"The Impact of Real Options in Agency Problem"

by

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Abstract

Managers participate in identifying and selecting projects and retain a strong direct control over important decisions of the project: active management may allow a project defer, expand, contract, abandon, or otherwise alter a project at different stages during its operating life, whereas venture capitalists only have the information provided by firms, but they do not know the intimate details of project.

In projects under a well-defined line of decisions (projects without real options), agency problem is a concern derived from the information asymmetry, the bounded rationality, and the different utility functions of agent and principal. However, managers may alter a project at different stages during its operating life. Hence, the information asymmetry, bounded rationality and differences in utility functions may result in a more noticeable issue in projects facing real options.

The objective of this paper is to theoretically demonstrate how flexibilities and uncertainties (real options) faced by projects affect the agency problem. Ours model differs from other similar models in a number of ways. To begin with, our model is theoretical instead of empirical, because option pricing is based on theoretical models. Second, our model is very simple but useful to understand how real options impact the agency problem, incorporating moral hazard in the different alternatives that managers have to invest.

We conclude that the optimal percentage that manager must obtain from project is similar to the percentage own in a project without real options embedded. However, the manager in charge of a project facing real options obtains a higher percentage, because of the marginal value of project by the real options embedded on it.

The augmented model gives predictions on 1) the determinants of ownership (r) in the presence of real options (θ), 2) a positive relation between real options and r, and 3) a positive effect on performance from managerial effort.

I. Introduction

Managers participate in identifying and selecting projects and retain a strong direct control over important decisions of the project: active management may allow a project defer, expand, contract, abandon, or otherwise alter a project at different stages during its operating life, whereas venture capitalists only have the information provided by firms, but they do not know the intimate details of the project.

In projects with a well-defined line of decisions, like new plants, and new machinery, agency problem is a concern derived from the information asymmetry, the bounded rationality, and the different utility functions of agent and principal. In projects facing market and technical uncertainties, like technological projects, information asymmetry, bounded rationality and differences in utility functions may result in a more noticeable issue.

Two lines of research depend on the conjunction of real options and agency problem: 1) the study of impact in real options value of relaxing the economic assumption of perfect alienation of principal and agent interests, and 2) the study of agency theory in projects facing real options. Both lines of research analyze real options and agency theory, but under different approaches. In the first approach, the real options value is a function of agency problem. It has been studied by Maeland (2002) and Grenadier (2005) for the timing option; Bernardo, Cai and Luo (2001), and Stein (2001) for the capital allocation decision, under asymmetric information and moral hazard. The second approach relies in the agency theory literature, where the magnitude of agency problem is a function of the existence of real options in the project. It has been studied by Bitler, Moscowitz, and Vissin-Jorgensen (2005).

The objective of this paper is to demonstrate how flexibilities and uncertainties (real options) faced by projects affect the agency problem (second approach). Ours model differs from the Bitler et al. (2005) in a number of ways. To begin with, our model is theoretical instead of empirical, because

option pricing is based on theoretical model, which has been also tested with numerical examples. Second, our model incorporates moral hazard and the different alternatives that managers have to invest.

The paper is organized as follow: Section II reviews the literature on agency theory and real options; section III presents the model; and section IV concludes the paper.

II. Literature Review

Agency Theory Literature

In a seminal work, Jensen and Meckling (1976) argued that it is impossible for the principal to align at zero cost the agent's interests to the principal's interests. This is known as the agency problem. The agency problem arises from the conflict of interests related to an agency contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf, which involves delegating some decisions making authority to the agent.

"If both parties to the relationship (agent and principal) are utility maximizers, there is good reason to believe that the agent will not always act in the best interests of the principal (Jensen and Meckling, 1976)."

Agency theory has been widely studied under different approaches. It has been classically applied to study the relationship between owners of an organization and the managers who run those firms (Fama & Jensen, 1983). In practice, it has been most often employed in research on the mechanisms used by owners to align CEO interests with those of the organization (Gomez-Mejia, 1994). The exception has been a few studies that have extended agency theory to other positions such as university faculty (Gomez-Mejia & Balkin, 1992), sales representatives (Eisenhardt, 1985), and production workers (Welbourne, Balkin & Gomez-Mejia, 1995).

Because the managers control organizational resources and are likely to know more about the tasks that they perform for the investors, an information asymmetry exists that could give an advantage to the managers, (Pratt and Zeckerhauser, 1985), and it may cause an opportunist behavior. This is a variant of the standard utility-maximization assumption in economic theory that says that agents always want more of what they like, and this may imply that interests are pursued in an opportunistic way (Williamson, 1985). Opportunism is always assumed to be present in agency

theory, therefore in projects with real options the opportunistic behavior is a continuous distress, because managers have more alternatives to decide along the projects and these alternatives may be manipulated to maximize their own interests.

Three fundamental assumptions underlie agency theory: a) that both parties are rational and self-interested, b) the agent is both effort and risk adverse (Baiman, 1990; Jensen & Meckling, 1976; Levinthal, 1988), and c) exists information asymmetry. The presence of almost one of these conditions creates the potential for an agency problem (Baiman, 1990; Eisenhardt, 1989; Nilakant and Rao, 1994).

The asymmetry in the information comes from both external and internal sources. The information received from internal sources comes from the development of project itself. The internal information constitutes the ultimate details of the project, starting with personnel to be employed, the real options embedded in the projects and ending with the success or failure of the options made along project. This information is known first by the entrepreneur and later, in a reduced and simplified way, by the principal. Because the agent works for the principal the principal only will know the relevant aspects of the project, but in the path, much of the important information is lost.

The external information comes from sources out of the firm. The external information constitutes news about new patents, new products, and laws, among others. This type of information is almost public, however the only the manager have the ability to gather both external and internal information in order to make the best possible modifications to the project.

Both managers and principals are subject to bounded rationality defined as limited ability of the human brain to reason. Simon (1957) defines it as "intendedly rational but limitedly so". This assumption is always claimed in agency theory, and it is may be amplified in projects with real

options because the information needed to incorporate more of only one alternative is greater than the information needed in projects with a well-defined line of decisions.

On the other hand, there is a large body of research that suggests that agents and principals are different type of maximizers. Managers and principals are expected to be risk-averse in most situations. Among the principals the owners are assumed to be those who are in the best position to bear the cost of risk (Copeland and Weston, 1988). This is so, because they may use their residual control rights to intervene if necessary and because they may control a fully diversified portfolio of assets. Hence, owners and managers differ in terms of risk aversion (Palmer, 1973) and this difference in risk aversion would be reflected in the chose/rejections of real options embedded in the project.

The theory argues that under conditions of incomplete information and uncertainty, which characterize most business settings, two agency problems arise: adverse selection and moral hazard. Adverse selection is the condition under which the principal cannot ascertain if the agent accurately represents his ability to do the work for which he is being paid. Moral hazard is the condition under which the principal cannot be sure if the agent has put forth maximal effort (Eisenhardt, 1989).

The problems of adverse selection and moral hazard mean that fixed wage contracts are not always the optimal way to organize relationships between principals and agents (Jensen and Meckling, 1976). A fixed wage might create an incentive for the agent to shirk since his compensation will be the same regardless of the quality of his work or his effort level (Eisenhardt, 1985). When agents have incentive to shirk, it is often more efficient to replace fixed wages with compensation based on residual claimancy on the profits of the firm (Alchian and Demsetz, 1972). The provision of ownership rights reduces the incentive for agents' adverse selection and moral hazard since it makes their compensation dependent on their performance (Jensen, 1983).

Real Options Literature

A real option is defined by Myers (1973) as an investment alternative within a project, which can not be properly measured through the traditional discounted cash flow methods (DCF). As a response to the limitations on DCF analysis, it was created a renaissance in valuing financial option contracts based upon the seminal works of Fischer Black, Robert Merton and Myron Scholes (1973) to value financial options. Together with Stewart Myers, they recognized that option-pricing theory could be also applied to real assets and non-financial investments. In order to differentiate the options on real assets from the financial options traded in the market, Myers coined the term "real options" that has been widely accepted in academic world.

The real options analysis is analogous to financial options analysis, but the real options approach valuates real assets instead of financial assets. The value of a real option is obtained from the uncertainty associated with an investment opportunity, expressed as the volatility of its potential returns. Until the option's expiration date (if there is any), the option holder has the opportunity to continuously reassess its potential payoff. If the value of the underlying asset goes up by more than the price of the option, the option holder should exercise it; otherwise, he will not exercise. Hence, the option holder preserves the ability to benefit from a great upside potential while limiting the downside risks to the cost of buying the option. In fact, real options analysis uses a holistic view of risk, changing the “avoiding uncertainty” paradigm to another one of strategic investment, where uncertainty is a source of value due to the opportunity to capitalize on future earnings while limiting the potential loss.

As a result of the gain in popularity of this new area of “real option” analysis among finance researchers during the early 1990s, several research papers in valuation (Quigg 1995; Buetow and Albert 1998; Hendershott and Ward 2000; Holland et al. 2000) have included real option valuation models. Recent articles (Kellogg and Charnes, 2000; Ahmran and Kulatilaka, 1998; DiMasi et al.,

1991 and Myers, 1997) have suggested using security option pricing models (decision-tree and binomial lattice methods) to value real options embedded in biotechnology companies. Furthermore some previous information systems researches have recognized the fact that many information technology (IT) investment projects in the uncertain world possess some option-like characteristics (Clemsons, 1991; Dos Santos, 1991 and Kumar 1996). Recently, Benaroth and Kauffman (1999, 2000) and Taudes, Feurstein and Mild (2000, quoted in Li and Johnson, 2002) apply the real options theory to real world business cases and evaluate this approach's merits as a tool for IT investment planning.

According to Amram and Kulatilaka (1999) there are five different types of real options. These are Waiting-to-Invest option, Growth option, Flexibility option, Exit option and Learning option.

The waiting option reflects the potential flexibility to wait before taking a decision, getting access to new and better information and be in a better position to decide when circumstances make worth do it. This means that in a very uncertain environment the action of sinking investment all at once will be like making a bet. If the investor can wait and access to better information, she would always be in better position to improve the bet and avoid bad states of the nature, while taking advantage of good ones (the options to invest is kept "alive" because is more valuable than exercised).

Another real option depicted in the literature is the growth option (or the right to make follow up investments when states of the nature are favorable to the investor). In this real option, the investor reacts to good states of the nature by scaling up investments. Follow up investment gives the investor the possibility of capitalizing on the good states of the nature. In the same tense as with the waiting option, the analogy with financial options comes associated to the call. In this cases, the investor or entrepreneurs exercises the right to buy new cash flows associated to scaling up former investment (which is similar to paying an exercise price), which lets her capture more value when things turn out

favorable, and avoiding investing further when states of the nature are unfavorable to the project. It can be easily seen that follow up investments are contingent on good states of the nature, and the investor has the right but not the obligation to invest (which in turn means she would not invest when nature does not show well for the decision).

The exit or abandonment option is like an American put option on a dividend paying stock with a stochastic strike price and no expiration date. The abandonment option has been studied as a control problem, where real option theory has it that corporate manager act to time their strategic decisions in an optimization framework that maximizes the expected value of the firm. Robichek and VanHorne (1967); Dyl and Long (1969) studied the abandonment option as a contingency in their forecast of cash flows for traditional net present value or internal rate of return analysis. Margrabe (1978) and Stulz (1982) model the option directly and consider two risky non-dividend paying assets. Johnson (1987) extends the analysis to several risky assets. Brennan and Schwartz (1985) develop shut-down abandonment decision rules at known intervals based on a constant salvage value, and the price of the underlying asset, while McDonald and Siegel (1985) costless, temporary shut-downs in their risk neutral evaluation of a dividend paying investment project with a known life. Myers and Majd (1990) use numerical methods to value the option to permanently to abandon a dividend paying investment project at any time over the project's known life when the salvage value is a constant and when it varies stochastically. Dixit and Pindyck (1994) consider an infinitely lived dividend paying investment with constant salvage value and derive rules for optimal abandonment.

There is a considerable amount of literature about the effects of the learning process. Arrow (1962) has one of the former works about the economic implications of "learning by doing". In Jovanovic and Mac Donald (1994a) firms improve their experience through innovation. There are also numerous works that explore the learning process through experimentation (Grossman et. al. 1977; Rob, 1991). More recently, Bernardo and Chowdry (2002) explore the learning process by the firm about its own skills using a real options approach.

III. The Model

According to Lazear and Rosen (1981) model the manager's utility function is $U(c - F(\mu))$, where c is consumption, and where $U(\cdot)$ is concave and $F(\cdot)$ convex. In this model the manager receives a fixed wage P, and a share, r, of the project value. Since the manager creates a value of Y, and free entry of firms implies zero expected profits, the expected payoff to the manager will equal the expected value of output.

$$E(I + rY) = E(Y)$$

$$I = (1 - r)E(Y) = (1 - r)\mu$$

Thus, the manager's payoff and consumption is,

$$c = I + rY = (1 - r)\mu + rY = \mu + r\varepsilon$$

The manager maximizes utility given I and r, and therefore chooses effort such that

$$F'(\mu) = r$$

Accordingly, the principal sets r to maximize managerial utility subject to the zero profit constraint.

$$r = \frac{1}{1 + R\sigma_{\varepsilon}^{2}F''(\mu)}$$

where R is the absolute risk aversion of the manager.

This simple model focuses on a hired manager and gives predictions on 1) the determinants of ownership r, 2) a positive relation between effort μ and r, and 3) a positive effect on performance Y

from μ. Most studies focus on stage 1, the determinants of the manager's ownership share as implied by equation (5)–specifically, the inverse relationship between risk (σ_{ε}^{2}) and ownership (r), or on the effect ownership has on firm performance (Y), a joint test of stages 2 and 3.

However, the standard model does not consider the real options that manager faces throughout the project until completion. In this scenario Y is not longer $Y = \mu + \varepsilon$, but $Y = \mu + \varepsilon + \theta$ where θ is a set of real options embedded in the project. In the real options model, manager will not only receive a share for observable project value, but also for real options value.

$$E(I + rY + r\theta) = E(Y) + E(\theta) \tag{1}$$

$$I = E(Y) + E(\theta) - rE(Y) - rE(\theta) \tag{2}$$

$$I = (1-r)E(Y) + (1-r)E(\theta) \tag{3}$$

$$\Rightarrow I = (1-r)\mu + (1-r)E(\theta) \tag{4}$$

Thus, the manager's payoff and consumption is,

$$c = (1-r)\mu + (1-r)E(\theta) + rY$$

$$\Rightarrow c = \mu + r\varepsilon + (1-r)E(\theta)$$

And, utility function is,

$$U = \mu + r\varepsilon + (1-r)\theta - F(\mu)$$

The manager maximizes utility, given I and r, and therefore chooses effort such that:

$$\frac{\partial U}{\partial r} = F'(\mu) = r$$

Knowing this, the principal sets r to maximize managerial utility subject to the zero profit constraint. This implies,

$$U = \mu + F'(\mu)\varepsilon + \left[1 - F'(\mu)\right]\theta - F(\mu)$$

$$r = \frac{1}{1 + R\sigma_{\varepsilon}^{2}F''(\mu) - R\theta F''(\mu)}$$

IV. Conclusions

We conclude that the optimal percentage that manager must obtain from project is similar to the percentage own in a project without real options embedded. However, the manager in charge of a project facing real options obtains a higher percentage, because of the marginal value of project by the real options embedded on it.

The augmented model gives predictions on 1) the determinants of ownership r in the presence of real options, 2) a positive relation between real options θ and r, and 3) a positive effect on performance Y from μ.

A further research may empirically prove the significance of real options factor. Also, a real options pricing model may be applied instead of the real options factor presented in this paper, in order to test the differences in agency problem derived from the different real options faced by managers.

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