INTERNAL CAPITAL MARKETS INSIDE FINANCIAL FIRMS: RENT-SEEKING BEHAVIOR VERSUS COST OF CAPITAL

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Abstract

In this paper we build a two-tiered agency model of a …nancial …rm that incorporates rent-seeking behavior from division managers, risk aversion from outside investors in a context of incomplete market and imperfect competition. We …nd no evidence for any socialism inside internal capital markets. Indeed we establish that divisions with better investment opportunities and high risk levels are allocated more capital relatively to other divisions. Divisions with poor investment opportunities and low risk level are allocated more cash wage budget. We also establish a positive correlation between the size of the division and its risk level. This result suggests that large banks are more risky than small ones. This conclusion is in accordance with the idea claimed by many authors, that the wave of merger and acquisitions in the banking industry increases the systemic risk inside the …nancial system.

Key Words: Internal capital markets, Capital Budgeting, …nancial institutions

JEL Classi…cation : G31, G34, G20

1 INTRODUCTION

Over the last twenty years, many finance observers (academics and practitioners) agreed that diversified firms were priced down by the markets relatively to focused firms. This idea finds a strong support in the literature. Indeed many papers provided an empirical evidence that diversification can destroy value. In particular Daley, Mehorta and Sivakumar (1997) and John and Ofek (1995), showed that shareholders gain, when firms become more focused by divesting unrelated segments. Others like Jarrell (1995) claimed that firms are priced abnormally high over the focusing period.

While authors agree over the idea that corporate diversification is value reducing, the reasons for that differs from one author to another and a wide range of explanations has been given in the literature. According to Scharfstein and Stein (2000) the conglomerate form of organization leads to investment inefficiencies that arise from managerial agency problems, while Jensen (1993), showed that in conglomerates, more resources are allocated to managers which could lead to over-investment. This could occur for instance, if the conglomerates borrow more against their assets than a comparable portfolio of specialized firms. While such an argument could hold in theory, Berger and Ofek (1995) established that in practice this extra borrowing effect is of trivial importance and thus, cannot explain investment inefficiencies that occur in conglomerate organizations.

Another alternative for explaining these inefficiencies inside diversified firms, is that their internal capital markets are in some ways inefficient. In other terms, they allocate too much in some divisions and too little in others. While this fact is observed in practice[1], it is far from obvious that such reallocation leads systematically to inefficient investment. It seems then clear that the main

[1] see Shin and Stulz (1997)

question here will be the following: Does the resource reallocation process inside a diversified firm lead systematically to inefficient investment, if so why?

According to the available literature, there is no unique answer to that question. Indeed, Stein (1997) noticed that the reallocation process of resources most of the time leads to higher efficiency if the CEO is deriving private benefits from control. This happens because the CEO's ability to appropriate private benefits should ultimately be roughly in line with the value of the enterprise as a whole. Others like Shleifer and Vishny (1989) claim that the CEO will prefer to invest in industries where they have more personal experience in order to make themselves more valuable for the firm. If the "bad" projects provide relatively high private benefits to the CEO, such investment decisions could lead to inefficiencies inside the internal capital market.

In the same time, many authors considered these arguments as a simplistic way to explain investment inefficiencies that occur inside conglomerates. Indeed Scharfstein and Stein (2000) claimed the existence of a socialist nature inside internal capital markets. In other terms weaker divisions are allocated too much resources relatively to stronger ones. Since such a socialist pattern cannot be rationalized simply by appealing to agency problems at the CEO level, they developed a two-tiered agency model, in which they consider also the incentives and the behavior of the division manager. They considered that by engaging in rent-seeking activities[2], the division manager extracts greater overall compensation from the CEO. This extra compensation could take the form of preferential capital budgeting allocation rather than cash wage.

Despite the consistency of their results[3], two major criticisms should be

[2] Rent-seeking activitiy could be considered as a non productive activity to the firm, while it increases the bargaining power of the division manager in the future when he negociates his compensation package with the CEO.

[3] For empirical evidence see Zingales and Rajan (1997) and Rajan, Servaes and Zingales

made. In their model, they consider the capital as a given parameter without any form of costs. This means that its allocation will not be subject to any cost constraint, which is quite restrictive from our point view. Secondly, they did not give an explicit de…nition of the production function, which is also very restrictive since they de…ne they the private bene…ts as a portion of the …rm's production. Finally all their analysis has been made in a context of risk-neutrality, complete markets and perfect competition, then we could ask ourselves if the same results hold when the analysis is made in a context of risk-aversion, incomplete markets and imperfect competition? This is basically what we will try to do in this paper.

Empirically, a number of recent papers, claimed the thesis that diversi…cation leads to lower …rm value: for instance Morck, Shleifer and Vishny (1990) show that during 1980s, diversifying acquisitions decrease shareholder wealth. Others like Lang and Stulz (1994) provide evidence that the q measure of diversi…ed …rms was signi…cantly smaller than the q of matching portfolios of specialized …rms. In the same time some theoretical papers argue that e¢cient internal capital market leads to higher value for shareholders. For instance Fluck and leach (1996) established that agency costs prevent the …nancing of some positive net present value projects by stand-alone …rms, but not within diversi…ed …rms. Despite the existence of a relatively strong arguments from both sides, it is important to put every analysis in its context, in particular many papers exclude from their set of data the banking industry. For instance Lamont and Polk (1999) as well as Berger and Ofek (1995) discarded …rms with segments in the …nancial services industry. It seems then too risky to generalize their results to all industries.

(1998)

In fact if we look at the banking literature, such as Berger and Udell (1995), Peek and Rosenberg (1996) and Berger and Udell (1996), we see that …nancial conglomerates seems to allocate their resources in a non-socialist way. For instance, Keeton (1996) and Santos (1997) showed that the wave of merger and acquisitions in the banking industry tends to reduce small business lending. This means that in …nancial conglomerates internal capital markets allocates more resources to divisions with high investment opportunities. Consequently we could ask ourselves if all the theoretical results (i.e., Scharfstein and Stein (2000) established for …rms in general hold if the …rm is a bank. In this paper we give one answer to this question and we try to see if internal capital market are e¢cient or not.

Before going further with the development it is necessary to agree on the definition of an e¢cient internal capital market. While any de…nition will depend on the variables considered, particularly when we deal with agency issues, we will refer in this paper to the de…nition given by Shin and Stulz (1997). These authors claim that internal capital market is e¢cient if : its allocation of funds to a segment falls when other segments have better investment opportunities, second it gives priority in the allocation of funds to the segment with the best investment opportunities; third it makes the investment of that segment less sensitive to its own cash ‡ow as well as to the cash ‡ow of the other segment.

The primary objective of this paper is to develop a two-tiered agency model, similar to the model of Scharfstein and Stein (1998), which explains how capital is allocated inside a …nancial …rm, when we are in a context of incomplete markets, risk-aversion and imperfect competition. We analyze the impact of manager's behavior on the resource allocation process and sees if this behavior leads to ine¢ciencies inside internal capital markets. While this model is built inside a …nancial …rm it has however a strong implications in the context of the global …nancial system. In particular, it shows the motivation of the wave of mergers and acquisitions observed recently in the banking industry.

This paper is structured as follows: Section 2 speci…es the di¤erent variables used in the model and discuss the robustness of the hypotheses set. Section 3 analyzes the model. Section 4 discusses empirical implications of the model and extends the results to the global …nancial system. Section 5 concludes.

2 THE MODEL

2.1 De…nitions

We consider …nancial institution (i.e.: bank) with two divisions. While such a case is quite unrealistic, it is however easier to manipulate. In the last section of this paper we will show that our results are independent from the number of divisions, as long as it is more than one division. The …rst division is involved in deposit-…nanced credit and …nancing activity. More explicitly, it collects deposits from clients and use them to invest whether in portfolios of debt by granting loans and credit facilities or in a portfolio of equity by buying some capital shares issued by companies. This activity generates a cash ‡ow which is a function of the productivity of the division and the risk level chosen. This return is usually higher than the interest paid by the bank on its deposits. The cash ‡ows are fully and costlessly veri…able.

We denote by:

$¼_i$ the expected net cash ‡ows of division i generated by one unit of capital invested. i=1,2

$µ_i$ the productivity of division i i=1,2

$¾_i$ the risk level of division i[4]. i=1,2

[4] Due to the complexity of determining an appropriate risk measure, we don't give any

The expected net cash flow is equal to the return received by the bank minus the cost of deposits and all the operating expenses. We define the cash-flow as a function of the risk level and the productivity. We also assume that the net cash flow is always positive.

$$\pi_i = \pi(\sigma_i; \theta_i) \qquad (1)$$

Usually the bank invests its resources whether in a portfolio of debt or equity. In Appendix A, we show that the cash-flow per one unit of capital is an increasing concave function of the risk level.

$$\text{with} \qquad \frac{\partial \pi_i}{\partial \sigma_i} > 0 \qquad (2) \qquad \text{and} \qquad \frac{\partial^2 \pi_i}{\partial \sigma_i^2} < 0 \qquad (3)$$

The second division is involved in self-financing derivatives trading. This consists of taking zero net investment positions in derivatives such as forwards and futures. This activity generates also a cash flow, which has the same characteristics as in (2) and (3).

Bankers are assumed to prefer higher expected return to lower expected return for a given risk level. We define the concept of productivity as the ability to generate cash-flow for a given level of risk. This means that higher productive divisions are supposed to generate more cash flow per unit of capital than lower productive divisions for the same risk level. Said differently higher productivity makes risk more productive and so managers of higher productive divisions have more incentives to take risk than their colleagues of the low productive

details concerning the way how this risk is computed. In the litterature there are various methods for measuring the risk such as value at risk (VAR).

divisions[5]. Consequently riskier divisions are assumed to be the most productive ones.

$$\frac{\partial^2 \pi_i}{\partial \sigma_i \partial \theta_i} \geq 0 \qquad (5)$$

Here we measure the productivity by the net cash-flow per unit of capital however we don't consider the cost of capital since in our case this cost -as we will see later- could differ for two divisions with the same risk level but with different sizes.

2.2 Cost of Capital

As we said previously, banks pay interest on most of their deposits and on their debt capital (i.e., notes and debentures). What do they have to pay for equity capital? The return that shareholders expect to earn on their investment represents the implicit cost of equity capital. In the following we will refer by the cost of capital, to the dividend yield required by outside investors (shareholders) and paid by the firm. This cost depends on the level of risk chosen by the firm. Note that the risk level of the firm is entirely and instantaneously observable by the shareholders. this means that any change in the risk level of the firm is immediately reflected in the cost of capital required by shareholders. We denote by C_i the cost of one unit of capital raised by the financial institution and allocated to division i.

As we stated in the introduction, our analysis is in a context of incomplete markets and imperfect competition. Complete market has been defined

[5] This is assumption is similar to the sorting condition introduced by Spence(1973) and Mirlees (1971) except that here we are not in a case of asymetric information than we could not talk about sorting condition.

by Grossman and Stiglitz (1976) as a market where a …rm issues a debt and this security does not alter the space of returns available in the securities market. The same authors de…ne competition as follows:" competition means that each investor believes that if the output of any …rm increases by x % in each and every state of nature, then the value of the …rm increases by x %". Diamond (1967) states that if, for example, the …rm is considering doubling its input (investment), this would be calculated as doubling the value of input payments (cost of investment), since the …rm acts as a price taker

The latter statement means that in a perfect competition context the cost of an investment is independent of its size. Said di¤erently, the cost of one unit of capital will be the same, for two projects with the same risk and di¤erent sizes. According to Krouse (1978) this also means that investment decision of the …rm does not a¤ect the implicit prices of individual investors[6]. Rubinstein (1978) claimed that in a context of imperfect competition, any change in the investment level of the …rm will be translated by a change in the investor's implicit prices. In the context of a certainty model he argues that even though an individual …rm may have a slight e¤ect on the interest rate (the inverse of the sum of implicit prices), the consumption e¤ect that the change in interest rate generates " may dominate the …rm's impact on the value of its own shares (which comprise a small portion of the consumer's portfolio). In our model this means that the cost of capital (the dividend yield required the shareholders) will depend on the size of the project and so on the level of capital provided[7]. Consequently we will have :

[6] Implicit prices are de…ned as the marginal rate of substitution of a unit of a return to be received at time one, for a unit of return to be received at time zero.

[7] Rubinstein argues in addition that assuming that …rms are " small relative to the rest of the economy" is not su¢ cient to justify the assumption that implicit prices will not be a¤ected by the …rm's investment level.

$$C_i = C(\sigma_i; k_i) \qquad (6)$$

where k_i is the amount of capital raised by the firm and allocated to division i and σ_i the risk level of division i.

According to Levy and Markowitz (1979) and using the mean variance framework, we establish that the cost of capital is an increasing convex function of the risk level. This convexity is given by the assumption that outside investors are risk averse. Therefore we have

$$\frac{\partial C_i}{\partial \sigma_i} > 0 \qquad (7) \qquad \text{and} \qquad \frac{\partial^2 C_i}{\partial \sigma_i^2} > 0 \qquad (8)$$

Intuitively, we could think that the cost of capital is an increasing function of the amount of capital invested. This because outside investors will evaluate any investment opportunity by using their implicit prices. If we start from a situation of equilibrium where investors set their investment allocation based on their implicit prices and the dividend yield offered[8]. If the firm decide to raise more capital unless it gives higher dividend yield, investors will not move from their initial optimum. Therefore for higher requested capital they should be given higher return otherwise they will not invest. Of course if the cost of capital increases indefinitely, there exists a hurdle rate above which the firm will prefer to not invest otherwise the project's value will be negative. Consequently we expect to see the cost of capital as an increasing concave function of the amount of capital invested. Here we will consider without any loss of generality

[8] An equilibrium in an economy involves both an equilibrium in the securities market corressponding to an investment allocation across firms and an equilibrium with respect to the allocation of investor's (consummer) endowements between present consumption and investment. At equilibrium, the interest rate is equal to the inverse of the sum of implicit prices.

that the amount of capital requested is not enough high to reach the level at which the cost of capital is equal to the hurdle rate[9]. Then we have:

$$\frac{\partial C_i}{\partial k_i} > 0 \qquad (9) \qquad \text{and} \quad \frac{\partial^2 C_i}{\partial k_i^2} < 0 \qquad (10)$$

2.3 Hierarchies

We assume that division managers derive private benefits from the performance of their divisions only, while the CEO derives private benefits from both divisions[10]. These private benefits are non contractible and they represent a small portion of the value of each division[11]:

$$\alpha \left[\pi(\sigma_i;\theta_i) - C(\sigma_i;k_i)\right] \quad \text{For manager of division i} \qquad (10)$$

$$\beta \sum_{i=1} \left[\pi(\sigma_i;\theta_i) - C(\sigma_i;k_i)\right] \quad \text{For the CEO} \qquad (11)$$

These private benefits could take the form of high hotel bills, trips on the firm's private jet... etc.

We assume that the CEO has the authority of allocating capital as well as hiring, retaining and setting the compensations of division managers. This

[9] We need this assumption to assure the monotonicity of the function and easier computation. However we will see later that this assumption doesn't have any influence on the results obtained.

[10] For more evidence concerning the use of manager compensation based on performance measures see Rogerson (1997)

[11] These private benefits could take many forms: the ususal perks, psychic benefits from empire building, etc. Other models including Bolton and Scharfstein (1990) and Hart and Moore (1998) suggests that managers can steal a large share of the cash flows. Our model is quite different since the private benefits are assumed to be relatively small and they are derived from the value of the firm (or division)

means that outside investors cannot contract directly with division managers. The latter hypothesis has been discussed in the literature, particularly McAfee and McMillan (1995), assume that the top principal is unable to contract with the agent due to limits on his time and attention. At the same time we consider that the division manager has the possibility to take some actions in order to improve his bargaining power versus the CEO over his compensation package. This kind of activity is called "Rent-seeking": it consists of spending a part of his time on activities that are non productive for the firm, however it will allow him to extract more compensation from the CEO at the time of negotiation. It is clear here that there is no way to force the division manager to spend his time in the right way. While there are different forms for the rent-seeking[12], we will consider here that the rent-seeking will take the form of " resumé-polishing"[13]. It consists for instance of spending time in attending industry conventions, accepting needless speaking engagement etc...

3 ANALYSIS

We consider a model with two time periods. At time 1, the division manager (DM_i) is deriving private benefits of $\alpha[\pi_{i;1} - C_{i;1}]$, while the CEO is deriving $\beta\sum_{i=1}^{2}[\pi_{i;1} - C_{i;1}]$;and $\pi_{i;1}$, $C_{i;1}$are respectively the cash flow of division i at time 1 and the cost of capital of division i at time 1. At the end of time 1 all the credit lines granted by the bank are paid back, all the trading positions are offset and there is a new round for investment at time 2. If the DM_i still in place at time 2 he gets $\alpha[\pi_{i;2} - C_{i;2}]$ private benefits. however if he leaves and a new manager is hired by the CEO the cash flow of division i falls by an amount

[12] Please see Schleifer and Vishny (1989) and Edlin and Stiglitz (1995) for other forms of "rent-seeking"

[13] See Scharfstein and Stein (2000)

M[14]. The intuition here is that during the first period the original manager has acquired some specific knowledge and expertise which any manager outside the firm cannot have immediately. This specific knowledge can be thought of in any number of ways: establishing a good relationship with clients, understanding the banking culture,etc. This makes the division manager particularly valuable for the firm, then he will try to bargain with the CEO for higher compensation at time2.

At time 1 the DM will anticipate his bargaining situation and would like to take some actions in order to increase his negotiating power at time 2. As mentioned in (2.3), one of the possibilities offered to him is to do some rent-seeking activities. By doing so he will get an outside option at time 2 denoted by $G(e)$; where e is the level of rent-seeking and $G(.)$ is an increasing concave function. In that case since the manager will not spend all his time on productive work we expect to see the cashflow of his division at time 1 falling by an amount $x(e)$; where $x(.)$ is an increasing convex function. Therefore if he rent-seeks he gets $\alpha[(1 - x)\pi_{i;1} - C_{i;1}]$ private benefits at time 1.

Assuming that at time 1 there is a certain level of rent-seeking. Therefore the manager has now an outside option $G(e)$. If the division manager leaves at time 2 he gets $G(e)$. If he stays he gets $W_i + \alpha[\pi_{i;2} - C_{i;2}]$; where W is the cash wage agreed to by the CEO. Without loss of generality we assume that $\beta M > G(e)$, and so it is always in the interest of the CEO to retain the division manager[15]. For convenience we assume that at time 2 the CEO could make a

[14] We assume that after one period on the division the DM has acquired some human capital which makes him valuable for the firm. See Stoughton and Zechner (1999)

[15] Suppose this assumption is not made, the problem is the same except that it will exist a certain level of rent-seeking above which the CEO will not retain the division manager and so there will be no extra-compensation. Since our purpose is to analyze what form the compensation will take, it seems then interesting to make this assumption

"take it or leave it" offer to the manager.

While one of our objectives in this paper is to see what form the compensation package will take - cash or additional equity capital - we first start by assuming that any compensation at time 2 will take only the form of cash wage W_i which comes entirely from the CEO's pocket. Then to formalize the situation faced by the CEO let us start from an initial situation where the capital is allocated efficiently across the divisions. More explicitly we denote by k_i^* the efficient investment level at equilibrium; it is obtained by solving the following problem[16] :

$$\frac{\partial \pi_{1;2}}{\partial k} - \frac{\partial C_{1;2}(\sigma_1; k_1^*)}{\partial k} = \frac{\partial \pi_{2;2}}{\partial k} - \frac{\partial C_{2;2}(\sigma_2; k_2^*)}{\partial k} \quad (13)$$

If the DM_i leaves at time 2 he gets $G(e_i)$, while if he stays he gets $W_i + \alpha[\pi_{i;2} - C_{i;2}]$, so to keep the DM_i in the firm the CEO has to pay him a cash wage W_i which satisfies the following retention constraint:

$$W_i + \alpha[\pi_{i;2}(\sigma_i; \theta_i) - C(\sigma_i; k_i^*)] \geq G(e_i) \quad (14)$$

An important issue here is how the cost of capital (dividend yield) will be chosen. For outside investors the expected total return can be viewed in term of a dividend yield and a price appreciation or capital gains[17]. Said differently they set their investment allocation so as to maximize their wealth between dividend yield to be received now and future capital gains. The problem here is whether this allocation maximizes the bank's value or not?

[16] while in this subsection we set the cash flow per one unit of capital invested as independent from the total amount invested and so $\frac{\partial \pi_{i;2}}{\partial k} = 0$, this condition will be removed in the next subsection.

[17] Because almost all bank stocks pay dividends and because banks are not considered growth stocks, bank stocks tend to trade on a combination of relatively attractive dividend yield and modest potential for price appreciation.

Various papers in the literature such as Rubinstein (1978), Mossin (1972) and Long (1972) have shown that when competition is imperfect, the value-maximizing allocations as in a mean-variance model with homogeneous expectations are not a competitive pareto-optimum. In the context of ex post analysis Leland (1978) demonstrates that the unanimously-preferred production level does not maximize the actual value of the firm. The proof of that result essentially involves implicit prices that depend on a firm's production. This suggests that investors will prefer a strategy which doesn't maximize the firm's value. Given a non perfect competition, and using the mean variance model with homogeneous expectations, Barron (1979) established that value maximization for the firm does not result in a pareto optimal allocation, even though the value of the firm is maximized. That maximization leads to a less desirable pattern of time-one return (dividend yield) than does the investment level resulting from the competitive process. In our case this means that outside investors will require higher dividend yield levels than the level at which the firm's value is maximized.

By observing inequality (14), we could say that if the DM is deriving high private benefits, then he has low incentives to rent-seek, while if his private benefits are relatively small he will look for rent-seeking to increase his compensation at time 2.

To determine the conditions under which the DM_i will rent-seek, we have to look at the sign of expression $[\pi_{i;2} - C_{i;2}]$: In fact we know that $\pi_{i;2} = \pi(\sigma_i; \theta_i)$ and $C_{i;2} = C(\sigma_i; k_i)$. According to equations (2); (3); (4); (5), (7); (8); (9), we plot a graph (see Fig.1), where we represent the dynamics of the cost and the cash flow as functions of the risk level (see appendix B for analytical proof).

It is clear from figure1 that σ could not exceed σ^{**} otherwise the cost of capital will be higher than the cash flow level and then the project will be

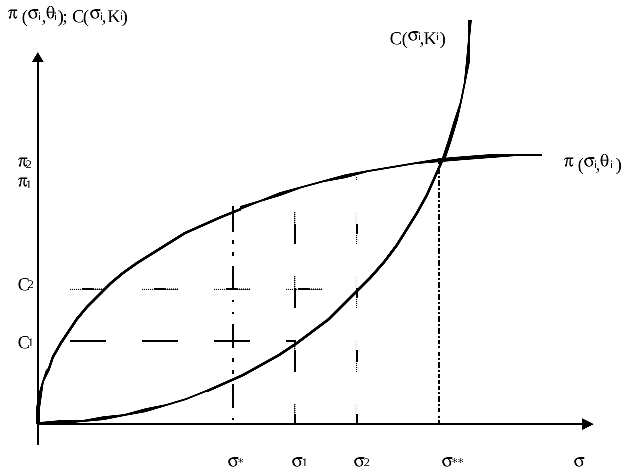

Figure 1:

rejected[18]. At the same time we have stated before that the cost of capital represents also the dividend yield required by outside investors. The CEO as well as the division managers would like to see the firm's value maximized, then the optimal level of C_i for them will be such that :

$$C_i^* \in \arg\max [\pi_i - C_i] \tag{15}$$

As we stated already investors will choose a dividend yield level higher than the level at which the firm's value is maximized this means that $C_i \geq C_i^*$. Equation (14) means also that, the minimum level of risk will be set such that $\frac{\partial C_i}{\partial \sigma_i} = \frac{\partial \pi_i}{\partial \sigma_i}$. Then we have $\sigma \in [\sigma_*; \sigma_{**}]$ (see fig1).

Now let us back to our previous question concerning the incentives for rent-seeking. As we have established above, the DM will rent-seek only if he is deriving a relatively weak private benefits. This means that if one DM is deriving less private benefits than his colleague, he will be more encouraged to rent-seek.

[18] We assume here that neither the DM nor the investor would like to invest in projects with negative value

The latter proposition doesn't mean that systematically only one DM will rent-seek. In fact both could rent-seek if their private benefits are too weak or both could choose to not rent-seek if their private benefits are high enough.

Let us assume that division 2 is more productive than division 1- $\theta_2 > \theta_1$: According to equation (5) higher productivity leads to more productive risk taking, and so, we will have $\sigma_2 > \sigma_1$: As we could observe in Fig.1 for the case where $\sigma_2 > \sigma_1$, we have $[\pi_2 - C_2] < [\pi_1 - C_1]$: Therefore DM_2 is deriving less private benefits than DM_1, he then has more incentives to rent-seek[19]. It is clear here that higher risk level would decrease the private benefits and then push the DM to rent-seeking. In fact, as long as $\sigma \in [\sigma_{*}; \sigma_{**}]$, the cost of capital is growing faster than the cash flow - due to convexity of the cost function and the concavity of the cash flow function. Consequently the decision of rent-seeking will be strongly related to the risk level of the division. This contrasts other papers like, Scharfstein and Stein (2000) and Rajan, Servaes and Zingales (1998) which stated that rent-seeking strategy is much more a matter of division productivity (low productive division will see their DM more likely to rent-seek):Indeed the previous results hold even if $\theta_1 < \theta_2$, since equation (5), states that higher productivity leads to more risk taking.

This situation is widely observed inside banks, particularly in the trading area. Indeed traders with high productivity - consequence of their high ability to make money- are allowed to take more risky positions in the markets relatively to "less skilled traders"[20]. To understand more clearly how this process works, let's analyze the way, how the risk level and the cost of capital are established.

We start, by assuming that investors observe the risk on the market and then

[19] Of course here we assume that the difference in private benefits is enough wide to push the DM to rent-seek. This also means that the difference in risk level is also large.

[20] Banks usually set position limits for each trader- limits in term of amount invested as well as in trems of risk level i.e: VAR limits.

set their dividend yield target (cost of capital). Now someone could ask why the DM do not increase the risk level of his division and so its expected cash flow? Since we consider a situation of a perfect symmetric information (risk levels are observed by the CEO, DM and outside investors), any change in the risk level by the DM, will be observed by the investor who will instantaneously adjust his return target by increasing the cost of capital. Since the marginal cost of capital is higher than the marginal cash flow (we have $\sigma \in [\sigma^*; \sigma^{**}]$), then any increase in the risk level will decrease the quantity $[\pi_i - C_i]$, and by so the private benefits of DM_i. Consequently it's not in the interest of the DM to increase the risk level.

Now let's back to our initial problem. We said that if DM_i rent-seeks he gets an outside option of $G(e_i)$. At the same time his private benefits at time 1 falls by $\alpha x(e_i)\pi_{i;1}$: Therefore if $G(e_i) \geq \alpha x(e_i)\pi_{i;1}$;the CEO has to compensate the DM_i with a cash wage W_i equal to $G(e_i) - \alpha x(e_i)\pi_{i;1}$.

Then for a given level of rent-seeking e_i the DM will rent-seek only if

$$\alpha\left[\pi_{i;2} - C_{i;2}(\sigma_i; k_i^*) + x(e_i)\pi_{i;1}\right] \geq G(e_i) \tag{16}$$

If there is a certain level of rent-seeking e_i that satisfies (16), then there will be some rent-seeking at equilibrium denoted by e_i^*:It is determined by equating the marginal loss in time 1 private benefits and the marginal gain in time 2 compensation. Therefore if at the level of e_i^* the condition in (16) is not satisfied, then there will be no rent-seeking. The main consequence of this analysis is that managers of riskier divisions (higher productive ones) have more incentives to rent-seek (see appendix B).

We could distinguish basically two regions for the risk level inside the interval $[\sigma^*; \sigma^{**}]$. First if σ is higher than some cutoff σ^{δ} the rent-seeking condition is satis…ed, so managers will rent-seek. In this region the level of rent-seeking increases as ¾ increases. In the second region if ¾ < ¾± managers do not rent-seek at all; the rent seeking condition (16) is not satis…ed. Indeed at these lower levels of risk the loss of private bene…ts for both managers are so high that they prefer to not rent-seek (see appendix C).

Consequently managers of higher productive divisions are given higher wages than those of low productive divisions. Since these managers are more encouraged to rent-seek so the CEO is compelled to give them higher compensation to get them to stay- recall here we did not introduced yet the possibility of compensating the DM through extra capital allocation. This scenario is quite close to what we usually see in practice, in fact DM of higher productive divisions get higher compensation packages.

At this stage let's summarize our conclusions in proposition 1:

Proposition 1 Division managers of risky (high productive) divisions have more incentives to rent-seek than their colleagues of lower risky (low productive) divisions. To avoid that, the CEO has to give them extra-compensation so that the retention constraint is binding.

Our conclusions for this section are contrasting those claimed by Scharfstein and Stein(2000) and Rajan, Servaes and Zingales (1997) where managers of low productive divisions are " overcompensated" relatively to their colleagues of stronger divisions. In fact the last argument has been advanced as one reason for ine¢ ciency inside internal capital markets. While at this stage of the analysis we established that there is no "socialism" in the conglomerate form of organization, It doesn't mean that internal capital markets are e¢ cient. In fact we simply claim that if there is ine¢ ciency it is not due to any form of socialism inside the …rm. Now it is compulsory to go deeper in the analysis and examine the situation where the compensation could take the form of cash wage or additional equity capital.

3.1 What Form Of Compensation the CEO will choose?

In the following we consider the same problem as previously, except that we allow the CEO to choose between two forms of compensation : cash wage or additional capital equity. As we saw already, DM of riskier divisions is more likely to engage some rent-seeking activities in order to increase his compensation. To prevent such a behavior the CEO has to give him extra-compensation. What we will try to analyze in this section is the form of compensation the CEO will choose.

We start by defining the objective function of the CEO:

$$Max\ \beta[\pi_{1;2}(\sigma_1;\theta_1) - C_{1;2}(\sigma_1;k_1) + \pi_{2;2}(\sigma_2;\theta_2) - C_{2;2}(\sigma_2;k_2)] - W \qquad (17)$$

Where W represents the total wage budget given by outside investors to the CEO and we assume that it is large enough to compensate both managers[21]. At this stage someone could ask to which extend investors could force the CEO to use the wage budget for compensating the division managers and not using it for himself. This issue was widely discussed in the literature and many authors agreed that, while investors could set some constraints on the use of the wage budget when they hire the CEO, it seems however very difficult from a practical point view for them to dictate him the way how to spend the cash wage[22]. In my point view, such a question is useless in our case, since it does not solve the problem of optimality for both investors and CEO. Indeed it is more important

[21] As you could notice we did not specify any constraint on the way how the wage budget is spent. This means that we do not care whether or not, the investor set a minimum portion of the wage budget to be given to managers.

[22] For more discussions of this point see Sharfstein and Stein (1998)

to analyze the consequence of the use of wage budget rather than checking to which party this wage goes. Said differently, we have to ask ourselves whether the use of the cash wage budget leads to higher efficiency or not?

To answer the above question let us start by considering the problem faced by both, division manager and the CEO. According to (14) the CEO is facing the following retention constraint:

$$W_i + \alpha[\pi_{i;2}(\sigma_i;\theta_i) - C(\sigma_i;k_i^*)] \geq G(e_i)$$

Since here we allow the CEO to allocate additional capital as a form of compensation, it is compulsory to modify shortly the cash flow function so as to depend also on the amount of capital invested in the division[23]. In the previous case it wasn't necessary to do so since, the only way of compensation was the cash wage. Then we could write that $\pi_i = \pi(\sigma_i;\theta_i;k_i)$ with k_i the amount invested in division i. Therefore the retention constraint becomes :

$$W_i + \alpha[\pi_{i;2}(\sigma_i;\theta_i;k_i) - C_{i;2}(\sigma_i;k_i)] \geq G(e_i) \qquad (18)$$

It is clear here that we allow k_i to differ from k_i^*(see equation (16)):

In order to retain DM_i, the CEO has to provide extra-compensation. If he chooses to compensate him with an extra-cash wage so that (18) is satisfied, the CEO will see his objective function under the optimal level - due to the negative sign of W. From the investors point view such a decision will not affect the value of the firm since the cash wage will come entirely from the "pocket" of the CEO, while for the CEO such a solution will affect his objective function.

[23] In our context of imperfect competition and incomplete markets, the cash flow which represents also the return per one unit of capital invested will depend also on the level of investment.

If he chooses to compensate the DM through additional capital, he will also see his objective function affected. Now the issue is to find which is better for the CEO cash wage or capital equity?

As we stated before the cash flow function depends on k, and it represents the amount of cash flow generated by one unit of capital invested. As we did in (9), we show that $\pi_{i;2}(\sigma_i;\theta_i;k_i)$ is an increasing and monotonous function of k. Consequently $\pi_{i;2}(\sigma_i;\theta_i;k_i)$ could take three forms: concave convex or linear. In appendix D, we show that for the cases where $\pi_{i;2}$ is convex or linear, there exists a unique level $k^{\delta} \neq 0$ at which $\pi_{i;2}(\sigma_i;\theta_i;k^{\delta}) = C_{i;2}(\sigma_i;k^{\delta})$: And for,

$$k < k^{\delta} \qquad \pi_{i;2}(\sigma_i;\theta_i;k^{\delta}) < C_{i;2}(\sigma_i;k^{\delta})$$
$$k > k^{\delta} \qquad \pi_{i;2}(\sigma_i;\theta_i;k^{\delta}) > C_{i;2}(\sigma_i;k^{\delta})$$

However for the case where $\pi_{i;2}$ is concave, things are less obvious, since $\pi_{i;2}$ and $C_{i;2}$ are both increasing and concave functions, it is possible that $\pi_{i;2} - C_{i;2} \neq 0$ for every $k \neq 0$. In order to understand the way how the cash flow will vary with the amount of capital invested, let's assume for instance that the bank's credit lending division will invest its capital in a portfolio of loans. The cash flow generated by one unit of capital will be an increasing concave function of k. At the same time we assume that an outside investor has the possibility to invest directly in the same portfolio rather than investing in the bank's capital. However this possibility will incur some monitoring costs which increases with k. While in this paper we assumed a perfect symmetric information and so there is no scale of economies in information production, these costs could be generated by the lack of knowledge and experience in managing loan portfolios[24].

Someone could ask here, why outside investor invests directly in the portfolio

[24] This concept is widely discussed in the litterature concerning the benefits of intermediation. See Gorton and Pennacchi (1990), Diamond (1991) and Krasa and Villamil (1992).

if he will support some monitoring costs. We explain this by the fact that he derives a certain utility U(k) from managing his own money. Then for 2 equivalent expected returns he will prefer to invest directly in the loan portfolio.

We denote by CM(k), the cost of monitoring supported by outside investor for one unit of capital invested directly in the loan portfolio. Then his utility in this case will be:

$$U(k) = R_p \text{ ¡ } CM(k) + U(k) \qquad (19)$$

where R_p is the return of the loan portfolio for one unit of investment, and U(k) is the total utility per one unit of capital invested directly in the portfolio.

Since the bank's division does not support any monitoring costs, its cash ‡ow function will be equal to the return of the portfolio: $¼_{i;2}(¾_i; µ_i; k_i) = R_p(k_i)$: If we observe (19) we see that, for a level of k close to zero the total utility from investing directly in the portfolio will be higher than R_p. Since we know that $\frac{±CM(k)}{±K} > 0$, then for a certain level of $k = k^±$ we will have $CM(k) = Ū$ and so:

$$U(k^±) = R_p(k^±) = ¼_{i;2}(¾_i; µ_i; k^±)$$

At this level the required return by outside investor will be equal to $C_{i;2}(¾_i; k^±) = U(k^±) = ¼_{i;2}(¾_i; µ_i; k^±)$: Consequently for the case where $¼_{i;2}(¾_i; µ_i; k_i)$ is concave, there exists a unique level $k^±$ 6= 0 at which

$¼_{i;2}(¾_i; µ_i; k^±) = C_{i;2}(¾_i; k^±)$:

Therefore we showed that if $¼_{i;2}(¾_i; µ_i; k^±)$ is an increasing and monotonous function of k, there exists a unique level of capital $k^±$ such that $¼_{i;2}(¾_i; µ_i; k^±) = C_{i;2}(¾_i; k^±)$. If $k < k^±$; we have $¼_{i;2}(¾_i; µ_i; k^±) < C_{i;2}(¾_i; k^±)$; while for $k > k^±$ we have $¼_{i;2}(¾_i; µ_i; k^±) > C_{i;2}(¾_i; k^±)$:

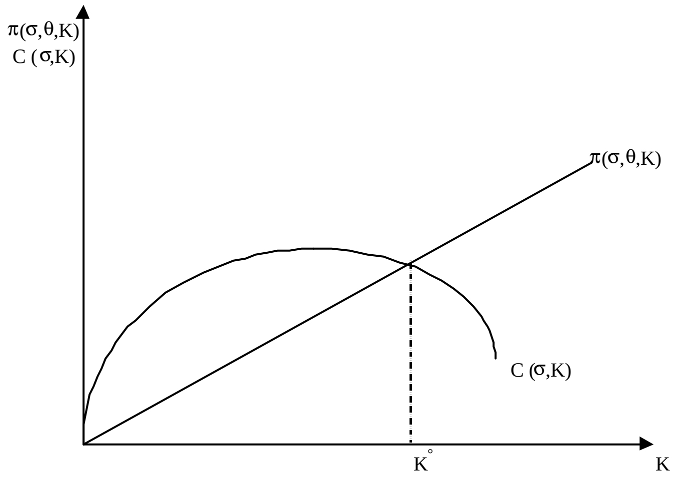

Figure 2:

For more illustration we proceed as for the previous case and we plot a graph (Fig.2), where we represent both the cost of the capital and the cash ‡ow functions. Here we consider the case where $¼_{i;2}(¾_i; µ_i; k^±)$ is concave. As we stressed already the same results hold for both cases of linearity and convexity[25].

We have $¼_{i;2}(¾_i; µ_i; k^±) = C_{i;2}(¾_i; k^±)$: As you could see in Fig 2, as long as K is below $K^±$ we have $¼_{i;2}(¾_i; µ_i; k_i)$ ¡ $C_{i;2}(¾_i; k_i)$ 0. Therefore if the capital allocated to the division is below $K^±$, this will lead to lower private bene…ts for both the DM and the CEO, due to the fact that the cost of capital will be higher than the cash ‡ow generated. It seems then more interesting here to compensate the DM with cash rather than additional capital, since in the latter case the retention constraint will not be satis…ed.

If the amount of equity capital allocated to DM is higher than $K^±$, both CEO and division manager will see their private bene…ts increasing, due to the fact that the cash ‡ow generated is higher than the cost of capital. Consequently it

[25] See appendix for analytical proof.

seems more interesting in this case for the CEO to compensate division manager with additional amount of capital as long as this amount is higher than K^*. The latter conclusion implies that if the rent-seeking is enough strong, there is a high probability to see extra-compensation taking the form of equity capital. This also means that the CEO will always prefer to compensate the DM with cash wage as long as the amount of capital necessary to satisfy (18) is not large. We summarize the results established at this stage in the following proposition:

Proposition 2 we denote by σ_i and σ_j respectively the risk measures of divisions i and j ; we have $\sigma_0 \in [\sigma_*; \sigma_{**}]$ which is the cutoff for which the rent-seeking condition is satisfied. We distinguish essentially three cases :

Case n°1 : σ_i and σ_j are both below σ_0. In this case the rent-seeking condition (16) for both division managers is not satisfied, consequently none of them would like to rent-seek.

Case n°2 : $\sigma_i > \sigma_0$ and $\sigma_j < \sigma_0$: Here DM_i will rent-seek while DM_j will not do so. If the rent seeking level is high then we will see an additional capital allocation towards division i. While if the level of rent-seeking is low, no extra-capital allocation will be observed, however we will see more cash wage granted to division i.

Case n°3 : $\sigma_i > \sigma_0$ and $\sigma_j > \sigma_0$; both division managers will rent-seek. If the level of rent-seeking is high for both, then we will see more capital allocated to both divisions. If the rent-seeking is not so strong, then no additional capital will be allocated, however we will see additional cash wage for both divisions. Finally if the rent-seeking is high for one division and low for the other one, we will see additional capital for the division of high rent-seeking and more cash wage for the division with low rent-seeking.

As a conclusion for this section we could say that the rent-seeking behavior is strongly related to the level of risk inside the division. Indeed if the division is enough risky ($¾ > ¾_0$), its division manager will have more incentives to rent-seek than his colleague of a lower risky division. Again we stress on the possibility that both managers could rent-seek at the same time, as well as both of them could choose to not rent-seek. Since we stated in our hypothesis that higher productivity leads to higher risk taking (eq(5)), we could extend our results to say that division managers of higher productive divisions have more incentives to rent-seek than their colleagues of lower productive divisions. These conclusions contrast those claimed by Scharfstein and Stein(1998), where rent-seeking is much more the behavior of managers of low productive divisions.

At the same time we showed that when the CEO has the choice between compensating division managers with cash wage or additional equity capital, it will be more optimal for him to do that with cash as long as the amount of capital necessary to satisfy the retention constraint of the DM is low ($K < K^{\pm}$). By the opposite when the amount of capital requested to satisfy (18) is large ($K > K^{\pm}$), it is more optimal for the CEO to compensate the division manager with additional equity capital. We stress here on the fact that allocating additional equity capital to one division doesn't mean necessarily that the other one will get less. Indeed by contrast with other models where the capital budget is …xed at the beginning, this model doesn't set any constraints on the amount of capital invested since every additional unit of capital involves higher costs for the …rm[26]. In this case, the question of whether outside investors will continue to inject money in the …rm "inde…nitely" or not? seems to be of low interest, since the required return is systematically adjusted respectively to both risk level and the amount of capital invested. So as long as the …rm pays the required cost of capital, no apparent reason could push investors to not invest.

[26] For models where there is a …xed capital amount see Rajan and Zingales (1997)

4 Empirical implications and related papers

In this section we show the relevance of our results for the understanding of observed capital budgeting procedures. Empirically we expect to see the following results:

1. High risky divisions are allocated relatively more capital than lower risky divisions. For instance we expect to see the trading division (high risky) getting more resources than the retail division (less risky).

2. Bigger divisions are more risky than smaller ones. This comes from the fact that bigger divisions will normally require high amounts of capital[27].

3. If the amount of capital requested is high, there is a strong probability for its acceptance by the CEO and the Top management[28]. Consequently we expect to see divisions with high investment opportunities -and so higher requests- allocated more capital than divisions with lower investment opportunities[29].

4. If the division is not requesting high amounts of capital, we will probably see its cash wage budget higher than those of higher capital requests. This means that the cash wage amount allocated to divisions with lower investment opportunities is relatively high to those with high investment opportunities.

5. There is a negative correlation between the amount of capital allocated and the cash wage budget : the more capital a division has, the less cash wage it will get.

[27] In our case we assumed a perfect symmetric information, then the division manager could not lie on the amount of capital he needs.

[28] While in this paper we assumed that the capital allocation decision is entirely in CEO's hand, in reality the situation is quite di¤erent. Indeed di¤erent parties could decide for the amount of capital allocated.

[29] Empirically we use the Tobin's q measure as a proxies for investment opportunities. See Shin and Stulz (1997) and Rajan, Raghuram G.; Servaes and Zingales (1997)

Our conclusions are strongly in line with those established by Harris and Raviv (1996). Indeed these authors showed that there is a positive correlation between the amount of capital requested and the approval probability. At the same time they claimed that divisions with high audit costs and high investment opportunities are allocated less managerial salary. Finally they expect to see monopolistic divisions with high investment opportunities having high approval probabilities for additional request. While the context of analysis in Harris and Raviv (1996) is quite di¤erent[30], it is clear that our results are basically in the same direction as those claimed by these authors.

If we extend these results -particularly 1 and 2- to the context of a …nancial system, we could suggest that bigger banks are more likely to be riskier than smaller ones. This means that the bigger the bank is the more risky it will be. This idea could partly explain why the wave of merger and acquisitions observed in banking industry leads to higher systemic risk[31]. In fact there is almost a general consensus in the …nancial community that the presence of larger institutions presents a danger to the safety and soundness of the …nancial system, because it can directly imposes losses on other institutions and also creates doubts about the health of other institutions. According to Mishkin (1999), the concerns about the contagion from the failure of a large institution is one reason why governments and regulators are reluctant to let large institutions fail[32]. Indeed, with a greater number of large institutions resulting from …nancial consolidation, the pressures to follow a too-big- to- fail policy, in which depositors and other creditors are fully protected against any losses, increases. For instance, if depositors and creditors of large …nancial institutions know that they are likely to be completely protected if the institutions fails, they have even

[30] they do not consider a case of a …nancial …rm. No cost of capital and no risk measure is considered.

[31] See Berger, Demsetz and Strahan (1999)

[32] The case of Long Term Capital Management fund is one example.

less incentive to monitor the institution and pull out their funds when it takes on too much risk. Because of this lack of monitoring, large institutions might take on even greater risks than they otherwise would.

Some static analysis as Berger and Udell (1995), Berger and Udell (1996) and Peek and Rosenberg (1996) have shown that large banking organizations devote lesser proportions of their assets to small business loans than do small organizations. These conclusions are quite in line with our results particularly the idea that the bigger the bank (division) is the more risky it is - we assume that small business projects are less risky than bigger ones. Others like Santos (1997), Keeton (1996) and Berger and Udell (1998) established that consolidation of large banking organizations tend to reduce small business lending. This is also in line with result 4.

Our results …nds also a strong empirical support in Shin and Stulz (1997). These authors …nd that internal capital market allocate more resources to segment that have better investment opportunities, however there is no evidence that investment budgets of a segment with better investment opportunities are protected when the …rm experiences an adverse cash ‡ow shock.

According to the de…nition of internal capital market's e¢ciency stated in the introduction, we could say that our results satisfy two conditions: Indeed we showed that more capital is allocated to divisions with better investments opportunities. While divisions with poor investment opportunities has low probability of approval when they request capital. However we do not know if the investment budget of high productive division is protected when the …rm experiences a sudden big decrease in its global cash ‡ow. Our answer here is that it will depend on the degree of interaction between di¤erent divisions and the risk correlation between di¤erent activities. If for instance a sudden change in the yield curve shape a¤ects the value of the trading Bond's portfolio, there is a high probability to see the credit lending activity affected too. This conclusion has an empirical evidence in Shin and Stulz (1997).

Despite the fact that some empirical papers support the idea that there is a type of socialism inside internal capital markets and by so they explain why conglomerates are priced down by the stock market, we should however look at theses results very carefully. In fact many papers exclude from their set of data the banking industry and so their results could not be applicable in our context. For instance Lamont and Polk (1999) as well as Berger and Ofek (1995) discarded firms with segments in the financial services industry.

While our conclusions plays in favor of a conglomerate form of organization, we should stress that our analysis is typically for the banking industry. Indeed our results are obtained partly through the assumption set on the cash flow function. In fact for a non financial firm, it would be hard to say that the cash flow is a continuous, increasing and concave function of the amount of capital invested. This is partly due to the scale economies inside a non financial industry[33].

In our analysis we assumed not only a perfect symmetric information inside and outside the firm but also a zero risk correlation. This means that the division's investment decision is totally independent from the investment level of another division. In reality however we are more likely to see, interactions between different divisions and so between different types of risks. This plays in a favor of a centralized budgeting process inside banks[34].

[33] Fixed costs are assumed to be relatively high in a non financial industry by comparaison with the banking industry ex: Mining industry

[34] see Froot and Stein (1998)

5 Conclusion

In this article we tried to …ll partially one lack in the literature by building a capital budgeting model which integrates both agency problems and costly capital, and where the interests of outside investors diverge with those of the CEO and the division managers. We showed that an optimal capital budgeting process in this context exhibits many characteristics of the actual allocation schemes. We established in particular that bigger divisions are more likely to be the riskier ones. In the same time we didn't found any form of socialism inside …nancial conglomerates, since we established that bigger divisions with higher capital request will be allocated more resources than smaller divisions. We also found a negative correlation between the wage budget granted to one division and its capital allocation. This means that divisions with smaller investments opportunities will have less capital but higher wages relatively to divisions with high investment opportunities. Although our results were established in a theoretical context, they have however a strong implications particularly in the …nancial system. Indeed we found that consolidation in the banking industry could lead to higher systemic risk. This conclusion is widely claimed in the literature.

Despite the consistency and the empirical evidence of our results some limits persist however. Particularly the assumption of perfect symmetric information and the absence of interaction between di¤erent divisions. Indeed we expect to see some di¤erences in the results if the risk was non observable by outside investors. It could be very interesting to analyze the same model in the context of asymmetric information and where divisional risks are correlated. Although these limits, we think that this paper took a step towards reconciling the budgeting theory and actual practice.

Appendix A.

The bank is assumed to invest in an equity portfolio (buy some shares issued by one firm in the market).

We denote by $A(t)$ the value of the firm's assets at time t, F the face value of a zero-coupon debt issued by the firm and maturing at date T and $D(t,T)$ the market value of the firm's debt at time t . We assume that the debt is bought by a third part outside the bank[35]. Let $S(t)$ denote the market value of equity at time t. The value of equity at date T is

$$S(T) = \left\{ \begin{array}{ll} A(T) - F & ; A(T) \geq F \\ 0 & ; A(T) < F \end{array} \right\}$$

Following Merton (1974), it is assumed that

$$\frac{dA(t)}{A(t)} = \mu \, dt + \sigma \, dB(t)$$

where μ is the instantaneous expected rate of return; σ the volatility and $B(t)$ is a Brownian motion. It assumed that μ and σ are constant implying that $A(t)$ is lognormally distributed. Hence we can write

$$A(t) = A(0) \exp\left[\left(\mu - \sigma^2/2\right) t + \sigma B(t)\right] \quad \text{(A1)}$$

Where $B(t)$ is normally distributed with zero mean and variance t.

Assuming that the default free rate of interest is deterministic over the period of $[0;T]$ and using the results in Merton (1974), we have:

[35] It could be another bank or another firm.

$$S(t) = c[A(t), T, F, \sigma] \qquad (A2)$$

where $c[A(t), T, F, \sigma]$ is the value of a European call option described by:

$$c[A(t), T, F, \sigma] = A(t)N(d_1) - FB(t, T)N(d_2) \qquad (A2.1)$$

with

$$d_1 = \left\{ \ln[A(t)/F\, B(t, T)] + \frac{1}{2}\sigma^2(T - t) \right\} / \sigma\sqrt{T - t}$$

$$d_2 = d_1 - \sigma\sqrt{T - t}$$

$B(t, T)$ = the value of a treasury bill at time t that pays 1$ for sure at date T.

Since π is the expected net cash flow per one unit of investment, it then represents the expected return on investment. For our example if we denote by I_0 the amount of capital invested by the bank in the equity portfolio, then we will have:

$$\pi = \{c[A(t), T, F, \sigma] - I_0\}/I_0 \qquad (A3)$$

and

$$\frac{\partial \pi}{\partial \sigma} = \frac{\partial c[A(t), T, F, \sigma]}{\partial \sigma} = \nu$$

$$\frac{\partial^2 \pi}{\partial \sigma^2} = \frac{\partial^2 c[A(t), T, F, \sigma]}{\partial \sigma^2} = \frac{\delta \nu}{\delta \sigma}$$

we know

$$\nu = A(t)\sqrt{T - t}\, N'(d_1) > 0 \qquad (A4)$$

with

$$N'(d_1) = \frac{1}{\sqrt{2\pi}} e^{-0.5 d_1^2} \qquad (A4.1)$$

and

$$\frac{\delta \nu}{\delta \sigma} = \frac{\delta (A(t)\sqrt{T-t}\,N'(d_1))}{\delta \sigma}$$
$$= \frac{\delta (N'(d_1))}{\delta \sigma} = -\frac{1}{\sqrt{2\pi}} \frac{\delta d_1}{\delta \sigma} e^{-0.5 d_1^2}$$

It is easy to show that

$$\frac{\delta d_1}{\delta \sigma} > 0$$

Then

$$\frac{\delta \nu}{\delta \sigma} = -\frac{1}{\sqrt{2\pi}} \frac{\delta d_1}{\delta \sigma} e^{-0.5 d_1^2} < 0 \qquad (A4.2)$$

Consequently the cashflow per one unit of capital invested is an increasing concave function of the risk level.

Appendix B.

$$\pi_i = \pi(\sigma_i; \theta_i) \quad \text{with} \quad \frac{\partial \pi_i}{\partial \sigma_i} > 0 \quad \text{and} \quad \frac{\partial^2 \pi_i}{\partial \sigma_i^2} < 0 \qquad (A5)$$

$$C_i = C(\sigma_i; k_i) \quad \text{with} \quad \frac{\partial C_i}{\partial \sigma_i} > 0 \quad \text{and} \quad \frac{\partial^2 C_i}{\partial \sigma_i^2} > 0 \qquad (A6)$$

we denote by $F(\sigma) = [\pi_{i,2}(\sigma_i; \theta_i) - C_{i,2}(\sigma_i; k_i)]$

According to (A5) and (A6)

$$\frac{\delta F}{\delta \sigma} = \frac{\partial \pi_i}{\partial \sigma_i} - \frac{\partial C_i}{\partial \sigma_i} \quad \text{and} \quad \frac{\delta^2 F}{\delta \sigma^2} = \frac{\partial^2 \pi_i}{\partial \sigma_i^2} - \frac{\partial^2 C_i}{\partial \sigma_i^2} < 0$$

Therefore F is a concave function and it admits a maximum. We denote by σ_* the risk level at which $F(\sigma)$ is maximized. σ_* is obtained by setting the first derivative equal to zero:

$$\frac{\delta F(\sigma^{*})}{\delta \sigma} = \frac{\partial \pi(\sigma^{*};\theta)}{\partial \sigma} - \frac{\partial C(\sigma^{*};k)}{\partial \sigma}$$

We denote by σ^{**} the risk level at which $F(\sigma^{**}) = 0$.

we know that $F(0)=0$ since $\pi_{i;2}(0;\theta_i) = C_{i;2}(0;k_i) = 0$: This assumes that there is always a risk level associated to any investment, and so if the risk is zero this also means that there is no investment.

we assumed that any project chosen by the manager must have a positive value ($F(\sigma) > 0$); otherwise it will be rejected.

$\pi_{i;2}(\sigma_i;\theta_i)$ and $C_{i;2}(\sigma_i;k_i)$ are both monotone, then F is also monotone (only because we are in $[\sigma^{*};\sigma^{**}]$)

$\frac{\delta^2 F}{\delta \sigma^2} = \frac{\partial^2 \pi_i}{\partial \sigma_i^2} - \frac{\partial^2 C_i}{\partial \sigma_i^2} < 0 \Rightarrow \frac{\delta F}{\delta \sigma}$ is a decreasing function of σ; then for $\sigma > \sigma^{*}$ we have $\frac{\delta F(\sigma)}{\delta \sigma} < \frac{\delta F(\sigma^{*})}{\delta \sigma}$:

$F(0)=0$ and $F(\sigma^{**}) = 0$, we know also that F is strictly positive and monotone and it admits a maximum at σ^{*}

$\Rightarrow$ F is a strictly decreasing function for every $\sigma \in [\sigma^{*};\sigma^{**}]$.

Therefore for every σ_i and σ_j such that $\sigma^{*} < \sigma_j < \sigma_i < \sigma^{**}$, we have :

$F(\sigma_i) = [\pi_{i;2}(\sigma_i;\theta_i) - C_{i;2}(\sigma_i;k_i)] < F(\sigma_j) = [\pi_{j;2}(\sigma_j;\theta_j) - C_{j;2}(\sigma_j;k_j)]$:

Then if division i is riskier than division j, the DM_i has less private benefits than his colleague DM_j: Therefore he has more incentives to rent-seek.

Appendix C.

According to (16), for a given level of rent-seeking e_i the DM_i will rent-seek only if

$$\alpha\left[\pi_{i,2} - C_{i,2}(\sigma_i, k_i^*) + x(e_i)\pi_{i,1}\right] \geq G(e_i)$$

This means that at equilibrium there is a rent-seeking level e_i^* such that $\frac{\delta x(e_i^*)}{\delta e_i}\pi_{i,1} = \frac{\delta G(e_i^*)}{\delta e_i}$. Therefore at e_i^* the constraint (16) is binding. For this level of rent-seeking corresponds a risk level $\sigma^\delta \in [\sigma_*, \sigma_{**}]$ such that

$$\alpha\left[\pi_{i,2}(\sigma^\delta, \theta_i) - C_{i,2}(\sigma^\delta, k_i^*) + x(e_i^*)\pi_{i,1}\right] = G(e_i^*)$$

Since we established (appendix A) that $F(\sigma_i) = [\pi_{i,2}(\sigma_i, \theta_i) - C_{i,2}(\sigma_i, k_i)]$ is a decreasing function of σ for every $\sigma \in [\sigma_*, \sigma_{**}]$, then for every σ below σ^δ we have $F(\sigma) > F(\sigma^\delta)$; and so:

$$\alpha[\pi_{i,2} - C_{i,2}(\sigma^\delta, k_i^*) + x(e_i^*)\pi_{i,1}] < \alpha[\pi_{i,2} - C_{i,2}(\sigma, k_i^*) + x(e_i^*)\pi_{i,1}] \quad (A7)$$

(A7) means also that for $\sigma < \sigma^\delta$ we have:

$$\alpha[\pi_{i,2}(\sigma, \theta_i) - C_{i,2}(\sigma, k_i^*) + x(e_i^*)\pi_{i,1}] > G(e_i^*)$$

and so the rent-seeking condition is not satisfied, then the division manager will not rent-seek.

In the same way, we show that for $\sigma > \sigma^\delta$

$$\alpha\left[\pi_{i,2}(\sigma,\theta_i) - C_{i,2}(\sigma,k_i^*) + x(e_i^*)\,\pi_{i,1}\right] < G(e_i^*)$$

Therefore the rent-seeking condition is satisfied and so the division manager will rent-seeks.

Appendix D.

1$^\delta$/ In the following we consider the case where $\pi_{i,2}(\sigma_i,\theta_i,k_i)$ is an increasing convex function of k. We will show that there exist a unique level of capital $k^\delta \neq 0$ such that $\pi_{i,2}(\sigma_i,\theta_i,k^\delta) = C_{i,2}(\sigma_i,k^\delta)$.

We know that:

$$\frac{\delta\pi_{i,2}(\sigma_i,\theta_i,k_i)}{\delta k} > 0 \quad \text{and} \quad \frac{\delta^2\pi_{i,2}(\sigma_i,\theta_i,k_i)}{\delta k^2} > 0 \qquad \text{(A8)}$$

So $\pi_{i,2}$ is an increasing, monotonous and convex function of k. On the other hand we know that :

$$\frac{\delta C_{i,2}(\sigma_i,k_i)}{\delta k} > 0 \quad \text{and} \quad \frac{\delta^2 C_{i,2}(\sigma_i,k_i)}{\delta k^2} < 0 \qquad \text{(A9)}$$

So $C_{i,2}$ is an increasing, monotonous and concave function of k. On the other hand we know that $\pi_{i,2}(\sigma_i,\theta_i,0) = C_{i,2}(\sigma_i,0) = 0$. According to (A8) and (A9), there exists k_a and k^δ both unique and different from zero such that:

$$\begin{aligned}\pi_{i,2}(\sigma_i,\theta_i,k^\delta) &= C_{i,2}(\sigma_i,k^\delta)\\ \frac{\delta\pi_{i,2}(\sigma_i,\theta_i,k_a)}{\delta k} &= \frac{\delta C_{i,2}(\sigma_i,k_a)}{\delta k}\end{aligned}$$

and

$$\frac{\pm ¼_{i;2}(¾_i; µ_i; k_a)}{\pm k} < \frac{\pm C_{i;2}(¾_i; k_a)}{\pm k} \quad \text{for} \quad k < k_a \qquad (A10)$$

$$\frac{\pm ¼_{i;2}(¾_i; µ_i; k_a)}{\pm k} > \frac{\pm C_{i;2}(¾_i; k_a)}{\pm k} \quad \text{for} \quad k > k_a \qquad (A11)$$

We de…ne F(k) such that $F(k) = ¼_{i;2}(¾_i; µ_i; k)$ ¡ $C_{i;2}(¾_i; k)$: Then we have:

$$\frac{\pm F(k)}{\pm k} = \frac{\pm ¼_{i;2}(¾_i; µ_i; k_i)}{\pm k} ¡ \frac{\pm C_{i;2}(¾_i; k_i)}{\pm k}$$

$$\frac{\pm^2 F(k)}{\pm k^2} = \frac{\pm^2 ¼_{i;2}(¾_i; µ_i; k_i)}{\pm k^2} ¡ \frac{\pm^2 C_{i;2}(¾_i; k_i)}{\pm k^2} ¸ 0$$

Therefore F(k) is a convex function and it admits a minimum at k_a: According to (A10) and (A11) for $0 < k < k_a$; F is a decreasing function of k, while for $k > k_a$ F is an increasing function of k. Since we know that $F(k^{\pm}) = 0$ and $F(0) = 0$ then $k^{\pm} > k_a$ and $F(k_a)$ is strictly negative. Consequently when $¼_{i;2}(¾_i; µ_i; k_i)$ is convex, there exists $k^{\pm} \neq 0$ such that $¼_{i;2}(¾_i; µ_i; k^{\pm}) = C_{i;2}(¾_i; k^{\pm})$ and we have:

$$¼_{i;2}(¾_i; µ_i; k) ¡ C_{i;2}(¾_i; k) < 0 \quad \text{for} \quad k < k^{\pm} \qquad (A12)$$

$$¼_{i;2}(¾_i; µ_i; k) ¡ C_{i;2}(¾_i; k) > 0 \quad \text{for} \quad k > k^{\pm} \qquad (A13)$$

$2^{\pm}$/ For the case where $¼_{i;2}(¾_i; µ_i; k)$ is linear we use exactly the same idea as for the previous case to show the existence of $k^{\pm}$ and we …nd also the same result as for (A12) and (A13).

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