NEW CAPITAL BUDGETING THEORY: AS A NEW MANAGEMENT INFORMATION SYSTEM TOOL

M. DASTGIR, Ph.D.
Associate professor
Shahid Chamran University
Ahvaz, I. R. of IRAN

Abstract - The purpose of this paper is to review the real options literature, which has provided a promising area of development in the capital budgeting process of the firm, and to emphasize that employing the new theory, as part of the information system, depends heavily on the implementation of computer information systems, as Decisions Support Systems (DSSs). The paper concentrates on two important real options: to wait and to abandon. It is shown that in absence of the real option values in the capital decision making models, the outcome of such models would be misleading and would lead to wrong decisions. The paper furnishes some avenues for further research in capital budgeting employing real option literature.

Keywords - Capital Budgeting, Real Options, Management Information System, Computer Information Systems, Decisions Support Systems.

INTRODUCTION

The use of information technology to increase the competitiveness of a firm has been a major area of interest in information systems literature. As information technology continues to diffuse into every level of a firm, making major impacts on the way it operates, corporate managers are becoming more responsive to the need for integrating the information system into the firm's strategic plan [30]. It has also been argued that information technology is driving corporate strategy [27].

Capital investment in information technologies is important in a company. It not only involves long-term resource commitment, but also ties with other potential investments [30]. Since investment selection requires making very important decisions, then, tools and techniques used in decision support systems become very crucial. DSSs employ a variety of tools, some drawn from other fields of study, to support managerial decision making, [7]. A decision support system is generally defined as a computer information system used by managers to support semi-structured decision tasks. Therefore, managers use computer information systems, as DSSs, to tackle the important decisions such as capital budgeting decisions. Current literature of capital budgeting involves different investment selection techniques that are known by all capital investment decisions makers. They require some sort of computer information systems, as DSSs, but not very extensively. These techniques

are proving to be inadequate in today's modern and challenging environment. In this paper we continue to discuss briefly the problems of current capital budgeting techniques and introduce a new theory of investment appraisal, which is heavily dependent upon computer information systems, as DSSs.

Many studies in the sixties, seventies and eighties showed that there is a gap between capital budgeting theory and practice [8,9,12, 21-23,34].

The traditional investment appraisal methods such as Net Present Value (NPV) and Internal Rate of Return (IRR), which are considered as sophisticated capital budgeting techniques, fail to account for the managerial flexibility to adapt and revise later decisions in response to changes in market conditions. The traditional Discounted Cash Flow Techniques (DCFT) are based on an assumption that once an investment project is accepted it should be kept until the end of its expected economic life. This is while in reality, economic conditions, due to the uncertainty surrounding the project, change over time. As a result, competitive interactions occur all the time. In such a situation, management's expectations also change over time and, as time passes, arrival of new information resolves some of the initial uncertainty about market conditions. Therefore, management may want to change its initial decision or strategy to cope with the new situation.

Decision scientists see the problem as nothing to do with the misuse of DCFT but rather in the application of the wrong valuation techniques altogether, since DCFTs ignore the value of management flexibility. To capture the value of future flexibility, Monte Carlo simulation and decision tree analysis are suggested, which recognize the possibility of different operating decisions given future events [33].

Operating flexibility often refers to the management ability, within a single project, to make or revise decisions at a future time, such as the option to delay, expand or abandon that project. The strategic option is related to the project interdependence with future and follow-up investments. Such managerial flexibility is known in the modern capital budgeting literature as a real option. Some researchers criticize the use of traditional DCFT and suggest that the practice of capital budgeting should be extended to incorporate the real option values that exist at the time of investment decision-making [11,19].

In the remaining parts of this paper, first, the theory of real options is introduced, then the real option foundation and assumptions are discussed, and different real options are introduced. Which option to wait and which option to abandon will also be discussed in more detail. The final part of this paper consists of summary and discussions which provide some avenues for future research.

REAL OPTIONS THEORY

The name real options is taken from the fact that real assets got options on them which can be exercised by the decision makers, much are similar to financial assets. A large

number of researchers have done a lot of works which ultimately led to the development of the real options theory [4,17,20,25,32]. By reviewing different types of real options, namely option to wait and option to abandon we refer to their works.

There are many real options and each investment opportunity embeds one or some of these options. In this section some important real options are discussed and relevant references are given:

Option to Wait (Option to Defer): Management has an option to choose the timing of investment. This type of real option usually occurs in natural-resource-extraction, real estate development, farming and fishery industries [10,18,31].

Option to Abandon: If market conditions change unfavourably management has an option to abandon current operation permanently and regain some of the initial investment cost by selling it. The abandonment option is mainly important in new product introductions in uncertain markets, capital-intensive industries, such as airlines, shipping lines and railroads [20].

Option to Switch Use (e.g., Inputs or Outputs): When output prices or the output demand changes management can change the output mix (product flexibility) or produce the same output using different types of inputs (process flexibility) [13,15].

Growth Options: This type of option occurs when initial investment is chained to other subsequent investment projects. Growth options are mostly expected in all infrastructure-based or strategic industries, hi-tech, R&D (computer, pharmaceuticals) and industries with multinational operations and strategic acquisitions [11,19,24].

Time-to-Build Option (Staged Investment): When investment costs occur in stages there is always an option to abandon the next stage of the investment if expectations change unfavourably. Each stage is an option on the value of the subsequent stages. This option is important in long-development capital-intensive projects, all R&D-intensive industries, energy generating plants and pharmaceutical industries [5,16].

Option to Alter Operating Scale (e.g. to Expand; to Contract; to Shut Down): If market conditions are more favourable than expected, the firm can expand the scale of production or accelerate resource utilization. Conversely, if conditions are less favourable than expected, it can reduce the scale of the operations. Examples of this real option can be found in natural-resource industries (mining), consumer goods and commercial real estate [3,17,24,33].

Among the above options, option to wait and option to abandon are recognized as the most important real options which are embedded in most investment opportunities. These two real options are discussed in detail in the following section of this paper.

- OPTION TO WAIT (INVESTMENT TIMING)

The NPV rule traditionally is used to accept or reject investment opportunities. Implicitly,

the NPV rule assumes that the decision setting is to invest now or never. Thus, the simple NPV rule neglects one important characteristic, timing, which is common in most investment opportunities. When irreversibility and uncertainty are present, investment expenditure involves the exercising or killing of an option - the option to productively invest at any time in the future. If the investment is undertaken the option to invest is exercised or killed. If the decision to invest is postponed up to the time that new information arrives and justifies the investment, then the option to wait is kept open.

The possibility to postpone investment project as sunk costs has been considered by some researchers like [25]. He shows in such circumstances that an investment should not be immediately undertaken just because it has a positive NPV. If the investment is delayed it might be more valuable in the future. He uses stochastic analysis and dynamic programming to value projects under further conditions of risk and irreversibility.

Some researchers suggest not taking values and break-even prices from traditional DCF analysis at face value, when price uncertainty and decision flexibility are present [2]. They give this advice as a result of studying investment decisions under price uncertainty. They calculate that the project's present value and the associated break-even price for triggering acceptance of the project have to be adjusted upwards. How much upwards depend both on actual parameters of the problem at hand and on the degree of flexibility present for postponing the decision.

Clearly if a decision maker is facing an irreversible and uncertain investment opportunity, he (she) has flexibility to invest now or to wait until some time in the future, when new information arrives and paves the way for undertaking or rejecting the investment opportunity. Hence, the option to wait has a positive value that should be included in the evaluation of investment opportunities [24]. Other authors refer to the value of the option to wait as an opportunity cost of investment and show that for investments with moderate levels of uncertainty such costs can be large [18]. They also find that the value of the option to wait cans be significant and it is wrong to invest whenever present value of the future cash flows equal to current investment cost. Instead, they suggest that it is reasonable to invest now only if the former is twice the amount of the investment cost. The essence of their argument is that one has to take into account the value of the option to wait as an opportunity cost of investment together with the direct cost of investment. There is, therefore, an option to wait for all irreversible and uncertain investments and that its value cannot be less than zero. The exact amount of this option value depends on the degree of irreversibility and uncertainty. Uncertainty increases the value of the company's investment options and hence the opportunity cost of irreversibly investing [24].

The question of investment and timing to invest in irreversible project under uncertainty has also been investigated by other researchers like [1]. He finds that the timing decision is a trade-off between the extra returns from early commitment against the benefits of increased information gained by waiting. When projects are irreversible, uncertainty can

depress current investment by making waiting for information more attractive.

Others consider the "time to build" problem [16]. An investment project's cost is not always a lump sum. In many cases it is sequential. The investment does not produce any profit unless the sequential investment cost is completed and usually there is a maximum rate for making investment outlays and building up the project. Thus, investment takes place in stages with irreversible characteristics. In such a situation, whenever a stage is completed the next stage can be delayed if new information arrives that justifies the delay.

So far we have emphasized the importance of option to wait, let us now consider factors that affect the value of this option. The length of time a project can be deferred is an important factor [11]. A decision-maker needs time to assess the alternative courses of future events to avoid losses if an unfavourable situation prevails. Therefore, the greater the ability to postpone an investment, the more valuable the option to wait will be.

Investment uncertainty is another factor that makes investment delay more valuable. In the real option approach to investment, the overall uncertainty, and not merely the systematic risk that is the case in the Capital Asset Pricing Model (CAPM), is also important. The reason for the importance of overall uncertainty is the asymmetry between potential upside gains and downside losses [5,11]. Ceteris paribus, as the uncertainty in the economy increases, it is more likely that waiting to invest in a particular project is worthwhile and less investment will take place. Another important factor is the interest rate. Kester [11] argues that the higher the interest rate the higher is the discount rate and the lower the NPV the less attractive the investment will be.

The effect of interest rate uncertainty on invest or postponed decision has been analyzed by [10]. They argue that delaying a project can be desirable and this is nothing to do with changes in cash flows of the project itself or with the effects of certain changes in interest rates. They show that in uncertain economy, nearly all investment projects have option rights values. This is true even for those projects with little or no uncertainty about their cash flows. The essence of their argument is that the option right exists whenever the economy as a whole is uncertain. In such a situation, the presence of option rights values has nothing to do with the project's cash flow uncertainty but, rather, with the uncertainty of the future interest rate. With uncertain interest rates, an investment should not be undertaken until its rate of return is substantially in excess of its break-even rate (discount rate).

- OPTION TO SHUT DOWN /ABANDON

Robichek and Van Horne [26] are the first to note that routine consideration of the abandonment option reduces the potential for downside movements in value. Using the option-pricing framework some researchers have shown that an asset's payoff is bounded from below when the abandonment option is explicitly considered [20]. Their approach

emphasizes the reduction of potential losses as opposed to risk and the increase in firm value implied by the abandonment option is more obvious.

Abandonment value is the value of the abandonment option and its worth should be included in the calculation of present value of future cash inflows [29]. The calculation of present value at time zero, PV0, provides the market valuation at such a point in time. As time passes, conditions, either endogenous or exogenous to the firm, will change the present value of an asset. Thus, the present value of future cash flows of the same asset will be different at any given point in time.

The question of whether to abandon and the decision process of the optimal timing of abandonment has been considered by [6]. They suggest that a policy of abandoning an asset one period after abandonment value (AV) becomes greater than the present value (PV), AV > PV, and this would benefit the firm.

Some researchers considered investment in a mine when mothballing can occur by incurring maintenance cost and costless abandonment of the mine is possible [3]. They find that it is optimal to close the mine only when the output price has fallen considerably below production costs and, conversely, it is not optimal to reopen a mothballed mine even when the output price rises, well above, to production costs. Thus, there is a range of values of output price over which whether or not it is optimal to produce depends not only on the current price but also on the previous history of prices. This phenomenon, that is a consequence of the interaction of sunk costs and uncertainty, is referred to in the economic literature as hysteresis. Dixit [4] reviewed this phenomenon and illustrated the hysteresis effect with a simple numerical example in which uncertainty is modeled by a diffusion process. Since there is a cost involved in each switching from the open state, to the closed state it indicates that the firm will not immediately shut down as soon as the output price has fallen below production cost. He showed that the hysteresis interval is large even for small costs of changing from open to closed or from closed to open.

Myers and Majd [20] calculate the value of the option to permanently abandon a project for its salvage value. They show that, other things constant, the value of the abandonment option increases with salvage value (the exercise price), project volatility, and project life (maturity), while it decreases with project value, as predicted by put-option pricing theory.

What all the above studies actually tell us is that most investments have some option values (in fact some of them consist of compound options), which should be taken into consideration when the investment is assessed. If the options are neglected in investment appraisals the resulting decisions could be grossly wrong and misleading.

SUMMARY AND DISCUSSIONS

According to the theory of capital budgeting thus far, the Net Present Value (NPV) and

the Internal Rate of Return (IRR) are the best two DCF techniques. They are widely discussed in the literature and classified as sophisticated capital budgeting techniques. Empirical research to date points out the existing gap between the normative literature and capital budgeting practice.

Based on what has been discussed in this paper, it can be concluded that corporate investment opportunities often contain "embedded" options. Such options give management the flexibility to defer investments they intend to undertake, or sometimes to decide to shut down temporarily operations until conditions improve, or to abandon the investment if adverse market condition seems permanent. This flexibility gives value to management. The real option values are potentially important factors in investment evaluation and should be incorporated in investment decisions.

Real options give project operators the ability to choose, in the future, the best operating mode. By providing the flexibility to eliminate bad states of nature, these options introduce asymmetries implying that, project cash flows cannot be calculated in a single mean scenario, even if the underlying probability distributions are symmetric [14].

Some studies show how to use numerical procedures, which in the simplest cases could be implemented on a spreadsheet [28]. It is important to note that the real option models, mathematically are very complex. The contingent claim analysis or dynamic programming is used to theoretically value real options. Therefore, the use of explicit real option models require computer information systems, as DSSs at very high stage. In other words, each company should design its own computer aided real option model which is unique to its on needs. Very often the opportunity to expand or develop new products is described as strategic and having an intangible payoff in the information system literature [30].

The question is whether firms correctly compute and take into accounts the opportunity cost of investment that arises when uncertainty and the degree of irreversibility of investment opportunities increases? Pindyck [24] argues that ignoring this cost results in over-investment. He continues:

> But there is anecdotal evidence that managers often base investment decisions on present values computed with discount rates that far exceed those that would be implied by the CAPM-diversifiable and non-diversifiable risk ... It may be then, that managers use the wrong method to get close to the right answer.

It is interesting to know whether capital budgeting practice is more sophisticated than it has been thought. For instance do managers not use the simple NPV method in the way the normative theory predicts because they might be aware of the missing elements of the simple NPV model? Such missing elements could be real options. If managers are aware of real option values then, it could explain part of the gap between capital budgeting theory and practice and, on the other hand, it is supportive evidence for the real options theory. Therefore, one research avenue is to study investment decision makers, real option

awareness, then to investigate that in the absence of explicit real option models how investment decision makers take real option values into account.

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