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► **To cite this version:**

G rard Mondello, Nissaf Ben Ayed Smaoui. Agency Theory and Bank Governance: A Study of the Effectiveness of CEO's Remuneration for Risk Taking. 2021. halshs-03502607

**HAL Id: halshs-03502607**

**<https://shs.hal.science/halshs-03502607>**

Preprint submitted on 26 Dec 2021

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# AGENCY THEORY AND BANK GOVERNANCE: A STUDY OF THE EFFECTIVENESS OF CEO'S REMUNERATION FOR RISK TAKING

***Documents de travail GREDEG***  
***GREDEG Working Papers Series***

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**GREDEG WP No. 2020-03**

<https://ideas.repec.org/s/gre/wpaper.html>

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# Agency Theory and Bank Governance: A Study of the Effectiveness of CEO's Remuneration for Risk Taking

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GREDEG Working Paper No. 2020-03

## Summary

**Abstract:** *This article studies the links between governance and risk-taking in banks. For the agency theory, when information are asymmetric, the disciplinary mechanisms of governance have a moderating effect on the remuneration policy and, consequently, the managers' choice concerning the balance between assets' revenue and risk. The following model shows that: i) The presence of effective disciplinary mechanisms does not reduce the latitude of managers to award themselves a high level of wages; ii) This binds the control of risk-taking through remuneration structures. Remuneration is not a determining factor in explaining risk-taking. iii) Contrary to the agency theory's teaching, excessive risk-taking is not induced by asymmetric information.*

**JEL Classification:** G2, G2, G24, G3, G34

**Keywords:** Agency theory, Bank governance, information asymmetry, CEO's remuneration, bank risk.

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## 1. Introduction

A wide shared opinion considers that the late 2000's financial crisis is mainly due to bankers' behavior. The latter would have taken excessive risks for themselves and their customers for years and years in speculation, hedging, competition, etc. (Shah (2009), Minhat (2016), Maudos (2017)). Both at the international and national levels, States and banks regulatory authorities took preserving measures to induce the banks' CEO to more cautious behavior (Bale III enforcement, European banking regulation under the Aegis of European Central Bank, etc.). However, nothing prove that those prudential policies could be satisfactory to preserve our financial and economic system from failure.

Consequently, constantly, financial and banking economists study how avoiding future new bank collapse. Then, among the possible research ways, understanding any banking crisis triggers is a first and necessary step (Laeven et al., (2010), Lang and Jagtiani (2010), Tarraf (2010), Clarke (2010)). Then, numerous empirical studies reveal that many bank bankruptcies all around the world are mainly due to slack bank governance (Kumar et Singh (2013), Yeoh (2009), Fetisov (2010), Blundell-Wignall et. al. (2008)). In this sense, the OECD report (Key Findings and Main Message, 2009) suggests that four aspects of bank governance explain these weaknesses:

- 1) The remuneration panel inside the financial sector seems both highly correlated to excessive risk-taking and seems disconnected from the business performance, (Kirkpatrick (2009),
- 2) The risk management system does not consider the company as a whole,
- 3) The risk seems inherent to the remuneration systems, and, finally,
- 4) The board is inefficient to curb the executive's willingness of excessive risk-taking, (Dobbin et al. (2010), Abdullah (2006)).

According to Jickling (2010), Blundell-Wignall et al. (2008), excessive manager's remuneration and weak governance are the main factors that induce undue risk-taking (Berrone (2008) and Van Den Berghe (2009)). Turner's report (March 2009) identifies the main crisis causes and it points out that improving the governance mechanisms is essential in the crisis wake (Peni and Vahamaa, 2011). Nowadays, to prevent new crises' resurgence governments and regulators draw up rules and norms. However, they bring attention only to the visible side (Dobbin et al. (2010)). Indeed, most analysis suggest that unsuitable remuneration structures constitute the main international banking crisis factor (Coles and al. (2006), Core and Guay

(2002), Chen et al. (2006), Low (2009), Mehran and Rosenberg (2008), and Rajgopal and Shevlin (2002)). With particular acuity, this raises the question of the governance mechanisms to choose controlling executives' payment levels and risk-taking behavior (Barkema and Gómez-Mejía (1998)).

Therefore, proposals mainly focused on regulation of the remuneration structure in the banking sector<sup>2</sup>. Several researchers propose to adapt the CEO's remuneration schedule to reduce the risk-taking. For instance, Bolton, Mehran, and Shapiro (2011) propose indexing a component of executive compensation on the firm's default risk. This allows aligning the goals' leader with the social objectives in the risk selection process. Sharfman, Toll, and Szydlowski (2009) suggest the adoption of a policy to recover executive compensation in order to control excessive risk-taking behavior. The belief that the CEO pay is an incentive for excessive risk takes its roots in the legal and financial approach to corporate governance (Boydallian and Ruiz-Verdu (2015)). Indeed, these problems arise from both the information asymmetry and the interest divergence between the principal (the shareholders) and agent (the executive) that result from the separation between ownership and control (Poulain-Rehm, (2003)). The CEO can take advantage to take decisions that maximize his own utility function through, notably, an excessive payoff that can lessen the shareholders' gain. The manager may benefit from his own private information to make decisions that maximize his own utility function through, among other things, excessive remuneration that reduces shareholder profit (Shleifer and Vishny (1997)). In this respect, the governance systems challenge lies in establishing incentive and control mechanisms that should prevent the agent's behavior to harm the principal's interests, and, on the contrary, to behave as if he sought to maximize the principal's utility function (Jensen and Meckling (1976), Fama (1980)).

Indeed, the managers' attitude towards risk may not be optimal from the shareholders' view. Without additional incentives such as incentive payment, managers may be too risk-averse because they do not want to endanger their personal financial assets or the human capital they invested in the business. This often leads to situations where the manager makes investments less risky than those preferred by shareholders (Shapiro (2005), Eisenhardt, (1989)). In this regard, to frame the decisions of the managers and align their interests with the shareholders' ones, supervisory structures must be set up. Supervisory control is a fundamental task of the board of directors and this involves taking a series of coercive or incentive measures, among which the structuring of remuneration plays a decisive role.

Agency theory addresses issues arising from the benefits of agents' divergent risks and information asymmetries and proposes governance mechanisms to monitor and motivate

managers to act in the shareholders' interest. The creation of disciplinary mechanisms (provided by the board of directors) and incentives (the compensation structure) are the main requirements of agency theory (Jensen (1993), Daily et al. (2003), Bebchuk, (2003).) The central objective of the governance mechanisms is minimizing the value losses resulting from the manager's deviant behavior who is supposed to pursue his own interests. This could notably issue through excessive remuneration (Charreaux and Wirtz (2006)). In summary, and according to the Agency theory predictions:

1) Corporate governance mechanisms create an environment that encourages executives to take excessive risks. Informational asymmetries, then, constitute a sufficient condition for this.

2) If disciplinary governance mechanisms are effective, the possibility of excessive remuneration for managers should be limited. On the other hand, the failure of such mechanisms increases the latitude of the managers to obtain a high level of salary.

May Agency Theory explains the excessive risk-taking issue (Dalton et al., (1998)) as seems thinking it Smith and al., (2009)? Or, is it unable to do it in spite of its strong normative capacity? Is risk-taking on the part of bank governance actually the cause of the crisis (Shah 2009)? One recognizes excessive risk-taking as the main crisis trigger, so, is it caused by executive remuneration structures? Then, because of these questions, the banks governance and its underlying theories must be thoroughly reviewed to avoid failures in the future.

To address these issues, we present a theoretical model that examines the impact of different types of executive remuneration on his strategic risk-taking decisions. The concern bears on to what extent the governance mechanisms (corresponding to different remuneration schemes) play an effective mitigating role on the remuneration policy and the level of risk taken by the bank. The question then arises whether it is possible to control the risk-taking of the executive through the remuneration structures (Ghoshal (2005)). We then distinguish two situations.

- The first one analyzes the case of symmetric information where both the bank's stockholders and the manager share the same interest. We analyze the choice of the manager in terms of risk, considering the equilibrium i) in the absence of a bank's failure condition and ii) and in the presence of this condition.

- The second introduces the information asymmetry assumption in order to analyze the risk taken by the manager in such a case. Precisely, the influence of information asymmetry on the manager's remuneration and, consequently, on his risk behavior is studied.

As a result, considering an observable risk, when the executive manages the bank in agreement with the Board of Directors ("one voice"), risk-taking is similar to the first-rank condition in any case. The model also shows that the type of remuneration is not decisive in explaining the risk-taking of the manager: a remuneration indexed to the risky assets does not automatically involve a greater risk-taking. The remuneration methods under consideration do not make it possible to achieve the optimal portfolio for shareholders (i.e. the level that maximizes their gain).

Under asymmetric information, effective disciplinary mechanisms do not reduce the latitude of the executive to obtain a high level of salary. Consequently, it seems unlikely that the Board of Directors will be able to monitor the risk-taking through the remuneration structures. This result contradicts the predictions of the agency theory for which remuneration is supposed to be an incentive mechanism of governance that makes convergent the interests of both managers and shareholders. In summary, the explanatory power of the agency theory in terms of banking risk behavior seems weak (Jensen and Murphy, (1990)).

The study is then structured as follows. Section 2 introduces the theoretical context by highlighting the theoretical basis of agency theory. Section 3 analyzes the bank's optimal risk choice by distinguishing between two assumptions: first, it considers the perfect convergence between managers and shareholders (i.e. the risk is observable), distinguishing two configurations: first, the equilibrium in the absence of bankruptcy and, second, equilibrium with the failure assumption. The second hypothesis analysis cases where the CEO's remuneration is associated with different incentives. Section 4 analyzes the choice of risk under the assumption of information asymmetry between shareholders and managers (i.e. unobservable risk), we consider several patterns of executive compensation. A final section concludes.

## **2. The model basic structure under symmetric information.**

The present model analyzes the behavior of a bank submitted to the threat of systemic risks. Concretely, this means that a competitive bank invests its resources in two categories of independent assets that present different levels of risk and profitability. The first type of asset presents a high-profit expectation but, also, a high risk of systemic failure. The second type presents lower earnings expectations but a lower risk level than the former. These asset classes correspond to well-specified types in which other banks also invest. For example, the portfolio may be composed with real estate loans on the one hand and with low income securities on the other one. The notion of risk refers to the bank's likelihood of potentially losing all of its assets and their earning. Indeed, here systemic risk means that the bank by investing in the assets under consideration contributes changing the market global risk and, consequently, the bank contributes to changing its own risk (Brownlees and Engle, (2017)). We specify below the characteristics of this process.

The bank invests its entire holdings in one or both of the above assets by seeking the highest level of return but minimizing its possible risk. Investors know that both asset classes have a non-zero risk of default. Thus, the more investors buy these assets hoping high returns, the more likely are to collapse. The most typical example is investment in unstable business (as the internet stocks crisis in the 2000s) or in favor of speculative real estate bubbles (sub-prime in the USA, or real estate crisis in Spain in the years 2008). In other words, if, in a given sector, the initial inflow of capital contributes to its expansion, then, a continuous financial feeding reaching a certain threshold triggers a lowering in revenues and contributes to potential ruin. By assumption, In the model, the high and low-risk thresholds have already been exceeded. Consequently, any increase in marginal financing, while not reducing gross profitability, nevertheless contributes to increasing the bankruptcy risk. Thus, no investment is risk-free and the likelihood of a portion of the portfolio's assets collapsing is non-zero. Then, above a certain threshold, investing in an asset increases its risk of default.

## **2.1 Notations, assumptions and basic relationships**

### **2.1.1 Basic presentation**

We consider  $\varphi$  the amount in account unity to be invested by the bank. This constitutes the bank's resource and is composed by its' customers' deposits  $d$  and by the bank's capital  $n$  constituted by  $n$  shareholders (where each one holds one unit of it) as in Bolton, Mehran and Shapiro (2010). Then, the bank's assets correspond to the sum of the deposits and the capital's owners:



$$\varphi = d + n \quad (1)$$

Here, the executive seeks to maximize the shareholders' earnings. To do that, he fully uses the available resources  $\varphi$  and invests them in two risky portfolios, respectively, portfolios A and B (no idle resources).

- The portfolio A's risk is supposed to be low and promises a payoff (capital+ interest)  $\bar{R}$  where  $\bar{R} = 1 + \bar{\Gamma}$  and  $\bar{\Gamma}$  is the profit rate of portfolio A.
- Portfolio B is riskier but also more profitable than A with an expected payoff of  $\underline{R}$ , where  $\underline{R} = 1 + \underline{\Gamma}$ .

Then, the fact that A brings lower profits than B, means that  $\underline{R} > \bar{R} > 0$ . Let consider now that,  $x$  and  $y$  are respectively:

- $x$ : the share of the resource  $\varphi$  invested in A,
- $y$ : the share of  $\varphi$  invested in B with

$$\varphi = x + y$$

As a simplification we normalize this writing:

$$\varphi = d + n = x + y = 1 \quad (2)$$

At the moment, we do not specify the variation sense of the following probability densities, we consider:

$p(x)$  : The portfolio A's probability of success, and  $(1 - p(x))$  its probability of failure. "Failure" means the shutdown of the portfolio value to 0.

$\pi(y)$  : The portfolio B's probability of success and  $(1 - \pi(y))$ , its failure probability.

The normalization  $\varphi = 1$  allows eliminating a variable, so  $y$  can be expressed as a function of  $x$ . As stated above, the investment in each asset is risky, this means that the bank may lose its fund, consequently, a bankruptcy causes a total loss expressed as 0. Thus, the expected payment of each asset becomes:

$$E_A[x] = \bar{R}xp(x) + 0x(1 - p(x)) = \bar{R}xp(x) \quad (3)$$

And, for asset B, we similarly operate:

$$\begin{aligned} E_B[y] &= E_B[(x)] = \underline{R}(1 - x)\pi(1 - x) + 0(1 - x)(1 - \pi(1 - x)) \\ &= \underline{R}(1 - x)\pi(1 - x) \end{aligned} \quad (4)$$

Consequently, having defined the event-tree of each asset category, we may describe the bank's expected payoff according four states of nature corresponding to the following situations where  $S$  describes the no-failure of either asset A our B and 0 the failure of asset A or B. Then, these four situations may be expressed in the set  $\mathcal{S}$  of the possible states of nature that the economy as a whole may take

$$\mathcal{S} = \{SS, S0, 0S, 00\}$$

If it is obvious that the situation  $\{00\}$  is a complete systemic crisis where both assets failed, but  $\{S0, 0S\}$  is also a systemic risk in which either asset A or asset B fully failed while the other one maintained. Even if it is low the probability of a full bankruptcy expresses as:

$$P(00) = (1 - p(x))(1 - \pi(1 - x))$$

Reaching this point some precisions about the assets' probability are needed. The probabilities  $\{p(00), p(S0), p(0S), p(SS)\}$  are dependent probabilities. Indeed, these depend on the amount of investment made by the other financial actors, and their values should be read as “ the probability of the event 00, for instance, is  $p(00)$ , given the investement  $C + g$  and  $C' + g'$  made by the other actors in, respectively, assets A and B (where  $g$  and  $g'$  are the investment made beyond  $C$  and  $C'$ , the points from which the returns are decreasing) . Or, still, more rigorously:

$$P(00) = P((00|C + g, C' + g'))$$

This reads as: “probability of a complete failure of both assets A and B, knowing that respectively the amounts  $C + g$  and  $C' + g'$  have been invested in each asset.

One may wonder why investors do not stop investing when  $C$  and  $C'$  are reached. In fact, both assets are not globally regulated, and nobody can stop investors to invest in such assets in so far as their expected value is positive. Even, with risk adverse investors, the probability of failure remains positive. We can express now, a specific bank's expected gain after having expressed the decision tree that it faces with (see below fig. 1). These questions allow to make some precisions. Hence, in this economy, the considered bank has a non-null weight and its investments in a given asset influence the probability of financial bankruptcy.

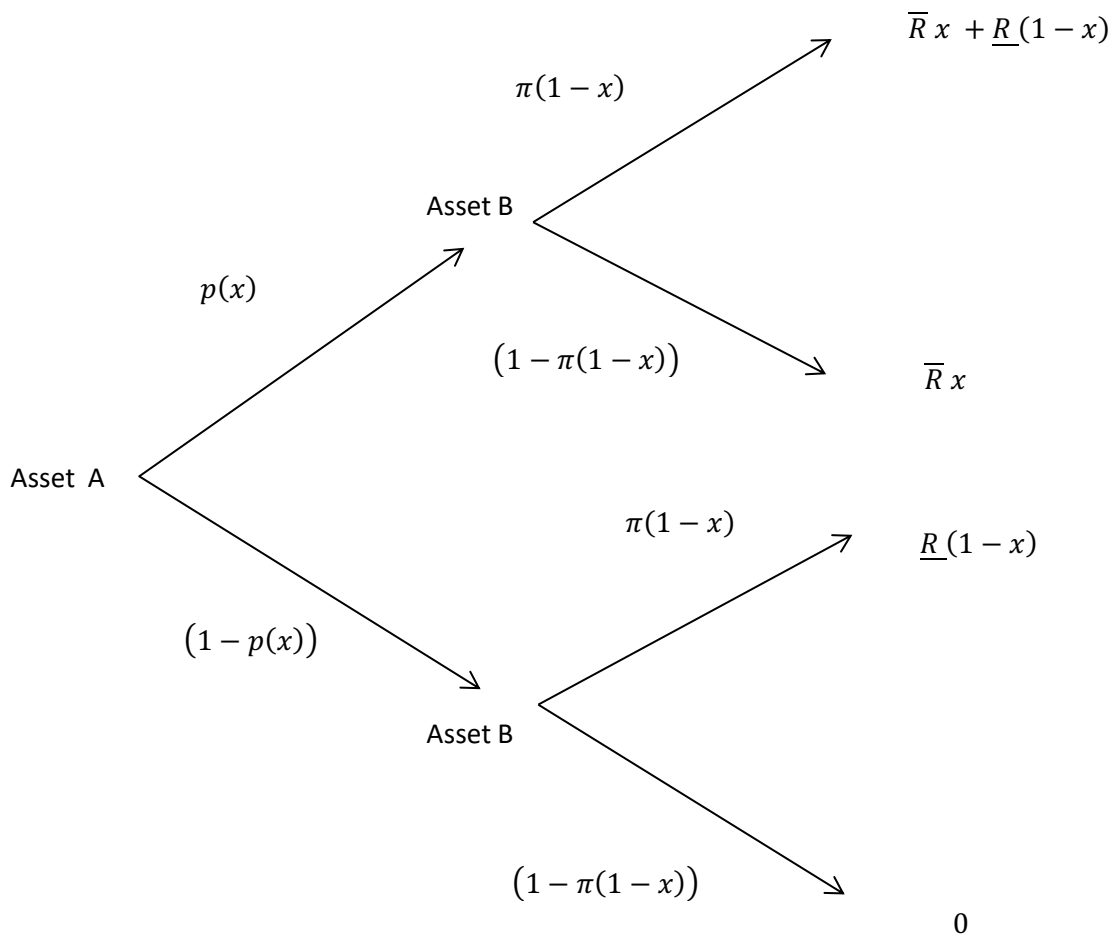


Figure 1: Decision tree of the Bank's portfolio.

We deduce from the above writing, the payoff of the bank's expected portfolio payoff  $[X]$  :

$$\begin{aligned}
E[X] &= p(x)\pi(1-x)\left(\bar{R}x + \underline{R}(1-x)\right) + p(x)(1-\pi(1-x))\bar{R}x \\
&\quad + (1-p(x))\pi(1-x)\underline{R}(1-x) + (1-p(x))(1-\pi(1-x))0 = \\
E[X] &= p(x)\bar{R}x + \pi(1-x)\underline{R}(1-x) = E_A[x] + E_B[1-x] \tag{5}
\end{aligned}$$

The maximization of the value of this portfolio depends on the probability distributions  $p(x)$  and  $\pi(1-x)$ .

### 2.1.2 Systemic risk situation

The Bank's systemic risk means that the bank invests in risky assets and that no “free from risk” asset does exist. By assumption, the bank invests in two risky asset classes that characterize the financial system of the whole economy. Thus, any actor is likely to invest in these assets. Our implicit assumption is that the banking economy is in a situation where the threshold of risk-free investment or lower risk is already exceeded. This means that if we consider the assets, A and B, then by hypothesis, the gain functions are growing up to a certain level, then they decrease from it as new funds still are invested in these assets. Thus, by assumption, for asset A, inside the interval  $[0, C]$ , the expected payoff  $E_A[x]$  is growing until  $C$  and decreasing then and for the asset B, the income  $E_B[y]$  grows inside the interval  $[0, C']$  and decreases beyond. In other words, from both limits (respectively  $C$  and  $C'$ ) the probability of bankruptcy increases and the expected return of each one decreases. We hypothesize that both assets have reached their profitability limit, which means that the opportunities left to the bank are assets in which investments that maximize income levels and minimize losses have already been realized. Then, as either  $x$  or  $y$  increases, then, the default risk increases too. Let the probability  $p(x)$  be a **no-default probability**. In order to make this expression analytically treatable, we make the following assumptions (recording that  $x + y = 1$ ) :

$$p(x) = \begin{cases} 0 & \text{if } x = 0 \\ 1 - ax, & \text{if } x \neq 0 \\ 1 - a & \text{if } x = 1 \end{cases} \tag{6}$$

$$\pi(y) = \begin{cases} 0 & \text{if } y = 0 \\ 1 - by, & \text{if } y \neq 0 \\ 1 - b & \text{if } y = 1 \end{cases} \tag{7}$$

Note that  $p(x)$  and  $\pi(y)$  are at their higher level when, respectively,  $x = 1$  and  $y = 1$ , because  $x, y \in ]0,1]$ . We set  $1 > b > a > 0$ , that means that the probability of no-default of the

risky asset is lesser than the no-risky one, i.e.  $p(x = 1) = 1 - a > p(Y = 1) = 1 - b$ . Obviously, these values are reached alternatively when  $x = 1$  (and  $y = 0$ ) or  $y = 1$  and ( $x = 0$ ). Then, we assume that  $\underline{R}(1 - b) < \bar{R}(1 - a)$ , with obviously  $E[X] \geq \bar{R}(1 - a)$ . Substituting these values in  $E[X]$ , we get:

$$E[X] = (1 - ax)\bar{R}x + (1 - b(1 - x))\underline{R}(1 - x) \quad (8)$$

$$E[X] = -(a\bar{R} + b\underline{R})x^2 + (\bar{R} - \underline{R} + 2b\underline{R})x + \underline{R}(1 - b) \text{ or still to simplify:}$$

$$E[X] = -Ax^2 + Bx + C \text{ or for } y,$$

$$E[Y] = -(a\bar{R} + b\underline{R})y^2 + (\bar{R} - \underline{R} + 2a\bar{R})y + \bar{R}(1 - a)$$

$$E[Y] = -Ay^2 + (2A - B)y - A + B + C \quad (9)$$

Or,  $(a\bar{R} + b\underline{R}) = A$ ,  $(\bar{R} - \underline{R} + 2b\underline{R}) = B$ , (where  $B > 0$ ) and  $\underline{R}(1 - b) = C$ .

This value represents the expected gross income of the wealth invested by the Bank in the previously defined asset portfolio. We now have to define the Bank's expected costs in order to define the expected net revenues.

## 2.2 The optimal portfolio with an observable risk (one voice)

Let us consider the case where the risk level is observable. As the whole set of the bank's resources is constituted from its clients' deposits and its owners' capital, the per share payoff  $s(x)$  depends on the ratio of  $x$  and  $y$  minus the interest rate  $r$  paid to depositors. On the closing date, net revenue from interest paid to the Bank  $G(x)$  is then:

$$G(x) = n(1 + s(x)) + d(1 - r) \quad (10)$$

The variables  $n$ ,  $d$  and  $r$  are given and, as:  $\varphi = n + d = 1$ , we get:

$$G(x) = n(1 + s(x)) + d(1 - r) = 1 + ns(x) - dr \quad (11)$$

For shareholders, the expected net gain of the portfolio consisting of A and B may be expressed as the difference between the return on the assets of these portfolios less deposits and the remuneration associated with them:

$$ns(x) = E[X] - d(1 + r) \quad (11)$$

And, per share, the remuneration is then:

$$s(x) = \frac{E[X] - d(1 + r)}{n} = \frac{-Ax^2 + Bx + C - d(1 + r)}{n}$$

Or still, after fully developing it, we get the following function:

$$s(x) = \frac{1}{n} \left( -(a\bar{R} + b\underline{R})x^2 + (\bar{R} - \underline{R} + 2b\underline{R})x + \underline{R}(1 - b) - 1 + dr \right) \quad (13)$$

(13) is quadratic and concave in  $x$  as shown by its first and second derivatives :

$$s'(x) = \frac{1}{n} \left( -2(a\bar{R} + b\underline{R})x + (\bar{R} - \underline{R} + 2b\underline{R}) \right) \text{ et } s''(x) = \frac{1}{n} \left( -2(a\bar{R} + b\underline{R}) \right) < 0$$

If the bank manager seeks to maximize the shareholders' interests, then he maximizes the bank's gain, which amounts to maximizing the earnings per share. To obtain this maximization, it suffices to find the level of  $x^*$  which cancels the first order condition:

$$s'(x^*) = 0 \text{ and } \frac{\partial s(x)}{\partial x} = \frac{2b\underline{R} + (\overline{R} - \underline{R}) - 2(a\overline{R} + b\underline{R})x}{n} = 0 \quad (14)$$

Then, it exists  $x^*$  such then:

$$x^* = \frac{2b\underline{R} + (\overline{R} - \underline{R})}{2(a\overline{R} + b\underline{R})} = \frac{B}{2A} \quad (15)$$

(Recall that  $2b\underline{R} + (\overline{R} - \underline{R}) = A$  and  $2(a\overline{R} + b\underline{R}) = A$ )

As  $1 > \frac{B}{2A} > 0$ , i.e.  $1 > x^* > 0$ .  $x^*$  expresses the proportion of the low-risk asset that maximizes the value of the share and we deduce:  $y^* = 1 - x^*$ . When  $x = 1$ , (the whole bank's capital is invested in the asset (A), then the expected value is:

$$s(1) = \overline{R}(1 - a) - d(1 + r) \quad (16)$$

While if the whole wealth is invested in the risky asset ( $x = 0$ ), then:

$$s(0) = \underline{R}(1 - b) - d(1 + r) \quad (17)$$

The bank can fail, and this may happen with the probability  $(1 - \pi(1 - x))(1 - p(x))$ . This could happen under a general banking system crash. In this case, the bank cannot reimburse depositors 'and bondholders' resources. Although this case may be exceptional, we cannot rule out a bank default that results in all expected returns not being recovered. To avoid this risk, we set a default condition.

### 2.3 The condition of no-bankruptcy

The assumption of no-bankruptcy involves that a certain level of income  $\beta E(X)$  (where  $\beta \in (0,1)$ ) must be guaranteed. Then, the no-bankruptcy condition must insure that:  $d \leq \frac{\beta E(X)}{1+r}$ . Then, the present value of the gains must be at least equal to the deposits of the customers and the CEO's program is then:

$$\text{Max}_x \{s(x)\} = \text{Max}_x \left\{ \frac{1}{n} (E(X) - d(1 + r)) \right\} \quad (18)$$

Under the constraint that the depositors and shareholders realize their expected income level:

$$d(1 + r) \leq \beta E(X) \quad (19)$$

Rewriting constraints and replacing  $d$  by the saturated constraint in the function profit, we get:

$Max_x \left\{ \frac{1}{n} (E(X)(1 + \beta)) \right\}$  or still, giving to  $E(X)$  its value:

$$Max_x \left\{ \frac{1}{n} \left( (-a\bar{R} + b\underline{R})x^2 + (\bar{R} - \underline{R} + 2b\underline{R})x + \underline{R}(1 - b) \right) (1 + \beta) \right\} \quad (20)$$

From the first order condition, we get:

$$\frac{\partial s(x)}{\partial x} = \frac{\partial \left[ \frac{1}{n} \left( (-a\bar{R} + b\underline{R})x^2 + (\bar{R} - \underline{R} + 2b\underline{R})x + \underline{R}(1 - b) \right) (1 + \beta) \right]}{\partial x} = 0 \quad (21)$$

And obviously:

$$x^* = \frac{2b\underline{R} + (\bar{R} - \underline{R})}{2(a\bar{R} + b\underline{R})} = \frac{B}{2A} \quad (22)$$

From this issue we deduce the following proposition:

**Proposition 1:** *When the risk is observable (i.e. the distribution between risky and non-risky investment is known) and when the CEO manages the bank "with one voice", despite a condition of no-bankruptcy, the bank's risk taking is similar to the first best condition.*

**Proof:** The proposition comes from the above argument.

This result is consistent with Bolton (2013) who uses a different way but concludes similarly. Does this result differ when the risk is unobservable? As the manager and the shareholders share the same interests, any level of  $x$  that diverges from  $x^*$  leads to a lower level of profit. Therefore, Proposition 1 extends to the non-observability of risk. The directors will seek to protect the interests of shareholders by minimizing executive compensation. Thus, can we expect that the executive's salary is more limited when the directors board plays an active role?

### 3. Unobservable risk: Dissociation of voices

By unobservable risk, we understand this situation where the executive chooses the portfolio independently from the shareholders and receives an incentive payment. However, the range of possible remuneration schemes is high, and consequently, we study some specific cases. The constant factor of the model holds by the fact that the CEO's remuneration comprises two elements. First, he perceives a fixed salary  $w_0$  and, second, he receives a profit

sharing. The question is then how to define this share to make it attractive enough to decide him to make the best choices for shareholders. We consider two possibilities :

- A premium on the riskier assets,
- A premium on the less risky assets.

### 3.1 Premium on the riskier assets

Let  $\alpha$ , be the share of the profit on the risky asset that is served to the executive where  $\alpha \in (0,1)$ . If  $W(x)$  represents the whole remuneration of the latter, then:

$$W(x) = w_0 + \alpha\pi(1-x)\underline{\Gamma}(1-x) \quad (23)$$

Where  $\underline{\Gamma}$  is the net rate of return of risky assets. Or, replacing  $\pi(1-x)$  by the analytic value of the probability:

$$W(x) = w_0 + \alpha[1 - b(1-x)\underline{\Gamma}(1-x)] \quad (24)$$

The shareholders' program becomes by putting  $S(x) = n s(x)$ :

$$Max_x\{S(x) - W(x)\} \quad (25)$$

Hence, replacing  $S(x)$  and  $W(x)$  by their analytic value too, the program becomes:

$$\mathfrak{L}(x)_1 = Max_x\{E(x) - d(1+r) - [w_0 + \alpha[1 - b(1-x)]\underline{\Gamma}(1-x)]\} \quad (26)$$

Looking for the cancelation of the first order conditions of  $\mathfrak{L}(x)_1$ , then,  $x^0$  is determined such that  $x^0 \geq 0$ :

$$\begin{aligned} \frac{\partial \mathfrak{L}(x^0)}{\partial x} &= 0 \Rightarrow \\ x^0 &= \frac{B - \underline{\Gamma}\alpha + 2b\underline{\Gamma}\alpha}{2(A + b\underline{\Gamma}\alpha)} \end{aligned} \quad (27)$$

As :

$$x^* = \frac{2b\underline{R} + (\overline{R} - \underline{R})}{2(a\underline{R} + b\underline{R})} = \frac{B}{2A} \quad (28)$$

We can compare  $x^0$  and  $x^*$ . Then,  $x^0 > x^*$  is true, if after simplification<sup>1</sup>:

---

<sup>1</sup> By assumption  $\frac{B - \underline{\Gamma}\alpha + 2b\underline{\Gamma}\alpha}{(A + b\underline{\Gamma}\alpha)} > \frac{B}{A}$ , then :  $-A\frac{1}{2A} + 2bA\frac{1}{2A} > bB\frac{1}{2A}$  et,

$-\frac{1}{2} + b > bB\frac{1}{2A} = bx^*$  with,

$$1 - \frac{1}{2b} > x^*$$



$$\frac{B - \Gamma \alpha + 2b\Gamma \alpha}{2(A + b\Gamma \alpha)} > \frac{B}{2A}$$

Or still :

$$1 - \frac{1}{2b} > x^* \quad (29)$$

This means that maximizing the shareholder's income will result in an increase in the share of the riskier asset if the above condition is verified. It should be noted that this condition is independent from the proportion of risky assets held.

**Proposition 2:** *If the remuneration of the executive consists of a fixed part and a variable part and the latter is made up of risky assets (according to the specificities of our model), then the manager chooses a riskier portfolio compared to a "one-voice" management situation if:*

$$1 - \frac{1}{2b} > x^* \quad (30)$$

*Otherwise, the share of risky assets will be less.*

**Proof:** (see the above argument).

The assertion that a remuneration of the manager over the risky part of the bank's portfolio would lead the bank to take additional risks is not automatically verified<sup>2</sup>. A similar reasoning can be applied if the remuneration includes part of the less risky asset.

### 3.2 Premium on the less risky asset

Here, surplus earnings depend on the expected income of the low-return portfolio.

$$W(x) = w_0 + \alpha[1 - ax]x\bar{\Gamma} \quad (31)$$

The program that maximizes the shareholders' expected wealth becomes:

$$\mathcal{Q}(x)_2 = \text{Max}_x \{E(x) + rd - [w_0 + \alpha[1 - ax]x\bar{\Gamma}]\} \quad (32)$$

Therefore, we search the proportion  $x^{00} \geq 0$  such that:

$$\frac{\partial \mathcal{Q}(x^{00})_2}{\partial x} = 0 \Rightarrow x^{00} = \frac{B + \bar{\Gamma} \alpha}{2(A + a\bar{\Gamma} \alpha)} \quad (33)$$

---

<sup>2</sup> Une autre condition qui doit être vérifiée est que :  $\frac{aA}{b(2A-B)} < 1$ , ou de façon similaire que  $\frac{b}{2b-a} < \frac{A}{B}$ . On sait que  $\frac{b}{2b-a} < 1$  car  $b - a > 0$ .

We now compare this value with the situation in which both the interests of the shareholders and the manager are confused, that is, the case where the manager is tempted to increase the level of the least risky portfolio (as the Board of Directors requires it). In other words, the conditions for  $x^{00} > x^*$ , which is true for:

$$\frac{1}{a} > \frac{B}{A} \Rightarrow \frac{1}{2a} > \frac{B}{2A} = x^* \quad (34)$$

We deduce the proposition 3:

**Proposition 3:** *If the remuneration of the manager integrates both a fixed part and a variable part and the latter is made up with a proportion of profit drawn from the less risky assets, then the manager modifies the portfolio for a less risky proportion compared to a "with one voice" management situation » if  $\frac{1}{2a} > \frac{B}{2A} = x^*$ . Otherwise, the portfolio will be riskier.*

**Proof:** (see the above argument).

As previously, the choice of a more or less risky portfolio is independent from the proportion of assets "captured" by the manager but depends on the ratio  $x^*$  (The portfolio of equilibrium in the situation where the interests of the manager merge with that of the shareholders) with the proportion  $\frac{1}{2a}$ . Again, differentiated risk-neutral remuneration does not lead to the conclusion that, automatically, the manager will choose to minimize the risk (or increase) the risk of the portfolio compared to the situation where the choice is carried out "with one voice".

#### 4. Asymmetric information and incentive remuneration

At present, the manager can take initiatives of his own without referring to the Board of Directors. As before, the remuneration of the manager is made up of a fixed part and a variable part calculated on the total profit. The remuneration conditions are defined a priori, and the board of directors must choose the officer who will be able to offer the highest remuneration for the lowest risk. Consequently, it chooses to delegate its management powers because it is incapable of managing it. As a result, the relationship with the manager is typically an agency relationship. Shareholders must choose the most efficient manager, i.e. the one who ensures the highest level of share valuation while guaranteeing the lowest risk. Here, the delegation process is similar to the choice of one project among several (e.g. projects for bank financing, or clients of an insurance company). The unknown is the manager capability and this choice corresponds to an adverse selection situation. Indeed, adverse selection assumes an information asymmetry

between the shareholders (the principal) and the manager (the agent). Here, the latter knows the bank market situation and disposes of information unknown by the board. Furthermore, to induce the executive to make effective decisions, his remuneration consists of an incentive governance contract. This one is based, as further emphasized, on the devolution of a portion of the profits to his remuneration. Indeed, by his choices, the manager can get a larger or a small share of the profits. For example, he can obtain stock options, or buy shares.

This behavior is linked to the manager's private information. Consequently, the bilateral contract signed with the principal must lead the agent to favor the shareholders' interests. To do this, the latter must be prepared to pay an information rent to the agent. This payment follows two objectives: first, it must induce the agent to adjust his choices to the shareholders' interests as well as to reveal and, second, it has to lead choosing the most effective agent. In the proposed scheme, the relationship is carried out within the framework of a contract between the future manager and the board of directors, because the choice is made once and for all, and there is no repetition in the period under consideration

When the information with the executive is asymmetric and after the setting of remuneration rule, the shareholders have to drive him to maximize their gains while giving him a reduced to a minimum informational rent. To address this issue, we assume that several payment contracts are available, and we compare them to choose the one that reveals the most efficient agent. Three types of remuneration are considered in addition to a fixed remuneration. The first is based on an incentive corresponding to the granting of a fraction of the portfolio as a whole, the second is based on a share of the profits of the riskiest assets and the third on the least risky ones.

#### **4.1 Remuneration based on the whole portfolio profits**

The model's foundation assumes that:

A1: The "Agent" is the Executive Officer while the Board represents the shareholders' interests and is called the "Principal".

A2: Agent and principal are both gifted with a Savage expected utility function and are supposed to be neutral to risk.

##### **4.1.1 The Model under symmetric information**

We recall that after payment of interest, the bank's global profit is:

$S(x) = E(X) - d(1 + r)$  and  $W$  is the executive's payment:

$$W(x) = w_0 + \alpha S(x), \quad 1 > \alpha > 0^3 \quad (35)$$

Where  $w_0$  is a fixed payment. So that, as before, the of Board of Directors' program is:

$$\text{Max}_x \{S(x) - W(x)\} = \text{Max}_x \{S(x) - (w_0 + \tilde{\alpha} S(x))\} \quad (36)$$

Let  $\mathcal{H}$  be the set of the feasible contractual remunerations:

$$\mathcal{H} = \{(x, W), x \in [0,1], W \in \mathbb{R}\}.$$

This set of contracts can be chosen under the authority of a third party, which may be a court. Therefore, it is important for the board to choose the most effective leader, that is to say one that is likely to deliver the highest earnings  $(1 - \alpha)S(x)$  at the lowest cost. For simplicity we assume that there are two categories of executives, one is efficient and is designated by  $\underline{\alpha}$  and the other one is inefficient and indexed by  $\bar{\alpha}$ , where  $\bar{\alpha} > \underline{\alpha}$ ;  $\underline{\alpha}$  and  $\bar{\alpha}$  are known proportions. In the absence of asymmetric information, the conditions of an optimal contract for the two categories of agents are those for which:

$$S'(\underline{x}^*) = W(\underline{x}^*) \quad (37)$$

and,

$$S'(\bar{x}^*) = W(\bar{x}^*) \quad (38)$$

In the specific case of the model, we get:

$$\underline{x}^* = \bar{x}^* = \frac{B}{2A} \quad (39)$$

Indeed, let us consider the shareholders' program:

$$\text{Max}_x \{S(x)(1 - \tilde{\alpha}) - w_0\} \quad (40)$$

In determining the first order conditions we get:

$$\frac{\partial S(\tilde{x})(1 - \tilde{\alpha})}{\partial \tilde{x}} = 0 \Rightarrow \frac{\partial (E(X) - d(1 + r))(1 - \tilde{\alpha})}{\partial \tilde{x}} = 0 \Rightarrow \tilde{x}^* = \frac{B}{2A}$$

$$(\forall \tilde{x}^* = \{\underline{x}^*, \bar{x}^*\}, \tilde{\alpha} = \{\underline{\alpha}, \bar{\alpha}\}). \quad (41)$$

Therefore, the interests of both the Board of Directors and the Executive are consistent and the portfolio level settled in:

$$\left(\tilde{x}^* = \frac{B}{2A}, \tilde{y}^* = 1 - \frac{B}{2A}\right) \quad (42)$$

---

<sup>3</sup> Rigorously, the remuneration should be written  $W(x) = w_0 + \alpha(S(x) - n)$ , indeed, the executive is paid on the net revenues, this comes writing:

$W(x) = w_0 + \alpha(E(x) - d - dr - n) = w_0 + \alpha(E(x) - 1 - dr)$  (as  $d + n = 1$ ). Then  $(E(x) - 1 - dr = S(x))$ .

Are things different under asymmetric information? In other words, will the equilibrium portfolio be different from the first rank portfolio of symmetric information and, if not, what should be the informational rent paid to the most effective manager to induce him to build up that portfolio?

#### 4.1.2 The model with asymmetric information

We consider now A1 and A2, the profit function  $S(x)$  and the agent's remuneration function  $W(x) = w_0 + \alpha S(x)$ , (or putting  $w_0 = 0$ ),  $W(x) = \alpha S(x)$ .

The principal must choose the most effective agent. In order to do this, we first examine the incentive conditions that the agent must fulfill. When information is asymmetric, some agents may benefit from asymmetry to obtain higher remuneration by offering less, that means here, by taking a greater share of the global profit. Here, the agent's profit consists in biasing the portfolio by increasing the share of the risky asset in order to obtain a higher remuneration level. So, the board of directors must ensure that the effective agent will receive a well-matched remuneration level with the quality of the portfolio he constituted. The lesser performance corresponds to the portfolio (i.e.  $\bar{x}$ ) made up by the less skilled agent, that is to say:

$$\underline{W} - \underline{\alpha}S(\underline{x}) \geq \bar{W} - \underline{\alpha}S(\bar{x}) \quad (43)$$

A symmetric argument applies to less effective agent that should receive compensation equivalent to the provided service:

$$\bar{W} - \bar{\alpha}S(\bar{x}) \geq \underline{W} - \bar{\alpha}S(\underline{x}) \quad (44)$$

We put together these two incentive constraints:

$$\underline{W} - \underline{\alpha}S(\underline{x}) \geq \bar{W} - \underline{\alpha}S(\bar{x}) \quad (43)$$

$$\bar{W} - \bar{\alpha}S(\bar{x}) \geq \underline{W} - \bar{\alpha}S(\underline{x}) \quad (44)$$

We then define the participation constraints that correspond to the minimum remuneration that should be respected:

$$\underline{W} - \underline{\alpha}S(\underline{x}) \geq 0 \quad (45)$$

$$\bar{W} - \bar{\alpha}S(\bar{x}) \geq 0 \quad (46)$$

These last two constraints mean that expected payments ( $\underline{W}$  et  $\bar{W}$ ) should not be less than the share of profits specified contractually,  $\underline{\alpha}S(\underline{x})$  and  $\bar{\alpha}S(\bar{x})$ .

From (43) and (44) the following monotonicity condition deduces:

$$\underline{W} - \underline{\alpha}S(\underline{x}) + \bar{W} - \bar{\alpha}S(\bar{x}) \geq \bar{W} - \underline{\alpha}S(\bar{x}) + \underline{W} - \bar{\alpha}S(\underline{x})$$

$$(\bar{\alpha} - \underline{\alpha})S(\underline{x}) \geq (\bar{\alpha} - \underline{\alpha})S(\bar{x}),$$

And, consequently:

$$(\bar{\alpha} - \underline{\alpha})(E(\underline{x}) - d(1+r)) \geq (\bar{\alpha} - \underline{\alpha})(E(\bar{x}) - d(1+r)), \text{ and,}$$

$$E(\underline{x}) \geq E(\bar{x}) \quad (47)$$

Inequality (47) shows a monotony expectation. In other words, the most effective agent's portfolio must yield the highest level of expected income compared to that of the less efficient agent. However, monotony in expectation is not sufficient ensuring that the remuneration is a discriminating factor that will provide shareholders with the highest income with lower returns.

**Proposition 4:** *Considering the shareholder payment function (40), the assumptions A1 and A2 as well as the constraints (43) (44), then the monotonic condition such that  $\underline{x} \geq \bar{x}$  is not verified.*

**Proof:** See appendix n°1

It follows that the remuneration rule cannot be implemented because of its non-responsiveness (Guesnerie-Laffont(1984)). The consequence is the impossibility of establishing discriminatory remuneration. In other words, by defining a system of remuneration based on the transfer of a share of the profits to the executive, the board of directors cannot determine whether the level of remuneration is sufficient to induce the latter to choose the portfolio that maximizes the shareholders' profit at the lowest risk level possible. In Annex 2, we develop this point which leads to proposition 5.

The following proposition confirms proposition 4, that, otherwise, could appear as excessively intuitive.

**Proposition 5:** *Considering the shareholder payment function (40), the assumptions A1 and A2 as well as the constraints (43) (44) and the proposition 3 then:*

- 1) *The proportion between risky and non-risky assets under the condition of the second order (informational rent) is the same as for the first-order condition:*

$$x^* = \frac{B}{2A}$$

*This is true regardless of the agent's efficiency level.*

- 2) *From 1, we deduce that asymmetry of information is not sufficient to distinguish between an effective and ineffective agent. The level of transfer is the following:*

- $\underline{W} = \bar{\alpha}S(x^*)$ , for the efficient agent,

- $\bar{W} = \bar{\alpha}S(x^*)$  for the inefficient one.

**Proof:** The proof is in appendix 2.

From propositions 4 and 5, it follows that the terms "effective" or "non-effective" calling potential executive do not refer to their skill but simply to the level of advertised remuneration. Given a level of service (in this case, the creation of an efficient portfolio), the most effective ones would be those who demand a lower remuneration level. The inefficiency of the remuneration system as an incentive system implies that informational rent must be set at the level required by inefficient managers, here those who demand the highest level of remuneration  $\bar{\alpha} > \underline{\alpha}$ . Consequently, profit-sharing-based remuneration does not lead to the choice of agent offering the lowest level of remuneration  $\alpha$ , and the board of directors must agree to pay the highest level to maximize the value of the portfolio.

Consequently, the behavior which assumes risk-taking is not induced by asymmetric information. Or, to put it another way, asymmetric information is not a sufficient condition to induce risky choices when the remuneration of the manager is made up of a share of all profits. The question that can arise is whether similar results can be obtained by changing the conditions of reward, i.e., not considering the full profits of the two portfolios as a whole, but only the riskiest assets or the least risky one. That is what we are focusing on now.

## 4.2 Remuneration based on the returns of the riskiest assets and less risky assets.

### 4.2.1 Remuneration with a share of the riskiest assets

Now, in addition to the fixed wage, the executive's salary includes a fraction of the profits of the highly risky asset. Then, the problem is similar to that of the previous sub-section: it is the board's task to define a level of remuneration that encourages the most effective agent to maximize the value of shareholders' assets. Here, the executive's remuneration is expressed as:

- For the efficient agent:  $W(y, \underline{\alpha}) = \underline{\alpha}y \pi(y)\Gamma$  (48)

- For the inefficient one:  $W(y, \bar{\alpha}) = \bar{\alpha}y \pi(y)\bar{\Gamma}$  (49)

The remuneration is carried out on profits and not on all the assets. Incentive constraints are represented by the following constraints:

$$\underline{W} - \underline{\alpha} \underline{y} \pi(\underline{y}) \underline{\Gamma} \geq \bar{W} - \underline{\alpha} \bar{y} \pi(\bar{y}) \underline{\Gamma} \quad (50)$$

$$\bar{W} - \bar{\alpha} \bar{y} \pi(\bar{y}) \bar{\Gamma} \geq \underline{W} - \bar{\alpha} \underline{y} \pi(\underline{y}) \bar{\Gamma} \quad (51)$$

Under asymmetric information, the compatibility scheme of incentives can only be realized under constraint and, as before, its effectiveness implies respect for monotonic conditions.

**Proposition 6:** *Considering the incentive constraints (50) and (51), then one cannot establish a monotonic relationship in such a way that  $\underline{y} \geq \bar{y}$  is always verified.*

Proof: See appendix 3

Proposition 6 shows that monotony is not respected. This means that the remuneration rule cannot be implemented because it proves inadmissible (Guesnerie-Laffont (1984)) as in the previous case. The board of directors cannot therefore prevent the manager from choosing the investment policy that suits him personally if the supervisor's means of control is limited to a wage policy.

#### **4.2.2 The less risky asset**

Since the remuneration structure is formally the same for the less risky assets, we can infer the same result because the demonstration is identical to the previous case and reaches a similar result: it is impossible to define a compensation structure for the manager that is incentive for the preservation of shareholder interests.

### **5. Conclusion**

This paper examines the effectiveness of executive's remuneration for risk taking. If the context of the model is static, however, the situation in which it is inscribed is not. Indeed, the agents make their choice considering some systemic risk. To take it into account, we consider that no asset is free from risk. Consequently, the bank invests in two types of assets, an exceedingly risky one and another more secure. Systemic risk appears from the probabilities of bankruptcy considering each asset. Indeed, the more the banks invest in a given asset category, the more the probability of a bankruptcy rises. In this specific context, the model shows that considering an observable risk, then, the manager chooses the portfolio required by the shareholders (one voice). On the other hand, facing an unobservable risk, the agency's standard approaches consider that the manager will tend to constitute a risky portfolio if his remuneration includes a share of the risky asset profit. Our model shows that this is not always the case. Portfolio formation is dictated by the level of risk and the executive can choose a less risky portfolio than expected. The same applies where the remuneration consists of a fraction of less risk asset profit. Risk thresholds explain the executive's choice, who may be a riskier portfolio than expected.



We consider then asymmetric information between shareholders and executive, and an adverse selection scheme. Here, the Boards of directors (Principal) chooses a manager among several and the principal has to be sure that the manager (Agent) ensures to shareholders an optimal portfolio, i.e. the one that maximizes profit and minimizes risk. As in the standard agency approaches, the model considers remuneration as a revelation device. However, the model shows that no remuneration scheme that would include either a part of the profit based on the whole portfolio, or on the riskier asset or, on the contrary, on the less risky one is relevant. In the case where the payment includes a fraction of the total profits, the model shows that considering informational rent requires paying the manager, whatever his level of competence, to the level required by the less effective managers. This means a higher level than would be required by a competent manager. This is a prerequisite for constituting the portfolio in line with the shareholders' best interests (first rank). In the other two cases (remuneration indexed on the profits of the risky portfolio or the less risky portfolio), the condition of portfolio monotony is not respected. Indeed, the remuneration rule shows non-responsiveness in the Laffont-Guesnerie (1984)) sense. As a result, the remuneration scheme as defined above is not a discriminatory device to induce the manager to constitute the best portfolio for preserving the shareholders' interest.

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## Appendix 1

### Proof of Proposition 4 (no-monotony)

We verify whether  $E[\underline{x}] \geq E[\bar{x}]$  may involve  $\underline{x} \geq \bar{x}$ . Indeed, the monotony of the relation is the condition for coherency of the remuneration scheme. Developing the writings of  $E[\underline{x}]$  et  $E[\bar{x}]$ :

$$E[\underline{x}] \geq E[\bar{x}] \Rightarrow (\underline{x} - \bar{x}) \geq \frac{A}{B}(\underline{x}^2 - \bar{x}^2) = \frac{A}{B}(\underline{x} - \bar{x})(\underline{x} + \bar{x})$$

or,  $1 \geq \frac{A}{B}(\underline{x} + \bar{x})$

It should be noted that this result is conditional on the value of  $\frac{A}{B}$  and  $(\underline{x} + \bar{x})$ . We know that  $\underline{x}, \bar{x} \leq 1$  and, consequently, when their sum is such that :  $(\underline{x} + \bar{x}) > 1$ , for instance in such a way that  $(\underline{x} + \bar{x}) = 1 + \varepsilon$ , ( $\varepsilon > 0$ ), then, if by assumption  $\frac{A}{B} = e < 1$ , then  $(1 + \varepsilon)e > 1$  if  $e > \frac{1}{(1+\varepsilon)}$ , consequently,  $E[\underline{x}] < E[\bar{x}]$ . Putting it otherwise, monotony in expectation is verified conditionally to the value of  $\frac{A}{B}$  and  $(\underline{x} + \bar{x})$ .

Furthermore, even if  $E[\underline{x}] \geq E[\bar{x}]$  is verified this does not involve that  $\underline{x} \geq \bar{x}$ . Indeed, consider that  $1 \geq \frac{A}{B}(\underline{x} + \bar{x})$  that may be verified for  $\underline{x} > \bar{x}$  or  $\underline{x} < \bar{x}$ . To see this point, consider that the relation  $\underline{x} > \bar{x}$  is true for  $\underline{x} = \frac{1}{K} < 1$  and  $\bar{x} = \frac{1}{K+a} < 1$ , ( $K > 1, a > 0$ ). However, this relation is all the same true if the reverse is verified:  $\underline{x} = \frac{1}{K+a}$  et  $\bar{x} = \frac{1}{K}$  with,  $\underline{x} < \bar{x}$ .

From this fact, the monotony  $\underline{x} \geq \bar{x}$  cannot be verified.

## Appendix 2

### Proof of Proposition 5

From the symmetric information model and different constraints, we deduct the informational rents  $\underline{U}$  and  $\bar{U}$  now, that result of informational asymmetry between the agent and the principal. This writes as:

$$\underline{U} = \underline{W} - \underline{\alpha}S(\underline{x}) \quad (1A)$$

For the efficient agent, and,

$$\bar{U} = \bar{W} - \bar{\alpha}S(\bar{x}) \quad (2A)$$

For the inefficient one.

Note that:

$$\begin{aligned} \bar{W} - \underline{\alpha}S(\bar{x}) &= \bar{W} - \bar{\alpha}S(\bar{x}) - \underline{\alpha}S(\bar{x}) + \bar{\alpha}S(\bar{x}) = \\ \bar{W} - \underline{\alpha}S(\bar{x}) &= \bar{U} + \Delta\alpha S(\bar{x}) \end{aligned} \quad (3A)$$

and,

$$\underline{W} - \bar{\alpha}S(\underline{x}) = \underline{U} - \Delta\alpha S(\underline{x}) \quad (4A)$$

(where:  $\Delta\alpha = \bar{\alpha} - \underline{\alpha}$ )

When he chooses the leader, the Board of Directors does not know his level of efficiency. What is known is only the proportions  $\beta$  of efficient managers and  $1 - \beta$  of inefficient ones. It follows that to encourage the executive to choose the portfolio that maximizes their profit level and minimizes the risk, the Board of directors should define a remuneration level that encourages the best manager to build an optimal portfolio. This involves solving the following program:

$$Max_{\{\underline{x}, \bar{x}\}} \{ \beta [S(\underline{x}) - \underline{W}] + (1 - \beta) [S(\bar{x}) - \bar{W}] \} \text{ under the constraints (43) to (46) } \quad (5A)$$

This program can be rewritten in terms of informational rent and this becomes after transformation:

$$Max_{\{\underline{U}, \bar{U}\}} \{ \beta [S(\underline{x})(1 - \underline{\alpha})] + (1 - \beta) [S(\bar{x}) - (1 - \bar{\alpha})] \} - \beta \underline{U} - (1 - \beta) \bar{U} \quad (6A)$$

Under the following incentive constraints:

$$\underline{U} \geq \bar{U} + \Delta\alpha S(\bar{x}) \quad (7A)$$

$$\bar{U} \geq \underline{U} - \Delta\alpha S(\underline{x}) \quad (8A)$$

And the participation constraints:

$$\underline{U} \geq 0 \quad (9A)$$

$$\bar{U} \geq 0 \quad (10A)$$

How to solve the problem is known (Laffont-Martimort 2002). Then, note that the constraint (10A) is satisfied for:

$$\bar{U} = 0 \quad (11A)$$

Reporting this value in (7A) that becomes:

$$\underline{U} = 0 + \Delta\alpha S(\bar{x}) \quad (12A)$$

We replace these new values in the previous program:

$$Max_{\{\underline{U}, \bar{U}\}} \{ \beta [S(\underline{x})(1 - \underline{\alpha})] + (1 - \beta) [S(\bar{x}) - (1 - \bar{\alpha})] \} - \beta \underline{U} - (1 - \beta) \bar{U} \quad (13A)$$

$$\mathcal{L}(\underline{x}, \bar{x}) = Max_{\{\underline{x}, \bar{x}\}} \{ \beta [S(\underline{x})(1 - \underline{\alpha})] + (1 - \beta) [S(\bar{x}) - (1 - \bar{\alpha})] \} - \beta \Delta\alpha S(\bar{x}) \quad (14A)$$

From the first order conditions we get:

$$\frac{\partial \mathcal{L}(\underline{x}, \bar{x})}{\partial \underline{x}} = 0 \Rightarrow \frac{\partial S(\underline{x})}{\partial \underline{x}} = 0$$

And solving  $\underline{x}^*$  gives :

$$\underline{x}^* = \frac{B}{2A}$$

$$\frac{\partial \mathcal{L}(\underline{x}, \bar{x})}{\partial \bar{x}} = 0 \Rightarrow \beta \frac{\partial S(\bar{x})}{\partial \bar{x}} (1 - \underline{\alpha}) - \beta \Delta\alpha \frac{\partial S(\bar{x})}{\partial \bar{x}} = 0 \Rightarrow \frac{\partial S(\bar{x})}{\partial \bar{x}} = 0.$$

Then, we get:

$$\Rightarrow \frac{\partial (E(X) - d(1 + r))}{\partial \bar{x}} = 0 \Rightarrow \bar{x}^* = \frac{B}{2A}$$

$\tilde{x}^*$  and, consequently :

$$\underline{x}^* = \bar{x}^* = x^* \quad (15A)$$

This means that, under asymmetric information, the chosen portfolio either by the efficient or by the inefficient director is identical, there is no distortion. The level of transfers is then the following:

- i)  $\underline{W} = \bar{\alpha} S(x^*)$  for the efficient agent,
- ii)  $\bar{W} = \bar{\alpha} S(x^*)$  for the inefficient one.

Then, both values are identical.

Proof:

If  $\bar{U}$  is saturated ( $\bar{U} = 0$ ), then  $\underline{U} = \Delta\alpha S(\bar{x})$ , and, putting this value in (7A):

$$1) \bar{W} - \bar{\alpha} S(\bar{x}) = \bar{U} + \Delta\alpha S(\bar{x}) \text{ and, as } \bar{U} = 0$$

$$2) \underline{W} - \underline{\alpha} S(\bar{x}) = \Delta\alpha S(\bar{x}) \text{ and, } \underline{U} = \underline{W} - \underline{\alpha} S(x^*), \text{ (because } \underline{x}^* = \bar{x}^* = x^* \text{).}$$

From the previous writing we deduce then  $\underline{W}^{SB}$  (where ("."<sup>SB</sup> corresponds to “second best”):

$$\underline{W}^{SB} = \underline{\alpha}S(x^*) + \Delta\alpha S(\bar{x}),$$

As by definition:  $\Delta\alpha = \bar{\alpha} - \underline{\alpha}$ , then:

$$\underline{W}^{SB} = \underline{\alpha}S(x^*) + \bar{\alpha}S(x^*) - \underline{\alpha}S(x^*) \text{ and } \overline{W}^{SB} = \bar{\alpha}S(x^*)$$

3)  $\overline{U} = \overline{W}^{SB} - \bar{\alpha}S(\bar{x}) = 0$  and, by the same argument as in 1):

$$\overline{W}^{SB} = \bar{\alpha}S(x^*) \quad (16A)$$

4) Consequently, from 1) and 2), we deduce that:

$$\overline{W}^{SB} = \underline{W}^{SB} \quad (17A)$$

This result means that to encourage the efficient agent to achieve the best portfolio,  $x^*$ , the board must pay him till the same level than the inefficient executive,  $w_0 + \bar{\alpha}S(x^*)$ .

### Appendix 3

#### Proof of proposition 6

By summing (50) and (51), it results that:

$$\begin{aligned} \underline{W} - \underline{\alpha} \underline{y} \pi(\underline{y}) \Gamma + \overline{W} - \bar{\alpha} \bar{y} \pi(\bar{y}) \Gamma &\geq \overline{W} - \underline{\alpha} \bar{y} \pi(\bar{y}) \Gamma + \underline{W} - \bar{\alpha} \underline{y} \pi(\underline{y}) \Gamma \\ \frac{\pi(\underline{y})}{\underline{y}} &\geq \frac{\pi(\bar{y})}{\bar{y}} \end{aligned}$$

This relationship can be verified for  $\underline{y} \geq \bar{y}$  because  $\pi(\underline{y}) \leq \pi(\bar{y})$ . However, nothing prevents the reverse, i.e.:  $\underline{y} \leq \bar{y}$  because  $\pi(\underline{y}) \geq \pi(\bar{y})$ . We can conclude to indeterminacy for the general case. This may also be checked for the model's specific probabilities. Then:

$$\begin{aligned} \underline{y} - b\underline{y}^2 \geq \bar{y} - b\bar{y}^2 \text{ or still : } \underline{y} - \bar{y} &\geq b(\underline{y}^2 - \bar{y}^2) \text{ and, consequently:} \\ 1 &\geq b(\underline{y} + \bar{y}) \end{aligned}$$

This expression is true for specific values of  $\underline{y}$ ,  $\bar{y}$ , and  $b$ . Consequently, this is not a general relationship that could always be checked.



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