“Moral Hazard when the Entrepreneur Seeks Outside Equity”

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Abstract

The aim of this research is to measure the impact that the existence of real options has on the size of moral hazard when an entrepreneur seeks for outside equity. Lazear and Rosen (1984) model is used to compute moral hazard and optimal percentage that the manager must receive. Additional to the Lazear and Rosen model it is also considered the Myers (2000) model, for a more realistic and modern setting in which managers contribute not only with labor, but also with human capital that adds value to the firm.

In a long lived corporation with real options embedded, moral hazard is given by the risk aversion of managers and the size of real options, implying that the greater the value of real options, the greater the moral hazard. This result maintains equal if manager is an expert that recognize real options before he entries in the firm, or if manager recognize real options once he is part of the firm. One important consideration is that if manager is risk neutral or if manager effort does not impact the real options value, the moral hazard disappears, even when real options are present in the firm.

When the manager is an entrepreneur that contributes with intangible assets to firm, the moral hazard depends on the value of real options and the percentage he receives of free cash flows. The greater the real options value, the greater the percentage he must receive of dividends, otherwise moral hazard increases.

This differs from Myers (2000), who argues that ownership share does not affect firm value. However, results of this dissertation are consistent with Jensen and Meckling (1976) that argued that an optimal incentive may reduce moral hazard and, with Grenadier and Wang (2005) and Bitler and Moscowitz (2005) that argued that incentives may induce manager to raise firm value exercising the appropriate real options.

Introduction

In a seminal work, Jensen and Meckling (1976) argued that it is impossible for the principal to align at zero cost the manager's interests to the principal's interests. This is widely known as the agency problem. Since JM, agency theory has steadily advanced, mainly by developing both theoretical contributions and empirical research on incentives, because they may reduce the agency problem in the firm, particularly the moral hazard, due to it is related to actions after a contract is written.

Initially, within agency theory, the problem of moral hazard was considered only inside the firm. More recently, it was extended also to principal-agent issues in the boundaries of it, in the interaction of the firm with the financial markets (Myers, 2000), consumer markets (Roemer, 2004) and, regulatory agencies (Lafont and Martimort, 2004; Lafont and Tirole, 1993). In the boundaries of the firm, where all the factor markets are considered as principal and the firm as agent, particularly relevant is the stream analyzing the relationship in between outside equity markets and the firm (Myers, 2000; Lambrecht and Myers, 2005; Jin and Myers, 2005; Lambrecht and Myers, 2006).

The relationship in between outside equity and the firm studied by Myers (2000; 2004; 2005) changed also the classical thinking in which the manager only contributes with labor in the production function, to a point of view in which the manager also contributes with capital, in the form of human (or knowledge) intangible capital.

However, Myers et al. consider a world of perfect and efficient markets, under full and complete information. Nonetheless, the labor market may not be considered as efficient if the manager contributes to production function not only with labor but also with human (knowledge) capital, which is intangible, very specific and scarce, characteristics opposed to an efficient market.

In the other hand, full and symmetric information is not either an attribute of most investment projects (specially when they have real options embedded), where the manager participates in the decision making process and he retains the control rights over important strategic decisions such as defer, expand, contract, abandon, or otherwise alter investments at different stages during their operating life.

The aim of this research is to measure the impact that the existence of real options has on the size of moral hazard when an entrepreneur seeks for outside equity. Lazear and Rosen (1984) model is used to compute moral hazard and optimal percentage that the manager must receive. Additional to the Lazear and Rosen model it is also considered the Myers (2000) model, for a more realistic and modern setting in which managers contribute not only with labor, but also with human capital that adds value to the firm.

The basic and standard model of optimal compensation under moral hazard and the model of interaction of firms with financial markets were joined and generalized to a real options setting for several reasons.

First, the augmented model is applied to an entrepreneurial setting of a firm with multiple real options embedded in its assets. An entrepreneur wishes to sell part of his equity to outside equity that is concerned with moral hazard on the part of the entrepreneur. The model describes the optimal contract between potential outside equity investors and the entrepreneur, from the latter's perspective. This deviates from the standard model of compensation where outside shareholders seek to hire a manager for their firm or project, to a one in which an entrepreneur seeks for outside equity. The main implications of the standard compensation model of Lazear and Rosen (1984) hold also in the entrepreneurial setting[1].

[1] See Bitler and Moscowitz, 2005 for a proof.

Second, to take the model to the modern setting in which the entrepreneur (manager) is part of the capital (in the form of knowledge capital) of the firm, several realistic features are added to the basic framework. These realistic features are taken from Myers (2000).

II. Literature Review

A moral hazard problem arises when the principal cannot observe agent's actions because (1) there is a positive cost of monitoring agent's actions and real options existence (2) he has not even able to perfectly infer agent's actions by observing the outcome because the agent's actions do not completely determine the outcome due to the existence of real options in the project. Traditionally, the literature argues that this latter phenomenon may result from the intervention of an unexpected-random-exogenous occurrence that has influenced the outcome, that is to say, it would be the consequence of some kind of windfall or misfortune and not of the agent's actions. Then the principal faces two difficulties.

First, he cannot design contracts based on his observation of agent's actions because the cost of monitoring his actions is generally prohibitive (McLean and Conlon, 1995). Second, the principal cannot entirely predicate the contract on the outcome for two reasons. First, he is uncertain about the causality between the agent's action and the outcome. And, second, because even if the principal would predicate the contract on his observation of the agent's actions anyway, the agent would not sign the contract because he is risk neutral (Tosi and Gomez-Mejía, 1989).

This state of affairs prevents the principal from designing complete contracts that make agent's fee contingent on either his actions or the outcome of his unobserved actions. In other words, the principal cannot contractually assign to the agent the full consequences of his actions (Li, 1994). Therefore, the agent is able to engage in discretionary behaviors, that is, undertake real options that may undermine the utility of the principal. In other words, under the presence of real

options, the agent may make decisions that go against the interest of the principal (Tosi, Katz and Gomez-Mejia, 1997).

In projects with a well-defined line of decisions, projects without real options, agency problem, specifically moral hazard, is a concern derived from separation of ownership and control rights (Jensen and Meckling, 1976; Myers, 2000; among many other). The bounded rationality (neither principal nor manager have complete information to make perfect rational decisions), information asymmetry (manager controls the project), and the different utility functions of manager and principal create a self-interest behavior under an aversion towards both effort and risk by the manager.

In this sense, moral hazard is a more noticeable issue in firms facing real options, because agency problem impacts through both information asymmetry and different utility functions, not only in the expected cash flows component of firm value but also in the real options value.

From this argument propositions raise:

Proposition 1a: Agency problem, particularly moral hazard, aggravates with the presence of real options.

Principal may monitor and incentivize managers, in order to reduce moral hazard. If inexpensive and reliable monitors of effort are available, then the best incentive scheme in order is a periodic pay, based on performance. However, when monitoring is difficult and costs of firing a manager and hiring a new one are high, so that managers can alter their performance with less than perfect detection, performance-pay schemes invite to commit moral hazard (Li, 1994).

According to Lazear (2001) the situation often can be improved if incentives are related to a more easily measured output level. In general, performance based pay is preferable because it changes the risk borne by workers in a favorable way (Roberts, 2004). When monitoring costs are

so high that moral hazard is a serious problem, the gains in efficiency from using performance based pay may compensate the risk-sharing losses.

Proposition 1b: The optimal incentives paid to manager must be higher when real options are present, in order to reduce moral hazard.

2.1 Basic standard model of optimal compensation under moral hazard

To illustrate the basic theory, consider the simple model of Lazear and Rosen (1981) that is the most cited non-linear model in optimal incentives contract.

The model assumes:

- Rationality of all economic agents.
- Perfect and competitive markets where: workers are paid the value of their marginal products, and price of product equals its marginal cost
- Productivity of workers holds equal across time.
- No taxes

The manager's output is a random variable whose distribution is controlled by the manager himself, by investing in costly skills prior to entering the market. However, there is a given productivity factor that is beyond anyone's control. Principal may observe output but cannot ascertain the extent to which it is due to investment expenditure or good fortune or to both. Managers know their input as well as output.

Production requires only labor. Therefore, the lifetime production of a manager may be considered also as the firm production:

$$q_j = \mu + \varepsilon ,$$

Where μ is the level of investment, a measure of skill or average output, chosen by the manager when young and prior to a realization of the random variable ε. Thus, μ may be also considered as the manager's effort and mean production and ε, the idiosyncratic firm risk (Bitler and Moscowitz, 2005). Average skill, μ, is produced at cost C(μ), with $C^{'}, C^{''} \rangle 0$.

The random variable, ε, is drawn out of a known distribution with zero mean and variance σ^2. It is assumed that productivity risk is not diversifiable by the manager himself, but principal may diversify it either by pooling managers together on one firm or, by holding a portfolio of well diversified assets (McGrath, 1997, Bitler and Moscowitz, 2005). Thus, manager is considered as a risk averse person, and principal as a risk neutral, as theory of the firm suggests.

Manager receives a fixed payment I[2], and a relative production share r. Thus, manager has an expected net income given by

$$Y = I + r\mu - C(\mu)$$

Accordingly, manager chooses an effort such that:

$$\frac{\partial E(U)}{\partial \mu} = r - C^{'}(\mu) = 0$$

$$r = C^{'}(\mu)$$

The expected revenue for the principal is a function of product price and manager expected income:

[2] Because manager is considered as a risk averse person, he would not accept a contract without a fixed amount as insurance against ε, which is not diversifiable for him.

$$E(Vq - I - rq) = (V - r)q - I$$

Marginal revenue for principal is such that:

$$\frac{\partial E}{\partial q} = V - r = 0$$

$$V = r = C'(\mu)$$

Showing that the setting is one of competitive markets, where marginal product of manager equals marginal revenue of firms.

Optimal piece rate

The problem for the principal is to pick an r, I combination that maximizes managers' expected utility

$$Max\ \left[E(U) = \max \int U(y)dy\right]$$

Where:

$$y = I + rq - C(\mu)$$

$$y = I + r\mu + r\varepsilon - C(\mu)$$

The manager's problem is to maximize utility given I and r, and therefore chooses effort such that

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

However, the optimal contract maximizes $\frac{\partial U}{\partial \mu}$; where $U = I + r\mu + r\varepsilon - C(\mu)$ and, $V = I + r\mu$.

$$\frac{\partial U}{\partial \mu} = \left[V - C'(\mu)\right]\frac{\partial \mu}{\partial r} + E\varepsilon U' = 0$$

Since risk aversion implies EεU' <0, it shows that V > C'(μ) in the optimum contract for risk-averse managers. This underinvestment is the moral hazard resulting from insurance I> 0 and r< V.

Using Taylor series approximations to the utility function it is found that optimal effort of manager is:

$$\mu = \frac{1}{C'}\left(\frac{V}{1 + sC''\sigma^2}\right)$$

Where $s = \frac{U''}{U'}$ represents the absolute risk aversion of manager. Accordingly, the principal sets r to maximize managerial utility subject to the zero profit constraint.

$$r = \frac{V}{\mu}\left(\frac{1}{1 + s\sigma_\varepsilon^2 C''(\mu)}\right)$$

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 q from μ. Most studies focus on stage 1, the determinants of the manager's ownership share as the inverse relationship between risk (σ_ε^2) and ownership (r), or on the effect ownership has on firm performance (q).

III. The Augmented Model

Consider an entrepreneur (first player) with an innovative investment project. The entrepreneur is an infinitely risk averse agent. Entrepreneur is not self-financed and his wealth is conceived as the cumulative knowledge around the project (ideas, concepts, prototypes and other intangible assets whose value is hardly verifiable). The entrepreneur expects to obtain benefit from the project when it has been accomplished. For the entrepreneur the project is like an option, he can exercise it and obtain profits from it, or he can drop it off into a box (not exercise it), and thus not to obtain any profit from it.

When the entrepreneur exercises the option, two processes merge to remove the entrepreneur of some of his initial roles. The project needs capital: financial, human, assets and so on to convert it into a firm. The project needs an investment outlay $K>0$ that is not fully reversible. Funding is provided by outside equity (second player), who also seeks to maximize his utility. Entrepreneur gives the property rights to the outside equity, who now is the principal of the firm.

The firm generates two sources of value. One portion is observable and contractible to both the principal and the manager, while the other portion is a bundle of real options wrapped in the firm assets, and is only contractible for manager because it is difficult to prove (Kulatilaka, 2005).

Assumptions of the Augmented Model

The assumptions of the augmented models differ from Myers and Lazear and Rosen in a number of ways. The following basic assumptions underlay the augmented model:

Financial capital, operating assets, and products are part of perfect and efficient markets. Managers are paid the value of their marginal products and, productivity holds equal across time. Price of product equals its marginal cost. There are two classes of assets: operating assets and

intangible assets. Operating assets are observable and have a well defined market value given by their opportunity cost. Operating assets do not depreciate and are perfectly marketable.

No taxes.

Insiders and outsiders are rational in a bounded way[3]. Insider (manager) is risk averse; principal is risk neutral. Personal risk aversion is important because it affects assets value and opportunity costs of human capital.

Firm production needs labor and capital. Labor is provided by manager. Capital is co invested by principal and manager. Capital is provided by principal in the form of money, and by manager as intangible assets[4].

The firm generates two sources of value. One portion is observable and contractible to both the principal and the manager, while the other portion is a bundle of real options wrapped in the firm assets, and is only contractible for manager because it is difficult to prove[5].

Property rights are enforceable by capital, and control rights are shared between principal and manager. The level of dilution of property rights determines the level of control rights that managers own (Myers, 2000; Kulatilaka and Patel, 2005).

Manager receives a fixed payment I, and a production share, r, as incentive. Principal can prevent manager from divert part of operating cash flow C for his own interests, through r.

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[3] Real options approach assumed strong form of rationality, while transaction costs approach assumed bounded rationality. This last is assumed because the subject under study is the moral hazard problem, not the real options.

[4] This assumption made by Myers (2000) changes the Jensen and Meckling (1976) vision of agents in which contribution to firm production is done only through labor.

[5] This assumption is common in capital budgeting literature (Harris, Kreivel and Raviv, 1982; Stulz, 1990; Harris and Raviv, 1996; Bernando, Cai and Luo, 2001, Kulatilaka and Patel, 2005)

Insiders have enough capital to cover their share of investment. Insiders bear some cost if they are forced to refinance or reconstitute the firm. This cost ensures that ties are broken in favor of co investment of human (intangible) and outside financial equity.

Uncertainty plus non-verifiability of the value of assets creates an information asymmetry between insiders and outsiders. Monitoring is difficult and costly. Principal's problem is to design a contract to prevent hidden action, and hidden information[6]. Hidden action is that the manager can influence the likelihood of increase firm value. An optimal contract induces the manager through r to provide costly (but unverifiable) effort. The hidden information is that firm value contains a component that is privately observed by manager. An optimal contract induces to manager, through dividend condition, to reveal the true value of privately observed component of firm value, and thus no actual value diversion takes place.

Bargaining is replaced by sequential actions. Each period manager pays a dividend. Outside investors pocket the dividend and then decide whether to organize, take control and replace management.

General equilibrium is given by Pareto efficient.

A Long-Lived Corporation

Corporation (principal) owns the firm and its operations assets, and thus can withdraw the assets, or deny their use to manager, at any time. Property rights of the corporation are not constrained, but control is by voting or takeover. Current operations control is exercised by manager. Bargaining power is inequaly distributed favoring principal that may deny to manager the use of operating assets, or that may allow a takeover of the firm.

[6] This distinction in the agency problem in the presence of real options was done by Grenadier and Wang (2005).

Manager receives a fixed payment I, and a production share r. Also, manager may divert part of the operating cash flow to his own interests, Z.

Each period principal obtains, from current operations, a dividend which results from the earnings minus operation costs and cash flow diverted. Corporation pockets the dividend and then decide whether to organize, take control, and replace management[7]. If corporation replaces manager, then the opportunity cost is gained instead of dividend. Thus, payoff from taking over equals αK.

Corporation does not have to forecast the entire, perpetual streams of future dividends. One future dividend is enough to decide for that period. In order to satisfy principal condition, dividend must be $(V-r)q - I - Z \geq \alpha K$.

Let q(t) represents the observable component of the firm's value, and θ the bundle of real options of firm assets, which is a privately observed component. Thus, the total value of the firm is $q(t)+\theta$[8], and $q(t) = \mu + \varepsilon + \theta$ where μ is the manager's effort and ε is idiosyncratic firm risk.

a) The case when real options are recognized by entrepreneur as long as the firm is running.

Because real options are wrapped in firm assets, manager recognizes them as long as the firm is up and running. It is assumed that real options need some manager's effort to realize its potential value for the firm[9].

Managers receive a fixed payment I, and a production share r, as incentive. Manager expects to receive an r for the expected part of the firm, $q(t) = \mu + \varepsilon + \theta$.

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[7] It is important to note that dividend must come from current operations and that does not decrease firm value. Otherwise, manager would have incentives to obtain dividend through diminishing firm value.

[8] There is not yet a tool to measure the systemic effects and synergies among net present value and real options. Thus, it is common in real options literature to represents cash flows as the sum of net present value and real options.

[9] It may be argued that there are options in which the option value is not a function of the manager effort. However, the simple fact that manager has to decide if he takes or not the option implies some effort.

Thus the expected income is:

$$E(Y) = E(I + r\mu + r\varepsilon + r\theta - C(\mu))$$

$$E(Y) = I + r\mu - C(\mu)$$

Accordingly, manager chooses an effort such that:

$$\frac{\partial E(U)}{\partial \mu} = r - C'(\mu) = 0$$

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

However, the optimal contract maximizes for manager $\frac{\partial U}{\partial \mu}$; where $U = I + r\mu + r\varepsilon + r\theta - C(\mu)$ and, $V = I + r\mu$.

$$\frac{\partial U}{\partial \mu} = [V - C'(\mu)]\frac{\partial \mu}{\partial r} + E\theta U' + E\varepsilon U' = 0 \qquad \text{q.e.d}$$

Since risk aversion implies $E\varepsilon U' < 0$, and $\theta > 0$ it shows that $V > C'(\mu)$ in the optimum contract in the presence of real options. The terms $E\theta U'$ and $E\varepsilon U'$ represent the size of moral hazard, in which $E\theta U'$ correspond to the real options moral hazard. This proves proposition 1a: agency problem aggravates with the presence of real options, because of the information asymmetry that real options cause. One important consideration is that if manager is risk neutral or manager effort does not impact the real options value, the moral hazard disappears, even when real options are present in the firm.

Dividend condition $(V - r)q - I \geq \alpha K$ also demonstrates that for low Is, it is unlikely that corporation allows a takeover, even when moral hazard exists. For high Is, it is more likely that

corporation allows a takeover if firing and hiring costs are zero. However, if firing-hiring costs are positive, then the real opportunity cost of corporation decreases and it is more probable that inefficient manager continues in the presence of real options, just because corporation obtains enough dividends.

Using Taylor series approximations to the new utility function it is found that optimal effort of manager is:

$$\mu_{RO} = \frac{1}{C^{'}}\left(\frac{V}{1 + sC^{''}\sigma_{\varepsilon}^{2} + sC^{''}\sigma_{\theta}^{2}}\right)$$

From $\frac{\partial U}{\partial \mu} = \left[V - C^{'}(\mu)\right]\frac{\partial \mu}{\partial r} + E\theta U^{'} + E\varepsilon U^{'} = 0$, it was showed that V > C'(μ) in a greater manner when a firm has real options. Thus

$$\mu_{Ro} \geq \mu$$

Accordingly, the optimal r would be:

$$r_{RO} = \frac{1}{\mu}\left(\frac{V}{1 + sC^{''}\sigma_{\varepsilon}^{2} + sC^{''}\sigma_{\theta}^{2}}\right) \text{ q.e.d}$$

Where now $V_{OR} \rangle V$, and then $r_{OR} \rangle r$.

b) The case when real options are recognized by entrepreneur at the beginning.

In this scenario manager receives a fixed payment I, and a production share r, as incentive to improve production. However, manager expects to receive an r not just for the expected (or observable) part of the project, but for the whole production that he actually knows that $q(t) = \mu + \varepsilon + \theta$.

The expected income is:

$$E(Y) = E(I + r\mu + r\varepsilon + r\theta - C(\mu))$$

$$E(Y) = I + r\mu + r\theta - C(\mu)$$

Accordingly, manager chooses an effort such that:

$$\frac{\partial E(U)}{\partial \mu} = r + r\frac{\partial \theta}{\partial \mu} - C'(\mu) = 0$$

$$r = \frac{C'(\mu)}{\left(1 + \partial\theta/\partial\mu\right)}$$

Since $\partial\theta/\partial\mu \geq 0$, the product share is not longer an efficient incentive method when real options are recognize by manager since firm is set up. This result is consistent with Myers (2000) that says that in some cases contract written does not improve the corporation results.

Because there is a contractible value that principal actually does not know (hidden information) manager may apply a lower effort (hidden action) because even when the part that is observable for principal is not achieved, the real options value of firm compensate it achieving the dividend condition. At the end the principal may not distinguishes if dividend comes from real options value or net present value.

The optimal contract maximizes $\frac{\partial U}{\partial \mu}$; where $U = I + r\mu + r\varepsilon + r\theta - C(\mu)$ and, $V = I + r\mu$.

$$\frac{\partial U}{\partial \mu} = \left[V - C'(\mu)\right]\frac{\partial \mu}{\partial r} + E\theta U' + E\varepsilon U' = 0 \qquad \text{q.e.d}$$

This result is equal to the case when manager recognizes real options as long as the firm is up and running. Again, if manager is risk neutral, moral hazard disappears.

The case of a new venture.

This is the case of a new venture with an entrepreneur that is also a manager. In this scenario manager contributes with intangible assets and principal (venture capitalists) with tangible assets, which are necessary to make production.

The firm requires capital investment of K that does not depreciate and generates an opportunity cost α which equals the certainty equivalent of outside opportunities for principal. Labor and operating assets (bought with K) are necessary complements to make production.

Entrepreneur has only F dollars and raise K-F from outside investors. If outside equity investor's fractional ownership is x, manager fractional ownership is (1-x).

Each period firm obtains, from current operations, a dividend which results from the product price minus operation costs $(V-r)q-I$. Once the firm is up and running, outside equity investors can at any period take out assets worth K and leave the firm. If they do this, they receive no dividend in that period because manager has no reason to make effort. But if manager choose to pay sufficient dividend, principal commits not to exit, and they wait until the next decision point.

In this scenario manager receives a fixed payment I, and a production share r, as incentive to improve production as manager. As partner, manager receives also, at the end of the period, his dividend part $(1-x)[(V-r)q-I-Z]$. However, manager expects to receive an r not just for the expected (or observable) part of the project, but for the whole production that includes real options

value $q(t) = \mu + \varepsilon + \theta$. It is assumed that real options need some manager's effort to realize its potential value for the firm[10].

Thus the expected income is:

$$E(Y) = E\left[(I + r\mu + r\varepsilon + r\theta - C(\mu)) + (1-x)(V-r)q - I\right]$$

$$E(Y) = I + r\mu + r\theta - C(\mu) + (1-x)(V-r)(\mu+\theta) - I$$

$$E(Y) = (\mu+\theta)\left[r + (1-x)(V-r)\right] - C(\mu)$$

Accordingly, manager chooses an effort such that:

$$\frac{\partial E(U)}{\partial \mu} = r + r\frac{\partial \theta}{\partial \mu} - C'(\mu) + (1-x)(V-r) + (1-x)(V-r)\frac{\partial \theta}{\partial \mu} = 0$$

$$r = \frac{C'(\mu) - V(1-x)\left(1 + {}^{\partial\theta}\!/_{\partial\mu}\right)}{x + {}^{\partial\theta}\!/_{\partial\mu}(1+x) + {}^{\partial\theta}\!/_{\partial r}}$$

Since ${}^{\partial\theta}\!/_{\partial\mu}$ and (1+x) ≥ 0, the product share is not an efficient incentive method when real options are recognized by manager and no by venture capitalists.

The optimal contract maximizes $\frac{\partial U}{\partial \mu}$; where $U = I + r\mu + r\varepsilon + r\theta - C(\mu) + (1-x)(V-r)q - I$ and, $V = I + r\mu$.

$$U = (\mu + \theta + \varepsilon)\left[V(1-x) + xr\right] - C(\mu)$$

[10] It may be argued that there are options in which the option value is not a function of the manager effort. However, the simple fact that manager has to decide if he takes or not the option implies some effort.

$$\frac{\partial U}{\partial \mu} = \left[Vq(1-x) - C'(\mu)\right]\frac{\partial \mu}{\partial r} + (1-x)V\left(E\theta U' + E\varepsilon U' + 1\right) = 0$$

Manager has now a conflict of interests choosing effort, because his effort has a cost, and also a fractional benefit for him. If $E\theta U' + E\varepsilon U' \leq -1$, the existence of moral hazard depends on the size of q(1-x).

Using Taylor series approximations to the new utility function it is found that optimal effort of manager is:

$$\mu_{RO} = \frac{1}{C'}\left[\frac{V}{\left(1 + sC''\sigma_{\varepsilon}^2\left(1 + (1-x)^2(\mu+\theta)^2\right) + sC''\sigma_{\theta}^2\right)}\right]$$

Thus, the new optimal effort depends on the size of (1-x) and θ.

Accordingly, the optimal r would be:

$$r_{OR} = \frac{V_{OR}}{\mu}\left(\frac{1}{\left(1 + sC''\sigma_{\varepsilon}^2\left(1 + (1-x)^2(\mu+\theta)^2\right) + sC''\sigma_{\theta}^2\right)}\right)$$

Conclusions

The overall concern of this research has been to investigate and produce knowledge about the impact of real options in the size of moral hazard of an inside manager that contributes with human and intangible capital to production, in the particular case when the firm is financed by outside equity.

In a long lived corporation with real options embedded, moral hazard is given by the risk aversion of managers and the size of real options, implying that the greater the value of real options, the greater the moral hazard. This result maintains equal if manager is an expert that

recognize real options before he entries in the firm, or if manager recognize real options once he is part of the firm.

If manager recognizes real options at the beginning, he may use this to obtain a higher I. When he starts to work in the firm he does not longer have incentives to achieve real options value, as he already got a better fixed payment. Thus, relative product share is not an efficient method when manager has more information than principal. This inefficiency comes from the risk aversion of manager.

One important consideration is that if manager is risk neutral or if manager effort does not impact the real options value, the moral hazard disappears, even when real options are present in the firm.

When the manager is an entrepreneur that contributes with intangible assets to firm, the moral hazard depends on the value of real options and the percentage he receives of free cash flows. The greater the real options value, the greater the percentage he must receive of dividends, otherwise moral hazard increases.

Thus, it is possible to conclude that more risk-averse managers must work in the corporate form than in the partnership, result that is similar to the one found by Dybvig and Wang (2002). The corporate form is more likely to be used by firms without real options. And firms with real options should use partnership models. These results are similar supporting the results of Kulatilaka and Patel (2002) that suggest that firms with real options do not go public.

The manager has the control rights to exercise or abandon the real options. Therefore, the actual potential rents of the firm are determined by the manager's real options value, which is a function of the incentives received. Therefore, optimal firm value is not necessarily achieved, because manager and principal interests are not perfectly aligned.

This differs from Myers (2000), who argues that ownership share does not affect firm value. However, results of this dissertation are consistent with Jensen and Meckling (1976) that argued that an optimal incentive may reduce moral hazard and, with Grenadier and Wang (2005) and Bitler and Moscowitz (2005) that argued that incentives may induce manager to raise firm value exercising the appropriate real options.

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