CHAPTER I

INTRODUCTION

1.1 Background and Problem Review

A warrant is a derivative giving the holder the right to buy the underlying security with a pre-specified price at a pre-specified date. A firm issues warrants because it needs to raise the capital. Sometimes warrants are also issued in conjunction with other debts such as bonds. Warrants are very similar to call options except that they are issued by a firm while call options are issued by the third party. More importantly, when warrants are exercised, the firm issues additional stocks to the warrantholders. Thus, the outstanding shares of the firm increase. This is the so-called "dilution effect" and also the primary reason why we could not value warrants in the same way as we value call options.

Warrants are popular in many markets such as Switzerland, Italy, and Hong Kong. In particular, warrants from the Swiss Stock Exchange contributed 52 percent of total number of listed securities in 2000 while there were 291 warrants listed in Hong Kong. The warrant turnover in Thailand grew at a rapid rate of 36% per annum during year 1996 to 2000. Additionally, the Singapore Exchange traded 10.6 billion dollars of premium value of warrants in 2005. Apart from the single series warrants, it is common for a firm to issue more than one series of warrants at a time particularly in Malaysia, Singapore and Switzerland such as DBS and Freight Links Express in Singapore and Malaysian Merchant Marine Berhad and YTL Corporation in Malaysia.

Since warrants are widely traded in several markets, there are numerous papers tried to price warrant e.g. Black and Scholes (1973), Schwartz (1977), Emanuel (1983) , and Longstaff (1990). In 1973, Black and Scholes introduce an option pricing model and suggest to value a warrant as an option on a share of the equity of the firm. Their model becomes very popular and is widely used because it is easy to implement. However, empirical tests on the Black-Scholes model shows that the model is biased when pricing warrants. It overlooks the potential dilution effect. Since warrants cannot be value as call options, the attempt to value warrants using option pricing framework has been challenged by many researchers. Samuelson (1965), Chen (1970), and Bierman (1973) ignore the dilution effect of exercising warrants. They

regard warrants as being equivalent to call options. Galai and Schneller (1978) show that price of the warrant is equal to the price of the call option on the firm's equity multiplied by the adjustment for dilution. Schulz and Trautmann (1994) propose a way to find the value and volatility of firm that are parameters in warrant pricing models.

As was stated above, it is common for a firm to issue multiple series of warrants[1] at a time. Valuing multiple series of warrants should be different from valuing single series of warrants. The models that have been used for pricing warrants may lead to pricing bias since the dilution effect of each warrant series can effect the price of other series. Exercising the earlier warrant series causes the dilution effect to occur and this affects the price of later warrant series. This effect is called "cross-dilution effect". Hence, it should be taken into account when valuing later warrant series issued by the same firm in that period. So far few papers have been focused on this issue. Darsinos and Satchell (2002) derive distribution free formulae for firms with warrants and employee stock options (ESOs)[2] of several maturities and strikes. Lim and Terry (2003) derive valuation formulae for two series of outstanding warrants. Dennis and Rendleman (2006) develop a model and the valuation technique to account for the interdependence of exercise decisions among ESOs of the same firm that mature on different dates. However, to the best of our knowledge, an empirical test on these models has not been performed. It is interesting to evaluate the empirical performance of these models.

In this paper, we try to find which model is superior in pricing multiple warrants by comparing to market price. The Galai-Schneller model which is used to price single warrants series is evaluated to help understading the dilution effect across multiple warrants series. Recall that the Galai-Schneller model takes into account the dilution effect and treats warrants as call options on the firm's equity. Multiple warrants pricing models of Lim and Terry (2003), Darsinos and Satchell (2002), and Dennis and Rendleman (2006) that are more suitable for valuing multiple warrants are investigated thoroughly. The empirical results of the three models are compared to see which model is the most suitable in pricing multiple series warrants. Finally, the regression analysis is performed to see the relationship between the prediction errors and the systematic effects of the model inputs.

[1] By multiple series of warrants, we mean that warrants are issued more than one series in a period.

[2] Exercising employee stock options increases both firm value and the number of shares outstanding like exercising warrants. Therefore, in our view, ESOs are analogous to warrants.

1.2 Statement of Problem / Research Question

The above discussion introduces the question of the most effective model and leads to the research question of this study: which model provides the best performance above other models?

1.3 Objective of the Study

- To investigate the effectiveness of multiple warrants valuation from each model by comparing the model price with the market price.
- To examine the model behaviors by analyzing the pricing errors.
- To examine the relationship between the pricing errors and the model input parameters by performing regression analysis.

1.4 Scope of the Study

This study focuses on the empirical performances of three multiple warrants pricing models, the Lim-Terry model, the Darsinos-Satchell model, and the Dennis-Rendleman model using Thai market data. The empirical results of each model are compared with market prices to examine the pricing errors. The pricing errors are then regressed with the model inputs which are the degree of moneyness, time-to-maturity, firm volatility, the risk-free rate of interest to see if there is any systematic relationship.

1.5 Contribution

This paper aims to test which model is the most appropriate for pricing multiple series warrants in practice by comparing the performance of each model. A model with theoretical value closest to market-determined warrant price has the best fit. The price of multiple series of warrants computed from best-performed model provides firms and warrantholders as a choice of benchmarks to determine if the market price undervalues or overvalues. This, thus, helps firms issue warrants with a fair price and helps warrantholders make a better decision in buying or selling warrants.