613706055	N/A	0.238791811	-0.000078006	0.014990896	0.000021193	0.012673477	123818.76
26	12/16/2008-1/26/2009	30	-0.497517966	N/A	0.234585421	0.000083840	0.012276078	0.000025696	0.011105014	24116.44
27	12/30/2008-2/9/2009	30	-0.602067710	N/A	0.256495048	-0.000074907	0.011697674	0.000031325	0.010915004	16092.35
28	1/13/2009-2/23/2009	30	-0.481593819	N/A	0.252266895	0.000078375	0.011942460	0.000029657	0.010651910	12297.71
29	1/27/2009-3/9/2009	30	-0.462535148	N/A	0.255380955	0.000091294	0.011697880	0.000026431	0.010145933	5487.10
30	2/10/2009-3/23/2009	30	-0.606945183	N/A	0.254837401	-0.000054148	0.011264415	0.000022007	0.010283946	5832.58
31	2/24/2009-4/6/2009	30	-0.607595671	N/A	0.229783423	-0.000063551	0.011456395	0.000022874	0.009826458	6765.71
32	3/10/2009-4/20/2009	30	-0.578874775	N/A	0.227810822	-0.000042107	0.010801667	0.000021166	0.008900639	9594.53
33	3/24/2009-5/4/2009	30	-0.475702647	N/A	0.232670801	0.000086385	0.008767399	0.000019394	0.007933409	9299.06
34	4/7/2009-5/18/2009	30	-0.528382088	N/A	0.231490680	0.000000407	0.008315796	0.000018773	0.007510696	6269.22
35	4/21/2009-6/1/2009	30	-0.610247419	N/A	0.225581399	-0.000001319	0.008048186	0.000019099	0.006914344	3015.16
36	5/5/2009-6/15/2009	30	-0.632210354	N/A	0.231431584	-0.000004950	0.007613301	0.000023011	0.007008748	3368.90
37	5/19/2009-6/29/2009	30	-0.565704682	N/A	0.228650791	-0.000068456	0.007434537	0.000029745	0.007382395	5997.06
38	6/2/2009-7/13/2009	30	-0.441104841	N/A	0.225547620	-0.000036211	0.007365699	0.000035859	0.007705457	5540.47
39	6/16/2009-7/27/2009	30	-0.513921516	N/A	0.244397223	0.000005131	0.006947390	0.000033621	0.006806259	4365.52
40	6/30/2009-8/10/2009	30	-0.515798117	N/A	0.231501986	-0.000078229	0.005360685	0.000026075	0.005329198	3456.33
41	7/14/2009-8/24/2009	30	-0.466288944	N/A	0.237897455	-0.000050452	0.004368685	0.000021649	0.004554547	5230.71
42	7/28/2009-9/7/2009	30	-0.479491190	N/A	0.233372200	0.000001298	0.003672578	0.000023034	0.003809443	3561.62
43	8/11/2009-9/21/2009	30	-0.473260438	N/A	0.230677241	-0.000002650	0.003066775	0.000030692	0.003827507	5355.47
44	9/8/2009-10/6/2009	30	-0.540131756	N/A	0.229839766	0.000054782	0.002013337	0.000042168	0.003380539	3918.35

Average Sum of Squared Errors   20,917.15

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>IBM</u> NYSE: <u>IBM</u> Industry: <u>Technology</u>

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{h}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.072313679	-96.909465922	0.243688744	N/A	0.001821469	0.000063912	0.004223424	8094.10
2	1/15/2008-2/25/2008	30	-0.050265343	-101.700115217	0.240844174	N/A	0.002751906	0.000068923	0.005194345	31363.03
3	1/29/2008-3/10/2008	30	0.018547220	-113.537897620	0.232035537	N/A	0.004133210	0.000086769	0.006845489	41000.60
4	2/12/2008-3/24/2008	30	0.003068852	-102.001175024	0.224011522	N/A	0.005169684	0.000088908	0.008063056	18837.85
5	2/26/2008-4/7/2008	30	0.016862801	-113.852980461	0.229193249	N/A	0.004955003	0.000081655	0.007051324	39100.65
6	3/11/2008-4/21/2008	30	-0.052105425	-104.989322911	0.222624190	N/A	0.003904367	0.000066149	0.005740809	10773.42
7	3/25/2008-5/25/2008	30	0.014191966	-111.533882658	0.223655403	N/A	0.002801558	0.000050692	0.004659842	12590.75
8	4/8/2008-5/19/2008	30	0.015490180	-107.747757019	0.231707109	N/A	0.002426942	0.000045531	0.004221552	4853.25
9	4/22/2008-6/2/2008	30	0.079050065	-97.478844588	0.239652958	N/A	0.002455938	0.000050660	0.004275496	5832.30
10	5/6/2008-6/16/2008	30	-0.092759155	-93.846526246	0.232400063	N/A	0.003017093	0.000056180	0.004562184	5635.82
11	5/20/2008-6/30/2008	30	0.037514647	-101.245195208	0.232121651	N/A	0.003698309	0.000059674	0.005642197	8957.31
12	6/3/2008-7/14/2008	30	-0.093409569	-95.978938186	0.232473789	N/A	0.004468688	0.000056664	0.005867665	10696.33
13	6/17/2008-7/28/2008	30	-0.097054564	-106.604564885	0.224512464	N/A	0.004639399	0.000053203	0.005916125	15874.84
14	7/1/2008-8/11/2008	30	0.009901507	-103.830784838	0.228719089	N/A	0.004381458	0.000044852	0.005522558	19577.25
15	7/15/2008-8/25/2008	30	-0.055745786	-101.938042621	0.228286387	N/A	0.003516909	0.000042700	0.004737814	3959.55
16	7/29/2008-9/8/2008	30	-0.071645495	-101.988768725	0.240164352	N/A	0.003598381	0.000042798	0.004696297	2331.44
17	8/12/2008-9/22/2008	30	-0.026318601	-98.086681394	0.233628246	N/A	0.003536227	0.000045506	0.004915486	5116.65
18	8/26/2008-10/6/2008	30	0.025539598	-99.344553663	0.239936777	N/A	0.004002201	0.000051104	0.005704978	14024.80
19	9/9/2008-10/20/2008	30	0.007211476	-108.173488903	0.245656543	N/A	0.004896019	0.000068157	0.006415816	17812.90
20	9/23/2008-11/3/2008	30	0.076457154	-110.876596974	0.252234564	N/A	0.006280393	0.000066554	0.007924830	29264.45
21	10/7/2008-11/17/2008	30	-0.045560918	-106.225650440	0.240831179	N/A	0.008320491	0.000051051	0.008721750	18912.99
22	10/21/2008-12/1/2008	30	-0.073853872	-103.998843533	0.257321254	N/A	0.011313431	0.000035123	0.011358417	82158.59
23	11/4/2008-12/15/2008	30	0.092545272	-106.085230272	0.247627437	N/A	0.016178946	0.000021447	0.011617381	92990.52
24	11/18/2008-12/29/2008	30	0.063159744	-96.008974334	0.252210957	N/A	0.018101295	0.000019384	0.015071910	66482.57
25	12/2/2008-1/12/2009	30	-0.070017680	-113.719189875	0.251093589	N/A	0.014815253	0.000023070	0.012496697	107278.56
26	12/16/2008-1/26/2009	30	0.056830140	-104.311752292	0.258373569	N/A	0.012979644	0.000026089	0.011073595	22265.11
27	12/30/2008-2/9/2009	30	0.051958370	-102.418475148	0.235073790	N/A	0.011793956	0.000031977	0.010426500	13240.36
28	1/13/2009-2/23/2009	30	0.095616263	-98.756364938	0.235589887	N/A	0.011040371	0.000028442	0.010364470	10311.64
29	1/27/2009-3/9/2009	30	-0.050302545	-112.419148134	0.238976349	N/A	0.011039360	0.000025355	0.009717264	4537.99
30	2/10/2009-3/23/2009	30	-0.018648097	-113.327296219	0.243752748	N/A	0.011425738	0.000021835	0.010545735	5443.40
31	2/24/2009-4/6/2009	30	0.029672482	-93.468695517	0.237223907	N/A	0.011734217	0.000023537	0.009981112	5863.07
32	3/10/2009-4/20/2009	30	-0.010558390	-108.396654522	0.249250782	N/A	0.010205526	0.000022138	0.009718278	9389.09
33	3/24/2009-5/4/2009	30	0.073929833	-113.587161970	0.238480114	N/A	0.009553811	0.000019102	0.007931119	9543.67
34	4/7/2009-5/18/2009	30	-0.035319902	-111.988264234	0.246338531	N/A	0.008249065	0.000018190	0.007398049	5368.13
35	4/21/2009-6/1/2009	30	0.017723809	-104.980827924	0.244099030	N/A	0.007982343	0.000018122	0.007201301	2489.55
36	5/5/2009-6/15/2009	30	-0.098952733	-93.725118351	0.242652132	N/A	0.007198482	0.000024374	0.006677705	3061.50
37	5/19/2009-6/29/2009	30	-0.088734081	-100.963883536	0.227280772	N/A	0.007748734	0.000029913	0.007119760	5514.18
38	6/2/2009-7/13/2009	30	0.051290637	-104.918413988	0.243738614	N/A	0.007625226	0.000034981	0.007613344	4892.08
39	6/16/2009-7/27/2009	30	-0.063450985	-108.055308214	0.227952259	N/A	0.006520819	0.000034457	0.006873177	3684.67
40	6/30/2009-8/10/2009	30	-0.086402314	-112.476923425	0.242417049	N/A	0.005249403	0.000026350	0.005685577	2930.62
41	7/14/2009-8/24/2009	30	0.024507607	-106.101947024	0.232690308	N/A	0.004463985	0.000022623	0.004389487	4699.45
42	7/28/2009-9/7/2009	30	-0.036627782	-111.753387370	0.241761011	N/A	0.003589400	0.000022634	0.004032397	3144.53
43	8/11/2009-9/21/2009	30	0.094758665	-102.340473582	0.220444096	N/A	0.003084659	0.000029522	0.003819693	4601.57
44	9/8/2009-10/6/2009	30	-0.072426579	-110.239366084	0.235615864	N/A	0.001911956	0.000043550	0.003265800	3257.00

Average Sum of Squared Errors 18,130.87

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>IBM</u>   NYSE: <u>IBM</u>   Industry: <u>Technology</u>

Model11 Default Intensity: $\xi[i,j]=c_0+c_1t+\dfrac{c_2}{s^{b_0+b_1t}}$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0+a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.063440105	-101.330724017	0.246065612	0.000063250	0.001858481	0.000060927	0.004128828	7225.91
2	1/15/2008-2/25/2008	30	0.082208415	-103.681260137	0.239552773	-0.000062443	0.002792141	0.000073578	0.005130864	28186.06
3	1/29/2008-3/10/2008	30	0.054730197	-97.413241265	0.233237376	0.000007711	0.004070363	0.000082419	0.006834887	37894.00
4	2/12/2008-3/24/2008	30	-0.020789516	-103.721198616	0.232225929	0.000038409	0.005194663	0.000088199	0.007767440	17560.60
5	2/26/2008-4/7/2008	30	-0.098191479	-98.542742606	0.233576929	-0.000076753	0.005055906	0.000079632	0.007099986	36389.29
6	3/11/2008-4/21/2008	30	0.070644823	-107.627882957	0.229321783	-0.000042886	0.004060040	0.000062762	0.005726721	9723.69
7	3/25/2008-5/25/2008	30	-0.017714821	-111.898957683	0.225324246	-0.000066846	0.002968539	0.000051293	0.004639710	11780.45
8	4/8/2008-5/19/2008	30	0.000497160	-94.219222628	0.241664455	-0.000006760	0.002650954	0.000048337	0.004014414	4250.02
9	4/22/2008-6/2/2008	30	0.024732077	-103.013867617	0.235901782	-0.000058166	0.002546040	0.000050171	0.004103241	5052.24
10	5/6/2008-6/16/2008	30	0.001678357	-106.076624107	0.239493367	-0.000049416	0.002768049	0.000057821	0.004784276	5369.28
11	5/20/2008-6/30/2008	30	0.020911228	-112.114239586	0.218920768	-0.000017572	0.003545699	0.000060207	0.005616149	8326.14
12	6/3/2008-7/14/2008	30	-0.084449508	-106.197645709	0.234836275	-0.000090934	0.004520844	0.000059034	0.006362313	9842.98
13	6/17/2008-7/28/2008	30	-0.097980089	-101.817552291	0.225208376	0.000093174	0.004527796	0.000054236	0.005760592	14121.53
14	7/1/2008-8/11/2008	30	0.091746881	-105.609590396	0.224261968	-0.000093360	0.004227895	0.000046422	0.005245375	17968.90
15	7/15/2008-8/25/2008	30	-0.003192414	-95.751333632	0.221200143	0.000042553	0.003542898	0.000039973	0.004590410	3613.10
16	7/29/2008-9/8/2008	30	-0.070633026	-103.415212208	0.221952806	-0.000017948	0.003581377	0.000040605	0.004706290	2072.16
17	8/12/2008-9/22/2008	30	-0.004809757	-105.060565388	0.223673053	0.000077474	0.003548897	0.000047188	0.004832942	4560.88
18	8/26/2008-10/6/2008	30	-0.069191266	-108.560047063	0.225060629	-0.000053706	0.004216342	0.000055221	0.005486764	12382.36
19	9/9/2008-10/20/2008	30	0.012812209	-113.425144141	0.236846379	-0.000025456	0.004956210	0.000066037	0.006849466	17653.53
20	9/23/2008-11/3/2008	30	-0.017152657	-99.650485104	0.248746447	0.000031107	0.006322957	0.000065468	0.007734271	25958.62
21	10/7/2008-11/17/2008	30	-0.059664234	-112.305186210	0.258587732	-0.000052231	0.008066666	0.000053505	0.008746149	16532.17
22	10/21/2008-12/1/2008	30	-0.075025875	-106.744733995	0.249631593	-0.000035023	0.012473193	0.000036661	0.011558175	72398.31
23	11/4/2008-12/15/2008	30	-0.055900263	-105.018129277	0.259488209	-0.000025614	0.017154662	0.000020788	0.011506914	84097.70
24	11/18/2008-12/29/2008	30	-0.058327901	-112.187033002	0.242450876	-0.000012512	0.017362712	0.000020425	0.014221026	60972.49
25	12/2/2008-1/12/2009	30	0.064531053	-102.200523220	0.258123587	0.000043441	0.015055217	0.000021582	0.012713796	99800.14
26	12/16/2008-1/26/2009	30	0.038878940	-110.468153229	0.244446359	-0.000061910	0.011913911	0.000027457	0.011437354	19684.34
27	12/30/2008-2/9/2009	30	0.030692570	-96.418884523	0.246442350	-0.000057532	0.011842015	0.000031062	0.010662697	11922.53
28	1/13/2009-2/23/2009	30	-0.000093194	-101.834430646	0.244535262	-0.000050927	0.012018868	0.000030416	0.010630886	9608.37
29	1/27/2009-3/9/2009	30	0.095258243	-104.074075739	0.253931129	-0.000030281	0.010959361	0.000026264	0.010013985	4314.75
30	2/10/2009-3/23/2009	30	-0.042227315	-94.297514686	0.236910541	-0.000076963	0.012183782	0.000022649	0.010418762	4901.36
31	2/24/2009-4/6/2009	30	-0.081329334	-96.123595278	0.246592159	-0.000097958	0.011132367	0.000022942	0.010379631	5471.69
32	3/10/2009-4/20/2009	30	0.011108200	-109.024768724	0.230096852	0.000086080	0.010287824	0.000022174	0.009780929	9241.31
33	3/24/2009-5/4/2009	30	-0.007717866	-102.159158377	0.236373154	-0.000094862	0.008935419	0.000019208	0.008254787	8971.60
34	4/7/2009-5/18/2009	30	-0.076046107	-106.894368773	0.226662629	0.000050017	0.008480008	0.000019156	0.007381575	5274.03
35	4/21/2009-6/1/2009	30	-0.013306101	-110.819104711	0.228752551	0.000095226	0.007778656	0.000018633	0.006708512	2329.12
36	5/5/2009-6/15/2009	30	0.042564729	-104.212508036	0.242549040	-0.000093394	0.007398864	0.000023807	0.006762771	2859.82
37	5/19/2009-6/29/2009	30	-0.033745144	-94.169540651	0.231935552	0.000056454	0.007639675	0.000028095	0.007474280	4937.22
38	6/2/2009-7/13/2009	30	-0.047770570	-111.959632075	0.244959627	0.000031548	0.007434719	0.000034265	0.007024638	4605.31
39	6/16/2009-7/27/2009	30	-0.033153228	-96.816015558	0.227072633	0.000015349	0.006640414	0.000032343	0.006563298	3499.22
40	6/30/2009-8/10/2009	30	-0.086797626	-99.340341996	0.227652566	-0.000048163	0.005140430	0.000026654	0.005416143	2246.57
41	7/14/2009-8/24/2009	30	-0.037668397	-110.920189397	0.232839603	-0.000013095	0.004484615	0.000021634	0.004503174	4659.85
42	7/28/2009-9/7/2009	30	0.088639876	-112.237617219	0.229309460	0.000087271	0.003496189	0.000022349	0.003727601	2860.26
43	8/11/2009-9/21/2009	30	-0.045386822	-95.544005986	0.220934739	0.000035943	0.002982281	0.000031938	0.003600322	4160.13
44	9/8/2009-10/6/2009	30	0.055782130	-93.498816773	0.228615496	0.000099428	0.001911122	0.000042391	0.003422204	2938.72

Average Sum of Squared Errors   16,550.43

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Kraft Foods Inc.   NYSE: KFT   Industry: Consumer Goods

Model 1   Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

| Time window | Period of time | The number of trading days | Extracted Parameters | | | | | | | Sum of squared errors |
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.478048321	N/A	N/A	N/A	0.011798758	N/A	N/A	97624.02
2	1/15/2008-2/25/2008	30	-0.42795962	N/A	N/A	N/A	0.013995172	N/A	N/A	138769.48
3	1/29/2008-3/10/2008	30	-0.425286963	N/A	N/A	N/A	0.015819484	N/A	N/A	157542.52
4	2/12/2008-3/24/2008	30	-0.468608018	N/A	N/A	N/A	0.018793190	N/A	N/A	226712.09
5	2/26/2008-4/7/2008	30	-0.51444836	N/A	N/A	N/A	0.018430091	N/A	N/A	253684.22
6	3/11/2008-4/21/2008	30	-0.49783057	N/A	N/A	N/A	0.017626421	N/A	N/A	262352.73
7	3/25/2008-5/25/2008	30	-0.51397259	N/A	N/A	N/A	0.014625975	N/A	N/A	123271.97
8	4/8/2008-5/19/2008	30	-0.45278437	N/A	N/A	N/A	0.013539196	N/A	N/A	90014.30
9	4/22/2008-6/2/2008	30	-0.527230217	N/A	N/A	N/A	0.013494425	N/A	N/A	85040.97
10	5/6/2008-6/16/2008	30	-0.439228592	N/A	N/A	N/A	0.014298554	N/A	N/A	93804.87
11	5/20/2008-6/30/2008	30	-0.436457726	N/A	N/A	N/A	0.014958411	N/A	N/A	96279.99
12	6/3/2008-7/14/2008	30	-0.504316441	N/A	N/A	N/A	0.015201331	N/A	N/A	100682.74
13	6/17/2008-7/28/2008	30	-0.392210483	N/A	N/A	N/A	0.014470253	N/A	N/A	105472.78
14	7/1/2008-8/11/2008	30	-0.465388059	N/A	N/A	N/A	0.013495752	N/A	N/A	103158.79
15	7/15/2008-8/25/2008	30	-0.461825004	N/A	N/A	N/A	0.012423575	N/A	N/A	69176.42
16	7/29/2008-9/8/2008	30	-0.502992098	N/A	N/A	N/A	0.012151720	N/A	N/A	61946.55
17	8/12/2008-9/22/2008	30	-0.378424959	N/A	N/A	N/A	0.012577982	N/A	N/A	78112.69
18	8/26/2008-10/6/2008	30	-0.477587022	N/A	N/A	N/A	0.013077639	N/A	N/A	88912.32
19	9/9/2008-10/20/2008	30	-0.479757359	N/A	N/A	N/A	0.014525824	N/A	N/A	123300.31
20	9/23/2008-11/3/2008	30	-0.524675626	N/A	N/A	N/A	0.016028399	N/A	N/A	127337.76
21	10/7/2008-11/17/2008	30	-0.51804855	N/A	N/A	N/A	0.016515040	N/A	N/A	103687.06
22	10/21/2008-12/1/2008	30	-0.536296529	N/A	N/A	N/A	0.017080419	N/A	N/A	117529.07
23	11/4/2008-12/15/2008	30	-0.530754472	N/A	N/A	N/A	0.017688713	N/A	N/A	145062.29
24	11/18/2008-12/29/2008	30	-0.522323095	N/A	N/A	N/A	0.018067440	N/A	N/A	132628.91
25	12/2/2008-1/12/2009	30	-0.492956193	N/A	N/A	N/A	0.016936763	N/A	N/A	119153.01
26	12/16/2008-1/26/2009	30	-0.387112237	N/A	N/A	N/A	0.015456751	N/A	N/A	40573.40
27	12/30/2008-2/9/2009	30	-0.425310999	N/A	N/A	N/A	0.012227730	N/A	N/A	15100.55
28	1/13/2009-2/23/2009	30	-0.422198686	N/A	N/A	N/A	0.012247009	N/A	N/A	11638.86
29	1/27/2009-3/9/2009	30	-0.527188429	N/A	N/A	N/A	0.012729711	N/A	N/A	25572.66
30	2/10/2009-3/23/2009	30	-0.403173227	N/A	N/A	N/A	0.016455254	N/A	N/A	23599.84
31	2/24/2009-4/6/2009	30	-0.552308952	N/A	N/A	N/A	0.013813184	N/A	N/A	17914.72
32	3/10/2009-4/20/2009	30	-0.480679021	N/A	N/A	N/A	0.013226015	N/A	N/A	26790.51
33	3/24/2009-5/4/2009	30	-0.470017465	N/A	N/A	N/A	0.011730853	N/A	N/A	50639.38
34	4/7/2009-5/18/2009	30	-0.550616489	N/A	N/A	N/A	0.010047619	N/A	N/A	49188.08
35	4/21/2009-6/1/2009	30	-0.373797914	N/A	N/A	N/A	0.010688918	N/A	N/A	30974.15
36	5/5/2009-6/15/2009	30	-0.465149924	N/A	N/A	N/A	0.009604781	N/A	N/A	14891.39
37	5/19/2009-6/29/2009	30	-0.502243277	N/A	N/A	N/A	0.009391224	N/A	N/A	12707.77
38	6/2/2009-7/13/2009	30	-0.367431893	N/A	N/A	N/A	0.009164259	N/A	N/A	12238.38
39	6/16/2009-7/27/2009	30	-0.466180691	N/A	N/A	N/A	0.008348104	N/A	N/A	30578.82
40	6/30/2009-8/10/2009	30	-0.465965423	N/A	N/A	N/A	0.006657022	N/A	N/A	40639.43
41	7/14/2009-8/24/2009	30	-0.463997566	N/A	N/A	N/A	0.005496307	N/A	N/A	17290.02
42	7/28/2009-9/7/2009	30	-0.50501894	N/A	N/A	N/A	0.005232458	N/A	N/A	9426.30
43	8/11/2009-9/21/2009	30	-0.375914612	N/A	N/A	N/A	0.007241038	N/A	N/A	85495.57
44	9/8/2009-10/6/2009	30	-0.469958863	N/A	N/A	N/A	0.009679234	N/A	N/A	124517.67

Average Sum of Squared Errors   85,023.53

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Kraft Foods Inc.   NYSE: KFT   Industry: Consumer Goods

Model 2   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.377427205	N/A	N/A	N/A	0.0063762139	0.000171403	N/A	25015.20
2	1/15/2008-2/25/2008	30	-0.513940126	N/A	N/A	N/A	0.0083178272	0.000179907	N/A	59675.64
3	1/29/2008-3/10/2008	30	-0.499718375	N/A	N/A	N/A	0.0096001119	0.000197597	N/A	59944.57
4	2/12/2008-3/24/2008	30	-0.383654469	N/A	N/A	N/A	0.0115833651	0.000229835	N/A	101246.52
5	2/26/2008-4/7/2008	30	-0.483479992	N/A	N/A	N/A	0.0110632905	0.000234566	N/A	117764.28
6	3/11/2008-4/21/2008	30	-0.55228842	N/A	N/A	N/A	0.0108159653	0.000216637	N/A	145760.46
7	3/25/2008-5/25/2008	30	-0.485796029	N/A	N/A	N/A	0.0089723966	0.000179419	N/A	39442.35
8	4/8/2008-5/19/2008	30	-0.466483324	N/A	N/A	N/A	0.0084964398	0.000160012	N/A	23115.82
9	4/22/2008-6/2/2008	30	-0.46024408	N/A	N/A	N/A	0.0084548948	0.000160155	N/A	20554.11
10	5/6/2008-6/16/2008	30	-0.389180551	N/A	N/A	N/A	0.0089258381	0.000171142	N/A	20819.51
11	5/20/2008-6/30/2008	30	-0.370490563	N/A	N/A	N/A	0.0092160095	0.000183380	N/A	13265.96
12	6/3/2008-7/14/2008	30	-0.463255312	N/A	N/A	N/A	0.0093332341	0.000187453	N/A	14084.28
13	6/17/2008-7/28/2008	30	-0.356583747	N/A	N/A	N/A	0.0089357832	0.000176576	N/A	28249.75
14	7/1/2008-8/11/2008	30	-0.550112904	N/A	N/A	N/A	0.0083312603	0.000164400	N/A	35609.06
15	7/15/2008-8/25/2008	30	-0.455701001	N/A	N/A	N/A	0.0076388649	0.000152011	N/A	8948.37
16	7/29/2008-9/8/2008	30	-0.502673825	N/A	N/A	N/A	0.0073998419	0.000150700	N/A	4375.25
17	8/12/2008-9/22/2008	30	-0.462779954	N/A	N/A	N/A	0.0074798997	0.000161527	N/A	11811.58
18	8/26/2008-10/6/2008	30	-0.529638944	N/A	N/A	N/A	0.0077246229	0.000169645	N/A	15918.99
19	9/9/2008-10/20/2008	30	-0.501052957	N/A	N/A	N/A	0.0088894766	0.000179010	N/A	42835.58
20	9/23/2008-11/3/2008	30	-0.518129114	N/A	N/A	N/A	0.0102936952	0.000182526	N/A	44538.58
21	10/7/2008-11/17/2008	30	-0.417249782	N/A	N/A	N/A	0.0109149678	0.000178215	N/A	27544.94
22	10/21/2008-12/1/2008	30	-0.476499162	N/A	N/A	N/A	0.0112656413	0.000184630	N/A	35174.76
23	11/4/2008-12/15/2008	30	-0.385503949	N/A	N/A	N/A	0.0116429753	0.000191172	N/A	55408.41
24	11/18/2008-12/29/2008	30	-0.518128569	N/A	N/A	N/A	0.0119647203	0.000192033	N/A	40444.83
25	12/2/2008-1/12/2009	30	-0.424722666	N/A	N/A	N/A	0.0126274845	0.000134958	N/A	72679.69
26	12/16/2008-1/26/2009	30	-0.353889458	N/A	N/A	N/A	0.0133376707	0.000066119	N/A	29632.44
27	12/30/2008-2/9/2009	30	-0.358033439	N/A	N/A	N/A	0.0146423010	0.000006273	N/A	14998.55
28	1/13/2009-2/23/2009	30	-0.442144469	N/A	N/A	N/A	0.0123594979	-0.000003505	N/A	11591.53
29	1/27/2009-3/9/2009	30	-0.422503337	N/A	N/A	N/A	0.0127848013	-0.000001721	N/A	25560.97
30	2/10/2009-3/23/2009	30	-0.53161763	N/A	N/A	N/A	0.0162681207	0.000005875	N/A	23509.19
31	2/24/2009-4/6/2009	30	-0.380283828	N/A	N/A	N/A	0.0166331464	0.000004273	N/A	17865.25
32	3/10/2009-4/20/2009	30	-0.371906745	N/A	N/A	N/A	0.0132240625	0.000000061	N/A	26790.49
33	3/24/2009-5/4/2009	30	-0.515426652	N/A	N/A	N/A	0.0118211356	-0.000002821	N/A	50607.94
34	4/7/2009-5/18/2009	30	-0.412614738	N/A	N/A	N/A	0.0120202266	0.000005484	N/A	49108.40
35	4/21/2009-6/1/2009	30	-0.441816142	N/A	N/A	N/A	0.0101458960	0.000017019	N/A	30207.13
36	5/5/2009-6/15/2009	30	-0.395348949	N/A	N/A	N/A	0.0086382274	0.000030374	N/A	12470.62
37	5/19/2009-6/29/2009	30	-0.478902046	N/A	N/A	N/A	0.0080484331	0.000042314	N/A	8054.12
38	6/2/2009-7/13/2009	30	-0.469808134	N/A	N/A	N/A	0.0077207777	0.000045482	N/A	6856.95
39	6/16/2009-7/27/2009	30	-0.475899014	N/A	N/A	N/A	0.0069942846	0.000042568	N/A	25826.97
40	6/30/2009-8/10/2009	30	-0.356358888	N/A	N/A	N/A	0.0053200571	0.000041955	N/A	35985.56
41	7/14/2009-8/24/2009	30	-0.395347334	N/A	N/A	N/A	0.0042139066	0.000040208	N/A	12847.78
42	7/28/2009-9/7/2009	30	-0.519945141	N/A	N/A	N/A	0.0038379170	0.000043688	N/A	4339.46
43	8/11/2009-9/21/2009	30	-0.474196811	N/A	N/A	N/A	0.0048984532	0.000073509	N/A	71208.51
44	9/8/2009-10/6/2009	30	-0.548698017	N/A	N/A	N/A	0.0060051074	0.000115599	N/A	89613.04

Average Sum of Squared Errors   36,620.53

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Kraft Foods Inc.   NYSE: KFT   Industry: Consumer Goods

Model 3   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.396884021	N/A	0.342201561	N/A	0.003969612	N/A	0.023631398	68318.67
2	1/15/2008-2/25/2008	30	-0.54722212	N/A	0.323057598	N/A	0.00465595	N/A	0.026934541	97452.55
3	1/29/2008-3/10/2008	30	-0.496594934	N/A	0.331204109	N/A	0.005522031	N/A	0.030533236	115172.96
4	2/12/2008-3/24/2008	30	-0.484390691	N/A	0.321579827	N/A	0.006520454	N/A	0.03778443	163630.22
5	2/26/2008-4/7/2008	30	-0.497432879	N/A	0.319339908	N/A	0.006389783	N/A	0.03584686	172314.13
6	3/11/2008-4/21/2008	30	-0.471642705	N/A	0.321084315	N/A	0.005900745	N/A	0.036300205	190570.07
7	3/25/2008-5/25/2008	30	-0.441368262	N/A	0.337081303	N/A	0.005017925	N/A	0.029052369	88602.11
8	4/8/2008-5/19/2008	30	-0.451053758	N/A	0.343308077	N/A	0.004386993	N/A	0.028043514	60175.30
9	4/22/2008-6/2/2008	30	-0.538706132	N/A	0.320081557	N/A	0.004490913	N/A	0.027404626	61100.53
10	5/6/2008-6/16/2008	30	-0.533494159	N/A	0.331350278	N/A	0.004753109	N/A	0.02898483	64592.04
11	5/20/2008-6/30/2008	30	-0.379186861	N/A	0.332592715	N/A	0.005174696	N/A	0.029702686	70206.56
12	6/3/2008-7/14/2008	30	-0.403831778	N/A	0.339667905	N/A	0.004993403	N/A	0.030880358	67738.42
13	6/17/2008-7/28/2008	30	-0.420550894	N/A	0.341144613	N/A	0.005016014	N/A	0.023424289	73761.92
14	7/1/2008-8/11/2008	30	-0.480578244	N/A	0.337047877	N/A	0.004664532	N/A	0.026938574	73799.00
15	7/15/2008-8/25/2008	30	-0.397659129	N/A	0.330621302	N/A	0.004145222	N/A	0.023754337	48602.57
16	7/29/2008-9/8/2008	30	-0.439761608	N/A	0.329851355	N/A	0.004021712	N/A	0.024367856	42707.12
17	8/12/2008-9/22/2008	30	-0.510288688	N/A	0.336644226	N/A	0.004246807	N/A	0.025524839	52543.63
18	8/26/2008-10/6/2008	30	-0.431735497	N/A	0.329990572	N/A	0.004565009	N/A	0.027385436	63342.91
19	9/9/2008-10/20/2008	30	-0.396403312	N/A	0.343552067	N/A	0.004943523	N/A	0.029047134	88553.16
20	9/23/2008-11/3/2008	30	-0.551339487	N/A	0.319687517	N/A	0.005432447	N/A	0.032010984	90152.51
21	10/7/2008-11/17/2008	30	-0.394945454	N/A	0.330679241	N/A	0.005289342	N/A	0.034553543	74359.56
22	10/21/2008-12/1/2008	30	-0.532252731	N/A	0.344324107	N/A	0.005668513	N/A	0.032520152	79970.21
23	11/4/2008-12/15/2008	30	-0.524945768	N/A	0.341657170	N/A	0.005956748	N/A	0.035142752	103867.74
24	11/18/2008-12/29/2008	30	-0.462478607	N/A	0.328872878	N/A	0.006233702	N/A	0.037203551	91913.25
25	12/2/2008-1/12/2009	30	-0.453080227	N/A	0.325215285	N/A	0.005400455	N/A	0.032963109	45540.68
26	12/16/2008-1/26/2009	30	-0.410617406	N/A	0.348081302	N/A	0.005283436	N/A	0.030083192	18805.05
27	12/30/2008-2/9/2009	30	-0.381965222	N/A	0.339783796	N/A	0.004264228	N/A	0.025455465	10074.77
28	1/13/2009-2/23/2009	30	-0.48095706	N/A	0.366486860	N/A	0.004035323	N/A	0.023593653	7632.36
29	1/27/2009-3/9/2009	30	-0.397955065	N/A	0.341765499	N/A	0.004099404	N/A	0.025661026	15279.55
30	2/10/2009-3/23/2009	30	-0.526131058	N/A	0.351214226	N/A	0.005658048	N/A	0.031399709	15659.47
31	2/24/2009-4/6/2009	30	-0.55000306	N/A	0.369627278	N/A	0.004586307	N/A	0.026557545	12251.83
32	3/10/2009-4/20/2009	30	-0.538242223	N/A	0.358245587	N/A	0.004545078	N/A	0.027655472	17573.85
33	3/24/2009-5/4/2009	30	-0.543663351	N/A	0.368892125	N/A	0.003844339	N/A	0.022885	30654.29
34	4/7/2009-5/18/2009	30	-0.500165366	N/A	0.350519112	N/A	0.003496282	N/A	0.021068473	20452.77
35	4/21/2009-6/1/2009	30	-0.480889911	N/A	0.327955054	N/A	0.003453276	N/A	0.021207407	14808.15
36	5/5/2009-6/15/2009	30	-0.510092237	N/A	0.348230292	N/A	0.003116636	N/A	0.020077342	6569.18
37	5/19/2009-6/29/2009	30	-0.491330183	N/A	0.332189014	N/A	0.00301406	N/A	0.019716921	8938.66
38	6/2/2009-7/13/2009	30	-0.546067028	N/A	0.344871583	N/A	0.002913959	N/A	0.019106368	8639.40
39	6/16/2009-7/27/2009	30	-0.4665139	N/A	0.351501917	N/A	0.002920526	N/A	0.017065647	2204.24
40	6/30/2009-8/10/2009	30	-0.505859518	N/A	0.349994759	N/A	0.002120709	N/A	0.012742012	2949.72
41	7/14/2009-8/24/2009	30	-0.464177766	N/A	0.346329438	N/A	0.001799203	N/A	0.011072739	8009.31
42	7/28/2009-9/7/2009	30	-0.436473077	N/A	0.350815426	N/A	0.001658674	N/A	0.010552476	6478.27
43	8/11/2009-9/21/2009	30	-0.484382361	N/A	0.340320576	N/A	0.002438685	N/A	0.014122006	9855.50
44	9/8/2009-10/6/2009	30	-0.546787933	N/A	0.351533162	N/A	0.003086635	N/A	0.019134844	87913.27

Average Sum of Squared Errors   55,766.76

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Kraft Foods Inc.</u>   NYSE: <u>KFT</u>   Industry: <u>Consumer Goods</u>

Model 4   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 - b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.408583413	N/A	0.343031576	0.024265955	0.003744289	N/A	0.024489554	64248.21
2	1/15/2008-2/25/2008	30	-0.395970766	N/A	0.324834678	0.027483516	0.004446212	N/A	0.027972084	89520.14
3	1/29/2008-3/10/2008	30	-0.522469805	N/A	0.331412457	0.032518382	0.005522662	N/A	0.031913894	104892.19
4	2/12/2008-3/24/2008	30	-0.375847471	N/A	0.323235979	0.039255947	0.006376342	N/A	0.037822432	158905.66
5	2/26/2008-4/7/2008	30	-0.500456986	N/A	0.319429305	0.036093372	0.005877949	N/A	0.037834180	166077.52
6	3/11/2008-4/21/2008	30	-0.361448869	N/A	0.321088458	0.035396949	0.005742121	N/A	0.035248558	169948.52
7	3/25/2008-5/25/2008	30	-0.476325933	N/A	0.315838528	0.029026846	0.004859235	N/A	0.028259604	83357.03
8	4/8/2008-5/19/2008	30	-0.516337881	N/A	0.333815389	0.026296156	0.004707388	N/A	0.028109159	54145.16
9	4/22/2008-6/2/2008	30	-0.371847161	N/A	0.329658261	0.027291656	0.004653351	N/A	0.026210264	57286.99
10	5/6/2008-6/16/2008	30	-0.531261494	N/A	0.331509687	0.027798243	0.004895730	N/A	0.028104052	57238.78
11	5/20/2008-6/30/2008	30	-0.495344057	N/A	0.327647025	0.028486161	0.005055128	N/A	0.029989667	65814.31
12	6/3/2008-7/14/2008	30	-0.487776999	N/A	0.324357818	0.029488163	0.005196637	N/A	0.031555104	59923.86
13	6/17/2008-7/28/2008	30	-0.545282999	N/A	0.328083565	0.030267338	0.004768489	N/A	0.027655717	71056.49
14	7/1/2008-8/11/2008	30	-0.542277479	N/A	0.343210043	0.027381746	0.004587410	N/A	0.026677208	71526.57
15	7/15/2008-8/25/2008	30	-0.469962152	N/A	0.332702643	0.025953959	0.003986230	N/A	0.023736482	44547.70
16	7/29/2008-9/8/2008	30	-0.545066741	N/A	0.309600667	0.024708363	0.003925352	N/A	0.023895329	37852.61
17	8/12/2008-9/22/2008	30	-0.379801121	N/A	0.337909784	0.025989284	0.004288410	N/A	0.024805981	49043.17
18	8/26/2008-10/6/2008	30	-0.499060128	N/A	0.312128393	0.027421590	0.004570174	N/A	0.025449468	59005.82
19	9/9/2008-10/20/2008	30	-0.431950422	N/A	0.345633962	0.028870999	0.004971691	N/A	0.027961240	79735.39
20	9/23/2008-11/3/2008	30	-0.389980436	N/A	0.337660562	0.033235732	0.005506822	N/A	0.032292045	80233.10
21	10/7/2008-11/17/2008	30	-0.398456437	N/A	0.322366464	0.034477827	0.005727085	N/A	0.032517662	68599.80
22	10/21/2008-12/1/2008	30	-0.478158786	N/A	0.346648122	0.033637992	0.005831362	N/A	0.034354315	70954.03
23	11/4/2008-12/15/2008	30	-0.526084502	N/A	0.329963971	0.036046177	0.005924477	N/A	0.035510105	94257.12
24	11/18/2008-12/29/2008	30	-0.369740819	N/A	0.334036630	0.037892153	0.006127857	N/A	0.037563584	89592.01
25	12/2/2008-1/12/2009	30	-0.496457793	N/A	0.340989763	0.034163359	0.005635736	N/A	0.034127669	44040.14
26	12/16/2008-1/26/2009	30	-0.535186493	N/A	0.326567138	0.032262565	0.005108398	N/A	0.031889914	17916.76
27	12/30/2008-2/9/2009	30	-0.539692109	N/A	0.339270776	0.024199223	0.004082398	N/A	0.023318109	9289.82
28	1/13/2009-2/23/2009	30	-0.503717649	N/A	0.349030723	0.024261386	0.004146412	N/A	0.024486072	6758.73
29	1/27/2009-3/9/2009	30	-0.386183655	N/A	0.345786468	0.026063878	0.004286911	N/A	0.025292055	14537.67
30	2/10/2009-3/23/2009	30	-0.414158811	N/A	0.356509376	0.033215304	0.005306913	N/A	0.032541223	13850.38
31	2/24/2009-4/6/2009	30	-0.395720117	N/A	0.345563840	0.026986278	0.004570441	N/A	0.026273994	11906.28
32	3/10/2009-4/20/2009	30	-0.493063523	N/A	0.340142960	0.025180268	0.004198035	N/A	0.026948093	16673.17
33	3/24/2009-5/4/2009	30	-0.430147202	N/A	0.370959766	0.022650174	0.004073199	N/A	0.024127296	28863.68
34	4/7/2009-5/18/2009	30	-0.391585474	N/A	0.360126306	0.020830110	0.003237686	N/A	0.020086059	19196.90
35	4/21/2009-6/1/2009	30	-0.466728279	N/A	0.328524393	0.020982962	0.003401340	N/A	0.021514796	14207.96
36	5/5/2009-6/15/2009	30	-0.522354389	N/A	0.342732468	0.019291180	0.003276057	N/A	0.018803897	5936.67
37	5/19/2009-6/29/2009	30	-0.438543558	N/A	0.340271773	0.019634791	0.003186224	N/A	0.019048852	8300.43
38	6/2/2009-7/13/2009	30	-0.455462660	N/A	0.352189621	0.017974433	0.002916737	N/A	0.018088902	8179.47
39	6/16/2009-7/27/2009	30	-0.406596001	N/A	0.330816880	0.015944317	0.002820669	N/A	0.017046658	2049.91
40	6/30/2009-8/10/2009	30	-0.537737209	N/A	0.345061718	0.013155869	0.002194699	N/A	0.013595867	2630.24
41	7/14/2009-8/24/2009	30	-0.426341623	N/A	0.330306339	0.011453080	0.001870101	N/A	0.011301186	7201.87
42	7/28/2009-9/7/2009	30	-0.553180622	N/A	0.321312241	0.010944986	0.001718502	N/A	0.010890010	6037.12
43	8/11/2009-9/21/2009	30	-0.472207624	N/A	0.326081355	0.013800279	0.002380635	N/A	0.014470961	9433.14
44	9/8/2009-10/6/2009	30	-0.506184559	N/A	0.324735414	0.019861880	0.003211950	N/A	0.020160782	84617.17

Average Sum of Squared Errors 51,804.31

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Kraft Foods Inc.</u>   NYSE: <u>KFT</u>   Industry: <u>Consumer Goods</u>

Model 5   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.049722905	-39.623227464	N/A	N/A	0.006333179	0.000175320	N/A	18513.89
2	1/15/2008-2/25/2008	30	-0.001142559	-39.554146954	N/A	N/A	0.008174815	0.000187975	N/A	47497.91
3	1/29/2008-3/10/2008	30	0.094759895	-38.924322204	N/A	N/A	0.009163427	0.000206903	N/A	43483.69
4	2/12/2008-3/24/2008	30	-0.008292641	-38.463877181	N/A	N/A	0.011691787	0.000227342	N/A	78017.33
5	2/26/2008-4/7/2008	30	-0.023325293	-35.257525194	N/A	N/A	0.010658749	0.000242658	N/A	89884.19
6	3/11/2008-4/21/2008	30	0.021426285	-41.754410076	N/A	N/A	0.011324437	0.000217669	N/A	109791.41
7	3/25/2008-5/25/2008	30	0.012988857	-37.871342392	N/A	N/A	0.009037025	0.000175415	N/A	28643.64
8	4/8/2008-5/19/2008	30	0.097814707	-40.700741418	N/A	N/A	0.008082303	0.000157324	N/A	17913.72
9	4/22/2008-6/2/2008	30	-0.000927151	-37.920203669	N/A	N/A	0.008742206	0.000166106	N/A	16155.33
10	5/6/2008-6/16/2008	30	0.075699068	-40.726420113	N/A	N/A	0.008985114	0.000177873	N/A	15915.31
11	5/20/2008-6/30/2008	30	0.083591242	-39.212864426	N/A	N/A	0.008778407	0.000190872	N/A	9995.00
12	6/3/2008-7/14/2008	30	0.002842342	-34.825904911	N/A	N/A	0.009107964	0.000182807	N/A	10944.86
13	6/17/2008-7/28/2008	30	0.074724982	-35.994732237	N/A	N/A	0.009188159	0.000171215	N/A	22402.92
14	7/1/2008-8/11/2008	30	0.024315055	-37.192043311	N/A	N/A	0.008338223	0.000169992	N/A	26252.39
15	7/15/2008-8/25/2008	30	0.003818802	-38.969451952	N/A	N/A	0.007741507	0.000148602	N/A	6678.82
16	7/29/2008-9/8/2008	30	-0.092253825	-38.351811207	N/A	N/A	0.007218734	0.000155646	N/A	3249.65
17	8/12/2008-9/22/2008	30	-0.090132945	-41.323305042	N/A	N/A	0.007181405	0.000155751	N/A	9157.49
18	8/26/2008-10/6/2008	30	-0.088921448	-42.108917903	N/A	N/A	0.008023044	0.000168115	N/A	12241.50
19	9/9/2008-10/20/2008	30	-0.094350478	-42.101760442	N/A	N/A	0.009055323	0.000179612	N/A	33875.80
20	9/23/2008-11/3/2008	30	0.094232847	-40.326129888	N/A	N/A	0.010459595	0.000185813	N/A	34392.40
21	10/7/2008-11/17/2008	30	0.098857806	-40.811280185	N/A	N/A	0.010781688	0.000186097	N/A	19982.47
22	10/21/2008-12/1/2008	30	0.075522556	-33.683613079	N/A	N/A	0.010972870	0.000191750	N/A	26510.71
23	11/4/2008-12/15/2008	30	-0.039959565	-40.462867810	N/A	N/A	0.011116388	0.000189865	N/A	41368.49
24	11/18/2008-12/29/2008	30	-0.099165289	-35.467923117	N/A	N/A	0.012080593	0.000196493	N/A	30451.68
25	12/2/2008-1/12/2009	30	-0.013320148	-37.221548560	N/A	N/A	0.013245603	0.000134344	N/A	52803.38
26	12/16/2008-1/26/2009	30	-0.072946915	-37.491911957	N/A	N/A	0.012936205	0.000065402	N/A	23211.82
27	12/30/2008-2/9/2009	30	0.093820773	-35.561155614	N/A	N/A	0.015162349	0.000006496	N/A	11447.62
28	1/13/2009-2/23/2009	30	0.037152536	-34.977450249	N/A	N/A	0.012755563	-0.000003368	N/A	8690.62
29	1/27/2009-3/9/2009	30	-0.061540111	-36.267459862	N/A	N/A	0.012817177	-0.000001700	N/A	19632.50
30	2/10/2009-3/23/2009	30	-0.049463956	-37.252253247	N/A	N/A	0.016985031	0.000006004	N/A	18676.16
31	2/24/2009-4/6/2009	30	0.022884877	-38.258400651	N/A	N/A	0.015981209	0.000004310	N/A	13474.28
32	3/10/2009-4/20/2009	30	-0.006130829	-35.833407128	N/A	N/A	0.013583856	0.000000059	N/A	20834.43
33	3/24/2009-5/4/2009	30	0.000573036	-41.360344697	N/A	N/A	0.012376807	-0.000002873	N/A	37430.29
34	4/7/2009-5/18/2009	30	-0.095837836	-40.966025533	N/A	N/A	0.011514022	0.000005572	N/A	38186.55
35	4/21/2009-6/1/2009	30	-0.096326177	-41.100637372	N/A	N/A	0.010426698	0.000017062	N/A	23717.00
36	5/5/2009-6/15/2009	30	-0.085295302	-36.518489282	N/A	N/A	0.008775115	0.000029791	N/A	9499.09
37	5/19/2009-6/29/2009	30	0.043070909	-36.252400345	N/A	N/A	0.007976822	0.000042017	N/A	6067.30
38	6/2/2009-7/13/2009	30	-0.063988000	-36.496270852	N/A	N/A	0.007788676	0.000043909	N/A	4981.34
39	6/16/2009-7/27/2009	30	0.088541036	-36.859126233	N/A	N/A	0.007173318	0.000041260	N/A	19583.46
40	6/30/2009-8/10/2009	30	-0.002264006	-36.823983228	N/A	N/A	0.005254848	0.000040302	N/A	28050.71
41	7/14/2009-8/24/2009	30	0.030260275	-38.726221670	N/A	N/A	0.004068210	0.000041465	N/A	9802.29
42	7/28/2009-9/7/2009	30	0.096665897	-42.040805656	N/A	N/A	0.003397791	0.000042752	N/A	3182.37
43	8/11/2009-9/21/2009	30	0.032065210	-39.657807390	N/A	N/A	0.004934059	0.000074202	N/A	56182.43
44	9/8/2009-10/6/2009	30	0.070597356	-37.210374476	N/A	N/A	0.006155847	0.000120174	N/A	64844.23

Average Sum of Squared Errors   27,809.51

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Kraft Foods Inc.</u> **NYSE:** <u>KFT</u> **Industry:** <u>Consumer Goods</u>

Model 6 **Default Intensity:** $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ **Default Probability:** $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ **Recovery Rate:** $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	a0	a1	b0	b1	c0	c1	c2	Sum of squared errors
1	1/1/2008-2/11/2008	30	0.013755499	-35.898636635	0.328761619	N/A	0.004003886	N/A	0.022639888	52630.54
2	1/15/2008-2/25/2008	30	-0.021032114	-40.233845591	0.322116986	N/A	0.004560494	N/A	0.029054033	75842.56
3	1/29/2008-3/10/2008	30	0.003742722	-38.481307232	0.339421381	N/A	0.005474923	N/A	0.031703252	92253.20
4	2/12/2008-3/24/2008	30	0.002500633	-40.105552767	0.326856248	N/A	0.006331289	N/A	0.038468042	129559.65
5	2/26/2008-4/7/2008	30	-0.078089403	-38.259659989	0.331549155	N/A	0.005956378	N/A	0.035618969	137741.85
6	3/11/2008-4/21/2008	30	0.012232240	-34.882635226	0.314646036	N/A	0.005605688	N/A	0.036816247	154838.05
7	3/25/2008-5/25/2008	30	0.014641712	-34.668110641	0.340339986	N/A	0.004690680	N/A	0.029663646	70048.43
8	4/8/2008-5/19/2008	30	0.082836645	-36.825128477	0.342977278	N/A	0.004550312	N/A	0.026635011	47871.42
9	4/22/2008-6/2/2008	30	-0.015507711	-34.882073655	0.325950691	N/A	0.004517589	N/A	0.026192823	46972.74
10	5/6/2008-6/16/2008	30	0.088460479	-34.778492894	0.331792409	N/A	0.004622386	N/A	0.028874900	51955.46
11	5/20/2008-6/30/2008	30	0.057352691	-38.562283103	0.324005695	N/A	0.005234705	N/A	0.031111140	54435.91
12	6/3/2008-7/14/2008	30	-0.054831872	-42.252652067	0.335980326	N/A	0.005103268	N/A	0.029396722	51153.95
13	6/17/2008-7/28/2008	30	0.084948825	-39.657274049	0.346532811	N/A	0.004693663	N/A	0.028980242	59779.04
14	7/1/2008-8/11/2008	30	0.030667927	-38.323721362	0.326888840	N/A	0.004713398	N/A	0.027022416	58155.42
15	7/15/2008-8/25/2008	30	0.045088301	-34.979575686	0.340141358	N/A	0.004040635	N/A	0.024591658	37796.48
16	7/29/2008-9/8/2008	30	0.023277177	-38.833342908	0.311506065	N/A	0.003895511	N/A	0.025500647	32507.23
17	8/12/2008-9/22/2008	30	-0.026276107	-37.538146163	0.317417116	N/A	0.004231298	N/A	0.025754236	39210.02
18	8/26/2008-10/6/2008	30	0.077885450	-40.919554504	0.310067553	N/A	0.004401136	N/A	0.025760663	47837.23
19	9/9/2008-10/20/2008	30	0.017111000	-40.520210140	0.324634707	N/A	0.004743070	N/A	0.030076815	68851.33
20	9/23/2008-11/3/2008	30	0.049446319	-37.632920391	0.328063085	N/A	0.005388123	N/A	0.033172340	72710.74
21	10/7/2008-11/17/2008	30	0.053944466	-36.653395817	0.323496850	N/A	0.005309580	N/A	0.034268749	58348.90
22	10/21/2008-12/1/2008	30	0.072384587	-40.801828143	0.337278425	N/A	0.005428673	N/A	0.032462280	64886.17
23	11/4/2008-12/15/2008	30	0.009484450	-36.780869765	0.350967505	N/A	0.005605874	N/A	0.034851130	79563.56
24	11/18/2008-12/29/2008	30	-0.090874753	-38.755766932	0.337692175	N/A	0.006061567	N/A	0.036258186	68516.69
25	12/2/2008-1/12/2009	30	-0.037506454	-34.704965137	0.327107322	N/A	0.005691398	N/A	0.032835938	34840.10
26	12/16/2008-1/26/2009	30	-0.042471299	-34.880144558	0.353986538	N/A	0.004946418	N/A	0.030677926	14380.07
27	12/30/2008-2/9/2009	30	-0.008816653	-36.941504737	0.331137364	N/A	0.003996563	N/A	0.024356022	7474.49
28	1/13/2009-2/23/2009	30	-0.068024312	-36.882917991	0.358916019	N/A	0.003885887	N/A	0.024633890	5744.60
29	1/27/2009-3/9/2009	30	0.039156862	-41.709853691	0.349348255	N/A	0.004445464	N/A	0.025114674	11391.35
30	2/10/2009-3/23/2009	30	-0.011084052	-42.130472904	0.352438566	N/A	0.005542354	N/A	0.031901412	12141.53
31	2/24/2009-4/6/2009	30	-0.041394175	-38.842358305	0.369519339	N/A	0.004734736	N/A	0.028841873	9928.40
32	3/10/2009-4/20/2009	30	0.056994770	-40.261985477	0.342035466	N/A	0.004219440	N/A	0.026559282	14256.09
33	3/24/2009-5/4/2009	30	-0.060889803	-41.694843013	0.342090125	N/A	0.003982392	N/A	0.022536039	23415.83
34	4/7/2009-5/18/2009	30	-0.002713228	-41.783318937	0.337391930	N/A	0.003373299	N/A	0.020671629	15241.48
35	4/21/2009-6/1/2009	30	-0.078285445	-40.415313141	0.347621665	N/A	0.003725782	N/A	0.020908630	11570.78
36	5/5/2009-6/15/2009	30	-0.068534781	-40.529117001	0.357591334	N/A	0.003061358	N/A	0.019195565	5275.62
37	5/19/2009-6/29/2009	30	0.072739112	-40.749868462	0.354168028	N/A	0.002979123	N/A	0.019311428	7124.56
38	6/2/2009-7/13/2009	30	0.069821836	-40.038612447	0.330299697	N/A	0.003095886	N/A	0.017831319	6866.96
39	6/16/2009-7/27/2009	30	0.028333353	-40.847559169	0.351711461	N/A	0.002835122	N/A	0.016670505	1800.63
40	6/30/2009-8/10/2009	30	0.027165627	-41.860865883	0.330014760	N/A	0.002251352	N/A	0.013906544	2406.65
41	7/14/2009-8/24/2009	30	-0.038755552	-41.045219948	0.344832006	N/A	0.001824517	N/A	0.011233296	6343.13
42	7/28/2009-9/7/2009	30	-0.014256413	-40.850445770	0.341399039	N/A	0.001826936	N/A	0.010663999	4920.08
43	8/11/2009-9/21/2009	30	0.020414734	-41.804974245	0.328058771	N/A	0.002394847	N/A	0.014558291	7837.77
44	9/8/2009-10/6/2009	30	0.005098749	-37.725470844	0.345236571	N/A	0.003306543	N/A	0.018805705	70883.18

Average Sum of Squared Errors 43,802.50

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

	Reference Entity:	Kraft Foods Inc.	NYSE:		KFT		Industry:	Consumer Goods	

Model 7 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.043268108	-35.782476156	0.329507573	0.000095741	0.003966541	N/A	0.023893164	51219.63
2	1/15/2008-2/25/2008	30	-0.024289694	-34.631948275	0.331250093	0.000066653	0.004434722	N/A	0.027483408	67015.01
3	1/29/2008-3/10/2008	30	0.003684233	-39.704353982	0.336574399	0.000081959	0.005045448	N/A	0.032713728	86095.15
4	2/12/2008-3/24/2008	30	0.024215388	-38.345044433	0.344424597	-0.000051990	0.006246669	N/A	0.037522700	122101.64
5	2/26/2008-4/7/2008	30	0.098584010	-41.584210742	0.339640368	-0.000034152	0.006206729	N/A	0.035479236	128942.07
6	3/11/2008-4/21/2008	30	-0.067746114	-40.930054991	0.313794481	0.000044732	0.005685699	N/A	0.035601326	148160.42
7	3/25/2008-5/25/2008	30	0.074187728	-37.447239062	0.334702846	0.000048539	0.004932976	N/A	0.030060043	65701.40
8	4/8/2008-5/19/2008	30	0.071629795	-40.057961419	0.330431961	0.000025948	0.004449743	N/A	0.027787754	44971.60
9	4/22/2008-6/2/2008	30	-0.078554732	-40.417751426	0.317362531	-0.000091894	0.004411910	N/A	0.028284911	44411.58
10	5/6/2008-6/16/2008	30	0.013736447	-36.851170896	0.323112992	0.000081424	0.004745916	N/A	0.029731603	48788.72
11	5/20/2008-6/30/2008	30	-0.049545418	-34.714063613	0.328091016	-0.000036021	0.004873315	N/A	0.028947807	51173.44
12	6/3/2008-7/14/2008	30	0.055928113	-38.445352237	0.341460109	-0.000017584	0.004868189	N/A	0.030849278	47914.88
13	6/17/2008-7/28/2008	30	-0.006186919	-37.183527809	0.322798840	-0.000023369	0.004755073	N/A	0.028995270	55799.79
14	7/1/2008-8/11/2008	30	-0.017380649	-38.473305198	0.320604325	-0.000035097	0.004590317	N/A	0.026206762	52071.83
15	7/15/2008-8/25/2008	30	0.011751949	-35.235184820	0.325757257	0.000095363	0.003947480	N/A	0.025981759	34304.24
16	7/29/2008-9/8/2008	30	0.047984297	-38.342629078	0.333308554	-0.000042603	0.003924335	N/A	0.024068789	29720.14
17	8/12/2008-9/22/2008	30	-0.097841148	-38.275240648	0.312324359	-0.000029000	0.004354762	N/A	0.025074437	36088.97
18	8/26/2008-10/6/2008	30	0.070907704	-37.134367753	0.319799842	-0.000059484	0.004249224	N/A	0.026169529	45338.25
19	9/9/2008-10/20/2008	30	-0.065125752	-36.492540625	0.326545651	0.000078481	0.004702715	N/A	0.030259457	66298.39
20	9/23/2008-11/3/2008	30	0.021327254	-37.936716484	0.346548773	-0.000052225	0.005228963	N/A	0.031679148	70265.07
21	10/7/2008-11/17/2008	30	0.080465923	-41.386430232	0.334483801	0.000065834	0.005736088	N/A	0.031664126	56335.07
22	10/21/2008-12/1/2008	30	0.088298766	-34.376372067	0.346179873	-0.000065397	0.005843813	N/A	0.032733244	57708.42
23	11/4/2008-12/15/2008	30	0.016351737	-37.462189786	0.342618880	0.000005201	0.005610281	N/A	0.035764825	74258.97
24	11/18/2008-12/29/2008	30	-0.043794118	-42.108534069	0.326056090	-0.000073211	0.005998856	N/A	0.034979078	61071.29
25	12/2/2008-1/12/2009	30	0.021371388	-35.313321021	0.346581430	0.000084494	0.005697440	N/A	0.033980470	31968.31
26	12/16/2008-1/26/2009	30	0.071855130	-39.840180748	0.345266561	0.000021233	0.005379471	N/A	0.029411075	12830.26
27	12/30/2008-2/9/2009	30	-0.015320337	-39.434275870	0.355203573	-0.000064935	0.004226534	N/A	0.023618364	6739.72
28	1/13/2009-2/23/2009	30	0.064449609	-40.761206721	0.360954765	-0.000099934	0.004244935	N/A	0.024962412	5182.67
29	1/27/2009-3/9/2009	30	-0.014748956	-40.654492758	0.366688518	0.000047526	0.004085984	N/A	0.024762544	10909.79
30	2/10/2009-3/23/2009	30	-0.098616196	-35.042475101	0.379008352	0.000085971	0.005609461	N/A	0.032842870	11362.70
31	2/24/2009-4/6/2009	30	0.089562637	-35.825384657	0.357978724	0.000015950	0.004812284	N/A	0.027547935	8871.58
32	3/10/2009-4/20/2009	30	0.023094922	-37.424826132	0.351063123	0.000038581	0.004222414	N/A	0.026976938	12883.34
33	3/24/2009-5/4/2009	30	-0.098485281	-37.360365573	0.342241688	0.000088754	0.003737099	N/A	0.022880841	21124.07
34	4/7/2009-5/18/2009	30	0.008373501	-38.727745694	0.354777133	-0.000054075	0.003360998	N/A	0.020344760	14581.45
35	4/21/2009-6/1/2009	30	0.068113951	-37.882037235	0.347379717	-0.000070292	0.003569656	N/A	0.021272502	11067.53
36	5/5/2009-6/15/2009	30	-0.006047854	-35.153198999	0.333268710	-0.000068507	0.003179762	N/A	0.018483362	5096.34
37	5/19/2009-6/29/2009	30	0.014624424	-35.068907980	0.352486240	0.000040238	0.003262517	N/A	0.019386025	6719.86
38	6/2/2009-7/13/2009	30	0.049463878	-38.504953860	0.344416225	-0.000013982	0.003103182	N/A	0.018882971	6394.41
39	6/16/2009-7/27/2009	30	-0.085563008	-37.752605065	0.329324509	0.000016435	0.002882898	N/A	0.016970960	1604.37
40	6/30/2009-8/10/2009	30	0.086186148	-37.052091417	0.347684870	-0.000043278	0.002158506	N/A	0.013022143	2268.87
41	7/14/2009-8/24/2009	30	0.020432045	-39.893656138	0.325859157	0.000005671	0.001839028	N/A	0.010869520	6071.76
42	7/28/2009-9/7/2009	30	0.069319405	-39.091224049	0.342212623	-0.000007431	0.001705258	N/A	0.010196508	4718.88
43	8/11/2009-9/21/2009	30	0.017824270	-37.017336271	0.343361072	-0.000069058	0.002309547	N/A	0.013801558	7432.79
44	9/8/2009-10/6/2009	30	0.016517234	-41.702317144	0.323455336	-0.000069365	0.003263472	N/A	0.019378915	63459.82

Average Sum of Squared Errors 40,841.92

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Kraft Foods Inc.</u> NYSE: <u>KFT</u> Industry: <u>Consumer Goods</u>

Model 8 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{1}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.551355699	N/A	0.333347800	N/A	0.006492661	0.000107215	0.009161081	15439.09
2	1/15/2008-2/25/2008	30	-0.479393773	N/A	0.332422224	N/A	0.008349149	0.000110013	0.010765429	36843.27
3	1/29/2008-3/10/2008	30	-0.462873017	N/A	0.317742404	N/A	0.009155232	0.000114717	0.012092303	37766.51
4	2/12/2008-3/24/2008	30	-0.521675100	N/A	0.316896495	N/A	0.011819787	0.000131931	0.015316259	63031.78
5	2/26/2008-4/7/2008	30	-0.514936010	N/A	0.321100085	N/A	0.011388456	0.000145987	0.015111016	73757.36
6	3/11/2008-4/21/2008	30	-0.468602462	N/A	0.329787284	N/A	0.010881192	0.000131473	0.013451951	89829.71
7	3/25/2008-5/25/2008	30	-0.451756807	N/A	0.333009291	N/A	0.008659456	0.000111741	0.011225413	26443.28
8	4/8/2008-5/19/2008	30	-0.419241865	N/A	0.327156999	N/A	0.008704098	0.000099467	0.011066584	14624.10
9	4/22/2008-6/2/2008	30	-0.354787183	N/A	0.338932226	N/A	0.008114539	0.000100310	0.010743364	13719.79
10	5/6/2008-6/16/2008	30	-0.553314038	N/A	0.322665612	N/A	0.009104328	0.000099950	0.011742261	13792.29
11	5/20/2008-6/30/2008	30	-0.389553035	N/A	0.341877351	N/A	0.009603758	0.000114497	0.011557318	8650.80
12	6/3/2008-7/14/2008	30	-0.358355203	N/A	0.317810277	N/A	0.009045495	0.000107889	0.011572378	8922.20
13	6/17/2008-7/28/2008	30	-0.413282539	N/A	0.345571206	N/A	0.009298124	0.000108887	0.011955136	17631.19
14	7/1/2008-8/11/2008	30	-0.516345711	N/A	0.327163364	N/A	0.008199351	0.000100585	0.010632723	23598.91
15	7/15/2008-8/25/2008	30	-0.494106149	N/A	0.316715133	N/A	0.007661571	0.000090704	0.009994563	5664.49
16	7/29/2008-9/8/2008	30	-0.520377138	N/A	0.336565800	N/A	0.007614358	0.000085977	0.009623588	2744.66
17	8/12/2008-9/22/2008	30	-0.374801116	N/A	0.307846003	N/A	0.007394226	0.000095527	0.010029678	7201.33
18	8/26/2008-10/6/2008	30	-0.503886125	N/A	0.331291122	N/A	0.007634217	0.000105201	0.010645059	9765.54
19	9/9/2008-10/20/2008	30	-0.429116370	N/A	0.343904373	N/A	0.008816767	0.000105627	0.011747404	26120.52
20	9/23/2008-11/3/2008	30	-0.399583313	N/A	0.318800041	N/A	0.010553155	0.000108218	0.012351634	29281.80
21	10/7/2008-11/17/2008	30	-0.421671213	N/A	0.331960014	N/A	0.011359187	0.000103430	0.013206792	17666.91
22	10/21/2008-12/1/2008	30	-0.445486781	N/A	0.328137008	N/A	0.011077457	0.000114343	0.013293623	22034.43
23	11/4/2008-12/15/2008	30	-0.385735532	N/A	0.332501408	N/A	0.011541272	0.000116504	0.014697190	36303.22
24	11/18/2008-12/29/2008	30	-0.512953195	N/A	0.335635967	N/A	0.012044891	0.000109777	0.013813374	26566.05
25	12/2/2008-1/12/2009	30	-0.402927074	N/A	0.328524747	N/A	0.012304314	0.000079049	0.013086974	45322.84
26	12/16/2008-1/26/2009	30	-0.395185374	N/A	0.341717954	N/A	0.012846214	0.000040902	0.012016250	18737.97
27	12/30/2008-2/9/2009	30	-0.425056188	N/A	0.343023778	N/A	0.014669318	0.000003623	0.010036757	10050.65
28	1/13/2009-2/23/2009	30	-0.490601779	N/A	0.345335997	N/A	0.012313716	-0.000002079	0.009579353	7435.38
29	1/27/2009-3/9/2009	30	-0.384681691	N/A	0.370214941	N/A	0.012283443	-0.000001056	0.010653584	15110.57
30	2/10/2009-3/23/2009	30	-0.387024369	N/A	0.366038911	N/A	0.016409224	0.000003436	0.012812667	15390.90
31	2/24/2009-4/6/2009	30	-0.382808431	N/A	0.364767414	N/A	0.016035710	0.000002680	0.011268316	10926.07
32	3/10/2009-4/20/2009	30	-0.422966729	N/A	0.358158842	N/A	0.013876016	0.000000036	0.010693365	16672.57
33	3/24/2009-5/4/2009	30	-0.496794455	N/A	0.365658091	N/A	0.012157481	-0.000001769	0.009286169	29996.89
34	4/7/2009-5/18/2009	30	-0.442374762	N/A	0.336280420	N/A	0.011973892	0.000003252	0.008298066	20367.07
35	4/21/2009-6/1/2009	30	-0.392295088	N/A	0.355705043	N/A	0.009853017	0.000009711	0.008522299	12283.60
36	5/5/2009-6/15/2009	30	-0.541131290	N/A	0.326985960	N/A	0.008398073	0.000018040	0.007602059	6552.95
37	5/19/2009-6/29/2009	30	-0.422566725	N/A	0.340373798	N/A	0.007903757	0.000025613	0.007801430	5292.97
38	6/2/2009-7/13/2009	30	-0.494080733	N/A	0.335490587	N/A	0.008064738	0.000027569	0.007133544	4448.59
39	6/16/2009-7/27/2009	30	-0.492136099	N/A	0.328518897	N/A	0.006870020	0.000026258	0.006420697	2008.13
40	6/30/2009-8/10/2009	30	-0.406606836	N/A	0.320725565	N/A	0.005228328	0.000023993	0.005129479	2773.61
41	7/14/2009-8/24/2009	30	-0.402351420	N/A	0.348841654	N/A	0.004102138	0.000024780	0.004463441	7937.58
42	7/28/2009-9/7/2009	30	-0.464526427	N/A	0.351096580	N/A	0.003811761	0.000025935	0.004208725	2675.44
43	8/11/2009-9/21/2009	30	-0.364573124	N/A	0.339372501	N/A	0.005044177	0.000042512	0.005964264	9511.64
44	9/8/2009-10/6/2009	30	-0.370722323	N/A	0.332771981	N/A	0.006212301	0.000072178	0.007602830	57089.44

Average Sum of Squared Errors   21,090.55

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Kraft Foods Inc.</u>   NYSE: <u>KFT</u>   Industry: <u>Consumer Goods</u>

Model9   Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.520737533	N/A	0.345118983	0.000090472	0.006381839	0.000105258	0.009586558	13962.96
2	1/15/2008-2/25/2008	30	-0.354605789	N/A	0.323294311	-0.000073742	0.008462829	0.000112827	0.011156178	34515.91
3	1/29/2008-3/10/2008	30	-0.487254629	N/A	0.334058936	-0.000078214	0.009737386	0.000115799	0.012620041	33449.46
4	2/12/2008-3/24/2008	30	-0.369801647	N/A	0.328412506	0.000020696	0.011852000	0.000141388	0.015557580	54775.20
5	2/26/2008-4/7/2008	30	-0.523340895	N/A	0.341081569	-0.000001907	0.010902175	0.000146132	0.014750659	69348.58
6	3/11/2008-4/21/2008	30	-0.442165107	N/A	0.333001277	-0.000015346	0.010609245	0.000124777	0.014325263	80901.52
7	3/25/2008-5/25/2008	30	-0.390164703	N/A	0.336377253	0.000077066	0.008808045	0.000108683	0.011969087	23105.31
8	4/8/2008-5/19/2008	30	-0.545139092	N/A	0.343644010	-0.000034845	0.008643724	0.000099487	0.010786185	12749.77
9	4/22/2008-6/2/2008	30	-0.386322155	N/A	0.311548966	-0.000024943	0.008106027	0.000091427	0.010740176	12097.65
10	5/6/2008-6/16/2008	30	-0.441811562	N/A	0.342538398	0.000059765	0.009346018	0.000102157	0.010988472	12562.40
11	5/20/2008-6/30/2008	30	-0.529873606	N/A	0.319055410	0.000040508	0.009025593	0.000114698	0.011708041	8169.76
12	6/3/2008-7/14/2008	30	-0.496088394	N/A	0.331917990	0.000075027	0.009685298	0.000116069	0.012428151	8096.05
13	6/17/2008-7/28/2008	30	-0.425588453	N/A	0.327638631	0.000060296	0.008619703	0.000103846	0.012092903	15583.38
14	7/1/2008-8/11/2008	30	-0.527306498	N/A	0.315666609	0.000062311	0.008450127	0.000100073	0.010540765	22180.69
15	7/15/2008-8/25/2008	30	-0.451334832	N/A	0.312889629	-0.000018431	0.007634068	0.000089760	0.009618369	5223.31
16	7/29/2008-9/8/2008	30	-0.552568569	N/A	0.330613083	-0.000088526	0.007564011	0.000093820	0.009649944	2616.74
17	8/12/2008-9/22/2008	30	-0.424578322	N/A	0.314392660	0.000021791	0.007551490	0.000098400	0.010435634	6764.07
18	8/26/2008-10/6/2008	30	-0.480499785	N/A	0.332093980	0.000053382	0.007933016	0.000100737	0.010309929	8694.66
19	9/9/2008-10/20/2008	30	-0.522515212	N/A	0.321936214	-0.000062766	0.008954897	0.000106312	0.012084025	23976.96
20	9/23/2008-11/3/2008	30	-0.451261695	N/A	0.322255788	-0.000075808	0.010669679	0.000105153	0.013076467	27077.75
21	10/7/2008-11/17/2008	30	-0.373074911	N/A	0.338937539	0.000023451	0.010828654	0.000108196	0.013400251	16219.84
22	10/21/2008-12/1/2008	30	-0.536835105	N/A	0.350333740	0.000056208	0.011068861	0.000116156	0.013373331	19078.00
23	11/4/2008-12/15/2008	30	-0.529485278	N/A	0.344207382	-0.000073656	0.012165129	0.000112636	0.013738239	32481.97
24	11/18/2008-12/29/2008	30	-0.488400915	N/A	0.338128773	-0.000079518	0.011767368	0.000111387	0.014143537	23047.80
25	12/2/2008-1/12/2009	30	-0.412199927	N/A	0.354164363	-0.000001998	0.012591907	0.000081325	0.013457848	43078.20
26	12/16/2008-1/26/2009	30	-0.504693685	N/A	0.340839534	-0.000047312	0.013600867	0.000039884	0.012655224	17086.13
27	12/30/2008-2/9/2009	30	-0.386125068	N/A	0.355836345	0.000076417	0.014220273	0.000003791	0.009393739	9070.59
28	1/13/2009-2/23/2009	30	-0.530184683	N/A	0.368182413	-0.000035152	0.012333939	-0.000002160	0.009546229	6722.02
29	1/27/2009-3/9/2009	30	-0.398562611	N/A	0.372335024	-0.000040460	0.012274510	-0.000001022	0.010684396	14022.93
30	2/10/2009-3/23/2009	30	-0.457856007	N/A	0.377118524	-0.000050548	0.015526870	0.000003355	0.013715249	12139.67
31	2/24/2009-4/6/2009	30	-0.540101035	N/A	0.341969481	-0.000098843	0.016930370	0.000002598	0.010779974	10439.36
32	3/10/2009-4/20/2009	30	-0.433547744	N/A	0.340063400	-0.000076993	0.013862388	0.000000036	0.010513073	15344.11
33	3/24/2009-5/4/2009	30	-0.549185558	N/A	0.348268066	-0.000077422	0.011835899	-0.000001656	0.009469541	26985.78
34	4/7/2009-5/18/2009	30	-0.369744465	N/A	0.351816286	0.000041997	0.012436125	0.000003258	0.007645171	18234.48
35	4/21/2009-6/1/2009	30	-0.355552358	N/A	0.338213262	-0.000009326	0.009658877	0.000010140	0.008847366	11405.52
36	5/5/2009-6/15/2009	30	-0.455561045	N/A	0.343913142	0.000057246	0.008299933	0.000017539	0.008004088	5863.78
37	5/19/2009-6/29/2009	30	-0.404751848	N/A	0.332858209	-0.000059829	0.007686601	0.000024557	0.007456570	5047.92
38	6/2/2009-7/13/2009	30	-0.369903483	N/A	0.350703433	0.000099645	0.007569389	0.000028419	0.007542185	3960.31
39	6/16/2009-7/27/2009	30	-0.533761504	N/A	0.323304088	-0.000051924	0.007111296	0.000025653	0.006646880	1945.72
40	6/30/2009-8/10/2009	30	-0.471457864	N/A	0.342340651	-0.000035301	0.005226406	0.000024675	0.005270825	2608.90
41	7/14/2009-8/24/2009	30	-0.528350441	N/A	0.344394395	0.000066038	0.004061512	0.000024066	0.004592511	7053.14
42	7/28/2009-9/7/2009	30	-0.539325929	N/A	0.350386769	0.000007242	0.003882727	0.000025524	0.004215620	2485.87
43	8/11/2009-9/21/2009	30	-0.508090485	N/A	0.325894546	0.000053043	0.005082708	0.000045696	0.005536676	9401.95
44	9/8/2009-10/6/2009	30	-0.527548749	N/A	0.328870397	-0.000063360	0.006230170	0.000066217	0.007872794	52904.34

Average Sum of Squared Errors   19,147.28

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Kraft Foods Inc. NYSE: KFT Industry: Consumer Goods

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{1}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.048478890	-38.643087758	0.340426638	N/A	0.006421470	0.000107562	0.009763975	11827.07
2	1/15/2008-2/25/2008	30	-0.042766384	-40.621304908	0.330584752	N/A	0.008337998	0.000112363	0.011106139	27254.67
3	1/29/2008-3/10/2008	30	0.079374593	-36.105935361	0.341649515	N/A	0.009375858	0.000124302	0.012315353	27705.02
4	2/12/2008-3/24/2008	30	0.033475722	-36.501525435	0.339517555	N/A	0.012006131	0.000141736	0.015409609	46778.89
5	2/26/2008-4/7/2008	30	0.039419568	-35.800820598	0.315602361	N/A	0.010644744	0.000136187	0.014404434	54102.38
6	3/11/2008-4/21/2008	30	0.005423159	-41.218345221	0.321720261	N/A	0.010836909	0.000123632	0.014356235	67025.98
7	3/25/2008-5/25/2008	30	-0.099328084	-35.218050066	0.319485907	N/A	0.009019292	0.000104110	0.011947007	18711.22
8	4/8/2008-5/19/2008	30	0.028591117	-36.775167540	0.326859796	N/A	0.008909189	0.000099513	0.010754598	11014.36
9	4/22/2008-6/2/2008	30	-0.002414476	-38.130976797	0.312980184	N/A	0.008535026	0.000096848	0.010907050	9722.33
10	5/6/2008-6/16/2008	30	-0.090259253	-41.017250086	0.335005560	N/A	0.008560810	0.000101176	0.011195318	10489.11
11	5/20/2008-6/30/2008	30	0.048203078	-34.972293999	0.317940391	N/A	0.009545575	0.000114683	0.011448567	6429.69
12	6/3/2008-7/14/2008	30	-0.024635343	-39.565658219	0.340764065	N/A	0.009545492	0.000112656	0.012763174	6599.45
13	6/17/2008-7/28/2008	30	-0.016255007	-37.723033051	0.317764979	N/A	0.008930499	0.000105066	0.011971235	12785.39
14	7/1/2008-8/11/2008	30	-0.078477492	-40.205224012	0.335002417	N/A	0.008385672	0.000103440	0.010625022	17294.99
15	7/15/2008-8/25/2008	30	-0.057688169	-36.589093811	0.339217299	N/A	0.007841454	0.000087591	0.009432733	3964.03
16	7/29/2008-9/8/2008	30	-0.014341545	-37.461608957	0.340090615	N/A	0.007581719	0.000091036	0.009883603	1915.84
17	8/12/2008-9/22/2008	30	-0.076766952	-39.925030075	0.331962376	N/A	0.007358525	0.000095373	0.009744179	5467.24
18	8/26/2008-10/6/2008	30	0.093668930	-37.233368898	0.326169832	N/A	0.007532877	0.000101427	0.010388725	6850.65
19	9/9/2008-10/20/2008	30	0.085077703	-35.680639193	0.322954795	N/A	0.008584231	0.000104127	0.012158910	18201.02
20	9/23/2008-11/3/2008	30	0.020732271	-38.942389397	0.335304944	N/A	0.010408726	0.000106536	0.012548351	20406.11
21	10/7/2008-11/17/2008	30	-0.002206252	-36.692250329	0.332691102	N/A	0.011006483	0.000112006	0.012941869	12421.92
22	10/21/2008-12/1/2008	30	-0.027882697	-40.037564216	0.339766647	N/A	0.010733635	0.000115701	0.013344456	15510.84
23	11/4/2008-12/15/2008	30	-0.001520466	-36.661677552	0.343753794	N/A	0.012025613	0.000118474	0.013855462	26528.79
24	11/18/2008-12/29/2008	30	-0.055290915	-39.692694377	0.353265066	N/A	0.011651374	0.000116808	0.013794299	18560.22
25	12/2/2008-1/12/2009	30	-0.032720001	-39.713589922	0.355502358	N/A	0.012359042	0.000081807	0.013727285	32765.47
26	12/16/2008-1/26/2009	30	-0.049247546	-36.869700421	0.348057401	N/A	0.012853450	0.000040579	0.011915136	14144.92
27	12/30/2008-2/9/2009	30	0.078235641	-40.751511127	0.354902706	N/A	0.014110321	0.000003581	0.010201984	7096.10
28	1/13/2009-2/23/2009	30	-0.085211136	-38.538115828	0.342574723	N/A	0.012338490	-0.000002009	0.010160158	5641.21
29	1/27/2009-3/9/2009	30	0.073768465	-36.201041536	0.359378194	N/A	0.013348338	-0.000001076	0.010224938	10697.92
30	2/10/2009-3/23/2009	30	0.078996277	-35.781400185	0.368727557	N/A	0.015872517	0.000003444	0.013210746	10940.49
31	2/24/2009-4/6/2009	30	0.005453386	-39.052770831	0.369861065	N/A	0.015805396	0.000002564	0.010957004	7848.31
32	3/10/2009-4/20/2009	30	0.030877791	-42.210137687	0.347159425	N/A	0.013363521	0.000000036	0.010413817	12938.02
33	3/24/2009-5/4/2009	30	-0.053611178	-36.281612089	0.366600095	N/A	0.011774847	-0.000001690	0.009322188	22557.01
34	4/7/2009-5/18/2009	30	-0.010377036	-38.199703089	0.351454771	N/A	0.011845925	0.000003411	0.008266377	14729.37
35	4/21/2009-6/1/2009	30	-0.043716640	-38.803480949	0.352976162	N/A	0.010580989	0.000010092	0.008826107	10569.57
36	5/5/2009-6/15/2009	30	-0.019658905	-41.542598819	0.335054714	N/A	0.008755113	0.000018772	0.007467420	5206.14
37	5/19/2009-6/29/2009	30	-0.058020938	-41.073518348	0.328078484	N/A	0.008320953	0.000025675	0.007335676	3991.45
38	6/2/2009-7/13/2009	30	0.092085644	-38.734252999	0.338704629	N/A	0.007832069	0.000027673	0.007647624	3278.15
39	6/16/2009-7/27/2009	30	-0.014577619	-35.444763820	0.349500833	N/A	0.006930097	0.000024932	0.006616330	1729.56
40	6/30/2009-8/10/2009	30	-0.027113345	-37.513726729	0.323650451	N/A	0.005470942	0.000026328	0.005311181	2080.56
41	7/14/2009-8/24/2009	30	0.041944683	-37.090417137	0.343056998	N/A	0.004378552	0.000024798	0.004312651	6186.63
42	7/28/2009-9/7/2009	30	-0.048708975	-36.523787306	0.341819578	N/A	0.003978009	0.000025886	0.003991820	1994.76
43	8/11/2009-9/21/2009	30	0.097338692	-38.957330607	0.347113079	N/A	0.004675237	0.000046120	0.005903587	7061.36
44	9/8/2009-10/6/2009	30	0.011975924	-39.428399792	0.330532985	N/A	0.006079523	0.000068937	0.007710672	42565.85

Average Sum of Squared Errors 15,490.68

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Kraft Foods Inc.   NYSE: KFT   Industry: Consumer Goods

Model11 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.068953313	-39.685700798	0.318050748	0.000044041	0.006573554	0.000098739	0.009408231	10200.03
2	1/15/2008-2/25/2008	30	0.040944489	-36.987752283	0.335908212	-0.000055723	0.007948389	0.000102898	0.011278590	23923.18
3	1/29/2008-3/10/2008	30	-0.079161554	-36.341534778	0.325737660	0.000035962	0.009289467	0.000123255	0.012326791	24241.63
4	2/12/2008-3/24/2008	30	-0.009928042	-38.437884658	0.334733263	-0.000020158	0.011197661	0.000144206	0.015318353	41029.42
5	2/26/2008-4/7/2008	30	-0.049768329	-35.042788311	0.315490506	0.000063305	0.010813223	0.000140096	0.014142461	46112.91
6	3/11/2008-4/21/2008	30	-0.024103519	-35.539235012	0.337929491	0.000045400	0.010928652	0.000126103	0.014731032	56945.44
7	3/25/2008-5/25/2008	30	0.045328215	-36.868348205	0.333187663	-0.000057659	0.008739499	0.000110510	0.011772061	16272.25
8	4/8/2008-5/19/2008	30	0.081893961	-41.880351276	0.335230225	0.000086882	0.008430615	0.000091650	0.011240851	10070.35
9	4/22/2008-6/2/2008	30	0.068354494	-40.142205602	0.331124878	-0.000055865	0.008238089	0.000091737	0.010417691	8755.94
10	5/6/2008-6/16/2008	30	0.031805635	-37.931560581	0.335734058	0.000078631	0.009270181	0.000102476	0.011356147	8915.47
11	5/20/2008-6/30/2008	30	-0.063100615	-39.455647923	0.340496240	0.000012515	0.009161644	0.000114248	0.012013908	5836.31
12	6/3/2008-7/14/2008	30	-0.052629574	-36.395701038	0.337023363	0.000038640	0.009520866	0.000109190	0.012619179	5979.41
13	6/17/2008-7/28/2008	30	0.062863322	-40.596100849	0.346470594	0.000011379	0.009268898	0.000109023	0.011703071	11909.92
14	7/1/2008-8/11/2008	30	-0.060478383	-39.381782836	0.332756981	-0.000034142	0.008321165	0.000101291	0.010261830	15117.34
15	7/15/2008-8/25/2008	30	0.054829470	-42.130033509	0.327482123	-0.000084653	0.007721296	0.000086861	0.010181286	3623.68
16	7/29/2008-9/8/2008	30	-0.082414959	-37.547332793	0.308833948	-0.000018273	0.007137739	0.000090507	0.009374443	1761.33
17	8/12/2008-9/22/2008	30	0.076344020	-42.151214240	0.317724822	-0.000080168	0.007123009	0.000094410	0.010551694	4946.63
18	8/26/2008-10/6/2008	30	0.045110728	-38.008820685	0.340583879	0.000061814	0.007508810	0.000098071	0.010181736	5921.36
19	9/9/2008-10/20/2008	30	-0.011512599	-35.777241668	0.328931565	0.000053896	0.008505428	0.000102966	0.012094155	16286.24
20	9/23/2008-11/3/2008	30	0.074801160	-36.556370901	0.345422715	-0.000083918	0.010115833	0.000109736	0.012536579	18346.12
21	10/7/2008-11/17/2008	30	0.047306944	-35.250038373	0.347533699	0.000029544	0.011454421	0.000112116	0.012673500	11163.81
22	10/21/2008-12/1/2008	30	-0.058294422	-42.275182908	0.323990354	0.000089937	0.011336820	0.000107483	0.013844787	13899.71
23	11/4/2008-12/15/2008	30	-0.044475012	-40.912980722	0.349794384	-0.000001250	0.012087258	0.000115565	0.014503526	23083.46
24	11/18/2008-12/29/2008	30	0.075038574	-34.906494222	0.335859774	0.000023967	0.012080324	0.000120500	0.014698101	16306.71
25	12/2/2008-1/12/2009	30	0.005649186	-38.931850950	0.323035190	0.000029554	0.012090130	0.000083188	0.013246357	29512.96
26	12/16/2008-1/26/2009	30	0.067264416	-39.285705761	0.326216791	0.000037506	0.013511150	0.000039092	0.011962664	12350.10
27	12/30/2008-2/9/2009	30	-0.099045727	-35.932050733	0.330244499	0.000090230	0.014930549	0.000003713	0.009351691	6507.02
28	1/13/2009-2/23/2009	30	-0.054598211	-39.057238239	0.340276087	-0.000043110	0.012886036	-0.000002196	0.010044420	4826.53
29	1/27/2009-3/9/2009	30	0.092468142	-35.239721993	0.368627324	-0.000007556	0.013050638	-0.000001053	0.010307857	9975.93
30	2/10/2009-3/23/2009	30	0.054592237	-34.706997554	0.353993836	0.000083656	0.016967478	0.000003597	0.013526474	9559.12
31	2/24/2009-4/6/2009	30	-0.003282527	-39.852758455	0.350961493	0.000027594	0.017392577	0.000002517	0.010551299	7123.39
32	3/10/2009-4/20/2009	30	0.009437336	-40.267682737	0.363977234	-0.000041597	0.013833093	0.000000037	0.010310207	10942.67
33	3/24/2009-5/4/2009	30	-0.048136651	-37.101513458	0.341756223	0.000062717	0.012174404	-0.000001767	0.009231083	20478.05
34	4/7/2009-5/18/2009	30	0.082855832	-37.991442789	0.346174032	-0.000054449	0.011563031	0.000003275	0.007704890	14504.08
35	4/21/2009-6/1/2009	30	0.016556066	-36.881096760	0.338487409	-0.000017701	0.009968177	0.000010458	0.008284367	10528.42
36	5/5/2009-6/15/2009	30	0.051802450	-35.488152309	0.332222828	-0.000021435	0.008854650	0.000018574	0.007589885	5046.42
37	5/19/2009-6/29/2009	30	-0.080578979	-36.294688591	0.335827195	0.000028151	0.007804699	0.000024560	0.007570040	3564.91
38	6/2/2009-7/13/2009	30	-0.089926246	-40.577119243	0.333026655	0.000054830	0.007920733	0.000026126	0.007601244	2899.82
39	6/16/2009-7/27/2009	30	0.047962271	-38.982156591	0.348438600	0.000068209	0.007291254	0.000025650	0.006899125	1529.70
40	6/30/2009-8/10/2009	30	0.019414606	-34.891995716	0.345621649	-0.000003155	0.005242267	0.000025289	0.005232792	1900.17
41	7/14/2009-8/24/2009	30	0.098580177	-35.118849155	0.322274810	0.000087927	0.004207081	0.000024068	0.004298932	5673.76
42	7/28/2009-9/7/2009	30	-0.008481790	-39.420789997	0.332486662	0.000004439	0.004028960	0.000027127	0.004094702	1844.56
43	8/11/2009-9/21/2009	30	-0.065740226	-39.051028338	0.353026273	-0.000064937	0.005033730	0.000044649	0.005809529	6961.01
44	9/8/2009-10/6/2009	30	-0.046987463	-36.836821296	0.333151059	-0.000039169	0.006128460	0.000067800	0.008051838	39442.60

Average Sum of Squared Errors   13,768.63

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Merck & Co. Inc.</u> NYSE: <u>MRK</u> Industry: <u>Healthcare</u>

Model 1   Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.473483842	N/A	N/A	N/A	0.004208032	N/A	N/A	25152.97
2	1/15/2008-2/25/2008	30	-0.444503021	N/A	N/A	N/A	0.005204581	N/A	N/A	31623.26
3	1/29/2008-3/10/2008	30	-0.513092977	N/A	N/A	N/A	0.005921611	N/A	N/A	30892.50
4	2/12/2008-3/24/2008	30	-0.527434515	N/A	N/A	N/A	0.006938581	N/A	N/A	48247.99
5	2/26/2008-4/7/2008	30	-0.383560646	N/A	N/A	N/A	0.007687286	N/A	N/A	62040.26
6	3/11/2008-4/21/2008	30	-0.412745224	N/A	N/A	N/A	0.008113019	N/A	N/A	56061.17
7	3/25/2008-5/25/2008	30	-0.40742721	N/A	N/A	N/A	0.007027588	N/A	N/A	66245.27
8	4/8/2008-5/19/2008	30	-0.416648646	N/A	N/A	N/A	0.005765186	N/A	N/A	45155.68
9	4/22/2008-6/2/2008	30	-0.393328249	N/A	N/A	N/A	0.004853662	N/A	N/A	21454.62
10	5/6/2008-6/16/2008	30	-0.390004642	N/A	N/A	N/A	0.004763926	N/A	N/A	19362.96
11	5/20/2008-6/30/2008	30	-0.440275277	N/A	N/A	N/A	0.004817002	N/A	N/A	19611.15
12	6/3/2008-7/14/2008	30	-0.468061708	N/A	N/A	N/A	0.004905946	N/A	N/A	20021.67
13	6/17/2008-7/28/2008	30	-0.408695011	N/A	N/A	N/A	0.005069853	N/A	N/A	21478.03
14	7/1/2008-8/11/2008	30	-0.417529486	N/A	N/A	N/A	0.005233354	N/A	N/A	22216.31
15	7/15/2008-8/25/2008	30	-0.522175592	N/A	N/A	N/A	0.005440374	N/A	N/A	24447.45
16	7/29/2008-9/8/2008	30	-0.461632303	N/A	N/A	N/A	0.005575934	N/A	N/A	24603.97
17	8/12/2008-9/22/2008	30	-0.435253531	N/A	N/A	N/A	0.006135649	N/A	N/A	34731.28
18	8/26/2008-10/6/2008	30	-0.458214333	N/A	N/A	N/A	0.006739291	N/A	N/A	42469.08
19	9/9/2008-10/20/2008	30	-0.372190962	N/A	N/A	N/A	0.007544569	N/A	N/A	49904.33
20	9/23/2008-11/3/2008	30	-0.478388921	N/A	N/A	N/A	0.008100956	N/A	N/A	53560.28
21	10/7/2008-11/17/2008	30	-0.371994306	N/A	N/A	N/A	0.008530403	N/A	N/A	45151.42
22	10/21/2008-12/1/2008	30	-0.476850552	N/A	N/A	N/A	0.009274714	N/A	N/A	51546.91
23	11/4/2008-12/15/2008	30	-0.507509549	N/A	N/A	N/A	0.010541107	N/A	N/A	66701.89
24	11/18/2008-12/29/2008	30	-0.384847315	N/A	N/A	N/A	0.011590340	N/A	N/A	57861.71
25	12/2/2008-1/12/2009	30	-0.470473599	N/A	N/A	N/A	0.011534487	N/A	N/A	58801.63
26	12/16/2008-1/26/2009	30	-0.493667816	N/A	N/A	N/A	0.011219655	N/A	N/A	51820.85
27	12/30/2008-2/9/2009	30	-0.363298037	N/A	N/A	N/A	0.011109340	N/A	N/A	54574.15
28	1/13/2009-2/23/2009	30	-0.434764427	N/A	N/A	N/A	0.010929692	N/A	N/A	64107.98
29	1/27/2009-3/9/2009	30	-0.531491987	N/A	N/A	N/A	0.008796156	N/A	N/A	74482.46
30	2/10/2009-3/23/2009	30	-0.494134371	N/A	N/A	N/A	0.009211050	N/A	N/A	71542.01
31	2/24/2009-4/6/2009	30	-0.359916349	N/A	N/A	N/A	0.011952776	N/A	N/A	47390.82
32	3/10/2009-4/20/2009	30	-0.381512745	N/A	N/A	N/A	0.012338347	N/A	N/A	15425.38
33	3/24/2009-5/4/2009	30	-0.363732407	N/A	N/A	N/A	0.011561965	N/A	N/A	16370.26
34	4/7/2009-5/18/2009	30	-0.514450961	N/A	N/A	N/A	0.010444393	N/A	N/A	22245.02
35	4/21/2009-6/1/2009	30	-0.426123851	N/A	N/A	N/A	0.009350849	N/A	N/A	21006.02
36	5/5/2009-6/15/2009	30	-0.398447212	N/A	N/A	N/A	0.008190353	N/A	N/A	10933.92
37	5/19/2009-6/29/2009	30	-0.48793165	N/A	N/A	N/A	0.007561626	N/A	N/A	6537.76
38	6/2/2009-7/13/2009	30	-0.509417947	N/A	N/A	N/A	0.007208378	N/A	N/A	6642.21
39	6/16/2009-7/27/2009	30	-0.356085935	N/A	N/A	N/A	0.006738092	N/A	N/A	11091.54
40	6/30/2009-8/10/2009	30	-0.361059704	N/A	N/A	N/A	0.005831614	N/A	N/A	18194.94
41	7/14/2009-8/24/2009	30	-0.484174769	N/A	N/A	N/A	0.004846256	N/A	N/A	15673.04
42	7/28/2009-9/7/2009	30	-0.408029123	N/A	N/A	N/A	0.004278390	N/A	N/A	7508.89
43	8/11/2009-9/21/2009	30	-0.395440191	N/A	N/A	N/A	0.004160672	N/A	N/A	7857.88
44	9/8/2009-10/6/2009	30	-0.442446498	N/A	N/A	N/A	0.004272579	N/A	N/A	8543.88

Average Sum of Squared Errors   34,802.11

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Merck & Co. Inc.</u>   NYSE: <u>MRK</u>   Industry: <u>Healthcare</u>

Model 2   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.49896794	N/A	N/A	N/A	0.0017532959	0.000076763	N/A	10025.39
2	1/15/2008-2/25/2008	30	-0.365790368	N/A	N/A	N/A	0.0023600776	0.000089052	N/A	11382.41
3	1/29/2008-3/10/2008	30	-0.359970001	N/A	N/A	N/A	0.0027904755	0.000098121	N/A	5562.02
4	2/12/2008-3/24/2008	30	-0.495433679	N/A	N/A	N/A	0.0033987171	0.000111007	N/A	17063.16
5	2/26/2008-4/7/2008	30	-0.454516685	N/A	N/A	N/A	0.0038582625	0.000120103	N/A	24279.27
6	3/11/2008-4/21/2008	30	-0.365960517	N/A	N/A	N/A	0.0041172333	0.000125448	N/A	14984.82
7	3/25/2008-5/25/2008	30	-0.361883239	N/A	N/A	N/A	0.0034573103	0.000112132	N/A	32249.57
8	4/8/2008-5/19/2008	30	-0.395048744	N/A	N/A	N/A	0.0027030036	0.000096153	N/A	20083.76
9	4/22/2008-6/2/2008	30	-0.406523059	N/A	N/A	N/A	0.0021625800	0.000084518	N/A	2707.83
10	5/6/2008-6/16/2008	30	-0.501369197	N/A	N/A	N/A	0.0021115629	0.000083390	N/A	1174.95
11	5/20/2008-6/30/2008	30	-0.408426363	N/A	N/A	N/A	0.0021456124	0.000084117	N/A	1189.14
12	6/3/2008-7/14/2008	30	-0.412744632	N/A	N/A	N/A	0.0022062153	0.000085015	N/A	1216.15
13	6/17/2008-7/28/2008	30	-0.511715946	N/A	N/A	N/A	0.0023004890	0.000087210	N/A	1694.65
14	7/1/2008-8/11/2008	30	-0.543055981	N/A	N/A	N/A	0.0023946961	0.000089343	N/A	1431.09
15	7/15/2008-8/25/2008	30	-0.520264932	N/A	N/A	N/A	0.0024937059	0.000092731	N/A	1282.11
16	7/29/2008-9/8/2008	30	-0.496423243	N/A	N/A	N/A	0.0025582427	0.000094852	N/A	1086.45
17	8/12/2008-9/22/2008	30	-0.544741015	N/A	N/A	N/A	0.0028096383	0.000104458	N/A	6153.48
18	8/26/2008-10/6/2008	30	-0.384484091	N/A	N/A	N/A	0.0030824001	0.000114898	N/A	7983.68
19	9/9/2008-10/20/2008	30	-0.390201135	N/A	N/A	N/A	0.0034460697	0.000128964	N/A	6762.20
20	9/23/2008-11/3/2008	30	-0.529690283	N/A	N/A	N/A	0.0037849817	0.000135954	N/A	5881.72
21	10/7/2008-11/17/2008	30	-0.350039005	N/A	N/A	N/A	0.0044341646	0.000129003	N/A	3717.07
22	10/21/2008-12/1/2008	30	-0.362807586	N/A	N/A	N/A	0.0053147728	0.000124427	N/A	12687.26
23	11/4/2008-12/15/2008	30	-0.366863067	N/A	N/A	N/A	0.0064675077	0.000127555	N/A	25376.93
24	11/18/2008-12/29/2008	30	-0.49654593	N/A	N/A	N/A	0.0071403306	0.000138805	N/A	8176.70
25	12/2/2008-1/12/2009	30	-0.404021504	N/A	N/A	N/A	0.0071155937	0.000137507	N/A	9578.96
26	12/16/2008-1/26/2009	30	-0.389644762	N/A	N/A	N/A	0.0069219651	0.000133532	N/A	6815.18
27	12/30/2008-2/9/2009	30	-0.371605565	N/A	N/A	N/A	0.0075535646	0.000110742	N/A	22716.28
28	1/13/2009-2/23/2009	30	-0.483038467	N/A	N/A	N/A	0.0102198816	0.000022095	N/A	62833.09
29	1/27/2009-3/9/2009	30	-0.505984096	N/A	N/A	N/A	0.0102987236	-0.000046685	N/A	65701.41
30	2/10/2009-3/23/2009	30	-0.466554038	N/A	N/A	N/A	0.0108553311	-0.000051138	N/A	61033.23
31	2/24/2009-4/6/2009	30	-0.463487179	N/A	N/A	N/A	0.0117476838	0.000006405	N/A	47277.67
32	3/10/2009-4/20/2009	30	-0.544512387	N/A	N/A	N/A	0.0103564625	0.000061969	N/A	5251.57
33	3/24/2009-5/4/2009	30	-0.485857334	N/A	N/A	N/A	0.0096441083	0.000059968	N/A	6837.82
34	4/7/2009-5/18/2009	30	-0.426864465	N/A	N/A	N/A	0.0087134879	0.000054133	N/A	14478.44
35	4/21/2009-6/1/2009	30	-0.469123521	N/A	N/A	N/A	0.0077968784	0.000048649	N/A	14753.21
36	5/5/2009-6/15/2009	30	-0.448363751	N/A	N/A	N/A	0.0068255289	0.000042826	N/A	6123.41
37	5/19/2009-6/29/2009	30	-0.425091254	N/A	N/A	N/A	0.0062787193	0.000040334	N/A	2296.88
38	6/2/2009-7/13/2009	30	-0.362317424	N/A	N/A	N/A	0.0057451503	0.000045995	N/A	1122.00
39	6/16/2009-7/27/2009	30	-0.37951868	N/A	N/A	N/A	0.0052102624	0.000047950	N/A	5058.45
40	6/30/2009-8/10/2009	30	-0.456678675	N/A	N/A	N/A	0.0043902838	0.000045189	N/A	12813.63
41	7/14/2009-8/24/2009	30	-0.508847613	N/A	N/A	N/A	0.0035595320	0.000040312	N/A	11226.73
42	7/28/2009-9/7/2009	30	-0.443525935	N/A	N/A	N/A	0.0029431926	0.000041780	N/A	2869.71
43	8/11/2009-9/21/2009	30	-0.497243157	N/A	N/A	N/A	0.0026502377	0.000047203	N/A	1911.31
44	9/8/2009-10/6/2009	30	-0.382500529	N/A	N/A	N/A	0.0027392425	0.000047878	N/A	2408.80

Average Sum of Squared Errors   13,346.81

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Merck & Co. Inc.</u> NYSE: <u>MRK</u> Industry: <u>Healthcare</u>

Model 3 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.484606112	N/A	0.296172907	N/A	-0.002338999	N/A	0.205916916	8945.00
2	1/15/2008-2/25/2008	30	-0.398006471	N/A	0.290515975	N/A	-0.006931591	N/A	0.276743177	8470.46
3	1/29/2008-3/10/2008	30	-0.469699796	N/A	0.293387616	N/A	0.005921611	N/A	4.47648E-12	30892.50
4	2/12/2008-3/24/2008	30	-0.505575437	N/A	0.311223406	N/A	0.006938581	N/A	2.66945E-12	48247.99
5	2/26/2008-4/7/2008	30	-0.458144665	N/A	0.301097289	N/A	-0.004126118	N/A	0.039454018	36098.50
6	3/11/2008-4/21/2008	30	-0.432036262	N/A	0.301042155	N/A	0.008113019	N/A	4.69539E-12	56061.17
7	3/25/2008-5/25/2008	30	-0.389749073	N/A	0.294724168	N/A	0.007027588	N/A	4.45055E-12	66245.27
8	4/8/2008-5/19/2008	30	-0.47768634	N/A	0.300988182	N/A	-0.003029668	N/A	0.035134454	34334.83
9	4/22/2008-6/2/2008	30	-0.525739163	N/A	0.306998732	N/A	-0.024989092	N/A	0.065625573	5322.61
10	5/6/2008-6/16/2008	30	-0.363962254	N/A	0.307836848	N/A	-0.074630849	N/A	0.118213856	1160.38
11	5/20/2008-6/30/2008	30	-0.512536614	N/A	0.317348094	N/A	0.003521255	N/A	0.00464078	16490.01
12	6/3/2008-7/14/2008	30	-0.482459881	N/A	0.308766305	N/A	-0.015443182	N/A	0.070489327	1620.59
13	6/17/2008-7/28/2008	30	-0.489868402	N/A	0.321719965	N/A	-0.003389307	N/A	0.044496833	4539.82
14	7/1/2008-8/11/2008	30	-0.44610268	N/A	0.312012558	N/A	-0.002620774	N/A	0.033841389	6105.39
15	7/15/2008-8/25/2008	30	-0.37239643	N/A	0.334030527	N/A	-0.002280257	N/A	0.031587599	10575.54
16	7/29/2008-9/8/2008	30	-0.53624901	N/A	0.327225860	N/A	-0.004756778	N/A	0.443173912	12230.96
17	8/12/2008-9/22/2008	30	-0.4256418	N/A	0.306262974	N/A	-0.076817178	N/A	0.178977147	6627.88
18	8/26/2008-10/6/2008	30	-0.365986563	N/A	0.330815064	N/A	-0.016889188	N/A	0.500248676	6023.87
19	9/9/2008-10/20/2008	30	-0.541656336	N/A	0.320692665	N/A	-0.000264164	N/A	0.54159422	20981.20
20	9/23/2008-11/3/2008	30	-0.396464101	N/A	0.330861499	N/A	0.006128914	N/A	0.602243221	47157.97
21	10/7/2008-11/17/2008	30	-0.396076011	N/A	0.331653497	N/A	-0.053024164	N/A	0.086173003	13687.27
22	10/21/2008-12/1/2008	30	-0.404166094	N/A	0.349029914	N/A	-0.236345727	N/A	0.024517202	6163.90
23	11/4/2008-12/15/2008	30	-0.407542506	N/A	0.332127029	N/A	0.007509959	N/A	0.522346344	49298.74
24	11/18/2008-12/29/2008	30	-0.467179361	N/A	0.332952924	N/A	0.00621293	N/A	0.460960965	17967.10
25	12/2/2008-1/12/2009	30	-0.528131655	N/A	0.329093958	N/A	-0.661881259	N/A	0.010043657	7698.87
26	12/16/2008-1/26/2009	30	-0.42630003	N/A	0.339193615	N/A	-0.18742051	N/A	0.030927237	6508.79
27	12/30/2008-2/9/2009	30	-0.371597627	N/A	0.334916064	N/A	-0.0645638	N/A	0.064055735	22451.02
28	1/13/2009-2/23/2009	30	-0.426612105	N/A	0.353419955	N/A	0.007989476	N/A	0.518633215	61689.83
29	1/27/2009-3/9/2009	30	-0.502179028	N/A	0.357205149	N/A	0.008796156	N/A	6.97783E-05	74482.46
30	2/10/2009-3/23/2009	30	-0.374577461	N/A	0.355212657	N/A	0.00921105	N/A	0.000129118	71542.01
31	2/24/2009-4/6/2009	30	-0.422991612	N/A	0.347588633	N/A	-5.63169E-05	N/A	0.020078605	47342.78
32	3/10/2009-4/20/2009	30	-0.403045887	N/A	0.363761162	N/A	0.009529494	N/A	0.585711594	11448.15
33	3/24/2009-5/4/2009	30	-0.395590637	N/A	0.366479011	N/A	0.008758828	N/A	0.592889905	12155.90
34	4/7/2009-5/18/2009	30	-0.529011074	N/A	0.350099873	N/A	0.008118133	N/A	0.665932413	19497.90
35	4/21/2009-6/1/2009	30	-0.400026503	N/A	0.358157607	N/A	-0.293704948	N/A	0.021183392	7655.10
36	5/5/2009-6/15/2009	30	-0.504809448	N/A	0.348321029	N/A	-0.175062843	N/A	0.026525898	4054.01
37	5/19/2009-6/29/2009	30	-0.442643744	N/A	0.346443784	N/A	-0.041967302	N/A	0.076644758	2123.53
38	6/2/2009-7/13/2009	30	-0.500832063	N/A	0.329785683	N/A	0.006828936	N/A	0.853152791	6362.01
39	6/16/2009-7/27/2009	30	-0.36504462	N/A	0.335771626	N/A	-0.031860463	N/A	0.125255161	1225.82
40	6/30/2009-8/10/2009	30	-0.471854964	N/A	0.340911822	N/A	-0.069139899	N/A	0.091584847	2180.24
41	7/14/2009-8/24/2009	30	-0.514375257	N/A	0.314059421	N/A	-0.222401386	N/A	0.034519789	3115.97
42	7/28/2009-9/7/2009	30	-0.526756009	N/A	0.330716280	N/A	-0.007051701	N/A	0.567836532	2882.01
43	8/11/2009-9/21/2009	30	-0.456076279	N/A	0.320058904	N/A	-0.002223571	N/A	0.855103073	3309.20
44	9/8/2009-10/6/2009	30	-0.507328578	N/A	0.304423534	N/A	0.004272579	N/A	0.894007108	8543.88

Average Sum of Squared Errors 20,261.78

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Merck & Co. Inc.</u>   NYSE: <u>MRK</u>   Industry: <u>Healthcare</u>

Model 4   Default Intensity: $\xi[i,j]=c_0+\dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.468411077	N/A	0.295021884	-0.000026698	0.001382125	N/A	0.008477425	8022.25
2	1/15/2008-2/25/2008	30	-0.445737794	N/A	0.287616952	-0.000000789	0.001724465	N/A	0.010731667	7769.45
3	1/29/2008-3/10/2008	30	-0.412760287	N/A	0.303212181	-0.000039961	0.001994959	N/A	0.012208819	28513.82
4	2/12/2008-3/24/2008	30	-0.414018654	N/A	0.291181438	0.000066661	0.002373332	N/A	0.013910217	42988.93
5	2/26/2008-4/7/2008	30	-0.463070230	N/A	0.315104640	-0.000017925	0.002537226	N/A	0.014678397	34860.70
6	3/11/2008-4/21/2008	30	-0.455108310	N/A	0.314244313	-0.000098348	0.002590474	N/A	0.016631375	50008.60
7	3/25/2008-5/25/2008	30	-0.440047888	N/A	0.324071152	-0.000051485	0.002258744	N/A	0.014303034	61815.45
8	4/8/2008-5/19/2008	30	-0.430075739	N/A	0.322559667	-0.000001053	0.001855674	N/A	0.011300931	30143.77
9	4/22/2008-6/2/2008	30	-0.455689311	N/A	0.313022681	-0.000055586	0.001541653	N/A	0.009860126	4981.13
10	5/6/2008-6/16/2008	30	-0.538702036	N/A	0.306442845	-0.000005990	0.001576000	N/A	0.009729048	1044.20
11	5/20/2008-6/30/2008	30	-0.407532468	N/A	0.326241137	0.000031449	0.001662337	N/A	0.009300165	15202.74
12	6/3/2008-7/14/2008	30	-0.526564069	N/A	0.312577736	-0.000046705	0.001711661	N/A	0.010024775	1503.87
13	6/17/2008-7/28/2008	30	-0.429748941	N/A	0.330519843	0.000025250	0.001714672	N/A	0.009691830	4206.08
14	7/1/2008-8/11/2008	30	-0.371342652	N/A	0.320719665	0.000080575	0.001755544	N/A	0.009947957	5501.43
15	7/15/2008-8/25/2008	30	-0.348604618	N/A	0.318877981	-0.000041921	0.001763480	N/A	0.011107597	9398.10
16	7/29/2008-9/8/2008	30	-0.431122479	N/A	0.325861185	0.000070599	0.001894283	N/A	0.011424978	11415.76
17	8/12/2008-9/22/2008	30	-0.383244511	N/A	0.336718972	-0.000074867	0.001977612	N/A	0.011813456	6036.74
18	8/26/2008-10/6/2008	30	-0.410435487	N/A	0.315107464	0.000033632	0.002291997	N/A	0.013435772	5766.42
19	9/9/2008-10/20/2008	30	-0.427407992	N/A	0.328109116	-0.000033912	0.002408742	N/A	0.015682950	18405.88
20	9/23/2008-11/3/2008	30	-0.438431665	N/A	0.327445443	-0.000099381	0.002586005	N/A	0.015669288	43852.17
21	10/7/2008-11/17/2008	30	-0.441288132	N/A	0.348662077	-0.000033684	0.002860045	N/A	0.017782780	12512.92
22	10/21/2008-12/1/2008	30	-0.437421577	N/A	0.330930307	-0.000079723	0.003073423	N/A	0.017774823	5713.72
23	11/4/2008-12/15/2008	30	-0.460911967	N/A	0.330021189	0.000095507	0.003513055	N/A	0.020417544	43202.35
24	11/18/2008-12/29/2008	30	-0.507274318	N/A	0.325267493	-0.000094359	0.004049106	N/A	0.022260656	16838.91
25	12/2/2008-1/12/2009	30	-0.440858972	N/A	0.339333123	0.000009139	0.003982510	N/A	0.021951776	7092.82
26	12/16/2008-1/26/2009	30	-0.387536677	N/A	0.338591438	-0.000025787	0.003770012	N/A	0.021417207	5762.41
27	12/30/2008-2/9/2009	30	-0.368332439	N/A	0.335234045	0.000009280	0.003591134	N/A	0.021525187	21028.86
28	1/13/2009-2/23/2009	30	-0.540465416	N/A	0.340866360	-0.000078167	0.003528011	N/A	0.022648087	57297.99
29	1/27/2009-3/9/2009	30	-0.426442167	N/A	0.353605892	-0.000060504	0.002805005	N/A	0.018018570	69145.47
30	2/10/2009-3/23/2009	30	-0.537283773	N/A	0.358973085	-0.000096546	0.003113200	N/A	0.017621531	68970.38
31	2/24/2009-4/6/2009	30	-0.393592994	N/A	0.359761385	-0.000015909	0.003990517	N/A	0.024884455	43421.81
32	3/10/2009-4/20/2009	30	-0.427748749	N/A	0.348890263	0.000005103	0.004132378	N/A	0.025146028	10229.53
33	3/24/2009-5/4/2009	30	-0.374515479	N/A	0.353932846	0.000007092	0.003903044	N/A	0.023497073	11553.64
34	4/7/2009-5/18/2009	30	-0.376860928	N/A	0.342607247	0.000018907	0.003342860	N/A	0.021559960	18339.07
35	4/21/2009-6/1/2009	30	-0.348570761	N/A	0.346018526	0.000074946	0.003092945	N/A	0.019087117	6799.14
36	5/5/2009-6/15/2009	30	-0.454462938	N/A	0.351135461	0.000057820	0.002858050	N/A	0.015843751	3653.54
37	5/19/2009-6/29/2009	30	-0.426011590	N/A	0.357410348	0.000011572	0.002556221	N/A	0.015731976	1968.45
38	6/2/2009-7/13/2009	30	-0.402472431	N/A	0.318321222	-0.000084633	0.002499903	N/A	0.014507880	5951.58
39	6/16/2009-7/27/2009	30	-0.503297084	N/A	0.335274982	0.000071717	0.002221625	N/A	0.013997453	1120.53
40	6/30/2009-8/10/2009	30	-0.456133177	N/A	0.330551161	0.000007022	0.001983235	N/A	0.011483941	2004.51
41	7/14/2009-8/24/2009	30	-0.371981864	N/A	0.315034789	0.000043889	0.001596254	N/A	0.010156727	2970.12
42	7/28/2009-9/7/2009	30	-0.410253066	N/A	0.308540721	-0.000055364	0.001429656	N/A	0.008832710	2645.76
43	8/11/2009-9/21/2009	30	-0.460300318	N/A	0.309202931	-0.000016695	0.001336705	N/A	0.008624552	3084.88
44	9/8/2009-10/6/2009	30	-0.466218495	N/A	0.324867221	-0.000007367	0.001481666	N/A	0.008697393	8034.19

Average Sum of Squared Errors   18,654.09

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Merck & Co. Inc.</u>   NYSE: <u>MRK</u>   Industry: <u>Healthcare</u>

Model 5 Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.009380894	-115.923687954	N/A	N/A	0.001735640	0.000077313	N/A	9374.78
2	1/15/2008-2/25/2008	30	0.036667459	-103.226840178	N/A	N/A	0.002272323	0.000091433	N/A	10550.79
3	1/29/2008-3/10/2008	30	-0.028110861	-108.214446272	N/A	N/A	0.002890939	0.000102338	N/A	5165.08
4	2/12/2008-3/24/2008	30	0.058634691	-98.084350568	N/A	N/A	0.003538857	0.000109316	N/A	16633.67
5	2/26/2008-4/7/2008	30	-0.055185887	-103.466076730	N/A	N/A	0.003921344	0.000118213	N/A	23600.16
6	3/11/2008-4/21/2008	30	0.089085500	-116.052916619	N/A	N/A	0.004132765	0.000125679	N/A	14188.78
7	3/25/2008-5/25/2008	30	-0.042733706	-106.810630172	N/A	N/A	0.003316705	0.000113565	N/A	30054.79
8	4/8/2008-5/19/2008	30	0.023447689	-109.639068460	N/A	N/A	0.002799565	0.000097126	N/A	19385.91
9	4/22/2008-6/2/2008	30	-0.004487421	-102.365783391	N/A	N/A	0.002258403	0.000083715	N/A	2493.71
10	5/6/2008-6/16/2008	30	-0.040063114	-111.193536980	N/A	N/A	0.002051086	0.000087110	N/A	1117.60
11	5/20/2008-6/30/2008	30	-0.042152464	-113.115616996	N/A	N/A	0.002113372	0.000083390	N/A	1130.44
12	6/3/2008-7/14/2008	30	0.030480437	-96.052109618	N/A	N/A	0.002115805	0.000084397	N/A	1133.92
13	6/17/2008-7/28/2008	30	0.079123412	-116.858564886	N/A	N/A	0.002384027	0.000086490	N/A	1670.16
14	7/1/2008-8/11/2008	30	0.051040913	-107.100171253	N/A	N/A	0.002494517	0.000092503	N/A	1348.11
15	7/15/2008-8/25/2008	30	-0.076840094	-110.841027385	N/A	N/A	0.002431996	0.000094754	N/A	1212.65
16	7/29/2008-9/8/2008	30	-0.098674968	-99.677230566	N/A	N/A	0.002663114	0.000094273	N/A	1079.91
17	8/12/2008-9/22/2008	30	-0.018348640	-111.178931395	N/A	N/A	0.002843212	0.000102471	N/A	5973.01
18	8/26/2008-10/6/2008	30	-0.036311040	-112.334783123	N/A	N/A	0.003192948	0.000113210	N/A	7516.62
19	9/9/2008-10/20/2008	30	0.038482943	-98.084175410	N/A	N/A	0.003296225	0.000127648	N/A	6733.45
20	9/23/2008-11/3/2008	30	-0.051634033	-106.489423956	N/A	N/A	0.003782985	0.000133006	N/A	5489.21
21	10/7/2008-11/17/2008	30	0.015983820	-113.793836106	N/A	N/A	0.004413528	0.000130402	N/A	3563.69
22	10/21/2008-12/1/2008	30	0.062351219	-38.491115279	N/A	N/A	0.005096424	0.000128750	N/A	11569.94
23	11/4/2008-12/15/2008	30	0.036115483	-113.944022985	N/A	N/A	0.006431033	0.000121327	N/A	23443.53
24	11/18/2008-12/29/2008	30	-0.063190826	-109.035366996	N/A	N/A	0.007309695	0.000134199	N/A	7760.12
25	12/2/2008-1/12/2009	30	0.022398032	-106.225268698	N/A	N/A	0.007255241	0.000137598	N/A	9485.53
26	12/16/2008-1/26/2009	30	-0.088799247	-110.124693128	N/A	N/A	0.007105295	0.000131714	N/A	6513.52
27	12/30/2008-2/9/2009	30	-0.054332448	-104.384899966	N/A	N/A	0.007682973	0.000113193	N/A	20513.78
28	1/13/2009-2/23/2009	30	0.008683818	-103.945706716	N/A	N/A	0.010554550	0.000022008	N/A	60951.19
29	1/27/2009-3/9/2009	30	-0.077853022	-98.629740494	N/A	N/A	0.010066953	-0.000046402	N/A	63087.25
30	2/10/2009-3/23/2009	30	-0.063451687	-100.603880495	N/A	N/A	0.010931295	-0.000050883	N/A	56380.97
31	2/24/2009-4/6/2009	30	0.075509063	-103.594066498	N/A	N/A	0.011731139	0.000006331	N/A	43759.99
32	3/10/2009-4/20/2009	30	0.014074715	-97.963584198	N/A	N/A	0.010207034	0.000064806	N/A	4984.54
33	3/24/2009-5/4/2009	30	-0.095155447	-97.927695621	N/A	N/A	0.009346286	0.000059135	N/A	6285.27
34	4/7/2009-5/18/2009	30	-0.060661478	-117.026141144	N/A	N/A	0.008399725	0.000055494	N/A	14383.34
35	4/21/2009-6/1/2009	30	-0.067187852	-99.837853246	N/A	N/A	0.007591552	0.000047953	N/A	14271.77
36	5/5/2009-6/15/2009	30	-0.058392740	-110.681225950	N/A	N/A	0.007101211	0.000044949	N/A	5554.49
37	5/19/2009-6/29/2009	30	-0.072415735	-100.197487742	N/A	N/A	0.005970510	0.000039056	N/A	2274.43
38	6/2/2009-7/13/2009	30	0.012407970	-97.033954038	N/A	N/A	0.005919301	0.000048263	N/A	1071.91
39	6/16/2009-7/27/2009	30	0.064016334	-107.845010941	N/A	N/A	0.005128807	0.000048684	N/A	4872.16
40	6/30/2009-8/10/2009	30	-0.042694236	-106.509922225	N/A	N/A	0.004400799	0.000046310	N/A	12079.59
41	7/14/2009-8/24/2009	30	0.055385472	-107.550714434	N/A	N/A	0.003702751	0.000038318	N/A	10808.99
42	7/28/2009-9/7/2009	30	-0.072738286	-104.931130999	N/A	N/A	0.002875618	0.000040095	N/A	2656.47
43	8/11/2009-9/21/2009	30	0.091321838	-111.397943387	N/A	N/A	0.002719894	0.000048759	N/A	1773.54
44	9/8/2009-10/6/2009	30	0.018908139	-114.175820896	N/A	N/A	0.002607741	0.000047094	N/A	2327.92

Average Sum of Squared Errors   12,641.52

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

| | Reference Entity: | Merck & Co. Inc. | NYSE: | MRK | Industry: | Healthcare |

Model 6   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.074617582	-104.958930414	0.299418228	N/A	0.001344730	N/A	0.008111672	7894.16
2	1/15/2008-2/25/2008	30	-0.020368199	-114.801580457	0.307443687	N/A	0.001808263	N/A	0.010818656	7545.18
3	1/29/2008-3/10/2008	30	-0.063144984	-103.397427861	0.291133868	N/A	0.001932400	N/A	0.012416691	29241.15
4	2/12/2008-3/24/2008	30	0.011839869	-117.006168878	0.313480379	N/A	0.002378397	N/A	0.013963197	46399.11
5	2/26/2008-4/7/2008	30	0.071807366	-100.094768387	0.301555788	N/A	0.002662823	N/A	0.014714173	34462.13
6	3/11/2008-4/21/2008	30	-0.027856908	-111.753285401	0.296363771	N/A	0.002726534	N/A	0.016141604	51639.69
7	3/25/2008-5/25/2008	30	0.027291786	-96.513401434	0.296288022	N/A	0.002379622	N/A	0.014186711	61425.06
8	4/8/2008-5/19/2008	30	0.051440193	-105.998827590	0.308764300	N/A	0.001947866	N/A	0.011204695	30811.10
9	4/22/2008-6/2/2008	30	0.073913027	-110.100040186	0.302297497	N/A	0.001606516	N/A	0.010072833	4752.99
10	5/6/2008-6/16/2008	30	-0.053141796	-108.828210825	0.326357954	N/A	0.001556856	N/A	0.009601917	1109.21
11	5/20/2008-6/30/2008	30	0.025151084	-103.231733392	0.317934024	N/A	0.001633936	N/A	0.009342022	15865.84
12	6/3/2008-7/14/2008	30	-0.055397583	-99.002913228	0.326228913	N/A	0.001693661	N/A	0.009491983	1508.75
13	6/17/2008-7/28/2008	30	0.019168750	-99.793274766	0.320085188	N/A	0.001685235	N/A	0.009853982	4235.77
14	7/1/2008-8/11/2008	30	0.061750598	-106.695303473	0.303381387	N/A	0.001731834	N/A	0.010619014	5671.22
15	7/15/2008-8/25/2008	30	-0.098949018	-112.705469778	0.325402884	N/A	0.001859401	N/A	0.010624516	9784.01
16	7/29/2008-9/8/2008	30	0.052419330	-116.397363581	0.314818163	N/A	0.001866926	N/A	0.010908627	11145.06
17	8/12/2008-9/22/2008	30	0.046437413	-102.373830979	0.334469801	N/A	0.002006437	N/A	0.012439273	6175.08
18	8/26/2008-10/6/2008	30	0.098182868	-103.039558597	0.319991138	N/A	0.002134388	N/A	0.013639382	5581.28
19	9/9/2008-10/20/2008	30	-0.071881811	-108.972348989	0.344768302	N/A	0.002574534	N/A	0.015321829	19136.33
20	9/23/2008-11/3/2008	30	-0.037283560	-115.555048323	0.328086414	N/A	0.002651048	N/A	0.015650348	42207.04
21	10/7/2008-11/17/2008	30	0.048554650	-96.661325415	0.345076048	N/A	0.002786838	N/A	0.016803301	12971.68
22	10/21/2008-12/1/2008	30	-0.061876665	-98.277151036	0.353032486	N/A	0.003190455	N/A	0.016360550	5548.99
23	11/4/2008-12/15/2008	30	0.015690610	-96.034632085	0.346897012	N/A	0.003533445	N/A	0.020256814	45538.51
24	11/18/2008-12/29/2008	30	0.020311827	-96.258266922	0.327634910	N/A	0.003766939	N/A	0.023636430	16147.33
25	12/2/2008-1/12/2009	30	-0.075939069	-96.226180426	0.336811678	N/A	0.003695991	N/A	0.023450043	7344.06
26	12/16/2008-1/26/2009	30	-0.073813181	-114.158997749	0.333573095	N/A	0.003742840	N/A	0.022109484	5903.13
27	12/30/2008-2/9/2009	30	0.038690068	-112.172838266	0.325542369	N/A	0.003587533	N/A	0.021862726	19682.10
28	1/13/2009-2/23/2009	30	0.077896733	-115.811350064	0.333473449	N/A	0.003730744	N/A	0.022072679	57800.06
29	1/27/2009-3/9/2009	30	0.093121334	-114.339807827	0.346243568	N/A	0.003018278	N/A	0.017806783	71034.65
30	2/10/2009-3/23/2009	30	0.000145936	-108.781013336	0.353984644	N/A	0.003150203	N/A	0.018127586	63052.07
31	2/24/2009-4/6/2009	30	0.029595924	-102.738171827	0.342160708	N/A	0.004039627	N/A	0.023770595	43903.97
32	3/10/2009-4/20/2009	30	0.010721813	-108.983897665	0.330635837	N/A	0.003975581	N/A	0.023977767	10132.29
33	3/24/2009-5/4/2009	30	-0.057091146	-113.914946469	0.363053017	N/A	0.003993001	N/A	0.022753452	10716.71
34	4/7/2009-5/18/2009	30	0.087784889	-101.189187466	0.357624870	N/A	0.003328812	N/A	0.020403823	18714.39
35	4/21/2009-6/1/2009	30	0.051678321	-98.327821037	0.344051035	N/A	0.003032649	N/A	0.019562702	6866.73
36	5/5/2009-6/15/2009	30	0.066446243	-115.603656516	0.334113407	N/A	0.002767830	N/A	0.015722787	3882.91
37	5/19/2009-6/29/2009	30	0.068046177	-96.697197086	0.325609857	N/A	0.002590780	N/A	0.015363955	1973.87
38	6/2/2009-7/13/2009	30	0.042854362	-99.401547564	0.348493560	N/A	0.002489954	N/A	0.014711831	5791.00
39	6/16/2009-7/27/2009	30	-0.062231716	-113.903080851	0.321233667	N/A	0.002320431	N/A	0.012882245	1178.08
40	6/30/2009-8/10/2009	30	-0.039603822	-109.257022689	0.319065882	N/A	0.001901725	N/A	0.012063294	1973.84
41	7/14/2009-8/24/2009	30	-0.058591371	-116.597860856	0.317999991	N/A	0.001654699	N/A	0.009302405	2963.17
42	7/28/2009-9/7/2009	30	-0.059960064	-102.478281074	0.326384639	N/A	0.001372920	N/A	0.008881207	2714.09
43	8/11/2009-9/21/2009	30	0.035775994	-107.465572345	0.319124564	N/A	0.001369358	N/A	0.008003751	3031.53
44	9/8/2009-10/6/2009	30	0.065410803	-108.253150423	0.305613214	N/A	0.001463415	N/A	0.008660018	8130.56

Average Sum of Squared Errors   18,717.86

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	Merck & Co. Inc.	NYSE:	MRK	Industry:	Healthcare

Model 7 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.059796718	-116.212458929	0.285925676	-0.000004271	0.001374877	N/A	0.008087925	7633.97
2	1/15/2008-2/25/2008	30	-0.043921507	-105.393727001	0.297308225	0.000068275	0.001757109	N/A	0.010083420	7454.70
3	1/29/2008-3/10/2008	30	-0.061777596	-107.329945342	0.296699403	0.000077966	0.001990985	N/A	0.011897362	27582.78
4	2/12/2008-3/24/2008	30	-0.055237782	-110.120367111	0.305093461	0.000018126	0.002292515	N/A	0.013366509	42403.88
5	2/26/2008-4/7/2008	30	-0.038069811	-108.033413297	0.306657015	-0.000024982	0.002603312	N/A	0.015522988	32910.98
6	3/11/2008-4/21/2008	30	-0.049590341	-109.764411537	0.316432966	0.000000071	0.002719739	N/A	0.016106473	49820.62
7	3/25/2008-5/25/2008	30	-0.015198859	-111.625334555	0.322091785	0.000033953	0.002309527	N/A	0.014731392	60126.63
8	4/8/2008-5/19/2008	30	0.059913430	-111.217677709	0.308956529	-0.000073456	0.001988496	N/A	0.011382345	28858.17
9	4/22/2008-6/2/2008	30	-0.026712638	-114.120123960	0.313979118	-0.000039955	0.001549875	N/A	0.009523415	4677.02
10	5/6/2008-6/16/2008	30	0.033574406	-100.937072213	0.302072136	-0.000081541	0.001651200	N/A	0.009232597	999.56
11	5/20/2008-6/30/2008	30	-0.049945906	-113.170653299	0.300055423	-0.000032282	0.001558108	N/A	0.009550992	13993.44
12	6/3/2008-7/14/2008	30	-0.088443598	-104.805801689	0.305025941	0.000069432	0.001569093	N/A	0.009699066	1427.50
13	6/17/2008-7/28/2008	30	0.056455013	-114.640018418	0.317876257	-0.000008056	0.001727749	N/A	0.010111251	4153.74
14	7/1/2008-8/11/2008	30	-0.012068883	-110.848945731	0.331453658	0.000086341	0.001781299	N/A	0.010529995	5271.52
15	7/15/2008-8/25/2008	30	0.019493923	-102.065637587	0.334130239	0.000099623	0.001816110	N/A	0.010933740	9336.01
16	7/29/2008-9/8/2008	30	0.016404872	-109.261569830	0.321676774	-0.000052162	0.001813733	N/A	0.011652907	10304.15
17	8/12/2008-9/22/2008	30	-0.044706122	-101.235701288	0.327574326	0.000084183	0.002010782	N/A	0.011701672	5950.50
18	8/26/2008-10/6/2008	30	-0.055122662	-114.576240667	0.320894464	-0.000037201	0.002170927	N/A	0.013503559	5354.49
19	9/9/2008-10/20/2008	30	0.070232978	-114.016353892	0.326121471	0.000096430	0.002562951	N/A	0.014606455	17902.93
20	9/23/2008-11/3/2008	30	0.016781775	-114.024200753	0.329298914	0.000038188	0.002821973	N/A	0.015741046	41523.95
21	10/7/2008-11/17/2008	30	-0.011039968	-106.894206254	0.332096767	-0.000055943	0.002882765	N/A	0.016754855	11924.42
22	10/21/2008-12/1/2008	30	0.084851951	-108.998615773	0.350809315	0.000026830	0.003151148	N/A	0.018539500	5283.91
23	11/4/2008-12/15/2008	30	-0.058955450	-105.160801052	0.344065080	-0.000071662	0.003585797	N/A	0.022104396	42980.21
24	11/18/2008-12/29/2008	30	-0.055393989	-100.983541025	0.352273905	0.000016648	0.003913220	N/A	0.022708315	15618.44
25	12/2/2008-1/12/2009	30	-0.024682624	-107.466408114	0.336231892	-0.000056140	0.003819205	N/A	0.023915669	7002.84
26	12/16/2008-1/26/2009	30	0.093254852	-107.790763221	0.350110823	0.000097872	0.003826684	N/A	0.022053253	5619.87
27	12/30/2008-2/9/2009	30	-0.061641091	-103.736420333	0.325603191	-0.000034430	0.003723324	N/A	0.021651835	18326.98
28	1/13/2009-2/23/2009	30	0.002197280	-96.822998001	0.357718023	0.000086705	0.003655042	N/A	0.021269114	53877.40
29	1/27/2009-3/9/2009	30	0.089863037	-108.984579804	0.344357171	-0.000079710	0.003040892	N/A	0.017387429	68816.51
30	2/10/2009-3/23/2009	30	0.075133962	-100.389815794	0.342212194	0.000012113	0.003001663	N/A	0.017632023	59528.56
31	2/24/2009-4/6/2009	30	-0.050164970	-104.556860524	0.348753822	0.000078845	0.004014622	N/A	0.024874852	42865.72
32	3/10/2009-4/20/2009	30	-0.018696319	-100.133533612	0.330470991	-0.000054267	0.004066842	N/A	0.025227598	9999.81
33	3/24/2009-5/4/2009	30	-0.096402590	-114.373071584	0.341130911	0.000061022	0.003712080	N/A	0.023175752	10315.17
34	4/7/2009-5/18/2009	30	-0.061257319	-97.869387985	0.361390257	-0.000044316	0.003545407	N/A	0.020218188	17423.81
35	4/21/2009-6/1/2009	30	0.027200300	-114.281717673	0.334179436	-0.000003664	0.003156580	N/A	0.019572097	6725.13
36	5/5/2009-6/15/2009	30	0.059549731	-103.535542773	0.352681209	-0.000034180	0.002718704	N/A	0.016004830	3591.23
37	5/19/2009-6/29/2009	30	-0.082920977	-95.943682084	0.345159078	-0.000021908	0.002471673	N/A	0.015522413	1845.88
38	6/2/2009-7/13/2009	30	-0.013782338	-112.605286594	0.321785192	0.000032987	0.002350578	N/A	0.014863535	5703.16
39	6/16/2009-7/27/2009	30	0.021963143	-104.142780240	0.343820471	-0.000057610	0.002328667	N/A	0.013415181	1073.41
40	6/30/2009-8/10/2009	30	-0.077241109	-98.043983146	0.311203528	0.000004007	0.001880226	N/A	0.011928159	1888.01
41	7/14/2009-8/24/2009	30	-0.006552314	-108.286101979	0.323969925	-0.000036761	0.001559835	N/A	0.009938200	2766.94
42	7/28/2009-9/7/2009	30	-0.089088585	-105.639461065	0.309273443	0.000097207	0.001391079	N/A	0.008263535	2597.00
43	8/11/2009-9/21/2009	30	-0.062291463	-96.624775520	0.326558555	0.000086499	0.001403012	N/A	0.007950088	3006.65
44	9/8/2009-10/6/2009	30	-0.093414240	-105.429813772	0.332064781	-0.000017942	0.001363756	N/A	0.008377468	8023.68

Average Sum of Squared Errors   17,829.35

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	Merck & Co. Inc.	NYSE:	MRK	Industry:	Healthcare

Model 8   Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^h}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.382666930	N/A	0.294551295	N/A	0.001785665	0.000044841	0.003394875	5923.32
2	1/15/2008-2/25/2008	30	-0.541179126	N/A	0.287461709	N/A	0.002443439	0.000055207	0.004256822	6284.63
3	1/29/2008-3/10/2008	30	-0.355668856	N/A	0.285728224	N/A	0.002690822	0.000057380	0.004628563	3164.82
4	2/12/2008-3/24/2008	30	-0.484144506	N/A	0.295047582	N/A	0.003500511	0.000068193	0.005391351	10066.10
5	2/26/2008-4/7/2008	30	-0.455716724	N/A	0.313642247	N/A	0.003786683	0.000070596	0.006341527	13842.22
6	3/11/2008-4/21/2008	30	-0.409875829	N/A	0.308870628	N/A	0.004076237	0.000071798	0.006382209	8900.52
7	3/25/2008-5/25/2008	30	-0.442720977	N/A	0.306053367	N/A	0.003626210	0.000064425	0.005756202	19187.12
8	4/8/2008-5/19/2008	30	-0.379596598	N/A	0.315793338	N/A	0.002695739	0.000056795	0.004653794	11523.84
9	4/22/2008-6/2/2008	30	-0.480505553	N/A	0.307287798	N/A	0.002211149	0.000049309	0.003904816	1490.13
10	5/6/2008-6/16/2008	30	-0.350329544	N/A	0.323849976	N/A	0.002152588	0.000048661	0.003788306	672.63
11	5/20/2008-6/30/2008	30	-0.389845423	N/A	0.300920933	N/A	0.002192189	0.000051776	0.003874273	664.85
12	6/3/2008-7/14/2008	30	-0.526331148	N/A	0.314833760	N/A	0.002109451	0.000051492	0.003814540	709.28
13	6/17/2008-7/28/2008	30	-0.423219191	N/A	0.326067661	N/A	0.002315403	0.000051823	0.004173547	930.34
14	7/1/2008-8/11/2008	30	-0.513486968	N/A	0.323515620	N/A	0.002291296	0.000053068	0.004177318	842.17
15	7/15/2008-8/25/2008	30	-0.402588474	N/A	0.307034288	N/A	0.002598748	0.000054940	0.004333215	713.37
16	7/29/2008-9/8/2008	30	-0.392364742	N/A	0.313741261	N/A	0.002646582	0.000055803	0.004500843	590.12
17	8/12/2008-9/22/2008	30	-0.414738511	N/A	0.335808013	N/A	0.002905719	0.000063749	0.004859932	3517.23
18	8/26/2008-10/6/2008	30	-0.476450043	N/A	0.322606509	N/A	0.003091510	0.000069996	0.005169982	4422.32
19	9/9/2008-10/20/2008	30	-0.398961277	N/A	0.317750591	N/A	0.003346800	0.000079032	0.006145423	3993.12
20	9/23/2008-11/3/2008	30	-0.419784487	N/A	0.347327596	N/A	0.003623837	0.000079525	0.006507396	3335.80
21	10/7/2008-11/17/2008	30	-0.370239957	N/A	0.334142027	N/A	0.004530533	0.000079213	0.007046914	2105.12
22	10/21/2008-12/1/2008	30	-0.423119295	N/A	0.346873372	N/A	0.005056970	0.000075830	0.007472900	6086.52
23	11/4/2008-12/15/2008	30	-0.467090832	N/A	0.354524510	N/A	0.006577014	0.000080334	0.008768130	14906.54
24	11/18/2008-12/29/2008	30	-0.442913673	N/A	0.343748867	N/A	0.006926450	0.000079124	0.009251659	4825.00
25	12/2/2008-1/12/2009	30	-0.491404625	N/A	0.327655629	N/A	0.007415048	0.000082663	0.008886155	5407.23
26	12/16/2008-1/26/2009	30	-0.479987278	N/A	0.336985591	N/A	0.007182216	0.000080522	0.009349940	3960.76
27	12/30/2008-2/9/2009	30	-0.372731191	N/A	0.341776195	N/A	0.007669725	0.000064152	0.009046943	12436.12
28	1/13/2009-2/23/2009	30	-0.346421975	N/A	0.346594409	N/A	0.010580640	0.000012687	0.008544957	34895.12
29	1/27/2009-3/9/2009	30	-0.462715441	N/A	0.354392797	N/A	0.010212482	-0.000026683	0.007047829	36617.54
30	2/10/2009-3/23/2009	30	-0.386726492	N/A	0.333554663	N/A	0.010747369	-0.000029618	0.007203044	34860.06
31	2/24/2009-4/6/2009	30	-0.427284902	N/A	0.354246170	N/A	0.011898434	0.000003832	0.009869381	25982.80
32	3/10/2009-4/20/2009	30	-0.386191107	N/A	0.345457707	N/A	0.010539100	0.000038035	0.009435645	2953.45
33	3/24/2009-5/4/2009	30	-0.365886304	N/A	0.351163706	N/A	0.009997064	0.000035040	0.009268187	3760.37
34	4/7/2009-5/18/2009	30	-0.476422810	N/A	0.337569020	N/A	0.008808859	0.000031913	0.008051248	8564.17
35	4/21/2009-6/1/2009	30	-0.493700336	N/A	0.328048809	N/A	0.008075296	0.000029340	0.007720974	7650.06
36	5/5/2009-6/15/2009	30	-0.449652507	N/A	0.349145217	N/A	0.006874278	0.000025925	0.006309036	3411.81
37	5/19/2009-6/29/2009	30	-0.408062780	N/A	0.335774751	N/A	0.006446162	0.000023828	0.005856982	1334.87
38	6/2/2009-7/13/2009	30	-0.423565788	N/A	0.338712873	N/A	0.005980839	0.000028813	0.006051496	624.26
39	6/16/2009-7/27/2009	30	-0.385681031	N/A	0.320425469	N/A	0.005359504	0.000029360	0.005199589	1178.59
40	6/30/2009-8/10/2009	30	-0.538178114	N/A	0.319764159	N/A	0.004196810	0.000027703	0.004472423	1437.25
41	7/14/2009-8/24/2009	30	-0.442238269	N/A	0.331796988	N/A	0.003473719	0.000023095	0.003996742	3076.99
42	7/28/2009-9/7/2009	30	-0.427790775	N/A	0.307026020	N/A	0.003071919	0.000023909	0.003465426	1651.13
43	8/11/2009-9/21/2009	30	-0.447458290	N/A	0.317550672	N/A	0.002667303	0.000028158	0.003257556	1047.80
44	9/8/2009-10/6/2009	30	-0.540935200	N/A	0.335081744	N/A	0.002615035	0.000029508	0.003452914	1360.65

								Average Sum of Squared Errors	7,293.37

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **Merck & Co. Inc.** NYSE: **MRK** Industry: Healthcare

Model9 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{\frac{1}{2}+\lambda t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.483029681	N/A	0.287783767	0.000072097	0.001708869	0.000048088	0.003259904	5909.77
2	1/15/2008-2/25/2008	30	-0.443354358	N/A	0.279335578	0.000089713	0.002339743	0.000051093	0.004090229	6186.00
3	1/29/2008-3/10/2008	30	-0.435928963	N/A	0.299872521	0.000042650	0.002833920	0.000061178	0.004554560	3102.07
4	2/12/2008-3/24/2008	30	-0.337311778	N/A	0.312833634	0.000090864	0.003462883	0.000066196	0.005744737	9094.27
5	2/26/2008-4/7/2008	30	-0.386667062	N/A	0.309767346	-0.000081454	0.003783393	0.000072715	0.005859033	13665.27
6	3/11/2008-4/21/2008	30	-0.395881789	N/A	0.301389959	-0.000050817	0.003972230	0.000075026	0.006413410	8730.51
7	3/25/2008-5/25/2008	30	-0.399639374	N/A	0.310029613	0.000021983	0.003486971	0.000066415	0.005710107	18357.40
8	4/8/2008-5/19/2008	30	-0.384549752	N/A	0.307758418	0.000006910	0.002769891	0.000057604	0.004668410	10626.50
9	4/22/2008-6/2/2008	30	-0.470920840	N/A	0.294838509	0.000007545	0.002106168	0.000050024	0.003975558	1437.44
10	5/6/2008-6/16/2008	30	-0.473834787	N/A	0.299743432	-0.000044109	0.002102871	0.000048079	0.003970701	584.36
11	5/20/2008-6/30/2008	30	-0.371355390	N/A	0.311018677	-0.000078715	0.002063021	0.000047974	0.003987776	615.76
12	6/3/2008-7/14/2008	30	-0.493770583	N/A	0.303038984	0.000003033	0.002296342	0.000052386	0.004015194	672.18
13	6/17/2008-7/28/2008	30	-0.433566453	N/A	0.312111877	0.000000490	0.002289986	0.000050965	0.004147002	909.81
14	7/1/2008-8/11/2008	30	-0.367783629	N/A	0.317557034	-0.000079504	0.002375810	0.000051914	0.004237654	808.08
15	7/15/2008-8/25/2008	30	-0.465272428	N/A	0.324598362	0.000091316	0.002456496	0.000055051	0.004152479	674.66
16	7/29/2008-9/8/2008	30	-0.470393922	N/A	0.327302112	0.000057341	0.002668348	0.000055086	0.004357302	491.43
17	8/12/2008-9/22/2008	30	-0.500943749	N/A	0.309388474	-0.000044844	0.002841689	0.000065775	0.005069313	3329.99
18	8/26/2008-10/6/2008	30	-0.527729287	N/A	0.331661823	0.000031955	0.003161348	0.000068841	0.005438727	4269.38
19	9/9/2008-10/20/2008	30	-0.457631061	N/A	0.342390299	-0.000075845	0.003485963	0.000073729	0.006281732	3967.64
20	9/23/2008-11/3/2008	30	-0.457537065	N/A	0.342523022	0.000095755	0.003833856	0.000084998	0.006213605	3293.24
21	10/7/2008-11/17/2008	30	-0.487862844	N/A	0.333262853	-0.000020962	0.004577588	0.000076966	0.007081973	2009.47
22	10/21/2008-12/1/2008	30	-0.527536694	N/A	0.349139767	0.000027753	0.005063892	0.000072682	0.007727823	5092.43
23	11/4/2008-12/15/2008	30	-0.356789672	N/A	0.339520340	0.000087047	0.006503616	0.000073118	0.008357055	14075.72
24	11/18/2008-12/29/2008	30	-0.411578615	N/A	0.326792676	-0.000018477	0.007078756	0.000082128	0.009495213	4628.66
25	12/2/2008-1/12/2009	30	-0.506898509	N/A	0.331161490	0.000032963	0.007288285	0.000084520	0.009378652	5071.97
26	12/16/2008-1/26/2009	30	-0.404740146	N/A	0.326906520	0.000060979	0.006822960	0.000082405	0.008833817	3685.87
27	12/30/2008-2/9/2009	30	-0.494720370	N/A	0.329730679	0.000093972	0.007830672	0.000064921	0.009155111	11745.93
28	1/13/2009-2/23/2009	30	-0.459022132	N/A	0.330488663	0.000034024	0.010496655	0.000013007	0.008915801	34415.88
29	1/27/2009-3/9/2009	30	-0.520052608	N/A	0.346426886	0.000039309	0.010529972	-0.000026649	0.006717786	35456.34
30	2/10/2009-3/23/2009	30	-0.517613794	N/A	0.360364437	0.000074611	0.011157925	-0.000030645	0.007523987	32571.74
31	2/24/2009-4/6/2009	30	-0.415757429	N/A	0.352050959	-0.000063964	0.011884819	0.000003702	0.009299970	25001.08
32	3/10/2009-4/20/2009	30	-0.509697433	N/A	0.345447583	-0.000029678	0.010604026	0.000036586	0.009927876	2858.93
33	3/24/2009-5/4/2009	30	-0.460991301	N/A	0.354237837	-0.000087941	0.009910951	0.000035563	0.009199857	3626.51
34	4/7/2009-5/18/2009	30	-0.442336941	N/A	0.346181169	-0.000097415	0.008735376	0.000032022	0.008352932	7907.42
35	4/21/2009-6/1/2009	30	-0.543483365	N/A	0.345063899	-0.000061520	0.008109300	0.000029337	0.007567287	6468.77
36	5/5/2009-6/15/2009	30	-0.457021416	N/A	0.329427503	0.000098915	0.006746868	0.000024732	0.006368847	3275.64
37	5/19/2009-6/29/2009	30	-0.379681312	N/A	0.325494052	-0.000079307	0.006295230	0.000024732	0.006217682	1314.33
38	6/2/2009-7/13/2009	30	-0.402107626	N/A	0.329998798	0.000031850	0.005962272	0.000027229	0.006036004	607.40
39	6/16/2009-7/27/2009	30	-0.454072657	N/A	0.324152137	0.000062640	0.004995123	0.000029224	0.005189554	1113.24
40	6/30/2009-8/10/2009	30	-0.464895304	N/A	0.324147050	-0.000041075	0.004603928	0.000026808	0.004686904	1428.84
41	7/14/2009-8/24/2009	30	-0.513753682	N/A	0.309548600	0.000065388	0.003580305	0.000024668	0.003855162	2968.17
42	7/28/2009-9/7/2009	30	-0.524335689	N/A	0.331055459	-0.000059352	0.003005571	0.000025994	0.003412296	1548.66
43	8/11/2009-9/21/2009	30	-0.446596920	N/A	0.334475908	0.000025301	0.002612330	0.000027611	0.003245211	1038.80
44	9/8/2009-10/6/2009	30	-0.464611380	N/A	0.331363357	-0.000019487	0.002808523	0.000028484	0.003567768	1342.93

Average Sum of Squared Errors 6,954.10

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

| Reference Entity: | Merck & Co. Inc. | NYSE: | MRK | Industry: | Healthcare |

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{\frac{t}{h}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.059088761	-115.543260436	0.282092142	N/A	0.001766506	0.000044219	0.003319566	5222.77
2	1/15/2008-2/25/2008	30	-0.039245237	-115.224065846	0.305952761	N/A	0.002420633	0.000050843	0.004340327	5743.83
3	1/29/2008-3/10/2008	30	-0.017016724	-97.391680652	0.286732682	N/A	0.002784796	0.000057947	0.004564592	2871.12
4	2/12/2008-3/24/2008	30	-0.048863713	-113.312157739	0.301094175	N/A	0.003360756	0.000069207	0.005357234	8823.28
5	2/26/2008-4/7/2008	30	-0.000173690	-96.040051854	0.296254931	N/A	0.003945618	0.000075174	0.006359879	12202.47
6	3/11/2008-4/21/2008	30	-0.040366129	-113.447775388	0.292913709	N/A	0.004113750	0.000077475	0.006168111	8270.19
7	3/25/2008-5/25/2008	30	0.079043380	-95.902605151	0.312559206	N/A	0.003291629	0.000069013	0.005579948	16444.96
8	4/8/2008-5/19/2008	30	-0.048880577	-103.408008885	0.298329225	N/A	0.002779052	0.000056004	0.004528371	10778.16
9	4/22/2008-6/2/2008	30	0.022454542	-101.371046103	0.300873674	N/A	0.002099954	0.000048179	0.003967948	1331.10
10	5/6/2008-6/16/2008	30	-0.063788302	-97.160333068	0.308915729	N/A	0.002185049	0.000052130	0.003773819	591.53
11	5/20/2008-6/30/2008	30	0.005084220	-99.208990258	0.320565444	N/A	0.002244051	0.000047981	0.003712156	575.31
12	6/3/2008-7/14/2008	30	-0.081833208	-108.273691554	0.330388585	N/A	0.002240044	0.000052387	0.003839175	666.95
13	6/17/2008-7/28/2008	30	-0.007607299	-109.549381448	0.303591297	N/A	0.002292056	0.000050699	0.004124776	824.67
14	7/1/2008-8/11/2008	30	-0.073109076	-101.794531926	0.316549942	N/A	0.002317576	0.000054146	0.004037867	781.00
15	7/15/2008-8/25/2008	30	-0.079247123	-103.567466985	0.330795171	N/A	0.002542560	0.000055583	0.004147288	619.75
16	7/29/2008-9/8/2008	30	-0.049904041	-111.677940304	0.319542376	N/A	0.002548110	0.000057709	0.004336807	523.21
17	8/12/2008-9/22/2008	30	0.008500077	-112.711541751	0.318436647	N/A	0.002881396	0.000064976	0.004917148	3129.96
18	8/26/2008-10/6/2008	30	0.058868109	-113.464958034	0.327758054	N/A	0.003010509	0.000071741	0.005638427	3894.64
19	9/9/2008-10/20/2008	30	0.054080011	-99.960826576	0.342459184	N/A	0.003335079	0.000079496	0.006075428	3607.67
20	9/23/2008-11/3/2008	30	-0.005010465	-106.851425021	0.344897980	N/A	0.003949160	0.000080367	0.006438519	3140.06
21	10/7/2008-11/17/2008	30	0.039052484	-97.851680800	0.332699115	N/A	0.004586404	0.000075894	0.006494604	1964.95
22	10/21/2008-12/1/2008	30	0.035672265	-105.073592008	0.350185805	N/A	0.005304763	0.000073094	0.007085048	5274.97
23	11/4/2008-12/15/2008	30	-0.084888895	-115.594572290	0.356493240	N/A	0.006363029	0.000076361	0.008305521	12749.14
24	11/18/2008-12/29/2008	30	-0.090222536	-110.195351195	0.349220687	N/A	0.006832795	0.000085070	0.009708707	4434.30
25	12/2/2008-1/12/2009	30	0.072539024	-115.488645758	0.335860160	N/A	0.007009445	0.000079927	0.009467911	4644.95
26	12/16/2008-1/26/2009	30	-0.057251930	-114.175053750	0.338762470	N/A	0.007257984	0.000076643	0.008831682	3427.87
27	12/30/2008-2/9/2009	30	-0.000220852	-110.530740110	0.341726432	N/A	0.007438464	0.000068972	0.009257357	11681.44
28	1/13/2009-2/23/2009	30	-0.043612015	-103.449581738	0.343319016	N/A	0.010436770	0.000013740	0.008416610	32237.97
29	1/27/2009-3/9/2009	30	-0.015294350	-97.412481394	0.335850251	N/A	0.010530718	-0.000028750	0.007103310	33672.68
30	2/10/2009-3/23/2009	30	-0.058529433	-106.088048642	0.335769579	N/A	0.011397897	-0.000030607	0.007574910	30453.52
31	2/24/2009-4/6/2009	30	-0.060270503	-109.796871227	0.358779598	N/A	0.011698359	0.000003921	0.009850365	24189.18
32	3/10/2009-4/20/2009	30	0.094219053	-115.627554307	0.339396906	N/A	0.010670192	0.000036706	0.009615683	2741.84
33	3/24/2009-5/4/2009	30	0.091851509	-102.461122943	0.365402514	N/A	0.009936197	0.000034977	0.008923053	3512.33
34	4/7/2009-5/18/2009	30	0.051250941	-98.795605654	0.335871778	N/A	0.008537179	0.000032829	0.008101371	7940.22
35	4/21/2009-6/1/2009	30	-0.017296387	-108.016855449	0.356314722	N/A	0.007822647	0.000028215	0.007796100	6506.10
36	5/5/2009-6/15/2009	30	0.015839600	-113.422326156	0.355147889	N/A	0.006558005	0.000026134	0.006784722	3064.89
37	5/19/2009-6/29/2009	30	0.027251802	-100.815540681	0.339513982	N/A	0.006519385	0.000023956	0.005981400	1215.73
38	6/2/2009-7/13/2009	30	0.073629855	-102.212692732	0.337843441	N/A	0.005467389	0.000027868	0.005626804	562.42
39	6/16/2009-7/27/2009	30	0.060054490	-108.864804248	0.330778827	N/A	0.005364836	0.000028961	0.005388170	1143.70
40	6/30/2009-8/10/2009	30	-0.003491921	-98.702201895	0.324728184	N/A	0.004227715	0.000027167	0.004493174	1282.77
41	7/14/2009-8/24/2009	30	0.017542666	-115.969618970	0.314649631	N/A	0.003630547	0.000025338	0.003989467	2910.92
42	7/28/2009-9/7/2009	30	-0.038181624	-109.473396646	0.317542868	N/A	0.002906313	0.000024545	0.003497738	1424.79
43	8/11/2009-9/21/2009	30	-0.006080542	-102.818619290	0.314197847	N/A	0.002650586	0.000027546	0.003344335	905.10
44	9/8/2009-10/6/2009	30	0.038805138	-102.529805736	0.311988156	N/A	0.002676619	0.000028951	0.003539720	1215.64

Average Sum of Squared Errors 6,572.73

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Merck & Co. Inc. NYSE: MRK Industry: Healthcare

Model11 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{c_3 + c_4 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	a0	a1	b0	b1	c0	c1	c2	Sum of squared errors
1	1/1/2008-2/11/2008	30	0.086122093	-116.063343269	0.297763740	0.000084485	0.001668229	0.000046760	0.003286074	5068.07
2	1/15/2008-2/25/2008	30	0.095227389	-104.197223836	0.290054802	-0.000018386	0.002466575	0.000052263	0.004293873	5171.89
3	1/29/2008-3/10/2008	30	0.016053735	-97.158101320	0.284181158	0.000071550	0.002738537	0.000056721	0.004930460	2625.38
4	2/12/2008-3/24/2008	30	-0.026716602	-115.854299361	0.307879581	-0.000037303	0.003435509	0.000066812	0.005608210	8298.89
5	2/26/2008-4/7/2008	30	-0.040695822	-96.266761076	0.299961330	-0.000043249	0.004037185	0.000068778	0.005964275	10932.53
6	3/11/2008-4/21/2008	30	0.055873235	-100.579184964	0.291611601	-0.000023245	0.004288912	0.000073715	0.006358960	7750.52
7	3/25/2008-5/25/2008	30	-0.033260109	-105.804169865	0.321349957	-0.000059614	0.003581081	0.000066974	0.005656215	15572.64
8	4/8/2008-5/19/2008	30	0.008624785	-96.469799712	0.298473242	-0.000061783	0.002737730	0.000055247	0.004776710	9915.27
9	4/22/2008-6/2/2008	30	-0.013983292	-102.564251631	0.301193053	-0.000018555	0.002098418	0.000050717	0.003794121	1276.72
10	5/6/2008-6/16/2008	30	0.079206307	-116.709885624	0.305995410	0.000066011	0.002162366	0.000051778	0.003818523	582.01
11	5/20/2008-6/30/2008	30	-0.063732172	-105.171061149	0.309136769	-0.000000120	0.002209380	0.000048018	0.003723314	518.35
12	6/3/2008-7/14/2008	30	0.049765023	-107.870768450	0.324678106	0.000029587	0.002196513	0.000049091	0.003775589	608.41
13	6/17/2008-7/28/2008	30	0.036291076	-112.047819392	0.320662621	-0.000049034	0.002318194	0.000050220	0.003912528	775.42
14	7/1/2008-8/11/2008	30	0.044594428	-107.063610670	0.313258975	-0.000028397	0.002373160	0.000052928	0.004042115	721.07
15	7/15/2008-8/25/2008	30	0.073325980	-105.294135080	0.321905016	-0.000022951	0.002445182	0.000057881	0.004148045	589.18
16	7/29/2008-9/8/2008	30	-0.024139416	-96.331185177	0.305597801	-0.000034271	0.002591486	0.000056774	0.004681154	467.56
17	8/12/2008-9/22/2008	30	0.005632935	-111.416192717	0.313644909	-0.000066991	0.002925285	0.000061106	0.004887019	2975.13
18	8/26/2008-10/6/2008	30	-0.008101875	-112.359366960	0.336430016	-0.000087466	0.003185396	0.000067055	0.005130957	3819.04
19	9/9/2008-10/20/2008	30	-0.033755226	-100.393884478	0.341440839	0.000023258	0.003505820	0.000080051	0.005814299	3442.88
20	9/23/2008-11/3/2008	30	-0.027212971	-116.070664150	0.350250036	0.000099938	0.003692463	0.000079735	0.006215789	2921.47
21	10/7/2008-11/17/2008	30	0.021664196	-95.958429230	0.336656432	0.000056544	0.004427735	0.000079102	0.006816883	1758.24
22	10/21/2008-12/1/2008	30	-0.071451338	-103.312416486	0.333446373	0.000049637	0.005043944	0.000072370	0.007371301	4613.89
23	11/4/2008-12/15/2008	30	0.077269197	-115.892397448	0.355392931	0.000048106	0.006470105	0.000073698	0.008141453	12184.61
24	11/18/2008-12/29/2008	30	0.013394403	-97.930836062	0.332156529	-0.000098897	0.007391528	0.000084778	0.009303097	4007.73
25	12/2/2008-1/12/2009	30	0.072428792	-112.380028955	0.338603728	-0.000025456	0.007313623	0.000086521	0.008767848	4329.89
26	12/16/2008-1/26/2009	30	-0.007967810	-106.821504949	0.340711213	-0.000041902	0.006792321	0.000081002	0.009164324	3196.16
27	12/30/2008-2/9/2009	30	0.047115903	-108.350353304	0.347168645	0.000023314	0.007531014	0.000068054	0.008751823	10948.96
28	1/13/2009-2/23/2009	30	0.096829807	-104.001153779	0.353482734	-0.000082228	0.010499564	0.000013804	0.008439003	30156.02
29	1/27/2009-3/9/2009	30	0.024922824	-95.942681228	0.339633245	-0.000097993	0.009925863	-0.000027354	0.007009709	31918.18
30	2/10/2009-3/23/2009	30	-0.063878335	-108.620299998	0.359094685	0.000082269	0.010710121	-0.000029680	0.007318234	29312.02
31	2/24/2009-4/6/2009	30	0.066902308	-98.907153359	0.357590029	0.000066791	0.012230830	0.000003955	0.009717226	23382.72
32	3/10/2009-4/20/2009	30	0.017437403	-109.622168954	0.359473948	0.000054457	0.010314564	0.000036264	0.010062980	2484.59
33	3/24/2009-5/4/2009	30	-0.007459864	-104.819946366	0.357295335	0.000096726	0.010084328	0.000034891	0.009322586	3440.38
34	4/7/2009-5/18/2009	30	0.086307431	-112.009457476	0.362697123	-0.000044789	0.009076296	0.000031819	0.008458607	7357.95
35	4/21/2009-6/1/2009	30	0.086372763	-112.661056138	0.334897944	0.000061244	0.008100339	0.000028329	0.007798177	6394.87
36	5/5/2009-6/15/2009	30	0.034565125	-113.131658018	0.331136905	0.000055488	0.006726279	0.000026383	0.006807997	2781.88
37	5/19/2009-6/29/2009	30	0.027591674	-114.433160547	0.330030399	0.000047177	0.006242961	0.000024266	0.006293072	1144.24
38	6/2/2009-7/13/2009	30	-0.057409719	-97.123722678	0.350653685	0.000002243	0.005861159	0.000028622	0.005807587	552.56
39	6/16/2009-7/27/2009	30	0.002294675	-102.907945496	0.318312391	0.000012503	0.005088439	0.000029360	0.005192922	985.13
40	6/30/2009-8/10/2009	30	0.021394565	-116.290510837	0.333062485	-0.000062753	0.004583990	0.000027203	0.004561125	1157.39
41	7/14/2009-8/24/2009	30	0.061606823	-115.506162371	0.339168016	0.000047953	0.003563503	0.000023263	0.003953976	2754.10
42	7/28/2009-9/7/2009	30	0.094371216	-99.871136972	0.306639884	-0.000046247	0.002981116	0.000024807	0.003510318	1385.55
43	8/11/2009-9/21/2009	30	0.080019079	-103.981804321	0.325720762	0.000070218	0.002610787	0.000029254	0.003244896	823.34
44	9/8/2009-10/6/2009	30	-0.055119267	-114.445842064	0.327352077	-0.000078054	0.002784062	0.000028320	0.003561862	1130.38

Average Sum of Squared Errors 6,187.12

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Wal-Mart Stores Inc.   NYSE: WMT   Industry: Retail

Model 1   Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.431663707	N/A	N/A	N/A	0.006117485	N/A	N/A	17633.07
2	1/15/2008-2/25/2008	30	-0.371207628	N/A	N/A	N/A	0.007092330	N/A	N/A	21896.07
3	1/29/2008-3/10/2008	30	-0.459152387	N/A	N/A	N/A	0.007788913	N/A	N/A	24874.10
4	2/12/2008-3/24/2008	30	-0.381666374	N/A	N/A	N/A	0.008276724	N/A	N/A	21394.75
5	2/26/2008-4/7/2008	30	-0.403497285	N/A	N/A	N/A	0.007533850	N/A	N/A	30018.68
6	3/11/2008-4/21/2008	30	-0.439819919	N/A	N/A	N/A	0.006789564	N/A	N/A	21001.22
7	3/25/2008-5/25/2008	30	-0.404562248	N/A	N/A	N/A	0.005998334	N/A	N/A	8494.34
8	4/8/2008-5/19/2008	30	-0.468828352	N/A	N/A	N/A	0.005921935	N/A	N/A	6832.89
9	4/22/2008-6/2/2008	30	-0.330839404	N/A	N/A	N/A	0.005853525	N/A	N/A	5914.76
10	5/6/2008-6/16/2008	30	-0.428032731	N/A	N/A	N/A	0.006088828	N/A	N/A	8339.25
11	5/20/2008-6/30/2008	30	-0.370270708	N/A	N/A	N/A	0.006260231	N/A	N/A	11820.74
12	6/3/2008-7/14/2008	30	-0.362975107	N/A	N/A	N/A	0.006507844	N/A	N/A	13557.89
13	6/17/2008-7/28/2008	30	-0.301656921	N/A	N/A	N/A	0.006513966	N/A	N/A	12653.15
14	7/1/2008-8/11/2008	30	-0.38387153	N/A	N/A	N/A	0.006306261	N/A	N/A	10967.43
15	7/15/2008-8/25/2008	30	-0.390857497	N/A	N/A	N/A	0.006097337	N/A	N/A	8645.61
16	7/29/2008-9/8/2008	30	-0.45637193	N/A	N/A	N/A	0.006128179	N/A	N/A	6914.16
17	8/12/2008-9/22/2008	30	-0.34054204	N/A	N/A	N/A	0.006605396	N/A	N/A	10980.14
18	8/26/2008-10/6/2008	30	-0.424668295	N/A	N/A	N/A	0.007174121	N/A	N/A	15273.17
19	9/9/2008-10/20/2008	30	-0.454475307	N/A	N/A	N/A	0.008962615	N/A	N/A	65392.38
20	9/23/2008-11/3/2008	30	-0.452503673	N/A	N/A	N/A	0.011785563	N/A	N/A	121339.46
21	10/7/2008-11/17/2008	30	-0.41644348	N/A	N/A	N/A	0.014478887	N/A	N/A	56802.19
22	10/21/2008-12/1/2008	30	-0.328738547	N/A	N/A	N/A	0.016615923	N/A	N/A	60327.20
23	11/4/2008-12/15/2008	30	-0.424498051	N/A	N/A	N/A	0.018230830	N/A	N/A	62685.02
24	11/18/2008-12/29/2008	30	-0.452537844	N/A	N/A	N/A	0.018511353	N/A	N/A	52657.02
25	12/2/2008-1/12/2009	30	-0.401607505	N/A	N/A	N/A	0.017329621	N/A	N/A	58126.62
26	12/16/2008-1/26/2009	30	-0.401293381	N/A	N/A	N/A	0.016514020	N/A	N/A	34084.59
27	12/30/2008-2/9/2009	30	-0.380941394	N/A	N/A	N/A	0.016760628	N/A	N/A	32342.22
28	1/13/2009-2/23/2009	30	-0.467293894	N/A	N/A	N/A	0.016984167	N/A	N/A	19601.06
29	1/27/2009-3/9/2009	30	-0.316579645	N/A	N/A	N/A	0.017005114	N/A	N/A	11919.29
30	2/10/2009-3/23/2009	30	-0.359807791	N/A	N/A	N/A	0.016831743	N/A	N/A	8657.78
31	2/24/2009-4/6/2009	30	-0.426699428	N/A	N/A	N/A	0.013529609	N/A	N/A	10262.30
32	3/10/2009-4/20/2009	30	-0.330368827	N/A	N/A	N/A	0.012899924	N/A	N/A	15788.05
33	3/24/2009-5/4/2009	30	-0.480376307	N/A	N/A	N/A	0.011818953	N/A	N/A	25839.26
34	4/7/2009-5/18/2009	30	-0.374086444	N/A	N/A	N/A	0.013004419	N/A	N/A	31272.82
35	4/21/2009-6/1/2009	30	-0.316801405	N/A	N/A	N/A	0.011565640	N/A	N/A	26835.84
36	5/5/2009-6/15/2009	30	-0.408430467	N/A	N/A	N/A	0.010022501	N/A	N/A	23606.48
37	5/19/2009-6/29/2009	30	-0.411974416	N/A	N/A	N/A	0.008962987	N/A	N/A	13152.98
38	6/2/2009-7/13/2009	30	-0.37082157	N/A	N/A	N/A	0.008186908	N/A	N/A	10648.08
39	6/16/2009-7/27/2009	30	-0.43043829	N/A	N/A	N/A	0.007664644	N/A	N/A	13221.65
40	6/30/2009-8/10/2009	30	-0.384734627	N/A	N/A	N/A	0.006794596	N/A	N/A	16510.88
41	7/14/2009-8/24/2009	30	-0.407884604	N/A	N/A	N/A	0.006266086	N/A	N/A	13580.96
42	7/28/2009-9/7/2009	30	-0.320787797	N/A	N/A	N/A	0.006307335	N/A	N/A	16958.46
43	8/11/2009-9/21/2009	30	-0.310848564	N/A	N/A	N/A	0.006910316	N/A	N/A	25846.19
44	9/8/2009-10/6/2009	30	-0.477124963	N/A	N/A	N/A	0.007553577	N/A	N/A	33684.54

Average Sum of Squared Errors   25,417.15

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Wal-Mart Stores Inc.</u>　NYSE: 　<u>WMT</u>　　Industry: <u>Retail</u>

Model 2　Default Intensity: $\xi[i,j]=c_0+c_1t$　Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$　Recovery Rate: $\phi[i,j]=N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.466085675	N/A	N/A	N/A	0.0038120134	0.000072247	N/A	5221.21
2	1/15/2008-2/25/2008	30	-0.499009323	N/A	N/A	N/A	0.0048429387	0.000070550	N/A	10111.79
3	1/29/2008-3/10/2008	30	-0.403794265	N/A	N/A	N/A	0.0055333602	0.000070801	N/A	12634.64
4	2/12/2008-3/24/2008	30	-0.441495569	N/A	N/A	N/A	0.0060901106	0.000068621	N/A	10294.22
5	2/26/2008-4/7/2008	30	-0.406041631	N/A	N/A	N/A	0.0055397558	0.000062463	N/A	20414.57
6	3/11/2008-4/21/2008	30	-0.308855918	N/A	N/A	N/A	0.0051474366	0.000051396	N/A	14464.75
7	3/25/2008-5/25/2008	30	-0.370366199	N/A	N/A	N/A	0.0046718581	0.000041552	N/A	4077.57
8	4/8/2008-5/19/2008	30	-0.350085865	N/A	N/A	N/A	0.0046548188	0.000039749	N/A	2807.69
9	4/22/2008-6/2/2008	30	-0.409168644	N/A	N/A	N/A	0.0045228720	0.000041803	N/A	1631.02
10	5/6/2008-6/16/2008	30	-0.427754349	N/A	N/A	N/A	0.0043761868	0.000053897	N/A	1264.42
11	5/20/2008-6/30/2008	30	-0.45714126	N/A	N/A	N/A	0.0041940710	0.000065144	N/A	1554.37
12	6/3/2008-7/14/2008	30	-0.404746992	N/A	N/A	N/A	0.0043251815	0.000068838	N/A	2111.95
13	6/17/2008-7/28/2008	30	-0.347274604	N/A	N/A	N/A	0.0044820819	0.000064065	N/A	2729.41
14	7/1/2008-8/11/2008	30	-0.427416645	N/A	N/A	N/A	0.0045781372	0.000054421	N/A	3775.58
15	7/15/2008-8/25/2008	30	-0.500839091	N/A	N/A	N/A	0.0044513981	0.000051795	N/A	1887.66
16	7/29/2008-9/8/2008	30	-0.468582657	N/A	N/A	N/A	0.0045959820	0.000048146	N/A	1241.96
17	8/12/2008-9/22/2008	30	-0.36238245	N/A	N/A	N/A	0.0049464959	0.000052074	N/A	4323.66
18	8/26/2008-10/6/2008	30	-0.431818492	N/A	N/A	N/A	0.0055035637	0.000052449	N/A	8530.36
19	9/9/2008-10/20/2008	30	-0.333076805	N/A	N/A	N/A	0.0071452855	0.000057199	N/A	57461.85
20	9/23/2008-11/3/2008	30	-0.330945412	N/A	N/A	N/A	0.0097033923	0.000065784	N/A	111030.81
21	10/7/2008-11/17/2008	30	-0.412180087	N/A	N/A	N/A	0.0120560280	0.000076764	N/A	43431.53
22	10/21/2008-12/1/2008	30	-0.319188332	N/A	N/A	N/A	0.0139173474	0.000091637	N/A	41229.45
23	11/4/2008-12/15/2008	30	-0.327670015	N/A	N/A	N/A	0.0150409694	0.000100749	N/A	39446.49
24	11/18/2008-12/29/2008	30	-0.39874158	N/A	N/A	N/A	0.0152893222	0.000101256	N/A	28722.91
25	12/2/2008-1/12/2009	30	-0.376322533	N/A	N/A	N/A	0.0141857699	0.000098429	N/A	35157.93
26	12/16/2008-1/26/2009	30	-0.475731632	N/A	N/A	N/A	0.0133418458	0.000099158	N/A	11451.17
27	12/30/2008-2/9/2009	30	-0.490827377	N/A	N/A	N/A	0.0142547994	0.000078515	N/A	17752.48
28	1/13/2009-2/23/2009	30	-0.34862944	N/A	N/A	N/A	0.0153662302	0.000050738	N/A	13526.47
29	1/27/2009-3/9/2009	30	-0.349433964	N/A	N/A	N/A	0.0164633225	0.000017018	N/A	11215.55
30	2/10/2009-3/23/2009	30	-0.318201625	N/A	N/A	N/A	0.0167756092	0.000001763	N/A	8650.22
31	2/24/2009-4/6/2009	30	-0.478488937	N/A	N/A	N/A	0.0136487708	-0.000003728	N/A	10208.17
32	3/10/2009-4/20/2009	30	-0.31073694	N/A	N/A	N/A	0.0130691316	-0.000005287	N/A	15682.26
33	3/24/2009-5/4/2009	30	-0.341749096	N/A	N/A	N/A	0.0117824617	0.000001140	N/A	25834.33
34	4/7/2009-5/18/2009	30	-0.45735755	N/A	N/A	N/A	0.0126534715	0.000011000	N/A	30976.10
35	4/21/2009-6/1/2009	30	-0.312898267	N/A	N/A	N/A	0.0110624194	0.000015786	N/A	26226.33
36	5/5/2009-6/15/2009	30	-0.37749809	N/A	N/A	N/A	0.0092880378	0.000023088	N/A	22311.25
37	5/19/2009-6/29/2009	30	-0.329944059	N/A	N/A	N/A	0.0079825964	0.000030871	N/A	10848.49
38	6/2/2009-7/13/2009	30	-0.306504935	N/A	N/A	N/A	0.0067434494	0.000045428	N/A	5647.80
39	6/16/2009-7/27/2009	30	-0.39886312	N/A	N/A	N/A	0.0060500100	0.000050735	N/A	6950.26
40	6/30/2009-8/10/2009	30	-0.34902135	N/A	N/A	N/A	0.0052047354	0.000049910	N/A	10419.25
41	7/14/2009-8/24/2009	30	-0.406659833	N/A	N/A	N/A	0.0047611704	0.000047236	N/A	7928.64
42	7/28/2009-9/7/2009	30	-0.304327783	N/A	N/A	N/A	0.0045675577	0.000054587	N/A	9651.09
43	8/11/2009-9/21/2009	30	-0.449328199	N/A	N/A	N/A	0.0044314007	0.000077768	N/A	11024.20
44	9/8/2009-10/6/2009	30	-0.428447193	N/A	N/A	N/A	0.0041997682	0.000105230	N/A	6618.42

Average Sum of Squared Errors　16,556.37

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Wal-Mart Stores Inc.</u>　　NYSE:　　　　<u>WMT</u>　　　　　Industry:　<u>Retail</u>

Model 3　Default Intensity: $\xi[i,j] = c_0 + \frac{c_2}{s^{b_0}}$　　Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$　　Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.345096591	N/A	0.279424771	N/A	0.002080791	N/A	0.012628676	10457.66
2	1/15/2008-2/25/2008	30	-0.478059268	N/A	0.293326244	N/A	0.002373116	N/A	0.014750452	12596.38
3	1/29/2008-3/10/2008	30	-0.38256018	N/A	0.290532905	N/A	0.00263929	N/A	0.016298275	14123.85
4	2/12/2008-3/24/2008	30	-0.318016435	N/A	0.273853070	N/A	0.002792667	N/A	0.016399403	12061.31
5	2/26/2008-4/7/2008	30	-0.368954002	N/A	0.286526122	N/A	0.002492791	N/A	0.015788745	16603.56
6	3/11/2008-4/21/2008	30	-0.320542437	N/A	0.281156708	N/A	0.002251479	N/A	0.013144113	11700.34
7	3/25/2008-5/25/2008	30	-0.45652778	N/A	0.283586765	N/A	0.00205575	N/A	0.01178885	4687.00
8	4/8/2008-5/19/2008	30	-0.49957361	N/A	0.279774035	N/A	0.002023744	N/A	0.011707733	3906.48
9	4/22/2008-6/2/2008	30	-0.414745211	N/A	0.277952129	N/A	0.001955225	N/A	0.011623365	3304.45
10	5/6/2008-6/16/2008	30	-0.384111413	N/A	0.280491033	N/A	0.002130457	N/A	0.012023012	4898.82
11	5/20/2008-6/30/2008	30	-0.322918679	N/A	0.277262593	N/A	0.002167142	N/A	0.012376375	6740.28
12	6/3/2008-7/14/2008	30	-0.395518222	N/A	0.265195018	N/A	0.002123785	N/A	0.013261273	7845.09
13	6/17/2008-7/28/2008	30	-0.352335184	N/A	0.280092969	N/A	0.002248891	N/A	0.013445679	7007.24
14	7/1/2008-8/11/2008	30	-0.457709126	N/A	0.278360635	N/A	0.002077961	N/A	0.012744765	6349.66
15	7/15/2008-8/25/2008	30	-0.400712766	N/A	0.276106065	N/A	0.001973115	N/A	0.011781872	4908.89
16	7/29/2008-9/8/2008	30	-0.480306852	N/A	0.273118539	N/A	0.002051003	N/A	0.01212557	3825.37
17	8/12/2008-9/22/2008	30	-0.337820104	N/A	0.267289231	N/A	0.002208833	N/A	0.013390663	6334.82
18	8/26/2008-10/6/2008	30	-0.346506901	N/A	0.260422889	N/A	0.002308204	N/A	0.014397276	8304.84
19	9/9/2008-10/20/2008	30	-0.46639182	N/A	0.271867365	N/A	0.003003206	N/A	0.018167859	38752.97
20	9/23/2008-11/3/2008	30	-0.481076293	N/A	0.279151019	N/A	0.003855123	N/A	0.024248872	70892.03
21	10/7/2008-11/17/2008	30	-0.310390586	N/A	0.275004066	N/A	0.004605181	N/A	0.029545767	33089.61
22	10/21/2008-12/1/2008	30	-0.3394754	N/A	0.268517349	N/A	0.005697046	N/A	0.033301484	33732.01
23	11/4/2008-12/15/2008	30	-0.48018991	N/A	0.271132310	N/A	0.005958632	N/A	0.037479914	36419.16
24	11/18/2008-12/29/2008	30	-0.372868794	N/A	0.285080644	N/A	0.006219528	N/A	0.0384893	28832.82
25	12/2/2008-1/12/2009	30	-0.437860676	N/A	0.282387642	N/A	0.005751052	N/A	0.034050904	31879.32
26	12/16/2008-1/26/2009	30	-0.434305816	N/A	0.289442628	N/A	0.005238318	N/A	0.032772867	19171.67
27	12/30/2008-2/9/2009	30	-0.32235064	N/A	0.283622721	N/A	0.005445337	N/A	0.03400021	19176.15
28	1/13/2009-2/23/2009	30	-0.420633525	N/A	0.297023887	N/A	0.0054852	N/A	0.03449202	11230.78
29	1/27/2009-3/9/2009	30	-0.449754046	N/A	0.281663048	N/A	0.005747964	N/A	0.033926984	7091.83
30	2/10/2009-3/23/2009	30	-0.457859924	N/A	0.279901012	N/A	0.005357666	N/A	0.035209784	4850.26
31	2/24/2009-4/6/2009	30	-0.373937388	N/A	0.294897486	N/A	0.004486373	N/A	0.028073757	5930.54
32	3/10/2009-4/20/2009	30	-0.361204445	N/A	0.276142576	N/A	0.004299049	N/A	0.024610139	8827.83
33	3/24/2009-5/4/2009	30	-0.432247025	N/A	0.283428326	N/A	0.003886777	N/A	0.024737859	15129.30
34	4/7/2009-5/18/2009	30	-0.41009482	N/A	0.290199358	N/A	0.00416898	N/A	0.025663471	17400.97
35	4/21/2009-6/1/2009	30	-0.442842884	N/A	0.295576214	N/A	0.00367849	N/A	0.023593396	15382.49
36	5/5/2009-6/15/2009	30	-0.465768881	N/A	0.284960559	N/A	0.003474731	N/A	0.020791826	12958.79
37	5/19/2009-6/29/2009	30	-0.418945337	N/A	0.271926243	N/A	0.003026419	N/A	0.017646294	7603.04
38	6/2/2009-7/13/2009	30	-0.495997046	N/A	0.284721793	N/A	0.002762906	N/A	0.015615053	6359.36
39	6/16/2009-7/27/2009	30	-0.414597567	N/A	0.286230851	N/A	0.002440341	N/A	0.015015485	7408.70
40	6/30/2009-8/10/2009	30	-0.436343155	N/A	0.294642649	N/A	0.002335976	N/A	0.013161281	9556.80
41	7/14/2009-8/24/2009	30	-0.374500643	N/A	0.293445273	N/A	0.002023863	N/A	0.012370537	7938.06
42	7/28/2009-9/7/2009	30	-0.483250204	N/A	0.290198868	N/A	0.002036525	N/A	0.012303556	9863.51
43	8/11/2009-9/21/2009	30	-0.408843032	N/A	0.286984217	N/A	0.002346747	N/A	0.01440077	14662.05
44	9/8/2009-10/6/2009	30	-0.344862758	N/A	0.285019439	N/A	0.00242099	N/A	0.014352988	19654.28

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* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	Wal-Mart Stores Inc.	NYSE:	WMT	Industry:	Retail

Model 4   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.392423035	N/A	0.274353551	0.000014256	0.002126307	N/A	0.011743511	9150.91
2	1/15/2008-2/25/2008	30	-0.491879026	N/A	0.284847516	-0.000044093	0.002273718	N/A	0.014527301	11173.22
3	1/29/2008-3/10/2008	30	-0.325962834	N/A	0.292157907	0.000085840	0.002583279	N/A	0.015320611	11838.05
4	2/12/2008-3/24/2008	30	-0.328569306	N/A	0.292712323	-0.000042045	0.002754907	N/A	0.015734429	10467.69
5	2/26/2008-4/7/2008	30	-0.379988849	N/A	0.287177124	-0.000061701	0.002564095	N/A	0.014807050	14307.59
6	3/11/2008-4/21/2008	30	-0.342362043	N/A	0.273198696	-0.000020225	0.002305886	N/A	0.014070416	10195.79
7	3/25/2008-5/25/2008	30	-0.380029763	N/A	0.287776754	0.000013533	0.001977007	N/A	0.012200953	4154.00
8	4/8/2008-5/19/2008	30	-0.496402897	N/A	0.272348433	-0.000085194	0.001899063	N/A	0.012288969	3271.18
9	4/22/2008-6/2/2008	30	-0.391621563	N/A	0.262320497	-0.000020673	0.001988054	N/A	0.012051524	2936.08
10	5/6/2008-6/16/2008	30	-0.465706410	N/A	0.279543684	-0.000090264	0.002100531	N/A	0.011928089	4418.73
11	5/20/2008-6/30/2008	30	-0.356831195	N/A	0.270485240	-0.000006718	0.002033254	N/A	0.012868394	5636.41
12	6/3/2008-7/14/2008	30	-0.407439842	N/A	0.267134096	-0.000037231	0.002100746	N/A	0.013315611	6551.19
13	6/17/2008-7/28/2008	30	-0.325594617	N/A	0.277688009	0.000096514	0.002217542	N/A	0.012922606	5950.52
14	7/1/2008-8/11/2008	30	-0.338261807	N/A	0.269247970	0.000020618	0.002194690	N/A	0.013117865	5630.77
15	7/15/2008-8/25/2008	30	-0.380746461	N/A	0.272397831	-0.000090553	0.001961546	N/A	0.011802745	4102.18
16	7/29/2008-9/8/2008	30	-0.443154365	N/A	0.261852584	-0.000092037	0.001949767	N/A	0.012287426	3467.56
17	8/12/2008-9/22/2008	30	-0.469166096	N/A	0.271216962	0.000006222	0.002103018	N/A	0.012949420	5431.37
18	8/26/2008-10/6/2008	30	-0.401648315	N/A	0.262568652	-0.000040563	0.002473369	N/A	0.014733759	7024.70
19	9/9/2008-10/20/2008	30	-0.370285001	N/A	0.270675157	0.000059651	0.003115867	N/A	0.017112408	32461.29
20	9/23/2008-11/3/2008	30	-0.417241855	N/A	0.275796199	-0.000096990	0.003877113	N/A	0.022675171	61558.50
21	10/7/2008-11/17/2008	30	-0.363622728	N/A	0.270193476	0.000017612	0.004993714	N/A	0.030310269	30029.06
22	10/21/2008-12/1/2008	30	-0.341729271	N/A	0.273376189	-0.000023978	0.005618968	N/A	0.034763058	30578.71
23	11/4/2008-12/15/2008	30	-0.322194065	N/A	0.271511537	0.000012606	0.005812897	N/A	0.034761203	32458.79
24	11/18/2008-12/29/2008	30	-0.446874203	N/A	0.270118169	-0.000015302	0.006290468	N/A	0.038061849	26007.83
25	12/2/2008-1/12/2009	30	-0.480214350	N/A	0.289907874	0.000040436	0.005751154	N/A	0.034768197	28519.40
26	12/16/2008-1/26/2009	30	-0.399159336	N/A	0.270737609	0.000060309	0.005708050	N/A	0.032252666	16797.41
27	12/30/2008-2/9/2009	30	-0.400614551	N/A	0.286187318	0.000002328	0.005539525	N/A	0.032695655	16274.45
28	1/13/2009-2/23/2009	30	-0.451406106	N/A	0.278747770	0.000097945	0.005927859	N/A	0.032340554	9510.64
29	1/27/2009-3/9/2009	30	-0.484559145	N/A	0.284248039	0.000079591	0.005511087	N/A	0.034397247	6204.73
30	2/10/2009-3/23/2009	30	-0.316965471	N/A	0.290754956	-0.000020756	0.005407312	N/A	0.035038811	4051.84
31	2/24/2009-4/6/2009	30	-0.383640180	N/A	0.286164731	-0.000005804	0.004711875	N/A	0.027299367	5171.80
32	3/10/2009-4/20/2009	30	-0.382447511	N/A	0.279502459	-0.000049545	0.004300900	N/A	0.025885970	7424.88
33	3/24/2009-5/4/2009	30	-0.319308036	N/A	0.296362894	-0.000092718	0.003864384	N/A	0.022821230	13030.29
34	4/7/2009-5/18/2009	30	-0.391305050	N/A	0.282647194	-0.000016969	0.004327181	N/A	0.026497902	15725.03
35	4/21/2009-6/1/2009	30	-0.324630814	N/A	0.288469394	-0.000011976	0.003782732	N/A	0.022528659	13152.80
36	5/5/2009-6/15/2009	30	-0.456369147	N/A	0.281286145	0.000006465	0.003443925	N/A	0.020182753	11285.26
37	5/19/2009-6/29/2009	30	-0.355945346	N/A	0.276626833	0.000016689	0.003044770	N/A	0.017477377	6597.79
38	6/2/2009-7/13/2009	30	-0.445582559	N/A	0.288064715	-0.000030824	0.002804671	N/A	0.015806840	5396.44
39	6/16/2009-7/27/2009	30	-0.379681856	N/A	0.272718399	-0.000044372	0.002431009	N/A	0.014845780	6207.19
40	6/30/2009-8/10/2009	30	-0.386751577	N/A	0.279411659	0.000034828	0.002153940	N/A	0.014062718	8294.86
41	7/14/2009-8/24/2009	30	-0.408693895	N/A	0.278661690	-0.000024010	0.002157698	N/A	0.012362402	7026.60
42	7/28/2009-9/7/2009	30	-0.493511610	N/A	0.267628187	-0.000052117	0.002105446	N/A	0.012317725	8517.42
43	8/11/2009-9/21/2009	30	-0.447849295	N/A	0.268101108	0.000038291	0.002194169	N/A	0.013257950	12695.53
44	9/8/2009-10/6/2009	30	-0.497612464	N/A	0.288208918	-0.000027650	0.002409112	N/A	0.014861267	16782.76

Average Sum of Squared Errors   12,669.76

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Wal-Mart Stores Inc.   NYSE: WMT   Industry: Retail

Model 5   Default Intensity: $\xi[i,j] = c_0 + c_1 t$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.016257419	-66.770174279	N/A	N/A	0.003999550	0.000071574	N/A	4325.02
2	1/15/2008-2/25/2008	30	0.087850749	-63.551623319	N/A	N/A	0.004666559	0.000072755	N/A	8775.33
3	1/29/2008-3/10/2008	30	-0.037998858	-72.152576268	N/A	N/A	0.005666960	0.000067504	N/A	10206.58
4	2/12/2008-3/24/2008	30	-0.036269614	-69.104312668	N/A	N/A	0.006086183	0.000068096	N/A	8866.63
5	2/26/2008-4/7/2008	30	0.006513503	-64.404210558	N/A	N/A	0.005621650	0.000059895	N/A	16946.69
6	3/11/2008-4/21/2008	30	-0.058050941	-70.467701757	N/A	N/A	0.005353928	0.000051088	N/A	11818.57
7	3/25/2008-5/25/2008	30	-0.048114964	-59.283523569	N/A	N/A	0.004674453	0.000042575	N/A	3520.90
8	4/8/2008-5/19/2008	30	0.071201084	-59.282909209	N/A	N/A	0.004788900	0.000040078	N/A	2257.28
9	4/22/2008-6/2/2008	30	0.061028589	-71.337656214	N/A	N/A	0.004659684	0.000041150	N/A	1341.54
10	5/6/2008-6/16/2008	30	-0.036131025	-67.670262866	N/A	N/A	0.004184838	0.000051912	N/A	1036.86
11	5/20/2008-6/30/2008	30	-0.048908392	-64.139191330	N/A	N/A	0.004065128	0.000063844	N/A	1254.85
12	6/3/2008-7/14/2008	30	0.056685857	-65.872217305	N/A	N/A	0.004510449	0.000066457	N/A	1742.99
13	6/17/2008-7/28/2008	30	-0.076018118	-65.181731748	N/A	N/A	0.004672243	0.000065032	N/A	2235.53
14	7/1/2008-8/11/2008	30	0.055194585	-65.245767878	N/A	N/A	0.004389803	0.000054309	N/A	3017.95
15	7/15/2008-8/25/2008	30	0.007830253	-60.035915782	N/A	N/A	0.004245950	0.000054023	N/A	1549.96
16	7/29/2008-9/8/2008	30	0.062101562	-66.198537749	N/A	N/A	0.004546162	0.000049440	N/A	1016.09
17	8/12/2008-9/22/2008	30	-0.006773964	-67.941257019	N/A	N/A	0.004808976	0.000050433	N/A	3410.19
18	8/26/2008-10/6/2008	30	-0.016714211	-71.827949304	N/A	N/A	0.005507910	0.000052101	N/A	7185.24
19	9/9/2008-10/20/2008	30	-0.018026334	-62.618694009	N/A	N/A	0.006966329	0.000057026	N/A	48228.91
20	9/23/2008-11/3/2008	30	-0.065388675	-60.784492569	N/A	N/A	0.010067399	0.000068512	N/A	90398.09
21	10/7/2008-11/17/2008	30	-0.057188407	-66.742504545	N/A	N/A	0.012016965	0.000079483	N/A	37477.75
22	10/21/2008-12/1/2008	30	-0.012000472	-59.763132519	N/A	N/A	0.013657528	0.000090225	N/A	33663.30
23	11/4/2008-12/15/2008	30	-0.016947204	-61.841451384	N/A	N/A	0.015084467	0.000096044	N/A	32053.36
24	11/18/2008-12/29/2008	30	0.061408149	-71.895155805	N/A	N/A	0.015887562	0.000098538	N/A	23586.58
25	12/2/2008-1/12/2009	30	0.001970333	-68.118629107	N/A	N/A	0.013752698	0.000095011	N/A	28847.81
26	12/16/2008-1/26/2009	30	0.078712970	-65.367431793	N/A	N/A	0.013192140	0.000098625	N/A	9640.51
27	12/30/2008-2/9/2009	30	0.077294498	-64.760989161	N/A	N/A	0.014074400	0.000075766	N/A	15114.78
28	1/13/2009-2/23/2009	30	-0.053500023	-61.924616495	N/A	N/A	0.014935249	0.000051709	N/A	10667.98
29	1/27/2009-3/9/2009	30	0.055504097	-61.070823834	N/A	N/A	0.015862334	0.000016263	N/A	9429.80
30	2/10/2009-3/23/2009	30	-0.046564833	-59.801456678	N/A	N/A	0.016486064	0.000001850	N/A	7209.92
31	2/24/2009-4/6/2009	30	-0.007388159	-64.075389087	N/A	N/A	0.014132309	-0.000003827	N/A	8288.58
32	3/10/2009-4/20/2009	30	-0.065248050	-68.736766942	N/A	N/A	0.013254471	-0.000005529	N/A	12758.69
33	3/24/2009-5/4/2009	30	-0.099744876	-69.657560537	N/A	N/A	0.012157339	0.000001183	N/A	20442.36
34	4/7/2009-5/18/2009	30	-0.075656837	-66.054067537	N/A	N/A	0.012237575	0.000011048	N/A	26317.39
35	4/21/2009-6/1/2009	30	0.047815267	-59.162208387	N/A	N/A	0.011514842	0.000016401	N/A	21541.60
36	5/5/2009-6/15/2009	30	-0.088719251	-68.397474229	N/A	N/A	0.009217872	0.000023933	N/A	19276.69
37	5/19/2009-6/29/2009	30	-0.086551971	-62.130948479	N/A	N/A	0.007589034	0.000031095	N/A	9210.43
38	6/2/2009-7/13/2009	30	-0.058507559	-60.072290135	N/A	N/A	0.007030033	0.000047383	N/A	4757.59
39	6/16/2009-7/27/2009	30	0.012771453	-61.614468963	N/A	N/A	0.005874929	0.000049251	N/A	5992.43
40	6/30/2009-8/10/2009	30	-0.046385844	-62.834823635	N/A	N/A	0.005326332	0.000051990	N/A	8448.55
41	7/14/2009-8/24/2009	30	-0.028269288	-66.315451912	N/A	N/A	0.004691312	0.000046573	N/A	6601.70
42	7/28/2009-9/7/2009	30	0.054475454	-69.392671265	N/A	N/A	0.004718765	0.000057208	N/A	7610.12
43	8/11/2009-9/21/2009	30	0.028632190	-64.437219559	N/A	N/A	0.004438503	0.000079333	N/A	9125.98
44	9/8/2009-10/6/2009	30	-0.047587319	-61.977474407	N/A	N/A	0.004366415	0.000107496	N/A	5321.65

Average Sum of Squared Errors   13,693.65

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Wal-Mart Stores Inc.</u> NYSE: <u>WMT</u> Industry: <u>Retail</u>

Model 6 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.066167860	-62.521821620	0.297292511	N/A	0.002010977	N/A	0.011705537	7889.10
2	1/15/2008-2/25/2008	30	0.001849615	-68.704914078	0.297261669	N/A	0.002300262	N/A	0.013707917	10136.64
3	1/29/2008-3/10/2008	30	0.046751857	-59.590185090	0.288002472	N/A	0.002641756	N/A	0.015180620	10677.94
4	2/12/2008-3/24/2008	30	0.092840364	-65.257882302	0.280450702	N/A	0.002808778	N/A	0.016463207	9233.66
5	2/26/2008-4/7/2008	30	-0.097763230	-63.601070651	0.278543238	N/A	0.002441038	N/A	0.014439242	13322.43
6	3/11/2008-4/21/2008	30	-0.084750130	-65.691003268	0.270541473	N/A	0.002318031	N/A	0.013980973	9110.77
7	3/25/2008-5/25/2008	30	-0.039810731	-64.487001076	0.285152643	N/A	0.002074925	N/A	0.012183054	3656.21
8	4/8/2008-5/19/2008	30	-0.036415132	-66.679034970	0.285072578	N/A	0.002018783	N/A	0.011885312	2949.63
9	4/22/2008-6/2/2008	30	-0.084535110	-63.275819404	0.276818151	N/A	0.002038809	N/A	0.012125841	2491.20
10	5/6/2008-6/16/2008	30	-0.051709490	-69.389042859	0.277207956	N/A	0.002027960	N/A	0.012778577	3893.52
11	5/20/2008-6/30/2008	30	-0.020790308	-63.328586732	0.270683566	N/A	0.002072306	N/A	0.013142861	5336.60
12	6/3/2008-7/14/2008	30	-0.004276159	-64.055813884	0.275971547	N/A	0.002106056	N/A	0.013636319	6189.64
13	6/17/2008-7/28/2008	30	0.027643472	-71.615911577	0.280596558	N/A	0.002136849	N/A	0.012992040	5308.87
14	7/1/2008-8/11/2008	30	-0.080131358	-61.628188344	0.281644548	N/A	0.002196611	N/A	0.012535054	5058.23
15	7/15/2008-8/25/2008	30	-0.013542906	-65.957397050	0.279377586	N/A	0.001974992	N/A	0.012489468	3593.21
16	7/29/2008-9/8/2008	30	-0.001851048	-71.913400039	0.283457415	N/A	0.002090965	N/A	0.012010264	2976.79
17	8/12/2008-9/22/2008	30	0.009630730	-67.434534225	0.266166221	N/A	0.002198182	N/A	0.013199208	4838.38
18	8/26/2008-10/6/2008	30	0.099032580	-67.828666094	0.278177222	N/A	0.002458276	N/A	0.014878998	6474.25
19	9/9/2008-10/20/2008	30	0.069516840	-65.796016093	0.269453722	N/A	0.002970993	N/A	0.018602963	29893.26
20	9/23/2008-11/3/2008	30	-0.087196260	-65.263940779	0.265127831	N/A	0.003998357	N/A	0.024115978	54987.63
21	10/7/2008-11/17/2008	30	-0.060058613	-71.486376288	0.291332151	N/A	0.005042394	N/A	0.027835984	24508.89
22	10/21/2008-12/1/2008	30	-0.033093945	-53.566545324	0.283877263	N/A	0.005501049	N/A	0.032248373	25985.47
23	11/4/2008-12/15/2008	30	0.011624088	-67.032742117	0.269475002	N/A	0.005816995	N/A	0.037132488	29259.28
24	11/18/2008-12/29/2008	30	-0.020991448	-62.181673770	0.275786667	N/A	0.006103516	N/A	0.038865028	21956.98
25	12/2/2008-1/12/2009	30	0.006921851	-71.073163452	0.273304959	N/A	0.006061068	N/A	0.033408314	24165.51
26	12/16/2008-1/26/2009	30	-0.074053558	-65.377801776	0.290048929	N/A	0.005253885	N/A	0.034470705	15097.92
27	12/30/2008-2/9/2009	30	-0.022176020	-72.066651425	0.271902680	N/A	0.005811339	N/A	0.035135555	14094.20
28	1/13/2009-2/23/2009	30	-0.003330099	-63.495004003	0.276291594	N/A	0.005380292	N/A	0.033742986	8259.41
29	1/27/2009-3/9/2009	30	0.061776798	-64.181352216	0.276696522	N/A	0.005617243	N/A	0.034017785	5486.55
30	2/10/2009-3/23/2009	30	0.036260602	-64.025378845	0.296038782	N/A	0.005455918	N/A	0.032767867	3779.60
31	2/24/2009-4/6/2009	30	0.062655744	-69.728566750	0.286297126	N/A	0.004463886	N/A	0.026541142	4767.37
32	3/10/2009-4/20/2009	30	0.072476597	-61.985028922	0.280158285	N/A	0.004272348	N/A	0.024709935	6640.31
33	3/24/2009-5/4/2009	30	-0.004539302	-67.926132494	0.279947290	N/A	0.003764823	N/A	0.024166127	12083.99
34	4/7/2009-5/18/2009	30	-0.042796363	-64.418739037	0.274799146	N/A	0.004491931	N/A	0.026503341	14047.47
35	4/21/2009-6/1/2009	30	-0.034895283	-66.554723735	0.284352257	N/A	0.004019393	N/A	0.024039065	11494.87
36	5/5/2009-6/15/2009	30	0.012439509	-67.970322855	0.291216833	N/A	0.003487849	N/A	0.019370478	10375.35
37	5/19/2009-6/29/2009	30	-0.025106929	-59.972201462	0.277925162	N/A	0.003125720	N/A	0.018273133	5902.19
38	6/2/2009-7/13/2009	30	-0.072347905	-65.761105954	0.276437830	N/A	0.002770631	N/A	0.015769494	4934.88
39	6/16/2009-7/27/2009	30	0.071360737	-64.306659508	0.285311520	N/A	0.002475432	N/A	0.015538989	5647.41
40	6/30/2009-8/10/2009	30	0.091662435	-69.082775236	0.292853975	N/A	0.002259273	N/A	0.014064597	7398.12
41	7/14/2009-8/24/2009	30	-0.005164695	-68.106401657	0.277592287	N/A	0.002162194	N/A	0.012693642	5813.29
42	7/28/2009-9/7/2009	30	0.065375497	-65.351227700	0.282687478	N/A	0.002145743	N/A	0.012313498	7773.92
43	8/11/2009-9/21/2009	30	-0.015925003	-67.378925795	0.293882725	N/A	0.002384806	N/A	0.014025910	11817.03
44	9/8/2009-10/6/2009	30	0.086941992	-61.185382834	0.271833720	N/A	0.002638261	N/A	0.014897051	15529.48

Average Sum of Squared Errors 11,246.31

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Wal-Mart Stores Inc.</u>   NYSE: <u>WMT</u>   Industry: <u>Retail</u>

Model 7   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.029212744	-68.620288140	0.293545207	-0.000056390	0.002140935	N/A	0.012670574	7578.85
2	1/15/2008-2/25/2008	30	0.027189317	-70.098814801	0.292795726	0.000024288	0.002438711	N/A	0.014310794	10024.37
3	1/29/2008-3/10/2008	30	-0.081282910	-70.078236323	0.290771621	-0.000030150	0.002611724	N/A	0.016021649	10672.93
4	2/12/2008-3/24/2008	30	0.079762094	-67.908964822	0.296852918	-0.000029946	0.002847384	N/A	0.016521341	9055.70
5	2/26/2008-4/7/2008	30	-0.081794643	-68.518544994	0.288494043	-0.000090012	0.002540038	N/A	0.014389346	12433.78
6	3/11/2008-4/21/2008	30	-0.030236839	-71.106634874	0.278064715	0.000092782	0.002367413	N/A	0.013800114	9068.05
7	3/25/2008-5/25/2008	30	-0.027816082	-62.912734842	0.278565124	-0.000051515	0.002004546	N/A	0.012190367	3650.30
8	4/8/2008-5/19/2008	30	0.001648993	-65.593598830	0.273174723	0.000000113	0.001991737	N/A	0.012344308	2878.04
9	4/22/2008-6/2/2008	30	0.039732921	-61.894254438	0.287563836	-0.000078874	0.001961348	N/A	0.011264996	2413.41
10	5/6/2008-6/16/2008	30	0.038776074	-72.194806541	0.261625437	-0.000084541	0.001955765	N/A	0.011937000	3863.06
11	5/20/2008-6/30/2008	30	-0.088637101	-62.266445466	0.268759335	-0.000085672	0.002098381	N/A	0.012695674	4979.38
12	6/3/2008-7/14/2008	30	0.041498269	-59.376972474	0.284192370	-0.000060158	0.002232594	N/A	0.012799748	6154.91
13	6/17/2008-7/28/2008	30	0.091589405	-67.953989503	0.261167724	-0.000021348	0.002199709	N/A	0.013668501	5226.77
14	7/1/2008-8/11/2008	30	-0.028749326	-69.042817065	0.268031320	0.000026553	0.002096199	N/A	0.012127594	4859.94
15	7/15/2008-8/25/2008	30	0.022851939	-65.207658519	0.272732761	0.000000986	0.002126034	N/A	0.012118131	3521.17
16	7/29/2008-9/8/2008	30	-0.092595732	-61.216357638	0.282645187	-0.000088211	0.002090121	N/A	0.012243878	2877.62
17	8/12/2008-9/22/2008	30	-0.003015643	-62.595588544	0.262905440	0.000014631	0.002233456	N/A	0.013475224	4747.40
18	8/26/2008-10/6/2008	30	-0.019941058	-61.355455595	0.274974182	-0.000041610	0.002328383	N/A	0.013802216	6405.73
19	9/9/2008-10/20/2008	30	-0.054557447	-66.180449543	0.268111910	-0.000038338	0.002887202	N/A	0.018752873	29057.97
20	9/23/2008-11/3/2008	30	-0.046387353	-69.774763633	0.291809862	-0.000079751	0.004021372	N/A	0.024348326	51488.60
21	10/7/2008-11/17/2008	30	-0.006824956	-66.377256769	0.287177449	-0.000088443	0.004591846	N/A	0.030124678	23552.68
22	10/21/2008-12/1/2008	30	0.063747681	-71.276036238	0.278663958	0.000058373	0.005787221	N/A	0.033765259	25647.78
23	11/4/2008-12/15/2008	30	0.051016480	-59.137449246	0.267245186	0.000096154	0.006072972	N/A	0.036902457	27971.74
24	11/18/2008-12/29/2008	30	-0.002851951	-60.363509739	0.269454312	0.000036211	0.005949545	N/A	0.038365166	21655.07
25	12/2/2008-1/12/2009	30	0.080489707	-61.341788900	0.279041986	-0.000023210	0.005602355	N/A	0.033327865	23260.34
26	12/16/2008-1/26/2009	30	-0.052283399	-59.824929103	0.279159095	0.000064273	0.005334318	N/A	0.033716050	14070.37
27	12/30/2008-2/9/2009	30	-0.090491171	-64.501858474	0.275132848	-0.000065732	0.005595107	N/A	0.033259470	13801.08
28	1/13/2009-2/23/2009	30	0.084111772	-68.498661162	0.286247250	0.000062318	0.005671810	N/A	0.034492018	8257.32
29	1/27/2009-3/9/2009	30	-0.020413541	-64.668151932	0.281677960	0.000069389	0.005755093	N/A	0.033667323	5428.79
30	2/10/2009-3/23/2009	30	-0.032213738	-71.281820687	0.287830476	0.000076518	0.005629215	N/A	0.032181030	3544.23
31	2/24/2009-4/6/2009	30	-0.077664193	-67.838639632	0.277944994	0.000085023	0.004296220	N/A	0.025937775	4508.81
32	3/10/2009-4/20/2009	30	0.037595579	-63.038182681	0.291485785	0.000028390	0.004209566	N/A	0.026310554	6567.98
33	3/24/2009-5/4/2009	30	-0.031474096	-68.118062303	0.295106961	0.000017568	0.004040123	N/A	0.023189416	11469.36
34	4/7/2009-5/18/2009	30	0.016367459	-69.846390818	0.290118119	-0.000043352	0.004505676	N/A	0.026534467	13168.71
35	4/21/2009-6/1/2009	30	-0.079988667	-63.040236447	0.269707912	-0.000097597	0.003671944	N/A	0.022829355	11185.90
36	5/5/2009-6/15/2009	30	0.017899693	-71.985927728	0.296452797	-0.000066999	0.003343163	N/A	0.020405701	9766.84
37	5/19/2009-6/29/2009	30	-0.094561093	-60.929217274	0.296191140	0.000010074	0.002987050	N/A	0.017451251	5589.38
38	6/2/2009-7/13/2009	30	0.072985623	-66.442150476	0.284015458	-0.000007648	0.002614634	N/A	0.015610351	4842.70
39	6/16/2009-7/27/2009	30	-0.057267300	-65.799196219	0.271577807	-0.000038496	0.002431184	N/A	0.014915702	5326.68
40	6/30/2009-8/10/2009	30	-0.014630175	-71.699435307	0.292283384	-0.000056391	0.002342632	N/A	0.014046518	7077.23
41	7/14/2009-8/24/2009	30	0.038876156	-61.220883857	0.282456903	0.000035682	0.001994957	N/A	0.012772882	5781.27
42	7/28/2009-9/7/2009	30	-0.071731619	-66.287191193	0.291320353	-0.000004214	0.002082168	N/A	0.012854647	7667.85
43	8/11/2009-9/21/2009	30	0.077914750	-59.493214864	0.281998675	-0.000029098	0.002279746	N/A	0.014007413	11107.66
44	9/8/2009-10/6/2009	30	0.031890731	-70.588650687	0.282182129	0.000024340	0.002537023	N/A	0.014373064	14741.01

Average Sum of Squared Errors   10,839.74

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Wal-Mart Stores Inc.</u> NYSE: <u>WMT</u> Industry: <u>Retail</u>

Model 8 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{\frac{1}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.491577905	N/A	0.296897421	N/A	0.003864786	0.000042299	0.005022357	3081.03
2	1/15/2008-2/25/2008	30	-0.481932908	N/A	0.285810374	N/A	0.005076914	0.000042540	0.005572173	6156.50
3	1/29/2008-3/10/2008	30	-0.433891841	N/A	0.292218127	N/A	0.005633369	0.000043824	0.006228031	7603.70
4	2/12/2008-3/24/2008	30	-0.465142344	N/A	0.289891111	N/A	0.006364037	0.000041700	0.006384969	6406.75
5	2/26/2008-4/7/2008	30	-0.352494645	N/A	0.282207011	N/A	0.005516307	0.000035908	0.006258261	12133.29
6	3/11/2008-4/21/2008	30	-0.414656551	N/A	0.266250974	N/A	0.005111131	0.000030379	0.005687327	9377.12
7	3/25/2008-5/25/2008	30	-0.331960236	N/A	0.268604591	N/A	0.004489166	0.000025509	0.004748147	2613.59
8	4/8/2008-5/19/2008	30	-0.314731963	N/A	0.280479356	N/A	0.004517169	0.000024176	0.004947728	1707.93
9	4/22/2008-6/2/2008	30	-0.494976745	N/A	0.266670423	N/A	0.004608710	0.000026055	0.004503620	1018.29
10	5/6/2008-6/16/2008	30	-0.322015267	N/A	0.281916456	N/A	0.004500942	0.000031310	0.005043874	801.29
11	5/20/2008-6/30/2008	30	-0.344257941	N/A	0.263575398	N/A	0.004207762	0.000040199	0.004831361	957.53
12	6/3/2008-7/14/2008	30	-0.462170549	N/A	0.284596935	N/A	0.004133313	0.000042507	0.005211632	1259.60
13	6/17/2008-7/28/2008	30	-0.449198794	N/A	0.286540752	N/A	0.004544889	0.000040271	0.004968864	1617.34
14	7/1/2008-8/11/2008	30	-0.331217350	N/A	0.267949648	N/A	0.004479962	0.000033045	0.005131848	2408.05
15	7/15/2008-8/25/2008	30	-0.372649579	N/A	0.276297786	N/A	0.004308277	0.000031530	0.004943842	1208.56
16	7/29/2008-9/8/2008	30	-0.316127023	N/A	0.266142578	N/A	0.004801814	0.000028705	0.005099351	783.49
17	8/12/2008-9/22/2008	30	-0.405154461	N/A	0.268564511	N/A	0.004777868	0.000032794	0.005222162	2749.70
18	8/26/2008-10/6/2008	30	-0.368044471	N/A	0.267335128	N/A	0.005247435	0.000031815	0.005530466	5394.43
19	9/9/2008-10/20/2008	30	-0.348646777	N/A	0.268938299	N/A	0.007275211	0.000035733	0.006912349	36567.58
20	9/23/2008-11/3/2008	30	-0.443114031	N/A	0.283631042	N/A	0.010177024	0.000038224	0.009377796	66615.93
21	10/7/2008-11/17/2008	30	-0.392294368	N/A	0.270865131	N/A	0.012484308	0.000044245	0.011294356	25869.53
22	10/21/2008-12/1/2008	30	-0.401821257	N/A	0.287214061	N/A	0.013350803	0.000053162	0.013566851	24473.73
23	11/4/2008-12/15/2008	30	-0.395008261	N/A	0.289610688	N/A	0.015579394	0.000060648	0.014062924	23459.45
24	11/18/2008-12/29/2008	30	-0.406566399	N/A	0.275084724	N/A	0.014556440	0.000061695	0.014251293	18113.80
25	12/2/2008-1/12/2009	30	-0.320682883	N/A	0.288663217	N/A	0.014203282	0.000060847	0.013267700	20725.61
26	12/16/2008-1/26/2009	30	-0.400233927	N/A	0.289856015	N/A	0.012965564	0.000060337	0.013767871	6862.64
27	12/30/2008-2/9/2009	30	-0.364981547	N/A	0.273591853	N/A	0.014371424	0.000045701	0.013884527	10807.76
28	1/13/2009-2/23/2009	30	-0.452952024	N/A	0.281726454	N/A	0.014786910	0.000031144	0.014006659	8398.20
29	1/27/2009-3/9/2009	30	-0.356411807	N/A	0.296288604	N/A	0.016187511	0.000010518	0.013745895	6790.39
30	2/10/2009-3/23/2009	30	-0.362924864	N/A	0.294485965	N/A	0.017566201	0.000001042	0.013380388	4826.60
31	2/24/2009-4/6/2009	30	-0.325825653	N/A	0.277785949	N/A	0.014146903	-0.000002273	0.011015846	5740.96
32	3/10/2009-4/20/2009	30	-0.312741354	N/A	0.269649034	N/A	0.012801842	-0.000003050	0.010596711	8533.15
33	3/24/2009-5/4/2009	30	-0.412574134	N/A	0.291105993	N/A	0.011758370	0.000000700	0.009371173	12700.79
34	4/7/2009-5/18/2009	30	-0.317335556	N/A	0.282765426	N/A	0.012756712	0.000006749	0.010129948	16864.20
35	4/21/2009-6/1/2009	30	-0.437552568	N/A	0.290875864	N/A	0.011367994	0.000009635	0.003563937	14506.29
36	5/5/2009-6/15/2009	30	-0.465949603	N/A	0.274455440	N/A	0.009056725	0.000014075	0.008310681	12571.76
37	5/19/2009-6/29/2009	30	-0.467819885	N/A	0.292310554	N/A	0.008199792	0.000018340	0.006863667	6466.56
38	6/2/2009-7/13/2009	30	-0.420924412	N/A	0.286272064	N/A	0.006548837	0.000027808	0.006847496	3675.58
39	6/16/2009-7/27/2009	30	-0.436136625	N/A	0.273087660	N/A	0.005905634	0.000030981	0.006430119	4148.19
40	6/30/2009-8/10/2009	30	-0.372657972	N/A	0.272482121	N/A	0.005010921	0.000030657	0.005577571	6604.89
41	7/14/2009-8/24/2009	30	-0.372931563	N/A	0.290341401	N/A	0.004897021	0.000029128	0.005136044	4934.24
42	7/28/2009-9/7/2009	30	-0.497293995	N/A	0.285394978	N/A	0.004566893	0.000032080	0.005207288	5975.39
43	8/11/2009-9/21/2009	30	-0.430555358	N/A	0.278110055	N/A	0.004321816	0.000048079	0.005523120	6811.18
44	9/8/2009-10/6/2009	30	-0.327120364	N/A	0.286659369	N/A	0.004203973	0.000060806	0.006258228	3975.84

Average Sum of Squared Errors 9,870.42

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Wal-Mart Stores Inc.</u> NYSE: <u>WMT</u> Industry: <u>Retail</u>

Model9 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{a_1 + a_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.407989031	N/A	0.296469398	-0.000065061	0.003877344	0.000041233	0.004805817	2751.74
2	1/15/2008-2/25/2008	30	-0.308230581	N/A	0.297373139	-0.000019324	0.004744986	0.000040357	0.005805432	5904.03
3	1/29/2008-3/10/2008	30	-0.443174220	N/A	0.273367420	0.000039885	0.005657680	0.000043270	0.006531488	7240.28
4	2/12/2008-3/24/2008	30	-0.340866663	N/A	0.279347685	0.000088887	0.006150834	0.000041753	0.006600944	5755.50
5	2/26/2008-4/7/2008	30	-0.457534059	N/A	0.284138697	-0.000081030	0.005407385	0.000035941	0.006219403	11459.33
6	3/11/2008-4/21/2008	30	-0.426982260	N/A	0.287992063	-0.000077091	0.005318761	0.000031320	0.005183932	8808.60
7	3/25/2008-5/25/2008	30	-0.449696831	N/A	0.275093385	-0.000020202	0.004479562	0.000025611	0.004718217	2386.49
8	4/8/2008-5/19/2008	30	-0.473318713	N/A	0.263375849	0.000036169	0.004861911	0.000023524	0.004955919	1543.48
9	4/22/2008-6/2/2008	30	-0.373499593	N/A	0.266293062	0.000097708	0.004635536	0.000024517	0.004908932	939.51
10	5/6/2008-6/16/2008	30	-0.303495028	N/A	0.261566356	0.000048294	0.004497467	0.000032679	0.005082772	740.27
11	5/20/2008-6/30/2008	30	-0.399398953	N/A	0.279568638	0.000001304	0.004390883	0.000038730	0.004830684	913.39
12	6/3/2008-7/14/2008	30	-0.397326646	N/A	0.278328245	-0.000047304	0.004313601	0.000040680	0.005040797	1180.74
13	6/17/2008-7/28/2008	30	-0.387317532	N/A	0.269894205	0.000057223	0.004505875	0.000038291	0.005200533	1528.95
14	7/1/2008-8/11/2008	30	-0.338565687	N/A	0.269504777	0.000022566	0.004764285	0.000031171	0.005142090	2156.55
15	7/15/2008-8/25/2008	30	-0.404818894	N/A	0.282844665	0.000004903	0.004284816	0.000030196	0.004779996	1119.29
16	7/29/2008-9/8/2008	30	-0.353411667	N/A	0.279419090	0.000063394	0.004701501	0.000027791	0.004942134	745.97
17	8/12/2008-9/22/2008	30	-0.482087461	N/A	0.270625482	0.000007294	0.005063991	0.000030077	0.005460568	2601.06
18	8/26/2008-10/6/2008	30	-0.353038754	N/A	0.279175025	-0.000048187	0.005457924	0.000031711	0.005590213	5200.80
19	9/9/2008-10/20/2008	30	-0.383473578	N/A	0.278947151	-0.000059336	0.006965135	0.000035145	0.007504474	32051.69
20	9/23/2008-11/3/2008	30	-0.356664126	N/A	0.273569991	0.000015799	0.009987951	0.000040622	0.009856010	60760.01
21	10/7/2008-11/17/2008	30	-0.343664991	N/A	0.280152461	-0.000025628	0.012165026	0.000047435	0.011146887	24945.96
22	10/21/2008-12/1/2008	30	-0.500667688	N/A	0.288913212	-0.000040821	0.014257817	0.000054312	0.013774709	21843.02
23	11/4/2008-12/15/2008	30	-0.400569124	N/A	0.287235595	-0.000095480	0.015103576	0.000063216	0.015182427	22128.34
24	11/18/2008-12/29/2008	30	-0.422500762	N/A	0.279696333	0.000062437	0.015355073	0.000063776	0.014911899	17340.83
25	12/2/2008-1/12/2009	30	-0.479268775	N/A	0.276708228	0.000094466	0.013644507	0.000058197	0.013926979	18513.55
26	12/16/2008-1/26/2009	30	-0.431998940	N/A	0.284104755	0.000011246	0.012771445	0.000061264	0.013230245	6545.85
27	12/30/2008-2/9/2009	30	-0.475714291	N/A	0.299350251	-0.000006420	0.013908803	0.000047960	0.013779686	9815.07
28	1/13/2009-2/23/2009	30	-0.464712717	N/A	0.272717188	0.000086764	0.015123794	0.000031736	0.013527466	7506.92
29	1/27/2009-3/9/2009	30	-0.473933128	N/A	0.294211953	-0.000006937	0.016143033	0.000010581	0.013596201	6143.21
30	2/10/2009-3/23/2009	30	-0.457769848	N/A	0.287211584	0.000075452	0.016982694	0.000001023	0.012921321	3891.82
31	2/24/2009-4/6/2009	30	-0.343838057	N/A	0.287730671	0.000022997	0.013808492	-0.000002274	0.011085737	4924.48
32	3/10/2009-4/20/2009	30	-0.376501367	N/A	0.276242043	0.000071073	0.012954679	-0.000003265	0.010117000	7185.39
33	3/24/2009-5/4/2009	30	-0.423169463	N/A	0.269817460	-0.000069452	0.012145480	0.000000694	0.009374843	12424.78
34	4/7/2009-5/18/2009	30	-0.362036921	N/A	0.286344408	-0.000054496	0.012661137	0.000006595	0.010313584	15499.66
35	4/21/2009-6/1/2009	30	-0.405881154	N/A	0.287246123	0.000055803	0.011093880	0.000009466	0.008891656	12499.52
36	5/5/2009-6/15/2009	30	-0.484860719	N/A	0.282718885	-0.000091374	0.009428737	0.000014272	0.008311502	10801.38
37	5/19/2009-6/29/2009	30	-0.304683505	N/A	0.275967869	-0.000068042	0.007970715	0.000018376	0.007035132	5871.71
38	6/2/2009-7/13/2009	30	-0.426881309	N/A	0.284096402	0.000014994	0.006565030	0.000027061	0.006863455	3217.51
39	6/16/2009-7/27/2009	30	-0.321001344	N/A	0.286449227	0.000039047	0.005381655	0.000029649	0.005966890	3934.50
40	6/30/2009-8/10/2009	30	-0.499626049	N/A	0.288484984	-0.000060412	0.005210371	0.000029758	0.005632192	6303.19
41	7/14/2009-8/24/2009	30	-0.431545010	N/A	0.292309339	0.000055414	0.004631927	0.000029445	0.004844256	4602.25
42	7/28/2009-9/7/2009	30	-0.486822603	N/A	0.280634068	-0.000043574	0.004702737	0.000034305	0.005179238	5291.01
43	8/11/2009-9/21/2009	30	-0.409027489	N/A	0.292753252	-0.000015867	0.004387020	0.000046442	0.005340595	6487.57
44	9/8/2009-10/6/2009	30	-0.334597026	N/A	0.288080692	-0.000022142	0.004277979	0.000063532	0.005930438	3643.84

Average Sum of Squared Errors 9,026.11

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: Wal-Mart Stores Inc.   NYSE: WMT   Industry: Retail

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \dfrac{c_2}{s^{\frac{1}{2}}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1 \lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.039886422	-71.990635200	0.307098757	N/A	0.003931484	0.000044248	0.005039722	2109.60
2	1/15/2008-2/25/2008	30	0.064017839	-63.651336705	0.301886449	N/A	0.004786944	0.000043175	0.005758083	4396.46
3	1/29/2008-3/10/2008	30	-0.049894838	-69.822309437	0.326444058	N/A	0.005367235	0.000040396	0.006142869	5453.80
4	2/12/2008-3/24/2008	30	0.057798365	-62.358986345	0.313032552	N/A	0.005883260	0.000042833	0.006482575	4820.30
5	2/26/2008-4/7/2008	30	0.092377630	-59.338290804	0.306549532	N/A	0.005752888	0.000038152	0.005877050	8397.89
6	3/11/2008-4/21/2008	30	-0.022238382	-68.313023669	0.315063389	N/A	0.005330937	0.000030273	0.005380073	6649.85
7	3/25/2008-5/25/2008	30	0.043225463	-59.737120029	0.307144765	N/A	0.004528203	0.000024045	0.004972663	1858.60
8	4/8/2008-5/19/2008	30	-0.064461755	-60.201356361	0.307164207	N/A	0.004451834	0.000024057	0.004929384	1223.56
9	4/22/2008-6/2/2008	30	-0.073225427	-64.923778330	0.315604319	N/A	0.004711056	0.000024030	0.004474907	704.23
10	5/6/2008-6/16/2008	30	0.025794566	-59.635638207	0.312694838	N/A	0.004516098	0.000031639	0.005036263	565.18
11	5/20/2008-6/30/2008	30	0.011177651	-66.509602999	0.296357552	N/A	0.004230592	0.000039816	0.004871420	713.91
12	6/3/2008-7/14/2008	30	0.016033239	-59.195494672	0.307452918	N/A	0.004248649	0.000042663	0.005219549	879.67
13	6/17/2008-7/28/2008	30	-0.027411433	-63.288087947	0.326195348	N/A	0.004328810	0.000037192	0.005369861	1195.93
14	7/1/2008-8/11/2008	30	0.069587564	-65.295599978	0.334315815	N/A	0.004720010	0.000033359	0.005199803	1726.76
15	7/15/2008-8/25/2008	30	-0.028716824	-71.009589902	0.308893682	N/A	0.004417226	0.000030627	0.004812974	865.61
16	7/29/2008-9/8/2008	30	0.040334879	-66.218344360	0.324257902	N/A	0.004447493	0.000028539	0.004977892	555.47
17	8/12/2008-9/22/2008	30	0.064360046	-66.078695421	0.338689299	N/A	0.004807126	0.000032150	0.005163488	2010.69
18	8/26/2008-10/6/2008	30	0.040649968	-66.096379804	0.365093616	N/A	0.005721745	0.000031344	0.005747672	3816.04
19	9/9/2008-10/20/2008	30	-0.097310882	-71.516323148	0.388065751	N/A	0.006913542	0.000033135	0.007427552	25986.77
20	9/23/2008-11/3/2008	30	-0.017857558	-67.251609501	0.438204427	N/A	0.009431577	0.000038140	0.009855037	49398.17
21	10/7/2008-11/17/2008	30	-0.018001850	-62.629896490	0.468971877	N/A	0.012389482	0.000043895	0.011328666	18275.95
22	10/21/2008-12/1/2008	30	0.063387748	-63.824063986	0.466037983	N/A	0.013413475	0.000052608	0.013709086	17918.38
23	11/4/2008-12/15/2008	30	-0.042834308	-65.243268794	0.512162036	N/A	0.015674309	0.000062284	0.015260223	16240.59
24	11/18/2008-12/29/2008	30	0.020811036	-60.857860914	0.492353735	N/A	0.014526180	0.000059955	0.014119582	12818.89
25	12/2/2008-1/12/2009	30	0.039361420	-72.167604938	0.491123760	N/A	0.014633777	0.000058266	0.013678765	14660.35
26	12/16/2008-1/26/2009	30	0.051274570	-62.446085442	0.482678987	N/A	0.013533419	0.000060759	0.013467355	4923.94
27	12/30/2008-2/9/2009	30	0.058724180	-61.702961517	0.552537839	N/A	0.014665996	0.000046642	0.013597376	7436.09
28	1/13/2009-2/23/2009	30	0.098309392	-63.457305048	0.565814877	N/A	0.014726960	0.000030509	0.013735648	5773.77
29	1/27/2009-3/9/2009	30	0.071074339	-68.323678608	0.626770774	N/A	0.015651554	0.000010139	0.013642748	5101.73
30	2/10/2009-3/23/2009	30	-0.086753026	-60.397030119	0.582124419	N/A	0.017428687	0.000001053	0.013882481	3709.01
31	2/24/2009-4/6/2009	30	0.086326342	-66.335640295	0.552382184	N/A	0.013104632	-0.000002150	0.010857054	4479.63
32	3/10/2009-4/20/2009	30	0.067177204	-69.646865683	0.485922275	N/A	0.012805982	-0.000003284	0.009878988	6268.74
33	3/24/2009-5/4/2009	30	0.007704797	-67.591390507	0.514406013	N/A	0.012302018	0.000000654	0.009391437	11177.05
34	4/7/2009-5/18/2009	30	-0.087877835	-60.826247130	0.513193908	N/A	0.012342529	0.000006358	0.010304105	13932.86
35	4/21/2009-6/1/2009	30	-0.001203766	-65.867521806	0.484262138	N/A	0.010842882	0.000009312	0.009425290	11168.66
36	5/5/2009-6/15/2009	30	-0.017325778	-70.821373830	0.470183583	N/A	0.008931444	0.000013716	0.007832803	9913.75
37	5/19/2009-6/29/2009	30	0.075668535	-69.935716505	0.458460947	N/A	0.008180987	0.000018383	0.007119968	4784.12
38	6/2/2009-7/13/2009	30	-0.095546442	-66.209283706	0.465285564	N/A	0.006708682	0.000028269	0.006849009	2694.64
39	6/16/2009-7/27/2009	30	-0.090649331	-63.488552261	0.467225281	N/A	0.005885803	0.000029923	0.006132479	3007.19
40	6/30/2009-8/10/2009	30	-0.036461564	-71.299416324	0.433393326	N/A	0.005003416	0.000029891	0.005202558	4531.73
41	7/14/2009-8/24/2009	30	0.029765966	-65.143867584	0.427360546	N/A	0.004954704	0.000028742	0.005084904	3424.54
42	7/28/2009-9/7/2009	30	0.080610238	-68.807448010	0.432395360	N/A	0.004792836	0.000033434	0.004801490	4297.45
43	8/11/2009-9/21/2009	30	0.051597008	-72.196007761	0.439426281	N/A	0.004364690	0.000048551	0.005775987	4971.40
44	9/8/2009-10/6/2009	30	-0.061270368	-61.578259297	0.402833460	N/A	0.004400710	0.000060571	0.006263734	2932.32

Average Sum of Squared Errors   7,222.07

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>Wal-Mart Stores Inc.</u>   NYSE: <u>WMT</u>   Industry: <u>Retail</u>

Model11 Default Intensity: $\xi[i,j]=c_0+c_1t+\dfrac{c_2}{s^{b_0+b_1t}}$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0+a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.010164758	-71.113550062	0.296068154	-0.000055453	0.003711014	0.000044977	0.005115531	1933.55
2	1/15/2008-2/25/2008	30	0.032925732	-61.026321460	0.291816347	0.000094471	0.005082007	0.000044418	0.005521370	3873.90
3	1/29/2008-3/10/2008	30	0.035833563	-61.027325254	0.293155333	0.000093128	0.005272631	0.000042363	0.005932089	4910.30
4	2/12/2008-3/24/2008	30	-0.018969265	-64.377234547	0.296601000	-0.000016939	0.006245721	0.000039221	0.006437627	4361.86
5	2/26/2008-4/7/2008	30	0.003487452	-65.221727537	0.281767939	-0.000045093	0.005548856	0.000038066	0.006301861	7624.03
6	3/11/2008-4/21/2008	30	-0.054094702	-64.028360991	0.286300155	0.000094425	0.004945862	0.000031757	0.005637424	5992.91
7	3/25/2008-5/25/2008	30	0.013969042	-64.112166772	0.263526624	-0.000002457	0.004731054	0.000024341	0.004793613	1667.50
8	4/8/2008-5/19/2008	30	-0.063470146	-65.161728175	0.269483252	-0.000083362	0.004696533	0.000024058	0.004743367	1123.25
9	4/22/2008-6/2/2008	30	-0.081990608	-62.375025741	0.275178328	0.000026241	0.004343542	0.000025514	0.004450415	637.42
10	5/6/2008-6/16/2008	30	0.023049322	-62.239233329	0.281804302	-0.000065685	0.004276032	0.000032903	0.004751366	538.57
11	5/20/2008-6/30/2008	30	-0.091032558	-63.055680859	0.265981111	0.000011631	0.004085155	0.000037965	0.004924748	639.58
12	6/3/2008-7/14/2008	30	0.005602355	-65.899815786	0.264840189	0.000043963	0.004424552	0.000041443	0.005255826	779.42
13	6/17/2008-7/28/2008	30	-0.024933612	-71.288956032	0.267657233	0.000091347	0.004478647	0.000039181	0.004962430	1107.79
14	7/1/2008-8/11/2008	30	-0.044864987	-59.702343082	0.262288112	-0.000070607	0.004535614	0.000033606	0.005268760	1540.96
15	7/15/2008-8/25/2008	30	0.079998417	-68.842202631	0.276654543	-0.000045201	0.004614212	0.000032471	0.004857533	794.16
16	7/29/2008-9/8/2008	30	-0.025696851	-59.261130946	0.261746935	0.000098723	0.004500251	0.000029386	0.004875477	505.96
17	8/12/2008-9/22/2008	30	0.097979915	-61.813727541	0.281152649	-0.000089566	0.005028336	0.000030531	0.005051590	1900.45
18	8/26/2008-10/6/2008	30	0.061501289	-64.786278982	0.265813910	-0.000035737	0.005711763	0.000031277	0.005732393	3349.20
19	9/9/2008-10/20/2008	30	-0.012314773	-59.763284257	0.262249219	-0.000080114	0.007399198	0.000032784	0.006989005	22494.98
20	9/23/2008-11/3/2008	30	0.076776165	-60.749540458	0.291467441	-0.000060730	0.009958787	0.000040018	0.009303677	46506.90
21	10/7/2008-11/17/2008	30	-0.040495879	-64.680634874	0.277427692	0.000070046	0.012144252	0.000046916	0.011407270	16529.98
22	10/21/2008-12/1/2008	30	0.073622810	-64.138815727	0.291768684	-0.000002373	0.013369636	0.000054131	0.013657222	16743.14
23	11/4/2008-12/15/2008	30	-0.013878497	-64.913266641	0.269900271	-0.000083693	0.015420036	0.000061090	0.014881354	15412.18
24	11/18/2008-12/29/2008	30	-0.067684542	-67.989981704	0.288466637	-0.000017657	0.015997998	0.000061060	0.014939024	11294.00
25	12/2/2008-1/12/2009	30	-0.068044467	-69.741726602	0.291300898	0.000090553	0.014097119	0.000061063	0.014148133	13642.78
26	12/16/2008-1/26/2009	30	0.044104110	-61.529898334	0.281914179	0.000037228	0.013900006	0.000061182	0.013407822	4266.44
27	12/30/2008-2/9/2009	30	-0.021008064	-71.332074295	0.281205558	-0.000097152	0.014604036	0.000045699	0.013165971	6983.69
28	1/13/2009-2/23/2009	30	0.078293651	-65.455692044	0.294138865	0.000075035	0.014653867	0.000031094	0.012971051	5071.87
29	1/27/2009-3/9/2009	30	-0.008422186	-60.805643049	0.270614299	-0.000024216	0.016427013	0.000010022	0.013407167	4681.35
30	2/10/2009-3/23/2009	30	0.031372427	-70.528083083	0.280437895	0.000088526	0.016304904	0.000001070	0.013707144	3383.23
31	2/24/2009-4/6/2009	30	-0.062748570	-65.981693898	0.275091263	0.000073854	0.013754220	-0.000002315	0.010561022	4165.69
32	3/10/2009-4/20/2009	30	0.062647059	-63.230271129	0.290935724	-0.000021420	0.012960531	-0.000003157	0.010555243	5899.81
33	3/24/2009-5/4/2009	30	0.058262000	-63.765042738	0.294465959	0.000039824	0.011598235	0.000000652	0.009133177	9969.08
34	4/7/2009-5/18/2009	30	-0.027801061	-62.560405043	0.269787310	-0.000097282	0.013249280	0.000006682	0.010192141	12078.67
35	4/21/2009-6/1/2009	30	0.079660183	-71.575534140	0.275698713	-0.000095393	0.011261640	0.000009686	0.008849597	10087.59
36	5/5/2009-6/15/2009	30	-0.060715702	-64.367639651	0.281496474	-0.000052307	0.009605610	0.000013690	0.008056988	8765.87
37	5/19/2009-6/29/2009	30	0.038215090	-59.505388176	0.284426728	-0.000045122	0.008003306	0.000018875	0.007264620	4185.05
38	6/2/2009-7/13/2009	30	-0.048255676	-60.181506406	0.272763745	0.000003806	0.007076191	0.000027770	0.006323554	2416.50
39	6/16/2009-7/27/2009	30	-0.034563624	-64.685346574	0.272924914	-0.000015935	0.006128508	0.000029834	0.006308317	2802.35
40	6/30/2009-8/10/2009	30	0.090547533	-63.045492833	0.269737204	0.000045165	0.005436687	0.000028862	0.005697338	4149.35
41	7/14/2009-8/24/2009	30	0.076209325	-61.107314728	0.269033931	0.000079485	0.004569466	0.000026967	0.005140420	3066.19
42	7/28/2009-9/7/2009	30	-0.054159827	-68.247129841	0.276446985	-0.000086816	0.004585954	0.000032005	0.005278669	4031.08
43	8/11/2009-9/21/2009	30	0.001602076	-66.432815511	0.286139162	0.000059636	0.004261012	0.000045275	0.005752572	4565.53
44	9/8/2009-10/6/2009	30	-0.018296468	-67.588631424	0.295155787	0.000082387	0.004018830	0.000062358	0.005892121	2621.53

Average Sum of Squared Errors   6,570.35

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: **The Walt Disney Co.** NYSE: **DIS** Industry: **Media, Broadcasting, Cable**

Model 1 Default Intensity: $\xi[i,j] = c_0$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.129201464	N/A	N/A	N/A	0.008111758	N/A	N/A	60155.67
2	1/15/2008-2/25/2008	30	-0.255768041	N/A	N/A	N/A	0.009339113	N/A	N/A	73034.21
3	1/29/2008-3/10/2008	30	-0.215266228	N/A	N/A	N/A	0.010416944	N/A	N/A	94445.98
4	2/12/2008-3/24/2008	30	-0.144361007	N/A	N/A	N/A	0.011450357	N/A	N/A	91534.84
5	2/26/2008-4/7/2008	30	-0.164612092	N/A	N/A	N/A	0.010534282	N/A	N/A	106634.41
6	3/11/2008-4/21/2008	30	-0.268539858	N/A	N/A	N/A	0.009066328	N/A	N/A	95655.91
7	3/25/2008-5/25/2008	30	-0.204336143	N/A	N/A	N/A	0.007184308	N/A	N/A	62299.99
8	4/8/2008-5/19/2008	30	-0.19435629	N/A	N/A	N/A	0.006330021	N/A	N/A	42158.55
9	4/22/2008-6/2/2008	30	-0.215300522	N/A	N/A	N/A	0.005798135	N/A	N/A	25985.77
10	5/6/2008-6/16/2008	30	-0.263896474	N/A	N/A	N/A	0.005931277	N/A	N/A	25841.88
11	5/20/2008-6/30/2008	30	-0.174062414	N/A	N/A	N/A	0.006241241	N/A	N/A	31780.33
12	6/3/2008-7/14/2008	30	-0.108573892	N/A	N/A	N/A	0.006796528	N/A	N/A	39231.97
13	6/17/2008-7/28/2008	30	-0.100247731	N/A	N/A	N/A	0.007206283	N/A	N/A	39754.44
14	7/1/2008-8/11/2008	30	-0.182925146	N/A	N/A	N/A	0.007107178	N/A	N/A	38507.49
15	7/15/2008-8/25/2008	30	-0.251656808	N/A	N/A	N/A	0.006914870	N/A	N/A	33174.24
16	7/29/2008-9/8/2008	30	-0.283225469	N/A	N/A	N/A	0.006821950	N/A	N/A	28024.49
17	8/12/2008-9/22/2008	30	-0.268133596	N/A	N/A	N/A	0.007101441	N/A	N/A	26884.09
18	8/26/2008-10/6/2008	30	-0.288824693	N/A	N/A	N/A	0.007519164	N/A	N/A	37176.43
19	9/9/2008-10/20/2008	30	-0.153606972	N/A	N/A	N/A	0.009107963	N/A	N/A	78178.76
20	9/23/2008-11/3/2008	30	-0.230329391	N/A	N/A	N/A	0.010787854	N/A	N/A	93598.73
21	10/7/2008-11/17/2008	30	-0.250638346	N/A	N/A	N/A	0.011915015	N/A	N/A	77395.88
22	10/21/2008-12/1/2008	30	-0.120962134	N/A	N/A	N/A	0.014601760	N/A	N/A	271165.81
23	11/4/2008-12/15/2008	30	-0.130114179	N/A	N/A	N/A	0.018600492	N/A	N/A	431680.84
24	11/18/2008-12/29/2008	30	-0.267290941	N/A	N/A	N/A	0.020712409	N/A	N/A	315111.61
25	12/2/2008-1/12/2009	30	-0.214922262	N/A	N/A	N/A	0.019061525	N/A	N/A	297693.17
26	12/16/2008-1/26/2009	30	-0.207462	N/A	N/A	N/A	0.016713285	N/A	N/A	103148.65
27	12/30/2008-2/9/2009	30	-0.262699119	N/A	N/A	N/A	0.015785952	N/A	N/A	25191.28
28	1/13/2009-2/23/2009	30	-0.122799086	N/A	N/A	N/A	0.015771631	N/A	N/A	11525.06
29	1/27/2009-3/9/2009	30	-0.247928985	N/A	N/A	N/A	0.015452601	N/A	N/A	6497.82
30	2/10/2009-3/23/2009	30	-0.211220582	N/A	N/A	N/A	0.015135855	N/A	N/A	7765.13
31	2/24/2009-4/6/2009	30	-0.26099814	N/A	N/A	N/A	0.014378549	N/A	N/A	16731.85
32	3/10/2009-4/20/2009	30	-0.180399373	N/A	N/A	N/A	0.012999596	N/A	N/A	15946.65
33	3/24/2009-5/4/2009	30	-0.164604246	N/A	N/A	N/A	0.011720592	N/A	N/A	9894.97
34	4/7/2009-5/18/2009	30	-0.181749152	N/A	N/A	N/A	0.011071614	N/A	N/A	4398.26
35	4/21/2009-6/1/2009	30	-0.12074678	N/A	N/A	N/A	0.010735343	N/A	N/A	3726.59
36	5/5/2009-6/15/2009	30	-0.129799144	N/A	N/A	N/A	0.010269153	N/A	N/A	10462.53
37	5/19/2009-6/29/2009	30	-0.20046346	N/A	N/A	N/A	0.010071735	N/A	N/A	14438.14
38	6/2/2009-7/13/2009	30	-0.132106536	N/A	N/A	N/A	0.010293838	N/A	N/A	19694.42
39	6/16/2009-7/27/2009	30	-0.117792253	N/A	N/A	N/A	0.010206255	N/A	N/A	28191.57
40	6/30/2009-8/10/2009	30	-0.178291723	N/A	N/A	N/A	0.008933844	N/A	N/A	50301.86
41	7/14/2009-8/24/2009	30	-0.155371024	N/A	N/A	N/A	0.007855789	N/A	N/A	39227.29
42	7/28/2009-9/7/2009	30	-0.241401046	N/A	N/A	N/A	0.007399040	N/A	N/A	28816.88
43	8/11/2009-9/21/2009	30	-0.125317235	N/A	N/A	N/A	0.007517533	N/A	N/A	32476.05
44	9/8/2009-10/6/2009	30	-0.219134097	N/A	N/A	N/A	0.007243494	N/A	N/A	37284.00

Average Sum of Squared Errors 67,791.47

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the historical recovery rate as the initial value of a0 when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity:	The Walt Disney Co.	NYSE:	DIS	Industry:	Media, Broadcasting, Cable

Model 2 Default Intensity: $\xi[i,j]=c_0+c_1t$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.17203886	N/A	N/A	N/A	0.0029904029	0.000161157	N/A	8640.73
2	1/15/2008-2/25/2008	30	-0.165365567	N/A	N/A	N/A	0.0041445438	0.000163664	N/A	20250.81
3	1/29/2008-3/10/2008	30	-0.262391075	N/A	N/A	N/A	0.0048294848	0.000176314	N/A	31480.44
4	2/12/2008-3/24/2008	30	-0.186963963	N/A	N/A	N/A	0.0054128450	0.000190663	N/A	20759.86
5	2/26/2008-4/7/2008	30	-0.109989907	N/A	N/A	N/A	0.0047928539	0.000180916	N/A	40021.65
6	3/11/2008-4/21/2008	30	-0.193005159	N/A	N/A	N/A	0.0038924833	0.000162743	N/A	41237.97
7	3/25/2008-5/25/2008	30	-0.276370431	N/A	N/A	N/A	0.0029187613	0.000134061	N/A	23839.48
8	4/8/2008-5/19/2008	30	-0.223823232	N/A	N/A	N/A	0.0026308734	0.000116280	N/A	13178.04
9	4/22/2008-6/2/2008	30	-0.293409025	N/A	N/A	N/A	0.0025343864	0.000102658	N/A	4172.10
10	5/6/2008-6/16/2008	30	-0.230265871	N/A	N/A	N/A	0.0026645465	0.000102894	N/A	4032.83
11	5/20/2008-6/30/2008	30	-0.253615107	N/A	N/A	N/A	0.0028327487	0.000107564	N/A	8108.40
12	6/3/2008-7/14/2008	30	-0.255690265	N/A	N/A	N/A	0.0031353134	0.000115628	N/A	11975.44
13	6/17/2008-7/28/2008	30	-0.281032839	N/A	N/A	N/A	0.0033483717	0.000121894	N/A	9532.83
14	7/1/2008-8/11/2008	30	-0.171262535	N/A	N/A	N/A	0.0032353503	0.000122223	N/A	8035.97
15	7/15/2008-8/25/2008	30	-0.214808422	N/A	N/A	N/A	0.0033243819	0.000113245	N/A	6020.47
16	7/29/2008-9/8/2008	30	-0.266501541	N/A	N/A	N/A	0.0034412623	0.000106451	N/A	4692.38
17	8/12/2008-9/22/2008	30	-0.175402214	N/A	N/A	N/A	0.0038832331	0.000101187	N/A	5703.86
18	8/26/2008-10/6/2008	30	-0.108645085	N/A	N/A	N/A	0.0041137989	0.000107088	N/A	13488.80
19	9/9/2008-10/20/2008	30	-0.219156276	N/A	N/A	N/A	0.0053751267	0.000117664	N/A	49894.56
20	9/23/2008-11/3/2008	30	-0.204461436	N/A	N/A	N/A	0.0060283447	0.000150464	N/A	47975.25
21	10/7/2008-11/17/2008	30	-0.235506628	N/A	N/A	N/A	0.0064250207	0.000173759	N/A	19033.40
22	10/21/2008-12/1/2008	30	-0.253347853	N/A	N/A	N/A	0.0070637933	0.000238701	N/A	161946.18
23	11/4/2008-12/15/2008	30	-0.26296375	N/A	N/A	N/A	0.0088699740	0.000308753	N/A	250452.84
24	11/18/2008-12/29/2008	30	-0.293614835	N/A	N/A	N/A	0.0098398842	0.000344244	N/A	88345.18
25	12/2/2008-1/12/2009	30	-0.243433544	N/A	N/A	N/A	0.0110780049	0.000251229	N/A	173554.85
26	12/16/2008-1/26/2009	30	-0.197218822	N/A	N/A	N/A	0.0126381839	0.000127483	N/A	71456.92
27	12/30/2008-2/9/2009	30	-0.129171049	N/A	N/A	N/A	0.0150145608	0.000024116	N/A	24008.24
28	1/13/2009-2/23/2009	30	-0.197996445	N/A	N/A	N/A	0.0152646322	0.000015865	N/A	11014.95
29	1/27/2009-3/9/2009	30	-0.124617811	N/A	N/A	N/A	0.0149506269	0.000015738	N/A	5981.68
30	2/10/2009-3/23/2009	30	-0.259552809	N/A	N/A	N/A	0.0145097122	0.000019629	N/A	6961.98
31	2/24/2009-4/6/2009	30	-0.157061285	N/A	N/A	N/A	0.0139151243	0.000014517	N/A	16276.00
32	3/10/2009-4/20/2009	30	-0.259641543	N/A	N/A	N/A	0.0126898218	0.000009684	N/A	15748.87
33	3/24/2009-5/4/2009	30	-0.145096358	N/A	N/A	N/A	0.0114110602	0.000009671	N/A	9697.16
34	4/7/2009-5/18/2009	30	-0.202844986	N/A	N/A	N/A	0.0107514168	0.000010013	N/A	4186.89
35	4/21/2009-6/1/2009	30	-0.255011993	N/A	N/A	N/A	0.0102455721	0.000015348	N/A	3233.97
36	5/5/2009-6/15/2009	30	-0.170374165	N/A	N/A	N/A	0.0092011378	0.000033588	N/A	8133.30
37	5/19/2009-6/29/2009	30	-0.198012164	N/A	N/A	N/A	0.0081710250	0.000059960	N/A	7102.74
38	6/2/2009-7/13/2009	30	-0.12720221	N/A	N/A	N/A	0.0079382250	0.000074361	N/A	8446.57
39	6/16/2009-7/27/2009	30	-0.269950807	N/A	N/A	N/A	0.0074929179	0.000085574	N/A	13259.23
40	6/30/2009-8/10/2009	30	-0.28902149	N/A	N/A	N/A	0.0062230473	0.000085373	N/A	35351.79
41	7/14/2009-8/24/2009	30	-0.184141421	N/A	N/A	N/A	0.0048817792	0.000093609	N/A	20587.25
42	7/28/2009-9/7/2009	30	-0.120631951	N/A	N/A	N/A	0.0044740539	0.000091962	N/A	11345.58
43	8/11/2009-9/21/2009	30	-0.289596026	N/A	N/A	N/A	0.0041847991	0.000104691	N/A	9775.76
44	9/8/2009-10/6/2009	30	-0.140065735	N/A	N/A	N/A	0.0034008501	0.000120579	N/A	7050.89

Average Sum of Squared Errors 30,818.05

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Walt Disney Co.</u> NYSE: <u>DIS</u> Industry: <u>Media, Broadcasting, Cable</u>

Model 3 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.276767154	N/A	0.339069807	N/A	0.001035158	N/A	0.006085588	27504.21
2	1/15/2008-2/25/2008	30	-0.264003823	N/A	0.326227459	N/A	0.001447885	N/A	0.007968766	73034.21
3	1/29/2008-3/10/2008	30	-0.147352884	N/A	0.317946851	N/A	0.001629598	N/A	0.009822642	94445.98
4	2/12/2008-3/24/2008	30	-0.169916967	N/A	0.327383683	N/A	0.001747965	N/A	0.010569927	91534.84
5	2/26/2008-4/7/2008	30	-0.177513658	N/A	0.330125196	N/A	0.001634026	N/A	0.009410458	42260.84
6	3/11/2008-4/21/2008	30	-0.176822989	N/A	0.312734173	N/A	0.001269178	N/A	0.007599215	35730.26
7	3/25/2008-5/25/2008	30	-0.130644932	N/A	0.323053405	N/A	0.000981245	N/A	0.006074743	62299.99
8	4/8/2008-5/19/2008	30	-0.157211174	N/A	0.303251024	N/A	0.000836829	N/A	0.005164542	13758.29
9	4/22/2008-6/2/2008	30	-0.183498801	N/A	0.321159683	N/A	0.000826634	N/A	0.005180147	25985.77
10	5/6/2008-6/16/2008	30	-0.268941421	N/A	0.317397428	N/A	0.000914424	N/A	0.005540888	25841.88
11	5/20/2008-6/30/2008	30	-0.130901919	N/A	0.331193876	N/A	0.000905263	N/A	0.00567876	31780.33
12	6/3/2008-7/14/2008	30	-0.188448911	N/A	0.322070198	N/A	0.001094834	N/A	0.006365232	39231.97
13	6/17/2008-7/28/2008	30	-0.126265065	N/A	0.334797676	N/A	0.001108228	N/A	0.007011292	39754.44
14	7/1/2008-8/11/2008	30	-0.21135473	N/A	0.329208101	N/A	0.001095473	N/A	0.006342837	38507.49
15	7/15/2008-8/25/2008	30	-0.155144363	N/A	0.334228512	N/A	0.001142826	N/A	0.00677699	33174.24
16	7/29/2008-9/8/2008	30	-0.219988835	N/A	0.318610472	N/A	0.00113963	N/A	0.006963002	28024.49
17	8/12/2008-9/22/2008	30	-0.288442229	N/A	0.327417917	N/A	0.001243307	N/A	0.007884263	4097.64
18	8/26/2008-10/6/2008	30	-0.278319039	N/A	0.332035195	N/A	0.001333653	N/A	0.008260174	12957.33
19	9/9/2008-10/20/2008	30	-0.294972903	N/A	0.343264868	N/A	0.001844711	N/A	0.010686407	21503.52
20	9/23/2008-11/3/2008	30	-0.265643871	N/A	0.360794423	N/A	0.001966613	N/A	0.011584176	29643.36
21	10/7/2008-11/17/2008	30	-0.205804589	N/A	0.369793294	N/A	0.002093082	N/A	0.013315592	40105.48
22	10/21/2008-12/1/2008	30	-0.151364605	N/A	0.365663575	N/A	0.002408059	N/A	0.014140138	71960.75
23	11/4/2008-12/15/2008	30	-0.239314379	N/A	0.368618948	N/A	0.002835283	N/A	0.017821785	127613.74
24	11/18/2008-12/29/2008	30	-0.225511025	N/A	0.338642872	N/A	0.003283773	N/A	0.01932525	96320.55
25	12/2/2008-1/12/2009	30	-0.207885917	N/A	0.346019932	N/A	0.00371955	N/A	0.02324628	189382.63
26	12/16/2008-1/26/2009	30	-0.269926131	N/A	0.353692999	N/A	0.004064166	N/A	0.026466935	74380.09
27	12/30/2008-2/9/2009	30	-0.22269987	N/A	0.382165390	N/A	0.004813202	N/A	0.028758576	23814.10
28	1/13/2009-2/23/2009	30	-0.165725683	N/A	0.392101815	N/A	0.00526974	N/A	0.032024977	11151.92
29	1/27/2009-3/9/2009	30	-0.250842372	N/A	0.387771074	N/A	0.005216776	N/A	0.03025795	6037.83
30	2/10/2009-3/23/2009	30	-0.142564052	N/A	0.366589434	N/A	0.004928416	N/A	0.027870133	6161.31
31	2/24/2009-4/6/2009	30	-0.210394863	N/A	0.382759738	N/A	0.004762631	N/A	0.028879998	12556.12
32	3/10/2009-4/20/2009	30	-0.262203385	N/A	0.378653583	N/A	0.004139371	N/A	0.024661365	11994.02
33	3/24/2009-5/4/2009	30	-0.280093596	N/A	0.371468016	N/A	0.003704104	N/A	0.023732822	7394.20
34	4/7/2009-5/18/2009	30	-0.223924386	N/A	0.333217981	N/A	0.003488751	N/A	0.021110383	3755.47
35	4/21/2009-6/1/2009	30	-0.122442662	N/A	0.331197066	N/A	0.003432127	N/A	0.020267694	3104.64
36	5/5/2009-6/15/2009	30	-0.244094052	N/A	0.348314319	N/A	0.003192022	N/A	0.017629927	6768.98
37	5/19/2009-6/29/2009	30	-0.131248343	N/A	0.361711142	N/A	0.002601884	N/A	0.016354866	10548.65
38	6/2/2009-7/13/2009	30	-0.275614084	N/A	0.332862471	N/A	0.002710853	N/A	0.016193834	17422.63
39	6/16/2009-7/27/2009	30	-0.186456091	N/A	0.333498145	N/A	0.002561492	N/A	0.015565973	5275.74
40	6/30/2009-8/10/2009	30	-0.175476885	N/A	0.346033013	N/A	0.002093709	N/A	0.012335564	11381.31
41	7/14/2009-8/24/2009	30	-0.119183346	N/A	0.343726504	N/A	0.001572434	N/A	0.010106723	12447.80
42	7/28/2009-9/7/2009	30	-0.126798137	N/A	0.337208002	N/A	0.001519172	N/A	0.00909716	13554.16
43	8/11/2009-9/21/2009	30	-0.222714342	N/A	0.335668966	N/A	0.001410274	N/A	0.008214639	14046.33
44	9/8/2009-10/6/2009	30	-0.153222412	N/A	0.329290928	N/A	0.001081801	N/A	0.006817995	16777.36

Average Sum of Squared Errors 35,568.79

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 1 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: The Walt Disney Co.   NYSE: DIS   Industry: Media, Broadcasting, Cable

Model 4   Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.209109867	N/A	0.333639195	-0.000069393	0.002725072	N/A	0.017024914	24899.54
2	1/15/2008-2/25/2008	30	-0.101460340	N/A	0.308274250	0.000041276	0.003215775	N/A	0.018379667	67518.26
3	1/29/2008-3/10/2008	30	-0.102174255	N/A	0.305785620	-0.000056279	0.003451634	N/A	0.021583692	86977.42
4	2/12/2008-3/24/2008	30	-0.253231436	N/A	0.307561611	0.000015542	0.003766417	N/A	0.022440121	85371.96
5	2/26/2008-4/7/2008	30	-0.214984108	N/A	0.323282540	0.000039723	0.003371210	N/A	0.021318673	38768.66
6	3/11/2008-4/21/2008	30	-0.174406236	N/A	0.331849316	0.000054606	0.003156468	N/A	0.018642054	33114.22
7	3/25/2008-5/25/2008	30	-0.222622237	N/A	0.318334428	0.000092052	0.002355639	N/A	0.014726724	56173.87
8	4/8/2008-5/19/2008	30	-0.187072240	N/A	0.320403426	0.000016386	0.002012566	N/A	0.012523602	12508.10
9	4/22/2008-6/2/2008	30	-0.172687654	N/A	0.322521010	-0.000062416	0.002002760	N/A	0.011256112	24004.54
10	5/6/2008-6/16/2008	30	-0.110246775	N/A	0.326246575	-0.000015836	0.002044591	N/A	0.011894548	23826.38
11	5/20/2008-6/30/2008	30	-0.261879970	N/A	0.313871757	-0.000013173	0.001997810	N/A	0.011953012	29454.45
12	6/3/2008-7/14/2008	30	-0.173716957	N/A	0.319524370	-0.000082927	0.002232255	N/A	0.013777267	36603.83
13	6/17/2008-7/28/2008	30	-0.202004145	N/A	0.326043308	0.000037773	0.002451613	N/A	0.015089440	36905.52
14	7/1/2008-8/11/2008	30	-0.111873275	N/A	0.337074302	-0.000056518	0.002454275	N/A	0.014684999	35636.67
15	7/15/2008-8/25/2008	30	-0.193474876	N/A	0.311247975	0.000076823	0.002403542	N/A	0.013431096	30943.14
16	7/29/2008-9/8/2008	30	-0.123901643	N/A	0.321220104	-0.000025297	0.002360848	N/A	0.014244940	26100.49
17	8/12/2008-9/22/2008	30	-0.216919911	N/A	0.327572307	0.000094075	0.002293339	N/A	0.013606923	3814.10
18	8/26/2008-10/6/2008	30	-0.126665067	N/A	0.321974464	-0.000008028	0.002492895	N/A	0.015363101	11976.18
19	9/9/2008-10/20/2008	30	-0.105548836	N/A	0.331754610	0.000001576	0.002909639	N/A	0.017865852	19651.05
20	9/23/2008-11/3/2008	30	-0.134596023	N/A	0.328772336	-0.000040266	0.003591335	N/A	0.021394776	27174.33
21	10/7/2008-11/17/2008	30	-0.233860463	N/A	0.356261927	0.000078599	0.003777557	N/A	0.024311927	37627.56
22	10/21/2008-12/1/2008	30	-0.125938076	N/A	0.363009928	0.000044213	0.004909857	N/A	0.030516115	65092.65
23	11/4/2008-12/15/2008	30	-0.180018667	N/A	0.375397532	-0.000055380	0.005969632	N/A	0.037709363	119560.68
24	11/18/2008-12/29/2008	30	-0.253550089	N/A	0.344694463	-0.000024544	0.007068657	N/A	0.042478822	88343.87
25	12/2/2008-1/12/2009	30	-0.106033659	N/A	0.353895326	0.000022552	0.006357653	N/A	0.037205417	177403.68
26	12/16/2008-1/26/2009	30	-0.161540356	N/A	0.370535858	-0.000075906	0.005737976	N/A	0.033952688	69254.26
27	12/30/2008-2/9/2009	30	-0.161902397	N/A	0.358937667	-0.000048254	0.005157967	N/A	0.030093628	22264.58
28	1/13/2009-2/23/2009	30	-0.101290166	N/A	0.369972494	-0.000044112	0.005203539	N/A	0.030248599	10197.00
29	1/27/2009-3/9/2009	30	-0.282040170	N/A	0.374131690	-0.000090546	0.005299179	N/A	0.031017400	5608.60
30	2/10/2009-3/23/2009	30	-0.291715319	N/A	0.402334878	-0.000016287	0.005242399	N/A	0.030437243	5716.34
31	2/24/2009-4/6/2009	30	-0.156211657	N/A	0.373451688	0.000093327	0.004906305	N/A	0.027610794	11650.86
32	3/10/2009-4/20/2009	30	-0.295367271	N/A	0.373900323	-0.000069650	0.004392703	N/A	0.026580814	11019.78
33	3/24/2009-5/4/2009	30	-0.254927917	N/A	0.351960694	-0.000017022	0.003920261	N/A	0.022480958	6819.58
34	4/7/2009-5/18/2009	30	-0.296904538	N/A	0.332431754	-0.000077484	0.003603518	N/A	0.021711161	3450.75
35	4/21/2009-6/1/2009	30	-0.286797237	N/A	0.345081188	-0.000035026	0.003515593	N/A	0.022077620	2812.17
36	5/5/2009-6/15/2009	30	-0.271132130	N/A	0.339188604	0.000050761	0.003464298	N/A	0.020323011	6149.88
37	5/19/2009-6/29/2009	30	-0.264365418	N/A	0.345163242	0.000092206	0.003237961	N/A	0.020960143	9618.95
38	6/2/2009-7/13/2009	30	-0.124195994	N/A	0.342050422	0.000062832	0.003482464	N/A	0.021066068	15846.54
39	6/16/2009-7/27/2009	30	-0.288569274	N/A	0.358955736	0.000081578	0.003392239	N/A	0.019451775	4927.21
40	6/30/2009-8/10/2009	30	-0.272097338	N/A	0.329913310	-0.000081720	0.003085406	N/A	0.017596088	10649.84
41	7/14/2009-8/24/2009	30	-0.246362808	N/A	0.322907991	-0.000005133	0.002497990	N/A	0.015891263	11620.81
42	7/28/2009-9/7/2009	30	-0.171869367	N/A	0.341601802	0.000073271	0.002403516	N/A	0.014889668	12669.34
43	8/11/2009-9/21/2009	30	-0.144954743	N/A	0.321314527	0.000038281	0.002563510	N/A	0.015249121	13009.73
44	9/8/2009-10/6/2009	30	-0.149920792	N/A	0.343468708	-0.000004860	0.002455823	N/A	0.014520137	15231.03

Average Sum of Squared Errors   32,908.38

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Walt Disney Co.</u> NYSE: <u>DIS</u> Industry: <u>Media, Broadcasting, Cable</u>

Model 5 Default Intensity: $\xi[i,j]=c_0+c_1 t$ Default Probability: $\lambda[i,j]=1-e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j]=N(a_0+a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.069336391	-35.372065559	N/A	N/A	0.002988875	0.000159300	N/A	7503.85
2	1/15/2008-2/25/2008	30	-0.052464341	-36.130762836	N/A	N/A	0.004207288	0.000168506	N/A	17510.82
3	1/29/2008-3/10/2008	30	0.006805252	-34.835721496	N/A	N/A	0.004963972	0.000168422	N/A	27870.43
4	2/12/2008-3/24/2008	30	-0.008254995	-34.785252481	N/A	N/A	0.005203294	0.000196064	N/A	17913.05
5	2/26/2008-4/7/2008	30	0.039940741	-38.374810472	N/A	N/A	0.004652809	0.000175208	N/A	35040.12
6	3/11/2008-4/21/2008	30	0.078445940	-36.308543587	N/A	N/A	0.003940648	0.000155842	N/A	35281.88
7	3/25/2008-5/25/2008	30	-0.081473391	-39.379942022	N/A	N/A	0.002834216	0.000130067	N/A	20326.22
8	4/8/2008-5/19/2008	30	0.063652573	-38.101499950	N/A	N/A	0.002608278	0.000116953	N/A	11583.04
9	4/22/2008-6/2/2008	30	0.069750639	-33.747051387	N/A	N/A	0.002493011	0.000102409	N/A	3627.93
10	5/6/2008-6/16/2008	30	-0.075365292	-40.377395534	N/A	N/A	0.002549600	0.000106689	N/A	3444.84
11	5/20/2008-6/30/2008	30	-0.024065108	-38.258747672	N/A	N/A	0.002801650	0.000110247	N/A	7183.94
12	6/3/2008-7/14/2008	30	0.060454935	-39.814043983	N/A	N/A	0.002983592	0.000120731	N/A	10592.47
13	6/17/2008-7/28/2008	30	-0.095736523	-40.548495933	N/A	N/A	0.003243570	0.000117882	N/A	8312.39
14	7/1/2008-8/11/2008	30	0.047948564	-40.357777344	N/A	N/A	0.003228843	0.000123850	N/A	7070.49
15	7/15/2008-8/25/2008	30	-0.089800092	-38.251943486	N/A	N/A	0.003365580	0.000114046	N/A	5247.27
16	7/29/2008-9/8/2008	30	0.042774676	-38.204535919	N/A	N/A	0.003434246	0.000107059	N/A	4094.72
17	8/12/2008-9/22/2008	30	-0.085964783	-37.626534069	N/A	N/A	0.003974742	0.000102093	N/A	4974.69
18	8/26/2008-10/6/2008	30	0.045521621	-34.246399570	N/A	N/A	0.004260818	0.000105464	N/A	11577.40
19	9/9/2008-10/20/2008	30	-0.091801417	-34.225994827	N/A	N/A	0.005433375	0.000112333	N/A	43481.12
20	9/23/2008-11/3/2008	30	0.043076666	-33.399777944	N/A	N/A	0.005855867	0.000156493	N/A	41895.79
21	10/7/2008-11/17/2008	30	-0.047922835	-39.268366870	N/A	N/A	0.006238672	0.000172282	N/A	16278.29
22	10/21/2008-12/1/2008	30	-0.047145731	-38.240336300	N/A	N/A	0.007035761	0.000243851	N/A	143527.40
23	11/4/2008-12/15/2008	30	0.013778284	-33.957420054	N/A	N/A	0.008499355	0.000295330	N/A	213669.23
24	11/18/2008-12/29/2008	30	-0.089231259	-34.077119257	N/A	N/A	0.009380273	0.000335940	N/A	76082.79
25	12/2/2008-1/12/2009	30	-0.073911897	-33.331820555	N/A	N/A	0.010582143	0.000249399	N/A	153505.04
26	12/16/2008-1/26/2009	30	0.040798867	-40.349449179	N/A	N/A	0.012312503	0.000124802	N/A	63257.99
27	12/30/2008-2/9/2009	30	0.014081004	-39.616920817	N/A	N/A	0.014643550	0.000023430	N/A	21283.86
28	1/13/2009-2/23/2009	30	-0.089783385	-39.517268765	N/A	N/A	0.015851628	0.000016248	N/A	9443.31
29	1/27/2009-3/9/2009	30	0.037808245	-36.205058986	N/A	N/A	0.015156517	0.000015751	N/A	5283.43
30	2/10/2009-3/23/2009	30	-0.083349031	-38.245580064	N/A	N/A	0.014589514	0.000019428	N/A	6102.32
31	2/24/2009-4/6/2009	30	0.040193808	-34.962485376	N/A	N/A	0.013339215	0.000015139	N/A	13899.17
32	3/10/2009-4/20/2009	30	0.089967324	-39.302665378	N/A	N/A	0.013220091	0.000009942	N/A	13536.88
33	3/24/2009-5/4/2009	30	0.087724188	-35.873788596	N/A	N/A	0.011794900	0.000009915	N/A	8464.48
34	4/7/2009-5/18/2009	30	0.046241104	-35.301168909	N/A	N/A	0.010787436	0.000009779	N/A	3592.41
35	4/21/2009-6/1/2009	30	-0.040026507	-36.366295185	N/A	N/A	0.010221646	0.000015761	N/A	2777.89
36	5/5/2009-6/15/2009	30	-0.009002150	-36.877759076	N/A	N/A	0.008851581	0.000032911	N/A	7019.10
37	5/19/2009-6/29/2009	30	-0.056796369	-39.604749842	N/A	N/A	0.007903643	0.000058429	N/A	6120.83
38	6/2/2009-7/13/2009	30	-0.017231241	-37.784358558	N/A	N/A	0.008214532	0.000077654	N/A	7349.03
39	6/16/2009-7/27/2009	30	-0.038005980	-39.011141481	N/A	N/A	0.007423024	0.000082022	N/A	11499.43
40	6/30/2009-8/10/2009	30	-0.010816888	-35.343050056	N/A	N/A	0.006031625	0.000088317	N/A	30382.90
41	7/14/2009-8/24/2009	30	0.048909960	-34.398817678	N/A	N/A	0.004691782	0.000089188	N/A	18249.29
42	7/28/2009-9/7/2009	30	-0.020386673	-40.576281406	N/A	N/A	0.004637983	0.000034742	N/A	9685.79
43	8/11/2009-9/21/2009	30	-0.032687603	-36.775615510	N/A	N/A	0.004217539	0.000103719	N/A	8488.87
44	9/8/2009-10/6/2009	30	-0.022384509	-38.291523387	N/A	N/A	0.003321039	0.000116801	N/A	6039.57

Average Sum of Squared Errors 26,819.81

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: __The Walt Disney Co.__ NYSE: __DIS__ Industry: __Media, Broadcasting, Cable__

Model 6 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.001811972	-35.966148487	0.337837408	N/A	0.001033219	N/A	0.005780817	23211.66
2	1/15/2008-2/25/2008	30	0.063643628	-34.918867106	0.329115405	N/A	0.001356647	N/A	0.008435277	62468.99
3	1/29/2008-3/10/2008	30	0.097802840	-39.253351894	0.335615407	N/A	0.001557069	N/A	0.009908617	83389.71
4	2/12/2008-3/24/2008	30	-0.059695359	-37.213528754	0.326910965	N/A	0.001731304	N/A	0.010763165	80265.12
5	2/26/2008-4/7/2008	30	-0.087368306	-38.329440562	0.331960670	N/A	0.001553069	N/A	0.009587981	36438.64
6	3/11/2008-4/21/2008	30	0.005431684	-35.559989344	0.324206503	N/A	0.001286465	N/A	0.007571533	30758.39
7	3/25/2008-5/25/2008	30	0.011425046	-33.381881051	0.315227548	N/A	0.000955022	N/A	0.005577211	55157.54
8	4/8/2008-5/19/2008	30	0.019957103	-39.282486181	0.312892599	N/A	0.000902142	N/A	0.005306537	12089.80
9	4/22/2008-6/2/2008	30	0.043589747	-34.971593268	0.325479595	N/A	0.000840808	N/A	0.004948795	22554.92
10	5/6/2008-6/16/2008	30	-0.030605382	-33.542224770	0.320793569	N/A	0.000858338	N/A	0.005370756	22206.30
11	5/20/2008-6/30/2008	30	-0.049913691	-38.664898342	0.307801076	N/A	0.000904688	N/A	0.005830964	27382.91
12	6/3/2008-7/14/2008	30	0.074461356	-38.614721475	0.305202545	N/A	0.001046630	N/A	0.006424954	34105.01
13	6/17/2008-7/28/2008	30	-0.041136903	-36.742392060	0.315176993	N/A	0.001107243	N/A	0.006733508	35238.75
14	7/1/2008-8/11/2008	30	0.023103925	-35.078912989	0.329433852	N/A	0.001032452	N/A	0.006377670	33211.32
15	7/15/2008-8/25/2008	30	-0.083173722	-36.302313245	0.316052035	N/A	0.001111491	N/A	0.006405042	28480.29
16	7/29/2008-9/8/2008	30	0.053317967	-34.958605222	0.333398670	N/A	0.001158654	N/A	0.006917221	24293.91
17	8/12/2008-9/22/2008	30	0.035660383	-35.671313953	0.315807415	N/A	0.001315431	N/A	0.008036125	3541.65
18	8/26/2008-10/6/2008	30	0.086195596	-36.629366096	0.322484879	N/A	0.001319451	N/A	0.008357441	11081.47
19	9/9/2008-10/20/2008	30	0.061640431	-39.393551407	0.348420832	N/A	0.001778963	N/A	0.010933735	18896.45
20	9/23/2008-11/3/2008	30	0.022454188	-34.139546471	0.352483368	N/A	0.002083781	N/A	0.012504272	25347.13
21	10/7/2008-11/17/2008	30	-0.085173940	-35.444111463	0.353842735	N/A	0.002098972	N/A	0.012618787	34681.47
22	10/21/2008-12/1/2008	30	0.049171206	-34.281968793	0.373341382	N/A	0.002451491	N/A	0.014630023	62851.96
23	11/4/2008-12/15/2008	30	-0.005421627	-38.917450066	0.345311655	N/A	0.002982560	N/A	0.018376696	111643.12
24	11/18/2008-12/29/2008	30	-0.024161396	-34.754249243	0.351509326	N/A	0.003120392	N/A	0.019674043	85104.98
25	12/2/2008-1/12/2009	30	0.045218269	-35.827141951	0.352406215	N/A	0.003822166	N/A	0.022971143	163861.98
26	12/16/2008-1/26/2009	30	-0.094609548	-38.655873167	0.359197518	N/A	0.004412853	N/A	0.025227984	64548.92
27	12/30/2008-2/9/2009	30	0.074184545	-35.666794513	0.384561418	N/A	0.005209700	N/A	0.029481130	20988.48
28	1/13/2009-2/23/2009	30	0.045412402	-35.284567174	0.397763258	N/A	0.004948385	N/A	0.029466256	9738.52
29	1/27/2009-3/9/2009	30	0.012796418	-35.460279693	0.379033673	N/A	0.005070952	N/A	0.031119073	5267.93
30	2/10/2009-3/23/2009	30	0.094666739	-34.505761127	0.378090032	N/A	0.004642002	N/A	0.029772607	5450.24
31	2/24/2009-4/6/2009	30	-0.047622116	-36.076423509	0.382522791	N/A	0.004658669	N/A	0.028739203	10755.61
32	3/10/2009-4/20/2009	30	-0.056648578	-38.467281751	0.380762044	N/A	0.004076861	N/A	0.026618644	10502.20
33	3/24/2009-5/4/2009	30	-0.006489486	-36.654408307	0.372587273	N/A	0.003973410	N/A	0.022321318	6410.53
34	4/7/2009-5/18/2009	30	0.041454058	-37.203623163	0.339595832	N/A	0.003455213	N/A	0.022089523	3210.35
35	4/21/2009-6/1/2009	30	0.084987818	-37.292748331	0.340403038	N/A	0.003567981	N/A	0.020659519	2661.85
36	5/5/2009-6/15/2009	30	-0.066321511	-34.784093623	0.357477528	N/A	0.003162236	N/A	0.017725627	5777.25
37	5/19/2009-6/29/2009	30	-0.061275497	-34.534357413	0.352841212	N/A	0.002707838	N/A	0.015622551	9308.71
38	6/2/2009-7/13/2009	30	-0.035089000	-35.246541996	0.335561802	N/A	0.002568539	N/A	0.015393993	15134.06
39	6/16/2009-7/27/2009	30	-0.056748471	-40.600601342	0.328140039	N/A	0.002500034	N/A	0.015545965	4644.64
40	6/30/2009-8/10/2009	30	-0.086021286	-36.810844432	0.352630133	N/A	0.002084334	N/A	0.012957444	9875.01
41	7/14/2009-8/24/2009	30	-0.060173711	-35.583928610	0.345546225	N/A	0.001687577	N/A	0.009839517	11015.10
42	7/28/2009-9/7/2009	30	0.018958958	-35.051605359	0.318878184	N/A	0.001552801	N/A	0.009148649	11740.29
43	8/11/2009-9/21/2009	30	0.015043386	-35.606587573	0.320527140	N/A	0.001396305	N/A	0.008090553	12298.83
44	9/8/2009-10/6/2009	30	0.075556155	-36.909943804	0.342586056	N/A	0.001149622	N/A	0.006905317	14622.12

__Average Sum of Squared Errors__ 30,959.41

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 3 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: The Walt Disney Co.   NYSE: DIS   Industry: Media, Broadcasting, Cable

Model 7 Default Intensity: $\xi[i,j] = c_0 + \dfrac{c_2}{s^{b_0+b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.010863166	-39.373478182	0.336964406	0.000079970	0.002732251	N/A	0.016566704	21103.01
2	1/15/2008-2/25/2008	30	0.018059536	-37.800061337	0.331419893	-0.000070956	0.003183597	N/A	0.018130005	60347.52
3	1/29/2008-3/10/2008	30	-0.002395013	-38.837761173	0.304210151	-0.000064312	0.003566685	N/A	0.020279506	76218.39
4	2/12/2008-3/24/2008	30	0.015250320	-34.495605042	0.310983170	0.000054657	0.003900701	N/A	0.022657411	76281.24
5	2/26/2008-4/7/2008	30	-0.032997356	-33.776954475	0.324400917	-0.000066403	0.003661414	N/A	0.020046841	33763.12
6	3/11/2008-4/21/2008	30	0.032318835	-34.455586853	0.308342940	-0.000022767	0.003119308	N/A	0.018902053	29618.03
7	3/25/2008-5/25/2008	30	0.004562191	-40.399809374	0.312171497	0.000049234	0.002303825	N/A	0.014379793	49898.07
8	4/8/2008-5/19/2008	30	0.038368499	-38.749111022	0.323570830	0.000030404	0.002138235	N/A	0.013241958	11794.11
9	4/22/2008-6/2/2008	30	0.003076350	-39.455683167	0.301104797	0.000022484	0.002020527	N/A	0.011185586	21524.67
10	5/6/2008-6/16/2008	30	0.004387999	-38.612492046	0.318120913	-0.000088219	0.001890052	N/A	0.012179769	20018.93
11	5/20/2008-6/30/2008	30	-0.042252470	-39.595888289	0.312681787	0.000022412	0.002012672	N/A	0.012395947	24265.36
12	6/3/2008-7/14/2008	30	-0.026006354	-33.650970739	0.310862628	0.000017504	0.002164934	N/A	0.013901181	32169.80
13	6/17/2008-7/28/2008	30	-0.016130575	-34.333611394	0.311250111	-0.000075670	0.002299028	N/A	0.014298520	33645.27
14	7/1/2008-8/11/2008	30	-0.053341099	-37.590750817	0.333578379	-0.000023996	0.002462552	N/A	0.013551384	31460.33
15	7/15/2008-8/25/2008	30	0.072925855	-38.013194931	0.328993858	-0.000003123	0.002249322	N/A	0.013292442	27206.13
16	7/29/2008-9/8/2008	30	-0.005193464	-35.708328050	0.306973540	0.000097293	0.002201885	N/A	0.013043800	22175.39
17	8/12/2008-9/22/2008	30	0.097076795	-36.855667581	0.327266436	-0.000065388	0.002407082	N/A	0.014506919	3303.83
18	8/26/2008-10/6/2008	30	0.077960806	-36.058977545	0.314702816	0.000068776	0.002473364	N/A	0.015129218	10097.79
19	9/9/2008-10/20/2008	30	0.010292992	-40.485312073	0.344851245	-0.000011418	0.003064544	N/A	0.018803476	18133.93
20	9/23/2008-11/3/2008	30	0.080024531	-38.048241397	0.329601347	0.000020751	0.003699245	N/A	0.021712685	23596.80
21	10/7/2008-11/17/2008	30	-0.091436759	-39.563094593	0.370342467	0.000097666	0.004072086	N/A	0.023096975	31570.56
22	10/21/2008-12/1/2008	30	0.085844400	-35.202215035	0.351756566	-0.000068349	0.004912168	N/A	0.029284590	57854.67
23	11/4/2008-12/15/2008	30	0.029545569	-36.311769743	0.355134270	-0.000094733	0.006343698	N/A	0.035815837	99506.63
24	11/18/2008-12/29/2008	30	0.095151544	-36.399807510	0.337728631	0.000038735	0.006609095	N/A	0.039703145	81808.85
25	12/2/2008-1/12/2009	30	-0.033644241	-39.239888397	0.340207553	0.000081986	0.006466298	N/A	0.038530431	152031.91
26	12/16/2008-1/26/2009	30	-0.028878343	-34.785799664	0.345050194	-0.000063319	0.005317880	N/A	0.033596850	57210.55
27	12/30/2008-2/9/2009	30	-0.033118815	-34.601979968	0.362291520	0.000042681	0.005129165	N/A	0.032626603	19662.29
28	1/13/2009-2/23/2009	30	0.024122989	-38.302294513	0.386764086	-0.000024633	0.005425408	N/A	0.031991777	9121.86
29	1/27/2009-3/9/2009	30	-0.039218762	-40.229934901	0.387598527	-0.000048333	0.005398653	N/A	0.030341174	4820.21
30	2/10/2009-3/23/2009	30	-0.087869473	-34.191061402	0.364331146	-0.000094954	0.005234670	N/A	0.031241975	4857.72
31	2/24/2009-4/6/2009	30	-0.008767299	-39.531230804	0.368277342	0.000030941	0.004738966	N/A	0.030033479	10102.18
32	3/10/2009-4/20/2009	30	0.049312195	-36.932166010	0.373299930	0.000035206	0.004261963	N/A	0.025886834	10231.04
33	3/24/2009-5/4/2009	30	0.000833149	-40.069968692	0.343406770	0.000021262	0.003880894	N/A	0.023256416	5996.98
34	4/7/2009-5/18/2009	30	-0.010435162	-36.694417814	0.361226895	0.000085153	0.003769740	N/A	0.022119318	3084.32
35	4/21/2009-6/1/2009	30	-0.014888447	-37.761032059	0.354466960	-0.000085973	0.003507782	N/A	0.022134880	2557.82
36	5/5/2009-6/15/2009	30	0.040386182	-35.601296241	0.340705439	-0.000022530	0.003279652	N/A	0.020552054	5520.28
37	5/19/2009-6/29/2009	30	0.026490701	-34.334350947	0.333790320	-0.000036022	0.003230754	N/A	0.019507641	8836.21
38	6/2/2009-7/13/2009	30	-0.070263888	-38.782082423	0.339085303	-0.000092847	0.003422498	N/A	0.021105052	14393.39
39	6/16/2009-7/27/2009	30	0.068433756	-37.849369214	0.329115529	-0.000043217	0.003562230	N/A	0.020086663	4144.10
40	6/30/2009-8/10/2009	30	-0.015433138	-34.248107925	0.330323448	-0.000061844	0.003100487	N/A	0.017789936	9477.60
41	7/14/2009-8/24/2009	30	0.035722798	-37.430080935	0.346577196	0.000000849	0.002589684	N/A	0.015383185	9861.45
42	7/28/2009-9/7/2009	30	0.078046879	-38.098059662	0.330900954	0.000037961	0.002367288	N/A	0.015415915	11436.40
43	8/11/2009-9/21/2009	30	0.065290851	-36.730931580	0.335064097	0.000040169	0.002517026	N/A	0.015249625	11042.25
44	9/8/2009-10/6/2009	30	-0.010928130	-38.670355819	0.340419758	0.000093598	0.002376938	N/A	0.013807777	14274.71

Average Sum of Squared Errors 28,773.31

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 6 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: The Walt Disney Co.   NYSE: DIS   Industry: Media, Broadcasting, Cable

Model 8 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.283370704	N/A	0.329347979	N/A	0.003112673	0.000098550	0.006593764	6502.35
2	1/15/2008-2/25/2008	30	-0.192032166	N/A	0.334579270	N/A	0.004298794	0.000095239	0.007481492	19775.85
3	1/29/2008-3/10/2008	30	-0.234474399	N/A	0.328279974	N/A	0.005048179	0.000101880	0.008157553	21632.05
4	2/12/2008-3/24/2008	30	-0.164095709	N/A	0.319781767	N/A	0.005459088	0.000117374	0.009316362	18764.71
5	2/26/2008-4/7/2008	30	-0.197618031	N/A	0.305266730	N/A	0.004677735	0.000111923	0.008803280	32761.72
6	3/11/2008-4/21/2008	30	-0.170896782	N/A	0.328029070	N/A	0.003906981	0.000035093	0.006943248	34742.88
7	3/25/2008-5/25/2008	30	-0.103373501	N/A	0.322381200	N/A	0.002806041	0.000083282	0.006006279	16631.59
8	4/8/2008-5/19/2008	30	-0.204503035	N/A	0.307347166	N/A	0.002527797	0.000068471	0.005142746	9191.52
9	4/22/2008-6/2/2008	30	-0.152848741	N/A	0.325364154	N/A	0.002411448	0.000062081	0.004609026	2909.18
10	5/6/2008-6/16/2008	30	-0.266100734	N/A	0.302844740	N/A	0.002548564	0.000058924	0.004548313	2827.54
11	5/20/2008-6/30/2008	30	-0.151947976	N/A	0.306729326	N/A	0.002698165	0.000064888	0.004951027	5578.75
12	6/3/2008-7/14/2008	30	-0.257885349	N/A	0.336111918	N/A	0.003291912	0.000066589	0.005695720	8284.13
13	6/17/2008-7/28/2008	30	-0.298832223	N/A	0.332404246	N/A	0.003465540	0.000076643	0.005719506	8773.10
14	7/1/2008-8/11/2008	30	-0.142023765	N/A	0.327463584	N/A	0.003180248	0.000072493	0.005909116	8012.55
15	7/15/2008-8/25/2008	30	-0.178113375	N/A	0.324546697	N/A	0.003374164	0.000068087	0.005476413	4455.55
16	7/29/2008-9/8/2008	30	-0.171872797	N/A	0.325113239	N/A	0.003505852	0.000061425	0.005539850	3450.35
17	8/12/2008-9/22/2008	30	-0.289139164	N/A	0.313655518	N/A	0.004036434	0.000059262	0.005465248	4058.19
18	8/26/2008-10/6/2008	30	-0.115865456	N/A	0.328207620	N/A	0.004210559	0.000064577	0.006123898	10037.55
19	9/9/2008-10/20/2008	30	-0.161261914	N/A	0.330366264	N/A	0.005605650	0.000072768	0.007532010	20936.49
20	9/23/2008-11/3/2008	30	-0.295177602	N/A	0.330312047	N/A	0.005730483	0.000088028	0.008449867	25272.46
21	10/7/2008-11/17/2008	30	-0.152801722	N/A	0.366855907	N/A	0.006568949	0.000104617	0.009911862	17480.68
22	10/21/2008-12/1/2008	30	-0.182795773	N/A	0.355513473	N/A	0.006882834	0.000143607	0.011830023	71084.00
23	11/4/2008-12/15/2008	30	-0.147255916	N/A	0.365330593	N/A	0.009178071	0.000184079	0.014691922	103861.88
24	11/18/2008-12/29/2008	30	-0.150837290	N/A	0.366432589	N/A	0.009768601	0.000216275	0.016899452	64886.98
25	12/2/2008-1/12/2009	30	-0.201719439	N/A	0.345970903	N/A	0.011250706	0.000155907	0.015038343	124487.93
26	12/16/2008-1/26/2009	30	-0.157318409	N/A	0.361279810	N/A	0.012309200	0.000075821	0.013753937	50870.35
27	12/30/2008-2/9/2009	30	-0.137848514	N/A	0.361709092	N/A	0.015455669	0.000015136	0.012738744	21489.15
28	1/13/2009-2/23/2009	30	-0.186802853	N/A	0.391377131	N/A	0.015723806	0.000009496	0.012531652	7852.05
29	1/27/2009-3/9/2009	30	-0.217596170	N/A	0.386761878	N/A	0.014645226	0.000009586	0.011898530	4366.02
30	2/10/2009-3/23/2009	30	-0.144670105	N/A	0.365793565	N/A	0.013940557	0.000012214	0.011699487	4998.04
31	2/24/2009-4/6/2009	30	-0.234923243	N/A	0.361926468	N/A	0.013532233	0.000008728	0.011992795	12190.31
32	3/10/2009-4/20/2009	30	-0.136669615	N/A	0.352559249	N/A	0.012496848	0.000005656	0.010163576	11072.22
33	3/24/2009-5/4/2009	30	-0.183752042	N/A	0.367716590	N/A	0.011070576	0.000005659	0.009571492	7314.63
34	4/7/2009-5/18/2009	30	-0.222984626	N/A	0.354466227	N/A	0.010609258	0.000006221	0.009023230	2890.24
35	4/21/2009-6/1/2009	30	-0.131649141	N/A	0.350950102	N/A	0.010531832	0.000009451	0.008254913	2232.40
36	5/5/2009-6/15/2009	30	-0.189605435	N/A	0.345036314	N/A	0.009007703	0.000019871	0.008160350	5571.57
37	5/19/2009-6/29/2009	30	-0.258450519	N/A	0.348148594	N/A	0.008051831	0.000034835	0.007786575	5152.53
38	6/2/2009-7/13/2009	30	-0.226530809	N/A	0.336613071	N/A	0.007891912	0.000046589	0.008428703	5860.62
39	6/16/2009-7/27/2009	30	-0.265157875	N/A	0.343375301	N/A	0.007748531	0.000053627	0.008207700	5047.69
40	6/30/2009-8/10/2009	30	-0.155879828	N/A	0.338239246	N/A	0.006519472	0.000052336	0.006815088	10277.36
41	7/14/2009-8/24/2009	30	-0.282703885	N/A	0.345620777	N/A	0.004884651	0.000058373	0.006309819	12422.15
42	7/28/2009-9/7/2009	30	-0.116060337	N/A	0.349943589	N/A	0.004275340	0.000056964	0.006176191	8486.81
43	8/11/2009-9/21/2009	30	-0.274382374	N/A	0.346018630	N/A	0.004094942	0.000061291	0.006281231	7336.85
44	9/8/2009-10/6/2009	30	-0.182892999	N/A	0.335790151	N/A	0.003488090	0.000073216	0.005916557	5252.26

Average Sum of Squared Errors   19,024.62

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 2 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Walt Disney Co.</u> NYSE: <u>DIS</u> Industry: <u>Media, Broadcasting, Cable</u>

Model9 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0 + b_1 t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0)$

| Time window | Period of time | The number of trading days | \multicolumn{7}{c}{Extracted Parameters} | Sum of squared errors |
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.156354125	N/A	0.335429069	-0.000008609	0.002973832	0.000094637	0.006731411	6074.31
2	1/15/2008-2/25/2008	30	-0.261324885	N/A	0.311200475	-0.000018707	0.004345886	0.000099264	0.007492132	12944.70
3	1/29/2008-3/10/2008	30	-0.173323903	N/A	0.319323237	-0.000018831	0.004910870	0.000101596	0.008079150	19559.47
4	2/12/2008-3/24/2008	30	-0.241930831	N/A	0.324758994	0.000051184	0.005258665	0.000113223	0.009525320	13620.10
5	2/26/2008-4/7/2008	30	-0.104066859	N/A	0.331991864	0.000024228	0.004942749	0.000104408	0.008831152	24570.47
6	3/11/2008-4/21/2008	30	-0.197221031	N/A	0.327516896	0.000052108	0.003715907	0.000039098	0.007199750	27075.45
7	3/25/2008-5/25/2008	30	-0.179322533	N/A	0.326016036	0.000047367	0.002791898	0.000082313	0.005522179	14781.31
8	4/8/2008-5/19/2008	30	-0.123690350	N/A	0.312424523	0.000044204	0.002718829	0.000066470	0.004892068	8399.02
9	4/22/2008-6/2/2008	30	-0.102472949	N/A	0.300166289	0.000019090	0.002414247	0.000061586	0.004410533	2722.89
10	5/6/2008-6/16/2008	30	-0.173550604	N/A	0.314988327	-0.000057256	0.002692368	0.000062229	0.004555642	2579.85
11	5/20/2008-6/30/2008	30	-0.272248756	N/A	0.331126880	-0.000024769	0.002937977	0.000066981	0.004803566	4825.34
12	6/3/2008-7/14/2008	30	-0.174081434	N/A	0.315312467	-0.000077228	0.003159168	0.000068451	0.005474915	7310.40
13	6/17/2008-7/28/2008	30	-0.217631154	N/A	0.323596050	-0.000073324	0.003398988	0.000075775	0.005854742	6388.73
14	7/1/2008-8/11/2008	30	-0.152913837	N/A	0.315119386	0.000080754	0.003382672	0.000076989	0.005422173	5426.13
15	7/15/2008-8/25/2008	30	-0.242778520	N/A	0.305415394	-0.000005191	0.003439979	0.000066873	0.005372704	3945.50
16	7/29/2008-9/8/2008	30	-0.177378540	N/A	0.317589401	0.000083783	0.003386288	0.000062079	0.005595447	2997.13
17	8/12/2008-9/22/2008	30	-0.288894484	N/A	0.328385372	-0.000049915	0.003694226	0.000062427	0.005452987	3740.12
18	8/26/2008-10/6/2008	30	-0.269771730	N/A	0.337962420	0.000036090	0.004262645	0.000066445	0.005793243	9306.84
19	9/9/2008-10/20/2008	30	-0.164148403	N/A	0.336466060	-0.000034856	0.005442395	0.000072604	0.007211558	18411.73
20	9/23/2008-11/3/2008	30	-0.154234643	N/A	0.351880426	-0.000094958	0.006001286	0.000089611	0.008901279	19819.93
21	10/7/2008-11/17/2008	30	-0.240226810	N/A	0.368766436	-0.000053049	0.006730213	0.000107469	0.009579203	11952.41
22	10/21/2008-12/1/2008	30	-0.201088701	N/A	0.372576637	0.000005223	0.007354949	0.000143962	0.012024463	64933.11
23	11/4/2008-12/15/2008	30	-0.253492096	N/A	0.365211094	0.000063336	0.008465834	0.000191914	0.014966586	102255.57
24	11/18/2008-12/29/2008	30	-0.296810887	N/A	0.356142771	-0.000064444	0.009445994	0.000215943	0.016236257	55663.69
25	12/2/2008-1/12/2009	30	-0.240227703	N/A	0.339213562	0.000089626	0.010768708	0.000148125	0.015899322	113910.97
26	12/16/2008-1/26/2009	30	-0.221699678	N/A	0.352135745	0.000040046	0.012575639	0.000074871	0.013115323	47136.39
27	12/30/2008-2/9/2009	30	-0.255747662	N/A	0.380690722	0.000023499	0.014612861	0.000015143	0.012152182	16406.85
28	1/13/2009-2/23/2009	30	-0.266767465	N/A	0.388072849	-0.000005132	0.015261404	0.000009598	0.012867667	6888.12
29	1/27/2009-3/9/2009	30	-0.187734174	N/A	0.392391255	-0.000068142	0.014639252	0.000009581	0.012539418	3871.74
30	2/10/2009-3/23/2009	30	-0.218446324	N/A	0.378913869	-0.000002193	0.014578874	0.000012001	0.012566315	4321.45
31	2/24/2009-4/6/2009	30	-0.127927714	N/A	0.366230543	-0.000034428	0.014054555	0.000008771	0.012046388	11165.28
32	3/10/2009-4/20/2009	30	-0.139525221	N/A	0.352013535	-0.000070625	0.012076446	0.000005923	0.010010457	9941.20
33	3/24/2009-5/4/2009	30	-0.238890742	N/A	0.370979968	-0.000080843	0.011204526	0.000006079	0.009811191	6530.04
34	4/7/2009-5/18/2009	30	-0.245075285	N/A	0.343089504	-0.000032372	0.010268507	0.000006305	0.008890168	2533.92
35	4/21/2009-6/1/2009	30	-0.124348987	N/A	0.343457477	-0.000061478	0.010546656	0.000009271	0.008970841	2040.64
36	5/5/2009-6/15/2009	30	-0.131334253	N/A	0.336314309	-0.000072824	0.009157035	0.000020254	0.008045857	4938.26
37	5/19/2009-6/29/2009	30	-0.256057526	N/A	0.360250514	-0.000050140	0.007848346	0.000035261	0.008050817	4770.36
38	6/2/2009-7/13/2009	30	-0.191251221	N/A	0.358128853	-0.000078207	0.007943699	0.000043628	0.007909160	5400.80
39	6/16/2009-7/27/2009	30	-0.289132737	N/A	0.353240830	0.000004023	0.007243191	0.000051774	0.008113020	4904.65
40	6/30/2009-8/10/2009	30	-0.267126657	N/A	0.353320557	-0.000060385	0.006291773	0.000052904	0.006812312	10203.77
41	7/14/2009-8/24/2009	30	-0.139455029	N/A	0.343481868	-0.000090038	0.005096698	0.000053476	0.006133068	10338.89
42	7/28/2009-9/7/2009	30	-0.241898001	N/A	0.345992041	0.000039079	0.004295685	0.000055712	0.006077879	7527.84
43	8/11/2009-9/21/2009	30	-0.241844727	N/A	0.345815603	0.000055371	0.004359612	0.000061519	0.006278836	6769.62
44	9/8/2009-10/6/2009	30	-0.289210386	N/A	0.336213696	-0.000007202	0.003494916	0.000073323	0.005546068	4594.03

Average Sum of Squared Errors   16,670.43

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: The Walt Disney Co. NYSE: DIS Industry: Media, Broadcasting, Cable

Model 10 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{b_0}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	0.094062234	-40.201608872	0.326855622	N/A	0.002937232	0.000099715	0.006645810	5679.82
2	1/15/2008-2/25/2008	30	0.049313608	-36.107624290	0.329684678	N/A	0.004320299	0.000099247	0.007341436	11863.44
3	1/29/2008-3/10/2008	30	-0.041867842	-33.426124032	0.328664001	N/A	0.004718725	0.000105545	0.008276723	17740.61
4	2/12/2008-3/24/2008	30	-0.066597462	-35.130397987	0.304103312	N/A	0.005267119	0.000119304	0.009440942	12347.41
5	2/26/2008-4/7/2008	30	0.078753647	-40.565915532	0.328142146	N/A	0.004878284	0.000109454	0.008392786	23825.26
6	3/11/2008-4/21/2008	30	-0.068868419	-33.948553420	0.314389519	N/A	0.003773397	0.000101978	0.007264188	22969.23
7	3/25/2008-5/25/2008	30	0.086078307	-34.899691325	0.311984734	N/A	0.002940204	0.000078100	0.005605523	14272.54
8	4/8/2008-5/19/2008	30	-0.084886918	-34.437911499	0.315541068	N/A	0.002722311	0.000069161	0.004981086	7408.71
9	4/22/2008-6/2/2008	30	-0.096318249	-36.468749133	0.300265276	N/A	0.002592760	0.000058339	0.004450168	2466.39
10	5/6/2008-6/16/2008	30	0.021968037	-34.942410626	0.305198478	N/A	0.002761740	0.000061681	0.004666105	2354.72
11	5/20/2008-6/30/2008	30	0.046349215	-37.533805170	0.320573498	N/A	0.002905396	0.000061893	0.005212154	4796.63
12	6/3/2008-7/14/2008	30	-0.014183605	-39.192887898	0.306185214	N/A	0.003197899	0.000066098	0.005689339	6839.82
13	6/17/2008-7/28/2008	30	-0.084317362	-39.888522387	0.335387078	N/A	0.003454120	0.000070118	0.006032388	5757.42
14	7/1/2008-8/11/2008	30	0.031449797	-35.823164604	0.315018433	N/A	0.003162443	0.000072741	0.005810583	5268.13
15	7/15/2008-8/25/2008	30	-0.057776555	-39.603853633	0.315335519	N/A	0.003389869	0.000067357	0.005540350	3742.96
16	7/29/2008-9/8/2008	30	0.088020314	-35.445233946	0.332343030	N/A	0.003413426	0.000061665	0.005540348	2937.45
17	8/12/2008-9/22/2008	30	-0.064289419	-40.543936408	0.325340383	N/A	0.004008723	0.000059205	0.005571414	3031.57
18	8/26/2008-10/6/2008	30	0.032188617	-38.255549847	0.317794355	N/A	0.004178784	0.000064803	0.006295384	8564.57
19	9/9/2008-10/20/2008	30	0.056395918	-39.883909836	0.347027409	N/A	0.005226480	0.000068384	0.007470143	15985.91
20	9/23/2008-11/3/2008	30	-0.038211228	-37.432093210	0.345228877	N/A	0.006234519	0.000090907	0.008516400	25075.75
21	10/7/2008-11/17/2008	30	-0.033410809	-34.535504212	0.366861169	N/A	0.006239122	0.000104768	0.009502378	11855.09
22	10/21/2008-12/1/2008	30	-0.068869530	-35.163498515	0.343955120	N/A	0.007361285	0.000142183	0.011656670	60960.59
23	11/4/2008-12/15/2008	30	0.081249166	-34.990098302	0.359864402	N/A	0.008657567	0.000176615	0.014939863	101331.52
24	11/18/2008-12/29/2008	30	-0.009051689	-39.947946922	0.348035150	N/A	0.009412257	0.000204460	0.017048976	52493.17
25	12/2/2008-1/12/2009	30	0.031171475	-33.689584313	0.342262281	N/A	0.011546313	0.000153901	0.014577095	104316.84
26	12/16/2008-1/26/2009	30	-0.030155563	-40.287137742	0.374749509	N/A	0.013185736	0.000078871	0.014024375	43256.15
27	12/30/2008-2/9/2009	30	0.055742484	-37.870789639	0.367584158	N/A	0.015308466	0.000014869	0.012505020	14140.51
28	1/13/2009-2/23/2009	30	0.077157460	-38.443925061	0.388921958	N/A	0.015333253	0.000009668	0.012929317	6638.33
29	1/27/2009-3/9/2009	30	0.021655006	-34.746931146	0.380590797	N/A	0.014812536	0.000009368	0.012301066	3651.89
30	2/10/2009-3/23/2009	30	0.026989260	-38.341277704	0.396770098	N/A	0.014772237	0.000012204	0.012414563	4069.01
31	2/24/2009-4/6/2009	30	-0.090822281	-38.323973036	0.368459889	N/A	0.014608812	0.000008789	0.011339693	10750.28
32	3/10/2009-4/20/2009	30	-0.050317785	-37.518571541	0.359172432	N/A	0.012937680	0.000005584	0.010878766	9517.95
33	3/24/2009-5/4/2009	30	0.032231012	-39.711974009	0.347125264	N/A	0.011479886	0.000006018	0.009157522	5877.91
34	4/7/2009-5/18/2009	30	-0.045779875	-38.029135366	0.358084175	N/A	0.010984050	0.000005762	0.008752093	2493.50
35	4/21/2009-6/1/2009	30	0.066402083	-38.271580598	0.345153122	N/A	0.010161186	0.000009490	0.009007506	1884.64
36	5/5/2009-6/15/2009	30	0.073571579	-40.000066785	0.333810651	N/A	0.009307422	0.000020277	0.008390054	4511.76
37	5/19/2009-6/29/2009	30	0.095144880	-39.155298981	0.338484438	N/A	0.008224348	0.000036157	0.008222721	4326.06
38	6/2/2009-7/13/2009	30	-0.068187305	-35.985132332	0.354034418	N/A	0.007909987	0.000046839	0.008050180	4778.86
39	6/16/2009-7/27/2009	30	-0.065143947	-34.532333017	0.333465295	N/A	0.007855386	0.000052849	0.007883743	4565.65
40	6/30/2009-8/10/2009	30	0.062006103	-38.199059385	0.326959690	N/A	0.005950451	0.000053532	0.007367425	9432.35
41	7/14/2009-8/24/2009	30	-0.043139513	-39.549094776	0.349161258	N/A	0.004654759	0.000054732	0.006439895	10393.51
42	7/28/2009-9/7/2009	30	0.088829341	-34.911160852	0.337360297	N/A	0.004618572	0.000055311	0.005668105	7104.53
43	8/11/2009-9/21/2009	30	-0.092823323	-34.028085974	0.342981153	N/A	0.004226238	0.000059819	0.006014332	6193.55
44	9/8/2009-10/6/2009	30	0.073625484	-33.458187038	0.340345188	N/A	0.003356865	0.000072070	0.005835592	4487.40

Average Sum of Squared Errors 15,726.35

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 8 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

Reference Entity: <u>The Walt Disney Co.</u> NYSE: <u>DIS</u> Industry: <u>Media, Broadcasting, Cable</u>

Model11 Default Intensity: $\xi[i,j] = c_0 + c_1 t + \frac{c_2}{s^{\frac{c_1}{c_1}+\lambda t}}$ Default Probability: $\lambda[i,j] = 1 - e^{-\xi[i,j]h}$ Recovery Rate: $\phi[i,j] = N(a_0 + a_1\lambda[i,j])$

Time window	Period of time	The number of trading days	Extracted Parameters							Sum of squared errors
			a0	a1	b0	b1	c0	c1	c2	
1	1/1/2008-2/11/2008	30	-0.089434556	-40.462064534	0.311527227	-0.000014200	0.002961863	0.000093121	0.006533255	5313.75
2	1/15/2008-2/25/2008	30	0.042421055	-35.929121864	0.317707675	0.000038845	0.004346382	0.000095017	0.007327643	11435.43
3	1/29/2008-3/10/2008	30	0.018644062	-39.478470527	0.305354137	-0.000024758	0.004819592	0.000107854	0.008049942	16749.61
4	2/12/2008-3/24/2008	30	-0.011664882	-39.051252051	0.322596172	0.000026173	0.005335151	0.000118778	0.009240922	11218.91
5	2/26/2008-4/7/2008	30	-0.094144347	-37.565653072	0.307146993	-0.000051098	0.005029386	0.000106016	0.008330660	21277.74
6	3/11/2008-4/21/2008	30	0.061552986	-34.947437255	0.313165316	-0.000064668	0.004025156	0.000096152	0.007477827	22138.29
7	3/25/2008-5/25/2008	30	-0.044884563	-35.055331030	0.308753176	0.000001595	0.002939914	0.000077755	0.005589151	12856.90
8	4/8/2008-5/19/2008	30	0.099155631	-39.239672377	0.323641570	0.000078059	0.002682532	0.000066371	0.004895858	6871.27
9	4/22/2008-6/2/2008	30	-0.004820802	-39.984029494	0.304782723	-0.000037832	0.002463784	0.000059842	0.004520946	2312.89
10	5/6/2008-6/16/2008	30	-0.009804935	-38.828675235	0.300421831	-0.000027244	0.002541521	0.000062431	0.004524912	2255.39
11	5/20/2008-6/30/2008	30	-0.008213314	-39.842228638	0.306704503	0.000084076	0.002732556	0.000062410	0.004929285	4332.96
12	6/3/2008-7/14/2008	30	-0.079121426	-37.283786449	0.305453731	-0.000020871	0.003045256	0.000070970	0.005431416	6225.43
13	6/17/2008-7/28/2008	30	0.028179242	-40.635468198	0.329323445	-0.000019033	0.003346075	0.000073369	0.005907348	5248.12
14	7/1/2008-8/11/2008	30	-0.073358224	-37.053554078	0.306614090	-0.000088196	0.003133080	0.000072057	0.005916733	4735.77
15	7/15/2008-8/25/2008	30	0.011393775	-37.595995224	0.309007487	0.000041295	0.003319642	0.000067522	0.005437950	3461.94
16	7/29/2008-9/8/2008	30	-0.064409714	-33.735698910	0.327816246	-0.000000671	0.003550850	0.000064950	0.005724373	2682.73
17	8/12/2008-9/22/2008	30	-0.043000602	-37.734673277	0.308764238	-0.000006483	0.003949386	0.000057884	0.005930242	2939.54
18	8/26/2008-10/6/2008	30	0.023199296	-35.698050404	0.314705611	-0.000053467	0.004179173	0.000062804	0.005815228	7662.74
19	9/9/2008-10/20/2008	30	-0.071530153	-36.838618325	0.349875191	-0.000093021	0.005400885	0.000068730	0.007270134	15282.23
20	9/23/2008-11/3/2008	30	0.036020817	-36.979115562	0.340833558	0.000038386	0.006025311	0.000093593	0.009031690	19240.32
21	10/7/2008-11/17/2008	30	0.003784547	-38.161546118	0.346273539	-0.000067329	0.006119437	0.000108487	0.009328160	10480.38
22	10/21/2008-12/1/2008	30	0.033994338	-37.458651950	0.368444367	0.000063225	0.006717022	0.000148367	0.011937266	57287.32
23	11/4/2008-12/15/2008	30	-0.004627299	-39.179055468	0.372895177	0.000010826	0.008998032	0.000177376	0.015091961	84646.07
24	11/18/2008-12/29/2008	30	0.044958104	-39.523351892	0.349472339	-0.000073308	0.010323451	0.000204593	0.016909392	50905.68
25	12/2/2008-1/12/2009	30	0.023790589	-39.415771381	0.338149738	-0.000034962	0.011236489	0.000149442	0.015853065	97934.68
26	12/16/2008-1/26/2009	30	-0.004918770	-39.057218974	0.356198935	0.000022494	0.012569015	0.000076324	0.013997599	39962.66
27	12/30/2008-2/9/2009	30	-0.014857122	-40.569208777	0.360961890	0.000069820	0.014864077	0.000015131	0.012909905	13251.65
28	1/13/2009-2/23/2009	30	-0.062760004	-37.650389298	0.396540152	0.000060829	0.015859083	0.000009361	0.012946961	6239.08
29	1/27/2009-3/9/2009	30	-0.087915652	-34.546852420	0.383140819	0.000059219	0.015557920	0.000009852	0.011838157	3417.07
30	2/10/2009-3/23/2009	30	-0.091037407	-34.972280522	0.367933192	0.000077852	0.014094039	0.000011806	0.011586048	3653.92
31	2/24/2009-4/6/2009	30	0.018084281	-39.736741079	0.364492434	-0.000016665	0.014018184	0.000008991	0.011475041	9161.35
32	3/10/2009-4/20/2009	30	0.008817405	-38.038533809	0.370245950	-0.000069327	0.013022073	0.000005552	0.010755446	8601.40
33	3/24/2009-5/4/2009	30	-0.071228412	-35.679036566	0.374677119	-0.000007085	0.011081294	0.000005677	0.009178853	5723.13
34	4/7/2009-5/18/2009	30	0.087379197	-36.456362632	0.333325956	-0.000055714	0.010350686	0.000006266	0.008472096	2306.63
35	4/21/2009-6/1/2009	30	-0.056997286	-33.622736363	0.358276514	0.000059581	0.010133569	0.000008811	0.008673090	1749.39
36	5/5/2009-6/15/2009	30	0.006877058	-35.421995851	0.360269879	0.000005821	0.008916279	0.000020516	0.008056350	4168.19
37	5/19/2009-6/29/2009	30	0.035597429	-37.338370175	0.333514221	-0.000008491	0.008451226	0.000037738	0.007759244	4072.24
38	6/2/2009-7/13/2009	30	0.084338224	-34.684012796	0.334877276	-0.000027826	0.007707349	0.000043851	0.008131030	4541.62
39	6/16/2009-7/27/2009	30	0.086691598	-40.132417146	0.335172060	0.000033838	0.007335970	0.000052593	0.008493523	4070.95
40	6/30/2009-8/10/2009	30	-0.025958008	-39.883824560	0.353524555	0.000082694	0.005933200	0.000048936	0.007410722	8945.98
41	7/14/2009-8/24/2009	30	0.067141263	-35.639783642	0.323468219	0.000077309	0.004722142	0.000057309	0.006003783	9528.79
42	7/28/2009-9/7/2009	30	0.000879481	-34.506128960	0.322031078	0.000046726	0.004641950	0.000053861	0.005892058	6724.39
43	8/11/2009-9/21/2009	30	-0.003373607	-35.628879071	0.318733763	-0.000078698	0.004335671	0.000064911	0.005721273	5527.46
44	9/8/2009-10/6/2009	30	0.017521849	-38.030614735	0.316072685	-0.000065028	0.003250776	0.000075020	0.006033913	4117.68

Average Sum of Squared Errors 14,346.81

* We perform Derivative-Free optimization, we use MATLAB and we set the number of iterations equal to 10,000 times (We perform Derivative-Free optimization 10 rounds with 1,000 times of iterations in each round)

** We use the variables obtained in model 10 as the initial value when performing Derivative-Free Optimization Method. The initial value(s) of the other variable(s) is/are 0

APPENDIX D

PUBLICATIONS AND PRESENTATIONS

Kitjakarnlertudom, C. and Suchintabandid, S.

"Credit Default Swap Pricing Using Forward-Looking Default Probabilities and Recovery Rates," was published in the Conference Proceedings of the First International Conference on Banking and Finance Perspectives 2011 (Famagusta, Cyprus) April, 2011.

Kitjakarnlertudom, C. and Suchintabandid, S.

"Risk-Neutral Dynamic of Forward-Looking Default Probabilities and Recovery Rates: Evidence from Credit Default Swap Prices of DOW30 companies," was published in Chinese Business Review (October 2011) 10:10

Biography

Mr.Chavalit Kitjakarnlertudom was born on May 11, 1982 in Bangkok, Thailand. He is fascinated by the world of travel and he has travelled to many parts of the world both on business and leisure.

He graduated with a Bachelor's Degree of Industrial Engineering in 2002 from Chulalongkorn University, Bangkok, Thailand with honors. During his study, he received "The Distinguished Students Scholarship" from Siam Cement (Public) Company which is granted only to very outstanding students. Also, He obtained 2 Master's degrees in Economics at Chulalongkorn University and Industrial Engineering at Columbia University, New York, United States of America. He was also selected to receive full scholarship to complete his Doctor of Business and Administration in Finance at Chulalongkorn University from the JDBA program (The Joint Doctoral Program in Business and Administration) which is a cooperation of three Thai leading institutions - Chulalongkorn University, Thammasat University and The National Institute of Development Administration (NIDA).

Chavalit Kitjakarnlertudom is now a Senior Vice President and the Chief Financial Officer of Calvin Corporation Limited, one of Thailand's most successful and well-known shoe makers, which is his family business. Apart from his main responsibility at Calvin Corporation Limited, he also dedicates himself to teaching on several Finance courses at Burapha University for both Bachelor's and Master's level students.