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The Construction of Assistant Decision Supporting System for Project Investment Based on Real Option Theory

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Abstract

Project investment decision has been drawing much attention from investors and decision makers due to its complex process and its profound influences. Generally speaking, a scientific project investment decision process should be based on mathematical methods and relevant data models. Beginning with analysis on project investment decision, the paper then further offers a general decision supporting model and verify its practicability with examples.

Keywords: Project investment decision, Decision supporting system, Investment decision based on Real options

1. Introduction

Involving a large sum of capital, a long period and many other factors, project investment is a dynamic system with multi-objectives, multi input and output as well as multi-interferences. As a result, its decision-making analysis is of obvious pertinence and timeliness. If conducted by human, such an analysis process is quite tough and its results may not be so scientific. Therefore, the computer should be employed to assist the decision-making process in order to guarantee its scientific effects. From the perspective of application, any decision supporting system is a subject-oriented system involving man-computer interaction, therefore, clear subjects are essential. Only when a subject has relevant mature theoretical models and detailed historical data will it be possible to develop a decision supporting system in conformity with the decision maker's demands. Starting with analysis on real option theory, this paper constructs an investment decision model and conducts relevant application analysis based on some mature decision supporting system models as well as project investment decision practice.

2. Advantages of the Real Option Method of Decision Making and Its Application Environment

The real option method is a decision-making method for enterprises' project investment generating in 1980s. What distinguishes it form those traditional methods lies in its claim that managers' project decision elasticity is of great value. Following this idea, Trigeorgic put forward the extended NPU method, which had the formula *extended NPV= traditional NPV+ the value of real options in the project*. In this method, the calculation of the value of real options is critical, which can be conducted with the binomial option pricing model or the Black-Scholes option pricing model. Then extended NPV can be worked out easily and decisions on project investment can be made with the method similar to traditional NPV.

The real option method is not a simple rejection of the NPV method but its development and perfection because the traditional NPV method only takes the potential cash flow of the investment project into consideration while neglecting the value of the real options of the project and hence needs to be amended according to its theory. As a result, some projects to be abandoned according to the NPV method should be accepted if based on the real option method. That is to say, this method helps enterprises to avoid missing some favorable investment opportunities.

Currently, this method is extensively applied to many fields, such as biological technology, development of natural resources, R&D of new technologies, risk investment, purchase and annex and so on. Because the real option method is different from the traditional NPV method in its consideration of the value of a project's real options (decision flexibility), only in those projects with high risks can it have its advantages fully revealed and help decision makers to make wiser decisions with the value of real options increasing with the growth of uncertainty. Many cases in international academic research field (Myers. S, 1984; Mcdonald. R&D. Siegel, 1986; Dixit A&R. Pindyck, 1994) and investment practice field (HP, a production and sales decision, 1990; Exxon, a natural gas development project, 1996; Airbus, abandoning option, 1996))have shown that real options can help to precisely analyze the uncertainty in project investment and reveal its value. Due to the complexity of the binomial option pricing model and the Black-Scholes option pricing model and the large amount of time and resources devoted to them, the computer can be employed to assist the decision-making process of those complex and risky projects based on real options in order to greatly improve

the quality and efficiency of decision making.

3. The construction of DSS Model Based on Real Options

3.1 Project Evaluation Indicators

DSS for project investment is generally composed of human-computer interaction system, database system, model base system and method base system. And in real practice, knowledge base system can be added to those complex and important investment projects to improve the reliability of project decisions.

a. Database System

The database in the investment decision model based on real options is constructed according to the characteristics of specific investment projects, including the market inventory, the cash flow statement, the income statement, the balance sheet, the accounting and financial parameter table, the investment estimation and schedule table, the cost expense table, the loan repayment tale, the project evaluation result table and the prediction of the volatility of indefinite cash flow and datasheets relevant to risk-free rate of returns. With the original input data fixed, the decision makers will get the result easily by changing the value of variable parameters.

During the process of data collection, a decision needs to be described in the written form first of all to explain what the potential decisions are, what factors may cause the changes of decisions and who has the right to implement decisions and so on. In addition, the source of uncertainty should also be predicted, including market and non-market risks as well as the forms of uncertainty. And finally, the financial market needs to be inspected to distinguish the uncertainty caused by market factors from those caused by non-market factors and to see whether there is any other framework in which financial market information can be utilized in the better way.

b. Model Base System

Generally speaking, model base system is composed of the model of capital demands prediction, the model of investment estimation, the model of uncertainty analysis, the model of financial profit earning ability analysis and the model of scheme comparison and so on. What is to be established in the paper is a model based on real options, which regards an investment project as a combination of a lot of real options (An, Zhang, 2001). Accordingly, real options become the object for decisions instead of projects, that is to say, the evaluation of investment projects is turned into setting price on real options.

According to the above, the investment decision model based on real options can be established as follows:

$$ENPV = NPV + OP$$

$$OP = SN(d_1) - Ke^{-rt}N(d_2)$$

$$d_1 = \frac{\log(S/K) + rt + \sigma^2 t/2}{\sigma\sqrt{t}}$$

$$d_2 = \frac{\log(S/K) + rt - \sigma^2 t/2}{\sigma\sqrt{t}} \quad (1)$$

In this model, $ENPV$ is the real value of the project or the extended net present value, NPV is the net present value of the project, OP refers to some flexible values or option premium, $N(d)$ refers to the density function of cumulative normal distribution, K is the executive price of options, S refers to the present value of the investment project, σ^2 is the variance of the investment profit rate during a period, t is the vesting period of options and r refers to the risk-free interest rate.

It is shown in the above model that the real value of an investment project refers to that of the real options included in the project, that is, the sum of NPV and OP. Certainly, as different real options have different option premium, different value composition is resulted. Particularly, for those real options with the null value of OP, the value of NPV is equal to that of $ENPV$ (Fang, Wu, 2001).

Decision makers are supposed to select different decision indicators when facing different investment schemes. Besides, static investment payoff period and the profit rate can be used as assistant indicators to evaluate investment projects. However, it must be pointed out that when the conclusion from the assistant indicators doesn't agree with that from the major ones (such as the net present value), the latter should be referred to. In this model, because real options are employed to assist investment decisions, $ENPV$ is the major indicator, including NPV and OP. In addition, during the process of fixing the price of real options, the present value of the underlying assets, cash flow, the holding period return and the fluctuation ratio of a variety of uncertainty also need to be calculated.

c. Method Base System

In this system, investment decisions need to be made and corresponding results need to be examined according to the pricing result. First all the method subprograms are classified according to the classification of models, then a multi-level nested menu should be formed which will enable evaluators to select the operating path as well as the system to employ some method subprograms to realize model combination and finish evaluation decisions. Here, relevant programs are compiled with Visual Basic according to the calculation formula of different indicators.

d. Man-Computer Interaction System

When designing this system, the computer skills of different decision makers have to be taken into consideration. As a result, difficult jargons should be avoided; detailed explanations should be provided; information feedback should be given timely; the function of accepting and correcting errors should be included; assistance should be provided when it is required; solutions to some decision-making problems should be given automatically and the corresponding results can be given in the form of visual diagrams, reports or words.

4. Analysis and Calculation of the Decision Model Based on Real Options

Supposing Enterprise A developed a new product in 2008 with the initial investment of 2,500,000 yuan, this project could be conducted in two steps: producing, selling the product and having R&D on its functional and technological updating in the first step (to be finished by the end of 2011); establishing new production lines to realize the renewal of products in the second step.

According to the DDS model based on real options, decision analysis can be conducted in the following steps:

First step: collecting data and establishing database

In this specific case, according to the result of market survey and analysis on the investment project, the cash flows in several successive years are respectively 400,000 yuan, 450,000 yuan, 500,000 yuan, 650,000 yuan, 600,000 yuan and 800,000 yuan. In addition, according to relevant prediction analysis on the financial market, K has the value of 2,000,000 yuan, T has the value of 3 years, σ is equal to 40% and the expected return rate is not less than 10%. All these data are input into the database for future use.

Second step: having decision analysis based on the established real option model

First of all, NPV is calculated. According to relevant Visual Basic program, its value proves to be -120,900 yuan <0.

Second comes the calculation of OP. This project is conducted in two steps: with the sales in the first step, the new product has got certain market share; its market share is expected to be expanded due to its second-generation product and the final NPV is expected to be over 0 because of the sharp growth of cash flow in the last 3 years. Therefore, this chance can be viewed as a European call option whose value can be calculated with the B-S real option pricing model. Here, still with the help of the compiled Visual Basic program, S can be figured out, that is, the net present value of the cash flow created by the product from 2012 to 2015, to be 2,964,700 yuan (d_1=1.1746, d_2=0.4818). Finally, OP has the value of 1,464,700 yuan.

After that, with relevant Visual Basic program, $ENPV$ is calculated to be 1,343,800 yuan >0, hence proving that this project is feasible.

Seen from the result of the real option model, this project is non-executable with only the net present value is considered (NPV =-120,900 yuan <0). However, it is proved to be executable with the real option model ($ENPV$ =1,343,800 yuan >0). Therefore, this model is able to exhibit the decision-making ability of investors more effectively and evaluate the profits brought about by the flexible and dynamic operation strategies in the risky condition correctly. In addition, the establishment of DSS enables decision makers to select decision schemes with the help of computer system more effectively, hence improving the efficiency and reliability of decision making.

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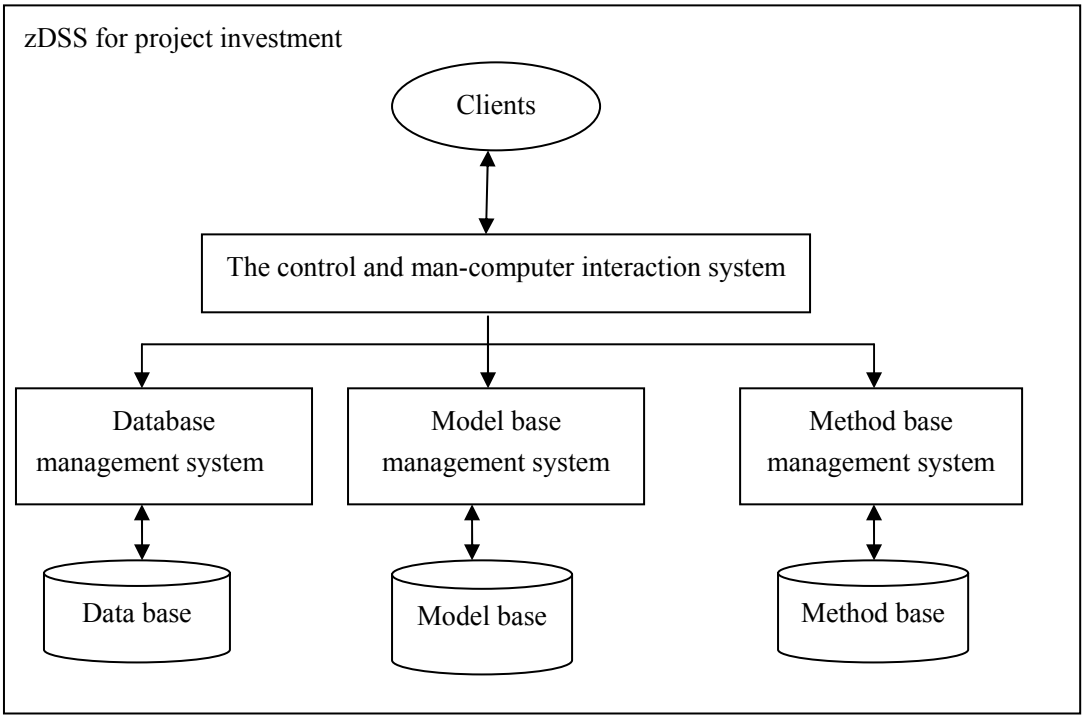

Figure 1. The Structure of DSS for Project Investment