CHAPTER II

LITERATURE REVIEW

This chapter draws on the literature review of the study. It presents the limitations of famous DCF and EMV concept and also introduces the preference theory as a modified theory to overcome shortcomings of those concepts.

2.1 Limitations of the traditional decision analysis tools

There are many decision analysis toolkits which are applicable in the upstream oil and gas industry today for investment appraisal decision making. These include, for example, discounted cash flow analysis (DCF), expected value concept (EV), Monte Carlo analysis[1], portfolio theory[2]. However, these decision analysis techniques have their own unique limitations. In this study, the limitations of the famous DCF and EMV are pinpointed since these tools are famous commonly applied in the upstream petroleum industry. However, our focus is on the eminent expected monetary value (EMV) concept since this concept is the most widely well known and generally used in the upstream industry. The following sections give the background of these techniques and their limitations.

2.1.1 The concept of Discounted Cash Flow (DCF)

DCF analysis is based on the idea of the time value of money that is an amount of money received at some point in the future is worth less than the same amount received today. Because the money received now could be invested so that in a year's time it will have earned interest. This implies that money that will be earned in the future should be discounted so that its value can be compared with sums of money being held now.

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[1]see Newendorp and Schuyler (2000) page 397-423 to see how the Monte Carlo Simulation works in details.

[2]see Markowitz (1991) for more detail of portfolio theory.

This process is referred to as discounting to present value (Macmillan, 2000). The most well known DCF tool is the net present value (NPV) method. The associated concept of NPV enables those who are evaluating potential investments to determine whether an investment should process or not. The net present value is the sum of the discounted cash flows and represents the difference between the present (discounted) values of the cash flows over the projected life of the project and the present values of the cash inflows. If the NPV is positive, the required rate of return is likely to be earned, and the project should be considered. If it is negative, the project should be rejected. Since the upstream oil and gas industry is a typically long payback period project, hence, this technique is the most widely used tool in the oil industry.

2.1.2 The limitations of the DCF

According to Bailey *et al.* (2000) the usefulness of DCF is limited by its insensitivity to the changing circumstances and long time scales in the oil industry. Therefore DCF is often used in junction with a sensitivity analysis technique in which the consequences of possible change to the variables are examined.

The NPV approach used in DCF tool assumes that the values of the input parameters are known. For example, in the case of the petroleum industry, its use presumes the analyst knows the original oil-in-place, decline rate, the oil price for each year of production, costs for each year, discount rate and tax structure, amongst others. However, in almost all cases, there is uncertainty surrounding the input variables. Expressing such parameters as single figure creates an illusion of accuracy. It also means that the decision maker has no indication as to how reliable the resulting decision making criterion is. Clearly, it would be much more realistic if there was a mechanism for incorporating the uncertainty surrounding the cash flow into the analysis (Macmillan, 2000).

Since the DCF technique considers the time value of money, it needs discount rate to be applied in order to discount the future sums of money into their present value. Choosing the appropriate discount rate constitutes the principal drawback of the NPV approach (Seba, 1998). Most firms now using the NPV measure of profitability appear to be using discount rates in the range of 9% to 15% for petroleum exploration investments. Some companies adopt a higher discount rate as a crude mechanism for quantifying risk and uncertainty. This is a practice that is not encouraged by many theorists since it does not explicitly consider the varying levels of risk between competing investment options (Macmillan, 2000)

2.1.3 The concept of Expected Monetary Value (EMV)

The EMV concept is usually used in combination with decision tree analysis. These two approaches are the *fundamental basis* of decision analysis. Both tools have many attentions in the decision analysis literature and have been applied to many real and hypothetical examples in the industry. The concept of EMV is simply a means of combining profitability and estimates of risk (via numerical probabilities) to yield a risk adjusted value. The parameter of EMV is computed as the sum of the mathematical product of the probability of each outcome times the value of that outcome for all the possible outcomes.

The EMV decision rules state that, all other factors being equal, when choosing among several mutually exclusive decision alternatives, the decision makers should select the decision alternative with the highest positive EMV. The EMV represents the average monetary value *per decision* that would be realized if the decision makers accepted the decision alternative over a series of *repeated trial*. This leads to some arguments that the EMV concept is perhaps particularly applicable to large organizations that have the resources to sustain losses on projects (Goodwin and Wright, 1991). This may explain why some small exploration companies have rejected using EMV. In addition, using the EMV concept also implies that the decision maker is insensitive to risk and the magnitudes of money involved in the gamble (Hammond, 1967; Newendorp and Schuyler, 2000). However, these shortcomings of the expected value concept have been known by the users.

The easiest way to illustrate how to compute EMV is to use a decision tree. A decision tree is a tool that encourages the decision maker to consider the entire sequential course of action, before the initial decision. Decision tree are constructed by diagramming all of the decision options and sequent chance events associated with the particular alternatives. It is accepted that decision tree provides decision makers with a useful tool with which to gain an understanding of the structure of the problems that confront them (Macmillan, 2000).

2.1.4 The limitations of the EMV

Because an expected value can be regarded as an average outcome if a process is repeated a large number of times, this approach is arguably most relevant to situations where a decision is made repeatedly over a long period. In many situations, however, the decision is not made repeatedly, and the decision makers may only have one opportunity to choose the best course of action. If thing goes wrong then there different. Though project B has higher probability of success (0.50), the payoff structure is less attractive than project A. The EMV criteria is inadequate in measuring the trade-offs between the potential and uncertain upside gains versus downside losses for individual project. It is evident that using EMV concept may lead to an inappropriate choice about competing risky investments.

In reality, most people would not accept to pay every gamble when the amount of loss is high because they are aware of the potential to lose a big deal of money when they fail. At some point, as the scale increases, most everyone would reach his or her "choke point", the point that people cannot be tolerate the risk to lose large money anymore. This indicates that people are not impartial to money.

The above sections already described the shortcomings of the conventional decision analysis tools. It is evident that the traditional DCF and EMV concept fails to take, in any quantitative form, the consideration of the particular attitudes and feelings the decision maker associate with money into account; it may not provide the most representative decision criterion. So, there is an attempt to develop the theory that allows us to incorporate risk preference of an individual into account in investment decision making process. That theory is known as "preference theory" which is developed by two mathematicians, von Neumann and Morgenstern.

2.2 The preference theory as a modified theory to incorporate risk attitude of a person into account

As early as 1720 academics were beginning to modify the concept to include biases and preferences that decision makers associate with money into a quantitative decision parameter. In essence these attempts were trying to capture the decision-maker's intangible feelings in a quantitative decision parameter which the decision-maker could then use to guide judgments. This approach is typically referred to as *preference theory* or *utility theory.*

2.2.1 Risk preference assessing method

There are many studies which tried to assess the risk attitude of a person. Generally, two dominant ways on literatures used to determine the risk preference of a person. First, asking or presenting the decision maker directly with hypothetical questions and second, analyzing from a set of real decisions which can be the past decision of the decision maker.

Swalm (1966) and Hammond (1967) tried to construct a decision maker's risk preference curve by using hypothetical investment questions to obtain the decision maker's response. Swalm (1966) determined the risk preference of businessmen by asking the businessmen with the questions. The businessmen are asked to make a decision involving risk. The question was in the form of two mutually exclusive choices; one with 50-50 chance between two possible outcomes while the second will always involve a certain outcome. Then the businessmen are required to specify their amount of the third in such a way that the businessmen would be indifferent to the choice between the gamble and the certain outcome. After that the preference curve of each person was determined based on the questions that the business replied. Hammond (1967) determination of the preference curve is similar to those of Swalm's except that after the preference curve was obtained he also verified the curve by checking to see that the curve was correctly reflected the decision maker risk attitude. He also showed step by step how a person's risk attitude can be combined with the decision tree to help a person making a more precise choice in the drilling decision making in the oil industry. The results from his preference curve assessment found that a person appeared the decreasing risk aversion and a person's attitude toward risk clearly depended on his/her asset position. Howard (1988) assessed the risk preference of the executives by assuming that their risk preferences were exponential function. He interviewed executives at four oil and chemical companies and compares their answers to their corporations' financial measures. He found that the risk tolerances were one-sixth of equity. However, Moore *et al.* (2005) argued that these measures are not easy to relate to the exploration business.

There are many later works make an attempt to obtain risk attitude of managers working in Oil Company by using actual decisions of the company to determine the corporate risk policy. Walls and Dyer (1996) utilized a preference theory model in order to estimate an implied utility function and implied firm's risk attitude of the 55 petroleum exploration companies over the period 1983-1990. The model was reconstructed the set of risky alternatives that were actually selected for resource allocation by the firms. Based on the risky choices each firm selected, an implied risk tolerance value for each firm was estimated.

Based on the methodology of firm's risk propensity assessment of Walls and Dyer (1996), Pinto *et al.* (2003) developed those methods to identify the behavior for different group of the 17 E&P firms during the period 1991 – 2000 involved in bidding for international frontier exploration acreage. In this case, a set of financial performance indicators (exploration budget, rate of exploratory success, number of exploratory wells reserve additions and NPV/boe) from the real last decisions of the firms was used to identify the behavior of each firm's risk tolerance. The main indicators used are exploration budget, rate of exploratory success, number of exploratory wells, reserve additions, and NPV/boe. Moore *et al.* (2005) determined the firm's risk tolerance by examining predrilled evaluation data of the firm in order to expand the use of risk adjusted value (RAV) in the exploration portfolio management. They analyzed dozens of global exploration transactions which establish value. Walls (2005) assessed the managerial risk tolerance in a business unit with US based major oil company with an annual capital budget of approximately $400million dollars. He developed an industry-specific survey that is completed by each participating manager. The survey is designed to imitate the types of decision making under uncertainty that the managers face in their normal decision making activity. He found that managers are generally risk averse but struggle in term of consistency.

2.2.2 Applications of preference theory

Applications of preference theory as one of the investment appraisal tools have been widely investigated especially in portfolio management. Motta *et al.* (2001) presented the important and potential of the integration between CAPM and preference theory by using the utility function and certainty equivalent concept in the determination of an optimum portfolio in the upstream sector.

One important parameter in the preference theory is the certainty equivalent (CE) or risk adjusted value (RAV). This parameter has attracted many attentions for its usefulness in decision making. Cozzolino (1978) proposed a new method of risk discounting by incorporating risk aversion of an exploration company into account. He measured the decision makers' reaction to the financial risk represented in the project. This measured result is the risk adjusted value (RAV) which was used as a new risk adjusted discount rate instead of the traditional interest rate. Walls and Clyman (1998) demonstrated an application technique for the resource managers to identify their optimal share in the risky projects. The decision and preference analysis method were combined to help a resource manager ranking and selecting participation level consistent with the firm's willingness to take on risk. Lima and Suslick (2005) also presented a model for valuation and decision making of a project to produce oil by using the risk adjusted value. They integrated the preference theory with the traditional discounted cash flow method and newly real options theory to determine the optimal working interest in the project venture.

In this chapter, the important shortcomings of the conventional DCF and EMV technique are discussed in that those techniques do not adequately take risk attitude of a decision maker into account. And then the risk preference assessing method which had been studied by many scholars is introduced. The following chapter presents the theoretical risk preference theory in which its concept and related issue are described in details.