CEO Compensation, Regulation, and Risk in Banks: Theory and Evidence from the Financial Crisis*

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This paper studies the relation between CEOs' monetary incentives, financial regulation, and risk in banks. We develop a model where banks lend to opaque entrepreneurial projects that need to be monitored by bank managers. Bank managers are remunerated according to a pay-for-performance scheme and their effort is not observable to depositors and bank shareholders. Within a prudential regulatory framework that imposes a minimum capital ratio and a deposit insurance scheme, we study the effect of increasing the variable component of managerial compensation on bank risk in equilibrium. We test the model's predictions on a sample of large banks around the world, gauging how the monetary incentives for CEOs in 2006 affected their banks' stock price and volatility

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during the 2007–8 financial crisis. Our international sample allows us to study the interaction between monetary incentives and financial regulation. We find that greater sensitivity of CEOs' equity portfolios to stock prices and volatility is associated with poorer performance and greater risk at the banks where shareholder control is weaker and in countries with explicit deposit insurance.

JEL Codes: G21, G38.

1. Introduction

The recent global recession has demonstrated that capital market failures may be responsible for economic downturns. In the wake of the financial crisis, a consensus appears to have emerged among researchers and practitioners that financial institutions took too much risk in the run-up to the crisis, notwithstanding risk-management arrangements and solvency regulations (Diamond and Rajan 2009). The monetary incentives given to executives have been cited as one of the culprits in the failure of banking governance.[1] Executive compensation tied to firm performance in its various forms—such as bonuses related to firm value, stock options, and equity plans—has become a standard instrument of managerial remuneration in all sectors, and especially in banking.[2] Given the growing importance of CEOs' variable compensation, we need to understand its impact on risk in banks.

We focus on the agency conflicts inside and outside the bank—shareholders vs. bank managers and insiders vs. depositors—to study the determinants of bank risk and its interaction with financial regulation. We develop a model in which bank managers have a variable compensation scheme, and use the resulting insights for empirical exploration of the relationship between CEOs' monetary incentives and bank performance.

[1]See Becht, Bolton, and Röell (2011) and Mehran, Morrison, and Shapiro (2011) for excellent reviews of the literature on the conflicts among the various stakeholders in banks and, in particular, on how executive remuneration can affect risk taking.

[2]Giannetti and Metzger (2013) find that the increase in equity-based compensation and the consequent increase in total compensation is bound up with heightened competition for talent, which creates a retention motive and exacerbates agency problems.

Our theoretical contribution serves to provide guidance in examining the empirical evidence. In our model, banks lend to opaque entrepreneurial projects that need to be monitored by a bank manager.[3] The bank manager might reduce loan losses by monitoring the loan portfolio, but this effort is not observable to outsiders. To induce monitoring, shareholders reward the manager with a bonus tied to the bank's performance.[4] Depositors are insured and minimum capital requirements are in place. Shareholders may directly inspect the bank manager and in some cases may decide to replace him with a new manager. In this setting, the risk choice is endogenous; it is the equilibrium outcome of the strategic interaction between bank managers and shareholders. Comparative statics exercises illuminate the way in which equilibrium risk at a bank reacts to changes in the CEO's variable compensation, and how its sign and measure are affected by regulation and by the efficacy of control by shareholders.

In particular, we suggest a possible perverse effect of larger managerial bonuses on bank risk. On the one hand, the larger the bonus, the greater the monitoring effort of the bank manager, so that bank risk is reduced; on the other hand, a larger bonus discourages shareholders' control by lowering their stake in the overall return of the loan portfolio, and so leads to greater risk. We also show that for a given capital structure and regulatory environment, the sign of the relation between bonus and risk is decreasing in the efficacy of shareholders' control. In other words, the perverse effect of the bonus is greater where shareholder control is weaker. Finally, within this framework, we find that a deposit insurance scheme, by incorporating the expectations of an increase in risk from larger bonuses, may under certain conditions weaken shareholders' control. In this case, the perverse correlation between executive bonus and risk is exacerbated.

[3]The model builds on Cerasi and Daltung (2007) in its version for banks, developed in Cerasi and Rochet (2014).

[4]The presence of a variable component in the compensation of executives may represent a choice for shareholders. Here, however, we take this specific form of the managerial compensation as exogenously set, taking as a stylized fact the observation that performance-based pay schemes are now standard for bank executives. As a matter of fact, the empirical analysis closely follows this approach, measuring how changes in the variable compensation of bank executives affect bank performance.

The empirical analysis is based on novel information on a panel of large banks in various countries for which executive compensation is observed. We exploit the cross-sectional heterogeneity in managerial compensation practices and financial regulation to study the impact on risk.[5] We find support for the main predictions of the theoretical model by analyzing the relation between monetary incentives provided to CEOs in 2006 and banks' return and risk during the financial crisis. We test whether the monetary incentives for executives fixed before the financial crisis explain banks' poor performance and greater incurred risk during the financial crisis of 2007–8. There are two reasons for using the crisis for an experiment. First, the design of executive compensation schemes is pointed to, in public discussion, as one of the main culprits in the increased risk taking that public opinion blames for the crisis. This issue has been analyzed in detail for the United States, notably by Fahlenbrach and Stulz (2011), but except for Suntheim (2010), less work has been done about other countries. Second, it is reasonable to assume that when shareholders designed their CEOs' contracts in the years preceding the financial crisis, they did not anticipate the collapse of the financial system; the monetary incentives we find in 2006 were presumably designed before that date. To summarize, the financial crisis cannot be classified as an anticipated shock; on the contrary, it is likely that both financial market operators and bank managers were unaware of the impending crisis. This thesis is supported by two facts: (i) average stock returns of banks were extremely high before the crisis;[6] (ii) if they had anticipated the financial crisis, they should have sold their stock, but we find no statistically significant change in the proportion of inside ownership of CEOs in our sample between the second quarter of 2005 or 2006 and the second quarter of 2007.[7]

[5]We combine four sources of data: Capital IQ – People Intelligence by Standard and Poor's, Bankscope, Datastream, and the third wave of the World Bank's Bank Regulation and Supervision Survey; see section 4 for a detailed description of the data-collection process.

[6]Furthermore, our regression analysis shows a negative correlation between stock returns in 2006 and performance during the crisis; this suggests that the better-performing banks in 2006 performed worse during the crisis.

[7]Insider holding is measured by the ratio of the number of restricted and unrestricted shares held by CEOs at the end of the second quarter of each year

In the empirical analysis, pay-for-performance sensitivity of CEOs' compensation is measured using information on cash bonuses and equity portfolios (the sum of the CEO's shares and stock options). We distinguish between two measures of pay-for-performance sensitivity of equity portfolios: (i) the sensitivity of CEOs' stock-option portfolios to share prices (option delta) plus the direct ownership of shares (ownership from shares and options); and (ii) the sensitivity of the stock-option portfolio to stock volatility (option vega). Finally, we measure bank performance as the buy-and-hold return and the standard deviation of stock returns over the period 2007:Q3–2008:Q4.

For the entire sample, we find that greater pay-for-performance sensitivity at the end of 2006 does not appear to be related to either the drop in stock returns or higher stock-price volatility during the financial crisis. This lack of evidence of a relation between variable compensation and bank risk extends the empirical evidence on U.S. banks by Fahlenbrach and Stulz (2011) to banks outside the United States as well. This result is also consistent with the insights of our model, namely that an increase in the managerial bonus has ambiguous effects on equilibrium risk; given that banks differ in governance and in the regulatory framework, the negative and positive effects of variable compensation may be partially offsetting for the sample as a whole. However, starting from this negative result and following the insights of our model, we exploit bank heterogeneity and cross-country differences to split our sample along several lines, capturing features of bank governance and regulation, to detect patterns in the correlation between the way executives are remunerated and bank risk.

In particular, we find that CEOs' equity incentives (ownership from shares and options and option vega) were associated with worse performance during the crisis by the banks where the shareholders'

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to the total number of shares outstanding at the end of the year. The average insider holdings were 1.41 percent, 1.76 percent, and 1.38 percent at the end of the second quarter of 2005, 2006, and 2007, respectively. There is no statistically significant change even excluding restricted shares. For the case of U.S. banks, similar evidence has been found by Fahlenbrach and Stulz (2011), while Cziraki (2014) found that only the executives of the banks most exposed to the housing market might possibly have foreseen the collapse starting in mid-2006.

control of delegated managerial activities was relatively ineffective compared with the whole sample. By using different proxies for efficacy of control at both the bank and country level, we support the theoretical prediction that weaker internal control combined with greater pay-for-performance sensitivity in executive compensation might explain increased risk taking.

Furthermore, we study the interaction between CEOs' variable compensation and measures of prudential regulation at the country level, such as the presence of an explicit deposit insurance scheme[8] and the difference between the actual capital at the bank level and the minimum capital requirement defined by each country authority in 2006.

The empirical evidence suggests that explicit deposit insurance, combined with our measures of variable compensation, may well have increased the risk appetite of insiders and resulted in worse performance (either lower buy-and-hold returns or greater stock-return volatility) during the financial crisis. We do not find evidence of interaction between CEOs' variable compensation and capital requirements during the crisis.

The rest of the paper is organized as follows: the next section relates this paper to the literature; section 3 presents our model; section 4 describes how we collected our data and provides some descriptive statistics on the sample of banks and their CEOs' compensation; section 5 analyzes the correlation between bank performance and CEO compensation in the whole sample; section 6 studies the interaction between executive incentives and bank performance in different sub-samples, in order to capture different aspects of financial regulation and bank governance; and section 7 concludes.

[8]Following Demirguc-Kunt, Karacaovali, and Laeven (2005), explicit deposit insurance differs from implicit deposit insurance by the presence of a formal definition of the scheme in national banking laws; explicit deposit insurance varies among countries in terms of the types of financial institution covered and the amount of coverage. In this paper we divide the countries into two groups, depending on whether or not an explicit law applies to commercial banks; we further assume that the insurance is funded by a fair premium paid by the commercial bank. Although restrictive, this assumption appears to fit the application of the law in most countries.

2. Related Literature

In the wake of the recent financial crisis, there is a growing literature on the relation between different aspects of corporate governance, executive compensation, and risk in banking and their interaction with financial regulation. Let us define our paper relative to the various contributions of that literature.

Banking mainly involves liquidity provision and maturity transformation. Thanks to the existence of deposit insurance, deposits are a cheap source of funding for banks, which explains why commercial banks represent a special case of highly leveraged firms, as discussed in Dewatripont and Tirole (1999) and in the excellent reviews of bank corporate governance by Becht, Bolton, and Röell (2011) and Mehran, Morrison, and Shapiro (2011). The corporate finance literature acknowledges the effect of leverage in altering the preferences for risk shifting and the conflict between shareholders and debtholders (Jensen and Meckling 1976). However, depositors, as they are insured, are quite passive claimholders and do not oppose shareholders' initiatives, as is shown extensively in Mehran, Morrison, and Shapiro (2011). This explains why bank shareholders are successful in aligning CEOs with their interests also in their taste for excessive risk taking; see the good discussion in Bolton, Mehran, and Shapiro (2010). In our model the bank is leveraged, deposit insurance is in place and the bank manager is remunerated according to a pay-for-performance scheme, and active shareholders may decide to inspect and possibly fire the top executive. In this context, increasing the variable component of compensation might discourage shareholders' initiative and so heighten bank risk.

Seminal contributions by John and John (1993) and Berkovitz, Israel, and Spiegel (2000) focused on the relation between CEOs' variable compensation and bank leverage, while John, Saunders, and Senbet (2000) focused on CEOs' compensation and regulation. Several more recent theoretical papers have studied how the design of compensation may affect risk taking in banks, with a view to suggesting how to redesign executive compensation so as to protect all the stakeholders in banking; see, for instance, Benmelech, Kandel, and Veronesi (2010), Bolton, Mehran, and Shapiro (2010), John, Mehran, and Quian (2010), and Kolm, Laux, and Loranth (2014). Unlike these contributions, our own exercise is intended to determine

how greater pay-for-performance sensitivity impacts risk taking in different corporate governance and regulatory settings. We do not seek to understand how close the actual remuneration is to the optimal remuneration but simply to gauge how a change in the level of remuneration might affect risk taking.

Empirically, we contribute to the literature on the role of bank CEO compensation in shaping risk taking and how corporate governance and financial regulation interact with it.

We build upon Laeven and Levine (2009) and Gropp and Kohler (2010), who empirically analyze the interaction between corporate governance and regulation and its effect on bank risk. In relation to the recent financial crisis, Beltratti and Stulz (2012) show that shareholder-friendly boards have effectively aligned bank managers with their interests at the expense of depositors. We complement those studies by exploring a specific tool of corporate governance, namely executive compensation.

Our paper is also close in spirit to Fahlenbrach and Stulz (2011) and Guo, Jalal, and Khaksari (2014), who have empirically explored the relation between CEOs' incentives and bank performance and risk in the 2007–8 financial crisis for a cross-section of U.S. banks. They find that banks where CEOs' monetary incentives were more closely aligned with shareholders' interests did not perform better. While confirming this result as regards our entire sample, we also find a negative correlation between variable compensation and ex post performance at banks with weaker governance and at banks in countries with explicit deposit insurance. In interpreting this evidence, we relate our findings to our model, where risk is endogenous and is shaped jointly by shareholders' oversight and managerial monetary incentives.

From a different perspective, Cheng, Hong, and Scheinkman (2010) assume that risk is an exogenous characteristic of the bank, together with productivity, and that risk-averse CEOs must be compensated with greater total remuneration when they are hired by a riskier bank. They find strong evidence of an effect of banks' fundamentals (risk and productivity) on total executive compensation, and weaker evidence of an effect on variable compensation. Their analysis challenges the interpretation of our empirical results, as the relation between ex post risk and ex ante CEO variable compensation may be affected by a confounding factor such as ex ante risk

or productivity; we address this concern in the empirical setting by accounting for differences in fundamental productivity and risk across banks.

Finally, Ellul and Yeramilli (2013) provide a first attempt to get inside the black box of the banks' internal organization, studying the effect of the risk-management function on risk in a sample of U.S. banks. Their analysis prompted us to examine the effect of executive compensation schemes and the potential conflict with other stakeholders.

3. The Model

Consider a bank holding a portfolio of size L_0 of risky loans with perfectly correlated returns. Each loan returns $R > 1$, although loan losses ℓ occur with probability p. Thus, the portfolio returns $(R-\ell)L_0$ with probability p, and RL_0 otherwise; the returns are fully observable by third parties. The bank collects funds from wealthy dispersed investors whose alternative return on their capital is 1. We assume that all agents are risk neutral.

At date 0, bank shareholders, who own capital E_0, collect deposits D_0 and extend loans L_0. Depositors are fully insured; hence, each unit of deposit bears zero risk premium.[9] Given the presence of the deposit insurance, the income of the loans portfolio is divided as follows: when the portfolio is successful, it returns RL_0, and what is left, once depositors are repaid the promised amount D_0, goes to bank shareholders; when loan losses are realized and the portfolio returns $(R - \ell)L_0 < D_0$, all the income goes to the deposit insurance fund that repays depositors D_0, which leaves bank shareholders without any income. We will assume that the deposit insurance premium is fully funded through taxpayers' money and that bank shareholders do not internalize it.[10] The amount of insured deposits

[9] A more realistic case is when the bank is funded by a mix of insured deposits and unsecured debt. In appendix 2 we discuss this case and show that when the great majority of debtholders are uninsured in equilibrium, the risk is identical to that of a bank with a risk-sensitive deposit insurance premium charged to the bank.

[10] In the last sub-section we will discuss the case of a risk-sensitive deposit insurance with a fair premium charged on the balance sheet of the bank at date 0.

that the bank will be able to collect is given by the bank's balance sheet at time 0, i.e.,

$$L_0 = E_0 + D_0. \tag{1}$$

We will assume in what follows that there is a capital ratio k imposed by the regulator requiring a minimum of capital for each unit of loans, namely $L_0 \leq E_0/k$.

Loans can be directly monitored by exerting an effort $m \in [0, 1]$ at a private cost $\frac{M}{2}m^2$ with $M \geq 0$ to reduce the probability of losses from p_H to p_L. Assume that

$$R - p_L\ell - \frac{M}{2} > 1 > R - p_H\ell,$$

which implies that only monitored loans are worth financing. When loans are monitored, they have a positive net present value; hence, the size of the bank is limited by its minimum capital ratio.

We assume that shareholders delegate the task of monitoring loans to a bank manager. Because monitoring cannot be observed but has a (private) cost, the bank manager might shirk this duty. To avoid this, shareholders can inspect the bank manager at random and also reward him with monetary incentives. We postpone the analysis of monetary incentives to the next sub-section and focus now on the inspection technology. The shareholders can inspect the activity of the bank manager with intensity $s \in [0, 1]$ at a (private) cost $\frac{C}{2}s^2$ with $C > 0$. As a result of this inspection, shareholders might decide to fire the manager and replace him with an external one (we explore this aspect later on).

The two efforts, the "internal" supervision by shareholders and the activity of monitoring the portfolio of loans, cannot be observed by outsiders of the bank but are privately costly for the party in charge of it, causing a double moral hazard problem. However, the combined impact of monitoring the loans and the internal supervision affects the probability of losses p. The specific value of this probability must be derived from the equilibrium choices of effort of the bank manager and shareholders, as will subsequently become clear.

We may summarize the timing of events on three dates $t = (0, 1, 2)$ as follows:

- At $t = 0$, bank shareholders with capital E_0 collect insured deposits D_0 and lend L_0 (limited by a capital ratio $L_0 \leq E_0/k$); they hire a manager to monitor loans.
- At $t = 1$, the bank manager might exert a monitoring effort with intensity m to reduce expected loan losses; the bank shareholders inspect the manager with probability s; and in some cases, they decide to replace the incumbent manager with an external one.
- At $t = 2$, the loans return a revenue, and the income is shared among the parties.

At the beginning of date 0, the managerial compensation is disclosed to all third parties. Effort choices are not observable, while returns from projects are observable to outsiders. This timing of events implies that outsiders can observe the managerial compensation but cannot infer the true effort choices of insiders. The model is solved backwards: equilibrium efforts and returns are computed for a given managerial compensation.

3.1 Bank Managerial Compensation

The bank manager, whose choice of effort responds to monetary incentives, is offered a monetary compensation, the sum of a fixed salary and a cash bonus on each loan. The fixed salary is set equal to zero for the sake of simplicity. In addition, the bank manager is paid a cash bonus $b \in [0, R)$ whenever the loan portfolio succeeds without losses and whenever shareholders—as a result of inspection—decide not to fire him.[11] The bonus represents the variable part of the managerial compensation and, given that it is tied to the good performance of the portfolio of loans, can be interpreted as a "pay-for-performance" scheme. Only conditional on the result of their inspection, shareholders might decide to fire the incumbent bank manager. Whenever the incumbent bank manager is fired, a new manager is hired and, as a result, the probability of loan losses switches from p to an average value $\phi \in (p_L, p_H)$. Because the new bank manager

[11] The decision to fire the bank manager is at the complete discretion of shareholders. This is in line with the empirical fact that managerial contracts are riskier than workers' labor contracts. In particular, in the managerial contract, there is no need for a "good cause" to fire the employee.

is offered the same managerial compensation, shareholders benefit from firing the incumbent bank manager only when—as a result of inspection—they observe an effort level below that of an average external manager.[12] Therefore, to reduce loan losses, it is strictly preferable to retain the incumbent manager. In conclusion, shareholders will not fire the incumbent manager unless they observe an effort level below that of an average external manager.

The insiders of the bank, shareholders and the bank manager, choose their efforts non-cooperatively and simultaneously. The equilibrium concept applied here is Nash equilibrium in monitoring and inspection choices. To derive the equilibrium bank risk, we have to solve for the efforts as a fixed point of the best reply functions.

Figure 1 describes the actions of the insiders together with the variables affecting their gross revenues for each different choice. From figure 1 we can derive the probability of loan losses, taking into account all the possible actions:

$$\begin{aligned} p(m,s) &= mp_L + (1-m)\left[s\phi + (1-s)p_H\right] \\ &= p_L + (1-m)\left[\Delta - s\Delta_\phi\right], \end{aligned} \tag{2}$$

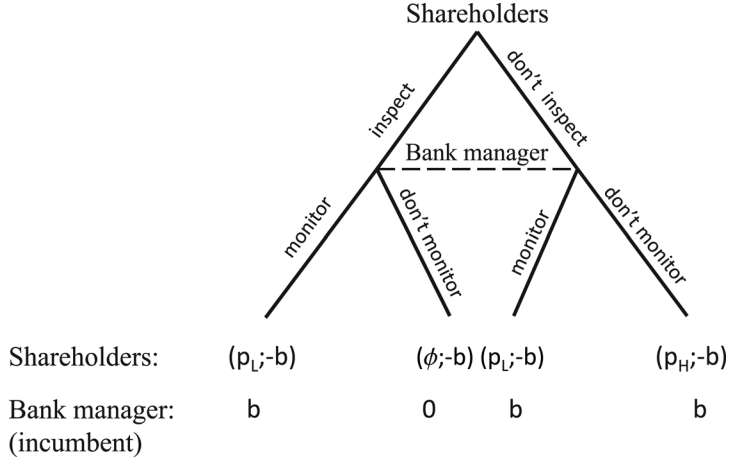
where $\Delta \equiv p_H - p_L$ and $\Delta_\phi \equiv p_H - \phi$. The probability of losses is p_L when the bank manager exerts effort regardless of the shareholder effort. Notice that inspection by shareholders is effective in reducing loan losses only if the external bank manager is more capable than the slacking incumbent manager, i.e., $\phi > p_L$.

The probability of loan losses p captures either a measure of loans' performance or a measure of the variance of the loan portfolio returns.[13]

[12]This assumption guarantees that shareholders do not always fire the incumbent bank manager, disregarding the outcome of the inspection, given that the managerial effort is not observable from outsiders. After firing the incumbent manager and hiring an external one, they reward the new manager with exactly the same compensation scheme: thus, firing the old manager does not allow saving on the bonus payment.

[13]In the model when the bank manager or the shareholders exert a greater effort in monitoring the loan portfolio risk, p decreases. This corresponds to either an increase in the mean value of the portfolio, $R(1-p)$, or a reduction of the variance, $Rp(1-p)$, when p is smaller than 0.5, which seems a sensible restriction to adopt when loan losses are rare. However, our ex ante measure of risk p cannot be observed and we must capture it with observable measures. In the empirical

Figure 1. Decision Tree for Shareholders and Bank Manager



Notes: The decision tree represents all the possible actions for shareholders and the incumbent bank manager. Each branch represents the decision about the action of monitoring and inspecting. At the bottom of the tree we report the specific values of the variables affecting the payoff of each player. For instance, in the left branch, shareholders and bank manager decide to exert their respective efforts, hence the probability of loan losses is p_L and, conditional on zero loan losses, the bank manager is rewarded the bonus b.

3.2 Equilibrium Bank Risk

Given bank shareholders' limited liability, in the event the loan portfolio falls shorter due to losses, the deposit insurance repays insured depositors the entire face value D_0. Hence, the expected profit of bank shareholders can be expressed as

$$U^B(m,s) = [1 - p(m,s)]\,[(R-b)\,L_0 - D_0] - \frac{C}{2}s^2 L_0,$$

where the probability $p(m,s)$ is defined in (2), the first term represents the expected total return of the bank portfolio net of

analysis our ex ante measure of risk p is approximated either by a measure of performance—that is, the buy-and-hold return of bank stock—or by a measure of ex post volatility, the standard deviation of bank stock returns.

managerial bonus and repayment to depositors, and the second term is the shareholders' inspection cost.

The best reply function of shareholders in terms of inspection intensity s is the solution to

$$\frac{\partial U^B}{\partial s} = (1-m)\Delta_\phi \left[(R-b) - \frac{D_0}{L_0}\right] - Cs = 0 \tag{3}$$

for each level of bank manager's monitoring m, where the amount of deposits D_0, the size of the loan portfolio L_0, and the managerial bonus b are all taken as given.

Equation (3) indicates that, for a given bonus and amount of deposits, the benefit of inspecting depends negatively upon the managerial effort: a greater managerial effort improves the probability of success of the project without costs for shareholders, while inspection entails a positive private cost. The shareholders prefer the bank manager to be the one to exert the effort to save their private cost of inspection. Hence, because of this free-riding problem, there is substitutability between the two efforts.

For given managerial compensation, the expected utility of the incumbent bank manager is

$$U^M(m,s) = [1 - q(m,s)]\, bL_0 - \frac{M}{2} m^2 L_0,$$

where $1 - q(m,s) \equiv 1 - p(m,s) - s(1-m)(1-\phi)$ is the probability that the bank manager will cash the bonus. The bank manager earns the bonus with probability $[1 - p(s,m)]$ unless he is fired with probability $s(1-m)$. Notice that the probability of observing loan losses is smaller than the probability of losing the bonus for the incumbent manager, that is, $p(m,s) - q(m,s) = -s(1-m)(1-\phi) < 0$. The portfolio of loans could be successful, and in this case, the incumbent bank manager does not pocket the bonus (because he is fired), and the bonus is paid to the new manager who has exerted the monitoring.

The best reply function of the bank manager in terms of monitoring m is the solution to

$$\frac{\partial U^M}{\partial m} = [\Delta + s(1-p_H)]\, b - Mm = 0 \tag{4}$$

for each intensity of inspection by shareholders s, where the managerial bonus b is given. Equation (4) indicates that, for a given bonus, the monitoring effort of the bank manager increases with the inspection of shareholders: a larger probability of inspection increases the threat of being fired and thus induces a greater managerial effort.

Shareholders and bank manager choose simultaneously and noncooperatively their efforts at date 1. We characterize the mixed-strategy Nash equilibrium of the game in the following proposition:

PROPOSITION 1. *When the lending size is limited by the capital ratio k such that $L_0 \leq E_0/k$ and there is a deposit insurance funded with public money, the monitoring intensity $\widehat{m}$ of the bank manager, the inspection of shareholders $\widehat{s}$, and the probability of loan losses $\widehat{p}$ are the solution to the following system of equations:*

$$(1-\widehat{m})A - C\widehat{s} = 0 \tag{5}$$

$$[\Delta + \widehat{s}(1-p_H)]\, b - \widehat{m}M = 0 \tag{6}$$

$$\widehat{p} - p_L - (1-\widehat{m})(\Delta - \widehat{s}\Delta_\phi) = 0, \tag{7}$$

with $A \equiv \Delta_\phi \left[R - b - (1-k)\right]$.

Proof. See appendix 1.

We might capture bank risk with the ex ante probability of loan losses $\widehat{p}$; therefore, we can perform some meaningful comparative static exercises around the equilibrium values $(\widehat{p}, \widehat{s}, \widehat{m})$. For instance, we can study the impact of a larger capital ratio k, as well as measures of ex post profitability such as R and cost of shareholders' control C, on equilibrium bank risk. In particular, it is possible to demonstrate the following result:

PROPOSITION 2. *The probability of loan losses $\widehat{p}$ decreases with a larger capital ratio k and with a smaller inspection cost by shareholders C.*

Proof. See appendix 1.

The model predicts that a larger capital ratio reduces the ex ante risk of the bank. The intuition is the following: a larger capital

ratio, a larger k, reduces the need for external funds from depositors for a given size of the bank L_0. This increases the marginal revenue of shareholders and improves their incentives to inspect the bank manager. This has a positive effect on managerial monitoring and on the overall expected return of the portfolio of loans. With the same logic, a smaller inspection cost by shareholders, a lower C, causes the opposite effect by decreasing the marginal cost of internal supervision. In the empirical analysis, we measure both effects, exploiting the cross-country variation of our sample. On the one hand, we measure the effect of different capital ratios, and on the other hand, we compare regulatory systems with different intensities of external supervision that affect the cost of internal control.

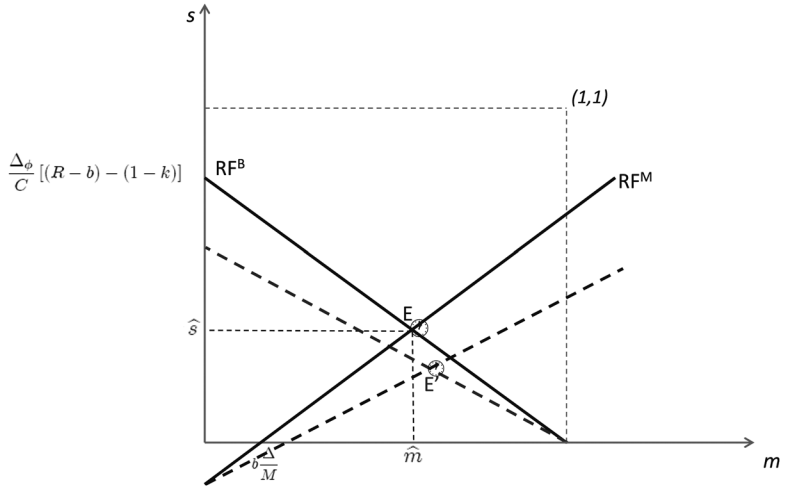
Finally, within our model we can study the effect of a larger managerial bonus on the risk of the bank.

Proposition 3. *A larger managerial bonus b has a negative effect on the intensity of inspection $\widehat{s}$ of shareholders, while it might improve the monitoring effort $\widehat{m}$ of the bank manager. Overall, a larger bonus has an uncertain effect on the probability of loan losses $\widehat{p}$.*

Proof. See appendix 1.

The ambiguity of the impact of the managerial bonus on bank risk derives from the complex interaction of monetary incentives set to reward the bank manager with shareholders' incentives. As a matter of fact, the efforts of the two insiders, shareholders and the bank manager, are substitutes. Shareholders' incentives might deteriorate as a consequence of paying a larger bonus. The stake retained by shareholders when paying a larger bonus is smaller (effect through b) and their inspection is less effective if the manager behaves (effect through $(1 - m)$); thus, ceteris paribus, in equation (3) the marginal benefit of inspection is smaller. However, a larger bonus has a positive impact on the monitoring effort of the bank manager. The overall effect on the equilibrium probability of loan losses $\widehat{p}$ is the result of these two opposite forces: an increased managerial effort due to the larger monetary incentive of the bonus and a reduced internal control by shareholders. This explains the uncertainty of the sign of the effect on risk when increasing the managerial bonus.

Figure 2. Increase in the Managerial Bonus *b*



Notes: The diagram represents the reaction functions of the shareholders, RF_B (negative slope), and the bank manager, RF_M (positive slope). The mixed-strategy equilibrium is at the intersection E of the two linear functions. An increase in the bonus b shifts both reaction functions (dashed grey lines). While the level of inspection by shareholders decreases, the effect on the monitoring effort is uncertain. The reason is that a larger bonus has a direct effect on the managerial effort due to the larger reward, but it also reduces the inspection intensity by shareholders.

In figure 2, we represent the equilibrium efforts as the intersection E between the two best reply functions; we can perform graphically the comparative static exercise that results from a change in b in proposition 3 by shifting the two best reply functions.

Proposition 3 shows that the equilibrium outcome, represented in the new intersection E', has an ambiguous effect on p due to the uncertain impact on bank managerial effort. While, on the one hand, the bonus increases the monetary reward for the bank manager who behaves, on the other hand, it decreases the inspection effort by shareholders, inducing greater shirking by the bank manager. The net effect on the managerial effort is therefore uncertain.

The ambiguity of this last result calls for an empirical exploration of the impact of a larger bonus on bank risk.

It is interesting to evaluate the effect of a larger bonus according to different levels of capitalization of the bank.

Proposition 4. *In a bank with a larger capital ratio k, a larger bonus b is more effective in reducing the probability of loan losses $\widehat{p}$.*

Proof. See appendix 1.

In appendix 3 we provide some numerical simulations to illustrate the results in propositions 3 and 4.

3.3 Risk-Sensitive Deposit Insurance

We now relax the assumption of a deposit insurance funded with taxpayers' money. When the deposit insurance premium is charged to the bank at date 0, there is an additional countervailing effect due to the expected impact of a larger managerial bonus on the risk through the deposit insurance premium.[14]

Assume that the bank shareholders pay a fair premium at date 0 to the deposit insurance to refund depositors for the expected shortfalls on the face value of their deposits, that is,

$$\pi_0 = p(m, s)\left[D_0 - (R - \ell)L_0\right]. \tag{8}$$

Now the bank's balance sheet at date 0 is given by

$$E_0 + D_0 = \pi_0 + L_0. \tag{9}$$

All the rest of the model is unchanged. Now the equilibrium is the following:

Proposition 5. *When the lending size is limited by the capital ratio k such that $L_0 \leq E_0/k$ and the deposit insurance premium charged on the bank is fair, the monitoring intensity $\widetilde{m}$ of the bank manager, the inspecting effort of shareholders $\widetilde{s}$, and the probability of loan losses $\widetilde{p}$ are the solution to the following system of equations:*

$$(1 - k) - (R - \widetilde{p}\ell) + (1 - \widetilde{p})\left[b + \widetilde{\Omega}\right] = 0 \tag{10}$$

[14]In appendix 2, we indicate that this case is perfectly equivalent to that of a bank funded mainly with unsecured debt. Our model can therefore be exploited to discuss the effect of a greater managerial bonus with different degrees of market discipline.

$$[\Delta + \widetilde{s}(1 - p_H)]\, b - \widetilde{m}M = 0 \tag{11}$$

$$\widetilde{p} - p_L - (1 - \widetilde{m})\,(\Delta - \widetilde{s}\Delta_\phi) = 0, \tag{12}$$

with $\widetilde{\Omega} \equiv \frac{C\widetilde{s}}{(1-\widetilde{m})\Delta_\phi}$.

Proof. Assume that conditions (3) and (4) are binding; after substituting the fair premium (8) into (9), we derive the equations (10) and (11). Adding the definition of probability (12), we derive the system of equations (10)–(12), which determines the equilibrium values $(\widetilde{p}, \widetilde{s}, \widetilde{m})$. Notice that this system is non-linear and therefore cannot be solved explicitly.

The effect of a change in the level of the bonus on the probability of loan losses $\widetilde{p}$ is based on the result in proposition 6 in appendix 1. When the overall effect of a larger bonus is positive, a risk-sensitive deposit insurance premium changes, reflecting a lower riskiness; therefore, the stake of revenues from loans retained by shareholders increases, improving their marginal benefit of inspection. This initiates a virtuous circle by which the negative effect on the inspection of shareholders is reduced. Hence, an increase in managerial bonus can be even more beneficial. However, when a larger bonus increases bank risk, a risk-sensitive deposit insurance premium might exacerbate the negative effect: a risk-sensitive premium reacts to the increase in risk by reducing the stake of revenues from loans retained by shareholders, and this creates a further disincentive to their inspecting effort. The overall negative effect on risk might be even larger with a risk-sensitive deposit insurance. This is why, in the empirical analysis, we measure the effect of a larger managerial compensation by taking into account the cross-country heterogeneity derived from the different institutional arrangements concerning deposit insurance.

4. Data Sources

In this paper, we contribute to the empirical literature with a new database by matching four different sources of data. The final objective is to build a panel of large banks from several countries where each single observation is a CEO and his bank. In particular, we combine information at the bank level (such as accounting records

information) with information on CEO compensation, for different years and for different countries. To link these data, absent direct linkages between accounting records and CEO compensation data, we merged observations from two different sources: Bankscope[15] and Capital IQ – People Intelligence.[16] From Capital IQ, we initially selected all commercial banks, savings institutions (SIC codes 6020, 6021, 6029, and 6036), and bank holding companies (BHCs, with SIC code 6719) for which the compensation of CEOs was available for at least one year within the period 2005–9; from BHCs we excluded banks for which the primary specialization is brokerage and financial services (SIC codes 6162, 6199, 6200, and 6211). We then matched these selected banks with the top ten largest publicly listed banks for each country; the largest banks have been ranked in terms of total assets and have been selected each year from 2005 to 2009. Following this repeated selection process (every year starting from 2005 to 2009), we discarded a bank if it was observed in the pre-crisis years but disappeared during the crisis because of mergers and acquisitions or insolvency. Then, we extracted information from Datastream about stock returns and equity prices at daily and weekly frequency in the years from 2005 to 2009. Finally, we added the indicators on financial regulation at the country level following Caprio, Laeven, and Levine (2007), who derived the information from the third wave of the World Bank's Bank Regulation and Supervision Survey.[17] In conclusion, we obtain a sample of the 116 largest banks from twenty-six countries.[18] Not surprisingly, the majority of observations belong to countries where the disclosure of managerial compensation is mandatory (as, for example, in the United States).

[15]Bankscope is a directory and financial reporting service on 30,000 banks worldwide provided by Bureau van Dijk. It provides standardized reports, ratings, and ownership data as well as financial analysis functions.

[16]Capital IQ – People Intelligence is a database provided by Standard and Poor's on the profiles of public and private firms worldwide, including financials, officers and directors, ownership, advisory relationships, transactions, securities, key developments, estimates, key documents, credit ratings, and filings.

[17]We present a list and a detailed description of our variables of interest in appendix 4.

[18]We present the final list of banks and countries in table 10 in appendix 5.

4.1 Descriptive Statistics

In the next two sub-sections, we provide summary statistics for our sample of banks and the way their CEOs are remunerated. In particular, in the following sub-section, we examine banks' accounting statements at the end of 2006 and their performance in the later period October 2007–December 2008; in the subsequent sub-section we examine summary statistics of CEO compensation and equity ownership measured at the end of 2006.

4.1.1 Banks

Table 1 provides the descriptive statistics for our sample of 116 large banks (all variables are in U.S. dollars). The value of total assets is in fact significantly larger compared to related papers that focus on U.S. banks—as, for instance, Fahlenbrach and Stulz (2011). Our sample is comparable to the sample in Beltratti and Stulz (2012), although we have fewer observations because compensation variables are not available for all banks due to the lack of mandatory disclosure rules. While sample size may represent a limit for the external validity of the empirical analysis, focusing on the largest banks has the advantage of enhancing their comparability. As argued by Laeven and Levine (2009), the largest groups tend to better comply with international accounting standards.

The average and median equity book-to-market ratio are smaller than 1; this indicates that banks were potentially growing in 2006. This evidence, combined with a positive average market stock return from stock prices between 2005 and 2006 of about 27 percent, suggests that the huge drop in stock returns from mid-2007 was, at least to some extent, unexpected even at the end of 2006. Tier 1 and total regulatory capital ratios are not observed for all banks in our sample. The mean value of the total regulatory capital ratio suggests that banks in 2006 had capital, on average, above the required minimum of Basel I. We will include tier 1 capital ratio as a control variable in our regression analysis, given its importance for the evaluation of bank stability for supervisory authorities—although we lack the information on its value for more than 10 percent of the banks in our sample. The average buy-and-hold return in the period 2007:Q3–2008:Q4 was approximately −48 percent; this underlines

Table 1. Summary Statistics for the Sample of Banks

	Mean	St. Dev.	Median	Number
A. Descriptive Statistics in 2006				
Total Assets	287171.4	558105.1	61590.9	116
Total Liabilities	270839.8	528171.2	56701.26	116
Market Capitalization	49713.84	236197.1	7491.345	116
Equity Book-to-Market Ratio	.9652698	1.339303	.6215296	116
Market Return from Stock Prices 2005–6	.2759742	.26403	.2703018	116
ROA	1.469828	1.547135	1.105	116
Equity over Total Assets (Book Value)	.0768866	.0153843	.0654814	116
Deposit Ratio	.8125634	.1464496	.8572832	113
Tier 1 Capital Ratio	9.5378	3.009371	8.61	100
Total Regulatory Capital Ratio	13.02724	5.323436	11.8	105
B. Performance Variables in the Financial Crisis				
Buy-and-Hold Return 2007–8	−.4833044	.2581407	−.4886037	116
Standard Deviation 2007–8	.0664146	.0198295	.0640443	116

Notes: The table provides summary statistics for our sample of banks. The definitions of the variables and the list of banks are in appendix 4 and 5, respectively. All variables in panel A are measured in millions of U.S. dollars at the end of fiscal year 2006. Original variables used to obtain performance indicators in panel B have been downloaded from Datastream in U.S. dollars.

how deep the financial crisis has been for the banking sector worldwide.

4.1.2 CEO Compensation

Table 2 provides descriptive statistics on the compensation packages and the value of equity portfolios for the CEOs employed in 2006 in our sample of banks. Panel A summarizes the various elements of total compensation. While average annual compensation is approximately $3 million, the median value is approximately $1 million; this suggests that even within our sample of large banks, there is

Table 2. Summary Statistics for CEO Compensation

	Mean	St. Dev.	Median	Number
A. Annual Compensation				
Total Compensation	3576.3	6029.7	1353.7	116
Salary	798.5	573.1	758.1	116
Cash Bonus	1410.1	2468.2	429.3	116
Equity Bonus	1367.7	3889.8	0	116
Cash Bonus over Salary	1.5	2.4	0.6	116
Equity Bonus over Salary	1.38	3.89	0	116
Total Bonus over Salary	2.88	5.75	.97	116
Cash Bonus over Total Bonus	0.5	0.4	0.6	116
B. Equity Portfolio				
Value of Shares	16385.6	41417.1	725.4	116
Value of Stock Options	19002.6	67158.2	0	116
Value of Total Equity Portfolio	35388.2	90413.2	1068.7	116
Value of Total Equity Portfolio/Total Compensation	21.4	93.9	1.1	116
Value of Total Equity Portfolio/Salary	48.46	125.44	1.93	116
C. Equity Portfolio Incentives				
Ownership from Shares (% over Total)	1.4	6.5	.02	116
Ownership from Shares and Options (% over Total)	1.5	6.5	.02	116
Percentage Equity Risk (Vega of Options)	0.7	2.4	0	116

Notes: The table provides summary statistics on the compensation and the portfolio of equity of CEOs appointed in the selected banks in 2006. The definitions of the variables are in appendix 4. All variables in panel A and panel B are measured in thousands of U.S. dollars at the end of fiscal year 2006.

a significant variability in total compensation across CEOs. Cash bonus is, on average, 1.5 times the salary. Moreover, cash bonuses are more widespread than bonuses paid in equity (shares and/or stock options); the median value of equity bonus is in fact zero, which implies that more than 50 percent of the banks in our sample

did not award any stock and/or option in 2006 to their CEOs. Panel B summarizes the statistics on the equity portfolio of CEOs. Equity portfolio is the sum of shares (restricted and unrestricted) and stock options held by each CEO at the end of 2006. The average value of the equity portfolio was $35 million. The median value of shares (restricted and unrestricted) was approximately $725,000 at the end of 2006. Panel C summarizes some of the variables that will be used in the empirical analysis; they measure the sensitivity of the value of equity portfolio to changes in returns and risk of banks' share prices. As for the stock options, following Core and Guay's (2002) approximation, we distinguish between the sensitivity of CEO stock-option portfolios to share prices (option delta) and the sensitivity to volatility of stocks (option vega). The reason is that while Guay (1999) finds that firm equity risk is positively related to the convexity of the monetary incentives provided to their CEOs, Coles, Naveen, and Naveen (2006) find that the stock-return volatility of risky investments is positively affected by the deltas and vegas calculated on managers' options. We finally define the ownership from shares and stock options as the sum of option delta and direct insider ownership from shares.[19]

The figures on the average value of ownership from shares and stock options in our data indicate that a CEO would gain an additional 1.4 percent in the value of his equity portfolio for a 1 percent increase in stock prices, while the value of percentage equity risk (the vega weighted for all options) means that a CEO would see an increase of 0.7 percent in his stock-options wealth for a 1 percent increase in volatility of stock prices.

5. Financial Crisis and CEO Compensation

In this section, we analyze how the variables related to CEO monetary incentives in the pre-crisis year affected the performance of banks during the financial crisis. Following the structure and the predictions of the model, in the empirical analysis, we assume that shareholders were not expecting the evolution of their bank performance in the financial crisis at the time when they set the

[19]See appendix 4 for a detailed definition of the variables used in the empirical analysis.

compensation schemes before the collapse. Consequently, we run the following OLS regression:

$$Y_{i,07-08} = \alpha + \beta VC_{i,2006} + \gamma Controls_{i,2006} + \epsilon_{i,07-08}, \qquad (13)$$

where the dependent variable $Y_{i,07-08}$ is either buy-and-hold return (BHR, hereafter) of each bank stock price or standard deviation (SD, hereafter) of stock returns in the period 2007:Q3–2008:Q4. We decided to exclude the first two quarters of 2009 when computing these variables because bank returns in this last part of the recession may have been affected by national recovery policies.[20] On the right-hand side of equation (13), we measure CEO monetary incentives by using different measures of variable compensation in 2006, $VC_{i,2006}$. Following related literature on the effect of variable compensation on risk (Benmelech, Kandel, and Veronesi 2010), we consider separately measures of shorter-term incentives given by annual cash compensation and measures of longer-term incentives given by the equity portfolio of CEOs. Short-term incentives are measured by cash bonus over salary in 2006. Equity incentives are measured by the ownership from shares and options and by the percentage equity risk evaluated in 2006. In the theoretical section of the paper, we have demonstrated that the risk of the bank arises endogenously from the strategic interaction between managers, whose effort depends on variable compensation, and the shareholders, whose effort depends on the capital structure of the bank; consequently, to isolate the effect of variable compensation on risk, it is important that our empirical results adequately control for bank characteristics that shape shareholder incentives. In our regression analysis, we will add variables at the bank level to control for size (the log of market capitalization), for leverage (measured by equity to total asset), and for capital adequacy and liquidity (tier 1 capital ratio). When analyzing the determinants of risk taking of a bank, it is also important to control for measures of productivity because the literature acknowledges that risk and productivity are endogenously determined (Hughes

[20] As a consequence, we do not conform to National Bureau of Economic Research dates of the Great Recession, namely 2007:Q3–2009:Q2. However, as a robustness check, we repeated the analysis by including the first and the second quarter of 2009 in the measure of BHR and SD. The results, not included in the current version, are substantially unchanged.

and Mester 2013, for instance). Furthermore, Cheng, Hong, and Scheinkman (2010) argue that risk and productivity represent a predetermined characteristic of the bank that is exogenous with respect to executives' compensation. To rule out the possibility that the relation between $Y_{i,07-08}$ and $VC_{i,06}$ can be confounded by some predetermined characteristics of the bank, such as productivity, we add controls such as the market return from stock prices between 2005 and 2006, the equity book-to-market ratio, and the ROA (return on assets) measured in 2006. The first two variables capture the expectations of financial markets about the future performance of the bank, while the latter is a standard measure of productivity.[21] Finally, although in the model we assume that all depositors are insured, in reality, a non-negligible fraction of bank external funding may be unsecured; in this case, uninsured creditors may exert market discipline in addition to the control of shareholders. For this reason, we incorporate the fraction of deposits from customers over total deposits (which include money-market and short-term funding from other institutions) as an additional control in the regression analysis.[22]

5.1 Stock Return

In this section, we consider the BHR in the period 2007:Q3–2008:Q4 as the dependent variable. Table 3 summarizes the results.

[21] As an additional robustness check, we also employ the asset turnover in 2006 as a measure of productivity; moreover, we repeat all the subsequent empirical analyses by controlling for the average ROA and the average asset turnover in the period 2005–7. Averages may represent a better measure of the fundamental productivity of banks because they might smooth down abnormal yearly changes. However, the inclusion of such averages comes at the cost of losing some observations: this is why we have left the ROA observed in 2006 in the current empirical exercise. Finally, we repeated all the analyses by considering as a further control the average of the standard deviation in the period 2005–7. All these robustness checks, available upon request, substantially confirm our main results.

[22] As an alternative measure for the intensity of the control by other stakeholders in addition to shareholders, we employ an index of monitoring by the private sector at the country level from the third wave of the Bank Regulation and Supervision Survey; our results, available upon request, are substantially confirmed.

Table 3. Regression Analysis: Buy-and-Hold Returns 2007:Q3–2008:Q4

Dependent Variable:	**BHR**				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Cash Bonus over Salary	−0.00752	−0.00261	−0.00439	−0.00699	−0.000348
	(0.0105)	(0.0112)	(0.0122)	(0.0115)	(0.0118)
Ownership from Shares and Options	0.333	0.242	−0.183	−0.313	−0.440
	(0.386)	(0.403)	(0.296)	(0.295)	(0.329)
Percentage Equity Risk	−1.324	−1.120	−1.723*	−1.726	−1.643
	(0.963)	(0.963)	(0.951)	(1.061)	(1.092)
Log of Market Capitalization		−0.0110	−0.0146	−0.000000413	0.00905
		(0.0110)	(0.0152)	(0.0189)	(0.0170)
Equity Book-to-Market Ratio			−0.431**	−0.0433**	−0.0344**
			(0.0203)	(0.0196)	(0.0164)
Market Return (2005–6)			−0.343***	−0.337***	−0.318***
			(0.0942)	(0.0857)	(0.0913)
ROA			0.00758	0.00335	0.0270
			(0.0194)	(0.0278)	(0.0460)
Equity over Total Assets (Book Value)				0.676	−0.327
				(0.808)	(1.088)
Deposit Ratio				0.459*	0.663***
				(0.272)	(0.208)
Tier 1 Capital Ratio					0.0185*
					(0.0107)
Constant	−0.468***	−0.382***	−0.214	−0.741**	−1.147***
	(0.0308)	(0.0964)	(0.161)	(0.360)	(0.300)
N	116	116	116	113	100
Adj. R^2	0.006	0.005	0.117	0.211	0.316

Notes: Robust standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. All covariates are measured in U.S. dollars at the end of fiscal year 2006.

In column 1, we study the relation between the BHR of banks during the financial crisis and three different components of the variable compensation of CEO remuneration. We use separate measures of CEO monetary incentives to distinguish between short-run incentives (cash bonus over salary) and long-run incentives (the equity portfolio); within this second type, we distinguish between the ownership from shares and options and the percentage equity risk. At first glance, we find no direct relation between each single component of the variable compensation and ex post performance. In columns 2–5, we analyze the effects of our measures of variable compensation, also controlling for variables at the bank level. In column 2, we control for size; in column 3, we add measures of ex ante performance and productivity; in column 4, we add a measure of leverage and the deposit ratio as additional controls; in column 5, we add the tier 1 capital ratio.[23] The results reveal that, while variable compensation had no direct impact on BHR for the whole sample, banks with higher stock returns and book-to-market ratios in 2006 performed significantly worse than other banks during the financial crisis; moreover, banks with higher tier 1 and banks that relied relatively more on customer deposits performed better. These results are in line with the findings of Fahlenbrach and Stulz (2011), although they focus on a sample of U.S. banks. In the next section, we will show how this conclusion might be challenged by introducing variables aimed at capturing the quality of bank governance and financial regulation.

5.2 Risk Return

Now we simply replicate the previous analysis using the standard deviation of stock returns as the dependent variable. The reason is that the convexity of monetary incentives given to CEOs may affect not only the average return of stocks of banks but also its risk (Coles, Naveen, and Naveen 2006). Results are in table 4.

The results in columns 1–4 indicate a statistically significant effect of monetary incentives given by stock options on realized

[23]While we acknowledge the importance of this variable for the performance of banks, we separately add it in the regression analysis, as it is not observed for approximately 10 percent of banks in our sample.

Table 4. Regression Analysis: Standard Deviation 2007:Q3–2008:Q4

Dependent Variable:	**SD**				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Cash Bonus over Salary	0.000602	−0.0001000	0.000767	0.000795	0.000602
	(0.000707)	(0.000753)	(0.000868)	(0.000779)	(0.000790)
Ownership from Shares and Options	−0.0481***	−0.0350***	−0.0346***	−0.0237**	−0.0129
	(0.0100)	(0.0109)	(0.0125)	(0.0109)	(0.0126)
Percentage Equity Risk	0.174*	0.144	0.190**	0.154*	0.163**
	(0.0972)	(0.0963)	(0.0957)	(0.0797)	(0.0772)
Log of Market Capitalization		0.00158*	−0.00108	−0.00173	−0.00105
		(0.000857)	(0.00129)	(0.00120)	(0.00102)
Equity Book-to-Market Ratio			−0.00437***	−0.00380***	−0.00316***
			(0.00136)	(0.00103)	(0.000975)
Market Return (2005–6)			0.0154***	0.0153***	0.0212***
			(0.00581)	(0.00465)	(0.00457)
ROA			−0.00231**	−0.00339	−0.00586**
			(0.00115)	(0.00258)	(0.00279)
Equity over Total Assets (Book Value)				0.0453	0.0535
				(0.0608)	(0.0871)
Deposit Ratio				−0.0404***	−0.0356**
				(0.0132)	(0.0147)
Tier 1 Capital Ratio					−0.00000409
					(0.000702)
Constant	0.0651***	0.0527***	0.0770***	0.112***	0.101***
	(0.00214)	(0.00724)	(0.0136)	(0.0203)	(0.0190)
N	116	116	116	113	100
Adj. R^2	0.060	0.077	0.163	0.242	0.279

Notes: Robust standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. All covariates are measured in U.S. dollars at the end of fiscal year 2006.

volatility of bank stock returns during the financial crisis. In particular, ownership from shares and options and the percentage equity risk affected the volatility of stock returns in two opposite directions. While the first is associated with a smaller volatility, the second is associated with a higher one. However, the effect of these variables becomes weaker in terms of statistical significance in column 5 when we add the tier 1 as an additional control. This last result calls for a further exploration of the relation between capital requirements and variable compensation.

6. The Effect of Financial Regulation

The evidence provided in the previous section is coherent with proposition 3 of our model: variable compensation may have an ambiguous effect on risk taking depending upon the incentives of bank managers and shareholders, which ultimately depend upon the regulatory environment and the relative efficiency of monitoring over inspecting activities; coherently, in our whole sample, we do not find any direct effects of variable compensation on performance. Our interpretation is that the potential positive effects of a larger variable compensation have been, to some extent, counterbalanced by their negative effects; as a result, we do not find a direct effect of the variable compensation of CEOs on return and risk. However, this result does not prevent the possibility that variable compensation may have significantly impacted the performance of banks only under certain regulatory/institutional conditions. The scope of the next analysis is precisely to explore the interaction between regulation and variable compensation on ex post performance, under the guidance of the insights from the theoretical section. In particular, we present additional empirical analysis to address three main theoretical predictions: (i) weaker control by shareholders, combined with variable compensation, might increase the risk-taking attitude of bank managers; (ii) when variable compensation has a negative effect on the risk of banks, a risk-sensitive deposit insurance premium might exacerbate its negative effect; for this reason, we will exploit differences in the institutional arrangements with regard to deposit insurance at the country level; and (iii) higher capital requirements may reduce risk-taking incentives by insiders.

6.1 The Effect of Shareholders' Control

Let us study the effects of CEO monetary incentives in contexts in which the efficiency and consequently the intensity of control by shareholders over bank managers is relatively stronger compared with the rest of the sample. For this purpose, we identify proxies for the efficiency of control both at the bank and country level, introducing measures of financial regulation. Following seminal contributions in the corporate governance literature (Jensen and Meckling 1976; Shleifer and Vishny 1986), we proxy the efficiency of control by ownership concentration in the bank. The main hypothesis is that in banks with lower ownership concentration, dispersed shareholders have less power and fewer incentives to control managerial behavior due to the greater marginal cost compared with the benefit. We measure ownership concentration as the sum of the shares of the largest three shareholders (C3 index) in 2006, and we examine how ownership concentration interacts with variable compensation in shaping the risk of individual banks. We split the sample into two sub-samples, according to whether the value of the C3 index is below (greater cost of inspection by shareholders, due to share dispersion) or above the median and explore if there is a significant difference in the average compensation schemes adopted in the two groups of banks. Evidence from table 5 indicates that banks with lower ownership concentration were significantly bigger (total assets measured at the end of 2006) and awarded significantly larger bonuses (both in form of cash and equity) to their CEOs in 2006.

To study if this difference in compensation structure has impacted performance of banks during the financial crisis, we run a regression analysis similar to that in section 5 by splitting the original sample into two sub-samples. Results are in table 6.

Columns 1 and 2 replicate the regression analysis of the full specification in column 5 of tables 3 and 4 for the sub-sample of banks with lower ownership concentration. Notice that we have fewer observations in this analysis compared with table 5, as the inclusion of tier 1 as a regressor reduces the sample size. The analysis reveals that, in banks with a lower ownership concentration, the larger the equity bonus (measured as either shares and stock-options holdings or percentage equity risk), the worse the bank performance both in terms of stock returns and volatility. Columns 3 and 4 follow a

Table 5. Ownership Concentration: Banks, Variable Compensation, Performance

	C3 Below Median	C3 Above Median	Difference
A. Bank-Level Descriptive Statistics			
Total Assets	413958.2	160384.6	253573.6*
	(690077.5)	(345696.9)	
Market Capitalization	86977.7	12449.9	74527.8
	(330701.1)	(19175.7)	
Equity over Total Assets (Book Value)	0.0714	0.0824	−0.0109
	(0.0340)	(0.0641)	
Market Return from Stock Prices 2005–6	0.267	0.285	−0.0109
	(0.254)	(0.276)	
Tier 1 Capital Ratio	9.276	9.810	−0.534
	(3.096)	(2.923)	
B. Compensation Variables			
Cash Bonus over Salary	2.144	0.853	1.291**
	(3.079)	(1.123)	
Equity Bonus over Salary	2.223	0.553	1.670*
	(5.231)	(1.338)	
Total Bonus over Salary	4.367	1.406	2.961**
	(7.663)	(1.913)	
Value of Total Equity Portfolio/Total Compensation	27.86	14.90	12.96
	(119.4)	(58.98)	
C. Performance in the Financial Crisis			
Buy-and-Hold Return 2007–8	−0.499	−0.468	−0.0312
	(0.272)	(0.245)	
Standard Deviation 2007–8	0.0691	0.0638	0.00531
	(0.0229)	(0.0159)	
N	58	58	

similar empirical strategy for the sub-group of banks with greater concentration. In this sub-group of banks, we do not find any effect of ownership from shares and option, while we find a positive effect of percentage equity risk on performance during the financial crisis;

Table 6. Ownership Concentration, Variable Compensation, and Performance in the Financial Crisis

Dependent Variable:	Low Concentration		High Concentration	
	BHR	SD	BHR	SD
	(1)	(2)	(3)	(4)
Cash Bonus over Salary	0.00316	0.000597	0.00358	0.000686
	(0.0138)	(0.000967)	(0.0271)	(0.00183)
Ownership from Shares and Options	−6.976***	0.276*	−0.173	−0.0105
	(2.344)	(0.155)	(0.397)	(0.0172)
Percentage Equity Risk	−2.524***	0.212***	3.172***	−0.161***
	(0.825)	(0.0666)	(0.678)	(0.0546)
Log of Market Capitalization	−0.0167	−0.000391	0.0280	−0.00136
	(0.0272)	(0.00224)	(0.0205)	(0.00130)
Equity Book-to-Market Ratio	−0.104***	−0.00246	−0.00442	−0.00307***
	(0.0323)	(0.00243)	(0.0124)	(0.00103)
Market Return (2005–6)	−0.364**	0.0267***	−0.317**	0.0177***
	(0.166)	(0.00900)	(0.131)	(0.00648)
ROA	−0.0114	−0.00404	0.0750	−0.00911
	(0.0665)	(0.00415)	(0.0759)	(0.00565)
Equity over Total Assets (Book Value)	0.135	−0.0480	−0.642	0.196
	(1.620)	(0.148)	(1.715)	(0.144)
Deposit Ratio	0.752**	−0.0327	0.761***	−0.0458**
	(0.324)	(0.0259)	(0.232)	(0.0194)
Tier 1 Capital Ratio	0.0448**	−0.000280	0.00443	−0.000646
	(0.0168)	(0.00122)	(0.0158)	(0.00115)
Constant	−1.079**	0.0969**	−1.344***	0.114***
	(0.487)	(0.0420)	(0.326)	(0.0214)
N	51	51	49	49
Adj. R^2	0.418	0.242	0.298	0.272

Notes: Robust standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. All covariates are measured in U.S. dollars at the end of fiscal year 2006.

this is in fact associated with higher returns and lower volatility.[24] These results support the prediction of the model. Greater variable compensation, in the form of equity bonuses, has led to worse performance (lower returns and higher volatility) in banks with weaker internal control by shareholders. This evidence is coherent with the findings in Gropp and Kohler (2010) indicating that more widely held banks faced greater loan losses in the financial crisis. To check the robustness of this result, we replace C3 with other proxies for the efficiency of supervision by exploiting some of the variables contained in the third wave of the World Bank's Bank Regulation and Supervision Survey. In particular, we use two proxies at the country level: (i) an index of restrictions on bank activities; (ii) an index of supervisory power of bank supervisory authorities. Our hypothesis is that, on the one hand, restrictions on bank activities by the financial authority reduce managerial slack and thus lead to higher efficiency; on the other hand, greater power of bank supervisory authorities makes the ex ante cost of bank manager misbehavior larger from the shareholder point of view, thus inducing greater internal control. We split the sample of banks into two sub-samples according to whether the values of those indices are above or below the median. Results (not reported in the current version, but available upon request) indicate that, in the group of countries where the restrictions on bank activities were below the median, a greater variable compensation (in particular, equity portfolio incentives) is related to worse performance (measured by using either stock return or standard deviation). In the other sub-group we don't find any effect of variable compensation. A similar result is obtained for banks in countries where the supervisory authority is less powerful. All these empirical findings seem to indicate that weaker supervision (due to higher internal shareholder costs), combined with higher pay-for-performance sensitivity in CEO compensation schemes, might explain the higher risk in banks.

6.2 Deposit Insurance

Theoretical insights from the version of our model that incorporates a risk-sensitive deposit insurance mechanism imply that, when

[24]These results are robust to the inclusion of an alternative measure of bank size, such as total assets, that replaces market capitalization.

the variable compensation reduces risk, the existence of an explicit insurance premium is beneficial. The opposite is true, however, when higher variable compensation implies higher risk incentives for insiders. Again, these results call for an empirical test of the predictions of the model. In this sub-section, we analyze the interaction between deposit insurance and variable compensation on risk in banks. To this purpose, we divide our initial sample of banks into two groups: those banks based in countries where an explicit deposit insurance arrangement was in place in 2006 and those in countries without it (which we label as countries with implicit deposit insurance systems). As a first step, we check if there is a significant difference in the average compensation schemes adopted in the two groups of banks. Evidence in table 7 reveals that the group of banks with explicit deposit insurance has rewarded more equity bonus to their CEOs; however, the small sample size of the other group does not make the statistical comparison reliable.

Keeping this sample limitation in mind, we test if the interaction of explicit deposit insurance with the compensation structure has an impact on the performance of banks during the financial crisis. While displaying the results also for the other sub-sample for the sake of completeness, we are aware that the small sample size reduces our confidence in the statistical significance of the results. We employ a regression analysis similar in spirit to the previous section. Results are in table 8.

Columns 3 and 4 replicate the regression analysis of the full specification in column 5 of tables 3 and 4 for the sub-sample of banks based in countries with explicit deposit insurance. Results in column 3 suggest that banks that provided higher equity incentives to their CEOs (both ownership from shares and options and percentage equity risk) are associated with worse performance in terms of stock returns during the financial crisis. Results in column 4 suggest, instead, that only percentage equity risk can be associated with higher volatility. Taken together, the theoretical insights and empirical results suggest that explicit deposit insurance, combined with variable compensation schemes, increased the risk attitude of shareholders and bank managers and resulted in worse performance during the financial crisis.

Table 7. Deposit Insurance: Banks, Variable Compensation, Performance

	Implicit Dep. Ins.	Explicit Dep. Ins.	Difference
A. Bank-Level Descriptive Statistics			
Total Assets	78758.6	449614.9	−370856.3**
	(95508.8)	(675523.4)	
Market Capitalization	78643.9	−67599.7	11044.2
	(14500.5)	(303572.6)	
Equity over Total Assets (Book Value)	0.0921	0.0632	0.0289*
	(0.0856)	(0.0277)	
Market Return from Stock Prices 2005–6	0.259	0.272	−0.0129
	(0.197)	(0.174)	
Tier 1 Capital Ratio	9.140	8.875	0.265
	(2.130)	(1.998)	
B. Compensation Variables			
Cash Bonus over Salary	1.269	1.935	−0.666
	(1.215)	(2.907)	
Equity Bonus over Salary	0.437	2.160	−1.723
	(0.651)	(4.893)	
Total Bonus over Salary	1.706	4.096	−2.389
	(1.480)	(7.150)	
Value of Total Equity Portfolio/Total Compensation	6.350	9.865	−3.514
	(12.35)	(24.79)	
C. Performance in the Financial Crisis			
Buy-and-Hold Return 2007–8	−0.418	−0.543	0.125*
	(0.181)	(0.241)	
Standard Deviation 2007–8	0.0635	0.0684	−0.00484
	(0.0125)	(0.0228)	
N	27	69	

6.3 Capital Requirements

In this last sub-section, we study the empirical relation between capital requirements, variable compensation, and risk taking. Theoretical insights from the model suggest that higher capital ratio (and,

Table 8. Deposit Insurance, Variable Compensation, and Performance in the Financial Crisis

Dependent Variable:	Implicit Deposit		Explicit Deposit	
	BHR	SD	BHR	SD
	(1)	(2)	(3)	(4)
Cash Bonus over Salary	−0.0421	0.00232	0.00549	0.000719
	(0.0273)	(0.00181)	(0.0118)	(0.000950)
Ownership from Shares and Options	−17.79**	−0.128	−1.751***	0.0351
	(6.877)	(0.596)	(0.381)	(0.0382)
Percentage Equity Risk	2.958**	−0.163	−2.181***	0.232***
	(1.069)	(0.103)	(0.532)	(0.0672)
Log of Market Capitalization	−0.0964*	−0.00652	−0.0118	−0.00177
	(0.0559)	(0.00499)	(0.0230)	(0.00178)
Equity Book-to-Market Ratio	−0.430***	−0.0197	−0.0484**	−0.00216
	(0.128)	(0.0123)	(0.0239)	(0.00168)
Market Return (2005–6)	0.720***	0.0411***	−0.0447	0.0193
	(0.143)	(0.0130)	(0.224)	(0.0192)
ROA	0.571***	0.00653	0.0724	−0.00640
	(0.199)	(0.0185)	(0.0744)	(0.00520)
Equity over Total Assets (Book Value)	−10.07**	−0.434	0.682	0.0302
	(3.614)	(0.286)	(1.456)	(0.142)
Deposit Ratio	0.428	−0.0610	0.478*	−0.0428
	(0.596)	(0.0490)	(0.257)	(0.0266)
Tier 1 Capital Ratio	−0.00477	0.00117	0.0462***	−0.00214
	(0.0279)	(0.00197)	(0.0154)	(0.00158)
Constant	0.246	0.182**	−1.241***	0.133***
	(0.830)	(0.0695)	(0.381)	(0.0333)
N	22	22	62	62
Adj. R^2	0.483	0.025	0.325	0.274

Notes: Robust standard errors are in parentheses. *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. All covariates are measured in U.S. dollars at the end of fiscal year 2006.

consequently, lower leverage) might lead to lower risk taking from the shareholder perspective because a larger capital ratio increases the marginal revenue of his effort. As a proxy for the level of capital, we consider the difference between the actual capital (total regulatory capital ratio measured at the bank level) and the minimum

Table 9. Distance between Actual and Required Capital Requirements: Banks, Variable Compensation, Performance

	Distance Below Median	Distance Above Median	Difference
A. Bank-Level Descriptive Statistics			
Total Assets	293935.2	332067.0	−38131.8
	(467886.3)	(677072.6)	
Market Capitalization	75052.6	34329.9	40722.7
	(346980.8)	(62990.7)	
Equity over Total Assets (Book Value)	0.0620	0.0887	−0.0267**
	(0.0262)	(0.0631)	
Market Return from Stock Prices	0.291	0.266	0.0250
	(0.233)	(0.261)	
Tier 1 Capital Ratio	8.068	11.13	−3.061***
	(1.598)	(3.366)	
B. Compensation Variables			
Cash Bonus over Salary	1.473	1.678	−0.205
	(2.553)	(2.434)	
Equity Bonus over Salary	0.744	1.952	−1.208
	(2.383)	(4.616)	
Total Bonus over Salary	2.217	3.630	−1.414
	(4.532)	(6.711)	
Value of Total Equity Portfolio/Total Compensation	14.44	31.21	−16.77
	(60.15)	(125.5)	
C. Performance in the Financial Crisis			
Buy-and-Hold Return 2007–8	−0.543	−0.426	−0.117**
	(0.223)	(0.229)	
Standard Deviation 2007–8	0.0675	0.0618	0.00572
	(0.0169)	(0.0166)	
N	52	53	

capital requirement (defined by each country authority).[25] We divide our sample of banks into two groups according to the value of this difference, one below and the another above the median. Evidence from the descriptive analysis in table 9 shows that there is not a

[25]The minimum required capital ratio has been collected directly from the third wave of the Bank Regulation and Supervision Survey (as described in appendix 4). Notice that about 80 percent of banks in our sample operate in countries where the required ratio is less than or equal to 8 percent.

significant difference in the balance sheet or CEO compensation variables between the banks in the two groups; instead, we find that more-capitalized banks performed relatively better during the financial crisis than poorly capitalized banks, confirming the baseline results in section 5. Turning to the regression analysis, we do not find consistent evidence that variable compensation affected return and risk in the two sub-groups of banks; this result, which is perfectly coherent with evidence found by Chesney, Stromberg, and Wagner (2010), Beltratti and Stulz (2012), and Demirguc-Kunt, Detragiache, and Merrouche (2013), suggests that shareholders in poorly capitalized banks may have perfectly aligned their incentives with those of their CEOs to take more risk.

7. Conclusions

This paper contributes to the recent literature on the determinants of risk in banks. In particular, we analyze the impact of CEOs' variable compensation as well as that of corporate governance and financial regulation. We set out a theoretical framework that can illuminate the determinants of risk in banks when the agency conflicts between managers, shareholders, and depositors are important; and we test the model's predictions with an analysis of banks' performance during the financial crisis, using a novel database on banks in different countries. We can summarize the results as follows:

- There is no evidence of an association between variable compensation and bank performance (measured as stock returns and standard deviation of stock returns) for the entire sample.
- There is evidence of a correlation between variable compensation and risk when we interact it with banks' corporate governance arrangements and the financial regulatory framework in the country where the bank is located.
- CEOs' monetary incentives are associated with lower stock returns and higher volatility in banks where shareholders'

control is weak—i.e., when ownership concentration is low—and where restrictions on banks' activities and the power of supervisory authorities are relatively weaker.
- For banks in countries with explicit deposit insurance, an increase in CEOs' variable compensation is associated with worse performance and greater risk.
- Highly capitalized banks were more resilient during the financial crisis; their stock returns dropped less and their standard deviation was smaller.

This evidence offers substantial support for the indications of our model. To our knowledge, the paper is one of the first model-assisted empirical studies of the interrelations between CEOs' monetary incentives, financial regulation, and risk taking at banks in different countries. The understanding of these interactions may have important policy implications in the current debate about prudential regulation.

Appendix 1. Computations and Proofs

Proof of Proposition 1

Assume that conditions (4) and (3) are binding; after substituting the balance sheet (1) into (3), we derive equations (5) and (6). We can solve this linear system of equations and derive the equilibrium values of $\widehat{s}$ and $(1-\widehat{m})$ as follows:

$$(1-\widehat{m}) = \frac{(M-\Delta.b)}{M+\frac{A}{C}(1-p_H)b}$$

and

$$\widehat{s} = \frac{A}{C}(1-\widehat{m}) = \frac{A}{C}.\left[\frac{(M-\Delta.b)}{M+\frac{A}{C}(1-p_H)b}\right].$$

We need to assume $M \geq \Delta.b$ in order to guarantee that the two efforts, and thus the two probabilities, are positive. To derive the risk in equilibrium, i.e., equation (7), we simply substitute the two values $\widehat{s}$ and $(1-\widehat{m})$ into (2).

Proof of Proposition 2

To sign the impact of changes on the equilibrium values of efforts, we can study the derivative of $\widehat{s}$ and $(1-\widehat{m})$ with regard to each of the variables of interest at the time and then derive the overall effect on (7).

Effect of a Change in k

The derivatives of k on the equilibrium value of the two efforts $\widehat{s}$ and $(1-\widehat{m})$ are given by

$$\frac{d\widehat{s}}{dk} = \frac{M.\frac{\Delta_\phi}{C}(M-\Delta.b)}{\left[M+\frac{A}{C}(1-p_H)b\right]^2} \geq 0$$

and

$$\frac{d(1-\widehat{m})}{dk} = -\frac{(M-\Delta.b)\frac{\Delta_\phi}{C}(1-p_H)b}{\left[M+\frac{A}{C}(1-p_H)b\right]^2} \leq 0.$$

Both effects can be signed without uncertainty. The overall effect of k on the equilibrium risk $\widehat{p}$ is given by the total derivative of (7) with regard to k, that is,

$$\frac{d\widehat{p}}{dk} = \frac{d(1-\widehat{m})}{dk}(\Delta - \widehat{s}\Delta_\phi) - (1-\widehat{m})\Delta_\phi\frac{d\widehat{s}}{dk}.$$

The overall effect on the probability of loan losses is negative, and therefore a stronger capital requirement reduces bank risk.

Effect of a Change in C

Similarly to the previous exercise, we can study the effect of a change in C on the equilibrium efforts. The derivatives of a change in C on the two equilibrium values $\widehat{s}$ and $(1-\widehat{m})$ are given by

$$\frac{d\widehat{s}}{dC} = -\frac{\frac{A}{C^2}(M-\Delta.b)}{\left[M+\frac{A}{C}(1-p_H)b\right]^2} \leq 0$$

and

$$\frac{d(1-\widehat{m})}{dC} = \frac{(M-\Delta.b)\frac{A}{C^2}(1-p_H)b}{\left[M+\frac{A}{C}(1-p_H)b\right]^2} \geq 0.$$

Both effects can be signed without uncertainty. The overall effect of C on the riskiness $\widehat{p}$ is given by the total derivative of (7) with regard to C, that is,

$$\frac{d\widehat{p}}{dC} = \frac{d(1-\widehat{m})}{dC}(\Delta - \widehat{s}\Delta_\phi) - (1-\widehat{m})\Delta_\phi \frac{d\widehat{s}}{dC}.$$

It is easy to see that the overall effect on the probability of loan losses is positive, and therefore a smaller inspection cost by shareholders reduces bank risk.

Proof of Proposition 3

The sign of the impact of changes on the equilibrium value of efforts can be studied by taking the derivatives of $\widehat{s}$ and $(1-\widehat{m})$ with regard to b and then studying the effect on (7). The derivatives of the two equilibrium values $\widehat{s}$ and $(1-\widehat{m})$ are given by

$$\frac{d\widehat{s}}{db} = -\frac{M.\left\{\frac{\Delta_\phi}{C}(M-\Delta.b) + \left[\Delta + \frac{A}{C}(1-p_H)\right]\right\}}{\left[M+\frac{A}{C}(1-p_H)b\right]^2} \leq 0$$

and

$$\frac{d(1-\widehat{m})}{db} = \frac{-M.\left[\Delta + \frac{A}{C}(1-p_H)\right] + \frac{\Delta_\phi}{C}(1-p_H)b(M-\Delta.b)}{\left[M+\frac{A}{C}(1-p_H)b\right]^2} \lesseqgtr 0,$$

which has an uncertain effect depending on which effect prevails. The first effect is the "direct" effect of the bonus on the managerial effort, while the second effect is the "indirect" substitution effect through the lower inspection intensity of shareholders. The overall effect on the riskiness depends upon the sign of the effect of the bonus on the managerial effort. The sign of the effect of b on the probability $\widehat{p}$ is given by the derivative of (7) with regard to b, that is,

$$\frac{d\widehat{p}}{db} = \frac{d(1-\widehat{m})}{db}(\Delta - \widehat{s}\Delta_\phi) - (1-\widehat{m})\Delta_\phi \frac{d\widehat{s}}{db}.$$

Given that the inspection effort diminishes as a consequence of a larger bonus, the probability of loan losses is reduced only when the increase in managerial effort compensates for the smaller effort by shareholders. Hence for riskiness to become smaller, the direct effect of the bonus must be stronger than the indirect effect. The larger is M, the more likely it is.

Proof of Proposition 4

Assume we increase simultaneously the capital ratio k and the bonus b in order to maintain the overall value of A unchanged, that is, $db = dk$. In this special case, it is easy to see that the equilibrium values of $(1 - \widehat{m})$ and $\widehat{s} = \frac{A}{C}(1 - \widehat{m})$ are smaller. The overall effect of the derivative of b on $\widehat{p}$ is more likely to be negative: the reason is that, on the one hand, the derivative $\frac{d(1-\widehat{m})}{db}$ is negative while its weight $(\Delta - \widehat{s}\Delta_\phi)$ is larger; on the other hand, the second term (with a negative sign) is the derivative $\frac{d\widehat{s}}{db}$, which is negative, but its weight $(1 - \widehat{m})\Delta_\phi$ is smaller. Overall, it is more likely that the term with a negative sign will prevail.

Proposition 6 and Its Proof

PROPOSITION 6. *A larger bonus b has a negative effect on the intensity of inspection $\widetilde{s}$ of shareholders, while it might improve the monitoring effort $\widetilde{m}$ of the bank manager. Overall, a larger bonus has an uncertain effect on the probability of loan losses $\widetilde{p}$.*

Proof. The sign of the impact of a change in the bonus b on the equilibrium values $(\widetilde{p}, \widetilde{s}, \widetilde{m})$ can be derived, following Chiang (1984), through the application of the Cramer rule to the system of linear equations (10)–(12) around the equilibrium values of $(\widetilde{p}, \widetilde{s}, \widetilde{m})$. Taking the total differential of the system of equations with regard to b, we have

$$G \times \begin{bmatrix} \frac{d\widetilde{p}}{db} \\ \frac{d\widetilde{s}}{db} \\ \frac{d\widetilde{m}}{db} \end{bmatrix} = \begin{bmatrix} -(1 - \widetilde{p}) \\ -[\Delta + \widetilde{s}(1 - p_H)] \\ 0 \end{bmatrix},$$

where G is defined as

$$G = \begin{bmatrix} -\left[(b-\ell)+\widetilde{\Omega}\right] & \widetilde{\Omega}\frac{(1-\widetilde{p})}{\widetilde{s}} & \widetilde{\Omega}\frac{(1-\widetilde{p})}{(1-\widetilde{m})} \\ 0 & (1-p_H)\,b & -M \\ 1 & (1-\widetilde{m})\Delta_\phi & (\Delta-\widetilde{s}\Delta_\phi) \end{bmatrix}.$$

The sign of the effect of b on the probability $\widetilde{p}$ is the ratio between two determinants, i.e., $\frac{d\widetilde{p}}{db} = \frac{|G_1|}{|G|}$. Matrix G_1 is the 3x3 matrix given by G in which the first column is replaced by the vector on the right-hand side of the system of linear equations. The determinant $|G_1|$ is

$$(1-\widetilde{p})\Bigg\{ -\left[(1-p_H)\,b(\Delta-\widetilde{s}\Delta_\phi) + M(1-\widetilde{m})\Delta_\phi\right] + \frac{\widetilde{\Omega}}{\widetilde{s}}\left[\Delta+\widetilde{s}\,(1-p_H)\right]\left[\Delta-2\widetilde{s}\Delta_\phi\right]\Bigg\}.$$

The sign of the effect is uncertain. Given that the determinant $|G|$,

$$-\left[(b-\ell)+\widetilde{\Omega}\right]\left[(1-p_H)\,b(\Delta-\widetilde{s}\Delta_\phi) + M(1-\widetilde{m})\Delta_\phi\right] - \frac{\widetilde{\Omega}(1-\widetilde{p})}{\widetilde{s}(1-\widetilde{m})}\left[M(1-\widetilde{m}) + (1-p_H)\,b\widetilde{s}\right],$$

is negative, the overall sign of the effect depends upon $|G_1|$. The overall effect is negative whenever $|G_1|$ is positive, and vice versa. The sign of the effect of b on the inspection $\widetilde{s}$ is the ratio between two determinants, i.e., $\frac{d\widetilde{s}}{db} = \frac{|G_2|}{|G|}$. Matrix G_2 is the 3x3 matrix given by G in which the second column is replaced by the vector on the right-hand side of the system of linear equations. Its determinant $|G_2|$,

$$\left[(b-\ell)+\widetilde{\Omega}\right]\left[\Delta+\widetilde{s}\,(1-p_H)\right](\Delta-\widetilde{s}\Delta_\phi) + (1-\widetilde{p})\left\{M+\frac{\widetilde{\Omega}}{(1-\widetilde{m})}\left[\Delta+\widetilde{s}\,(1-p_H)\right]\right\},$$

is positive. Given that $|G| < 0$ and $|G_2| > 0$, the overall sign of the effect is negative, that is, $\frac{d\widetilde{s}}{db} < 0$. Finally, the sign of the effect

of b on the monitoring intensity $\widetilde{m}$ is the ratio between two determinants, i.e., $\frac{d\widetilde{m}}{db} = \frac{|G_3|}{|G|}$. Matrix G_3 is the 3x3 matrix given by G in which the third column is replaced by the vector on the right-hand side of the system of linear equations. Its determinant $|G_3|$ is

$$-\left[\Delta + \widetilde{s}\,(1-p_H)\right]\left\{\left[(b-\ell)+\widetilde{\Omega}\right](1-\widetilde{m})\Delta_\phi + (1-\widetilde{p})\frac{\widetilde{\Omega}}{\widetilde{s}}\right\}$$
$$+\,(1-\widetilde{p})\,(1-p_H)\,b.$$

When the last term is not too large (small b), then $|G_3| < 0$, and given that $|G| < 0$ the overall sign of the effect is positive, that is, $\frac{d\widetilde{m}}{db} > 0$.

Appendix 2. Case with Unsecured Debt

Assume the bank is funded at date 0 with α% unsecured debt (uninsured depositors) and $(1-\alpha)$% insured deposits with $\alpha \in [0,1]$. We also let the deposit insurance premium be charged on the bank for a proportion $\beta \in [0,1]$, where $\beta = 0$ captures the case of a premium funded with taxpayers' money and $\beta = 1$ captures the risk-sensitive premium charged directly to the bank. The balance sheet in this case is

$$E_0 + \alpha D_0 + (1-\alpha)D_0 = \beta\pi_0 + L_0.$$

The returns of the portfolio of loans at date 2 must be divided among the different stakeholders of the bank in all possible states of the world. If the portfolio of loans returns RL_0, then each insured depositor is repaid D_0, while unsecured debtholders receive D_2 and the bank manager is rewarded the bonus b. If the portfolio of loans returns $(R-\ell)\,L_0$, then the deposit insurance repays $(1-\alpha)D_0$ to insured depositors, while unsecured debtholders receive $\max\{0;(R-\ell)L_0-(1-\alpha)D_0\}$ and the bank manager does not cash the bonus. The fair deposit insurance premium is therefore defined as

$$\pi_0 = p\max\left\{(1-\alpha)D_0 - (R-\ell)\,L_0; 0\right\}.$$

The participation constraint for unsecured debtholders requires that their future revenue compensates their date 0 investment, i.e.,

$$(1-p)D_2 + p\max\left\{(R-\ell)\,L_0 - (1-\alpha)D_0; 0\right\} = \alpha D_0. \qquad (14)$$

The best reply function of bank shareholders is

$$\frac{\partial U^B}{\partial s} = (1-m)\Delta_\phi \left[(R-b) - (1-\alpha)\frac{D_0}{L_0} - \frac{D_2}{L_0}\right] - Cs = 0. \quad (15)$$

We have to distinguish between two cases.

CASE 1. $(R-\ell)\,L_0 \leq (1-\alpha)D_0$.

In this case, the portfolio revenue is not sufficient to repay unsecured debtholders, since insured depositors are the majority; therefore, condition (14) becomes

$$\frac{D_2}{L_0} = \frac{\alpha}{1-p}\frac{D_0}{L_0},$$

while the fair deposit insurance premium is

$$\frac{\pi_0}{L_0} = p\left\{(1-\alpha)\frac{D_0}{L_0} - (R-\ell)\right\}.$$

After substituting those two expressions into the date 0 balance sheet, the best reply function (15) becomes

$$\frac{\partial U^B}{\partial s} = (1-m)\Delta_\phi \left[(R-b) - \frac{[1-p(1-\alpha)]}{1-p}\frac{[1-k-\beta p\,(R-\ell)]}{1-\beta p(1-\alpha)}\right] - Cs = 0.$$

When $\alpha \to 0$ (100 percent insured deposits), it is immediate to derive the two special sub-cases developed in the paper, that of a deposit insurance paid with taxpayers' money ($\beta = 0$) and that of a risk-sensitive deposit insurance premium charged directly to the bank ($\beta = 1$).

CASE 2. $(R-\ell)\,L_0 \geq (1-\alpha)D_0$.

In this case, the portfolio revenue is high enough to repay something to unsecured debtholders, since there are few insured depositors; condition (14) becomes

$$\frac{D_2}{L_0} = \alpha\frac{D_0}{L_0} + \frac{p}{1-p}\left[\frac{D_0}{L_0} - (R-\ell)\right];$$

and the fair deposit insurance premium is null. After substituting these two values into the date 0 balance sheet, the best reply function (15) becomes

$$\frac{\partial U^B}{\partial s} = (1-m)\Delta_\phi \left[(R-b) - \frac{[1-k-p\,(R-\ell)]}{1-p}\right] - Cs = 0.$$

For any value of α, provided that it is large enough to fit case 2—as, for instance, $\alpha \to 1$ (100 percent unsecured debt)—this is equivalent to the case of a risk-sensitive deposit insurance charged at date 0 directly on the bank balance sheet (i.e., $\beta = 1$).

Appendix 3. A Numerical Example

Here we provide some numerical simulations to gain insights on theoretical propositions 3 and 4. We first fix the values of the parameters of the model as follows:

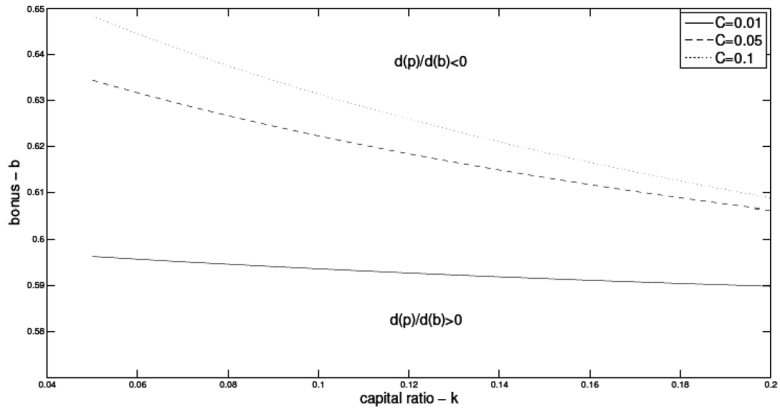
Parameter	Value
R	2.5
M	0.7
p_H	0.4
p_L	0.0
ϕ	0.1

We select a grid of reasonable values for the other two parameters of interests, k and C. Finally, we plot the combinations of b and k for which the derivative is zero, i.e.,

$$\frac{d\widehat{p}}{db} = \frac{d(1-\widehat{m})}{db}(\Delta - \widehat{s}\Delta_\phi) - (1-\widehat{m})\Delta_\phi \frac{d\widehat{s}}{db} = 0.$$

Then we repeat the exercise for different values of C. Figure 3 shows the different combinations of bonus and capital ratio such that the derivative of the probability with regard to the bonus is zero. These numerical results illustrate the result in proposition 2, namely that the overall effect of a larger bonus on the probability of loan losses depends upon a combination of k and C, since they affect both the incentive of shareholders and of the bank manager. Notice that,

Figure 3. The Effect of a Larger Bonus b on Risk



Notes: The diagram represents the combinations of bonus b and capital ratio k such that the impact of a change in the bonus on the probability of loan losses p is zero. Above the curves the derivative is negative (hence a larger managerial bonus reduces bank risk), while the opposite occurs below the curve. The curves are drawn for different values of C. The smaller is C (greater efficiency in control by shareholders), the more likely it is that the bonus reduces bank risk.

conditionally on these parameter values, the area where the derivative is positive is increasing in C. This implies that, for a given capital ratio k, an increase in the bonus reduces the probability of loan losses when the efficiency of inspection is high (C is low—solid line); however, the same jump in the bonus may instead increase the probability of loan losses if the efficiency of inspection is low (C is high—dotted line). Intuitively, an increase in the bonus leads to a reduction in the inspection by shareholders; the higher the inspection cost, the greater the reduction. This indirect effect on the managerial effort, through a reduction in inspection, might overcome the direct effect of an increase in the bonus, causing an increase in risk. The figure also highlights that the magnitude of the effect of the increase in C is decreasing in the capital ratio k; in fact, the higher the capital ratio, the smaller the distance between the curves. This finding intuitively validates proposition 4. In strongly capitalized banks, the elasticity of the inspection effort of shareholders with respect to the bonus is smaller. This implies that the area where the derivative of

the probability of loan losses with respect to the bonus is positive shrinks for higher values of k; the higher the value of C, the greater the reduction.

Appendix 4. Definition of Key Variables

Balance Sheet (Source: Bankscope)

- Total Assets: Total earning assets plus cash and due from banks plus foreclosed real estate plus fixed assets plus goodwill plus other intangibles plus current tax assets plus deferred tax plus discontinued operations plus other assets in 2006.
- Total Liabilities: Total interest-bearing liabilities plus fair-value portion of debt plus credit impairment reserves plus reserves for pension and other plus tax liabilities plus other deferred liabilities plus discontinued operations plus insurance plus other non-interest-bearing liabilities in 2006.
- Market Capitalization: Total number of shares at the end of 2006 multiplied by the price of shares at the end of 2006.
- Equity Book-to-Market Ratio: Total equity (common equity plus non-controlling interest plus securities revaluation reserves plus foreign exchange revaluation reserves plus other revaluation reserves in 2006) over market capitalization.
- Deposit Ratio: Total customer deposits (current plus savings plus term deposits) over total deposits, money-market, and short-term funding.
- Tier 1 Capital Ratio: A regulatory measure of capital adequacy, that is, the shareholder funds plus perpetual non-cumulative preference shares as a percentage of risk-weighted assets and off-balance-sheet risks measured under the Basel rules.
- Total Regulatory Capital Ratio: Total capital adequacy ratio under the Basel rules. It measures tier 1 plus tier 2 capital, which includes subordinated debt, hybrid capital, loan loss reserves, and the valuation reserves as a percentage of risk-weighted assets and off-balance-sheet risks.
- ROA: Return on average asset (before tax).

- Market Return from Stock Prices 2005–6: Share price at the end of 2006 plus dividend per share in 2006 minus the price at the end of 2005, all over the price of shares at the end of 2005.
- C3: The sum of the shares of the largest three shareholders.

Compensation (Source: Capital IQ – People Intelligence)

- Total Compensation: Salary plus cash bonus plus equity bonus paid in 2006.
- Salary: Amount paid as fixed salary in 2006.
- Cash Bonus: Amount paid in cash as bonus in 2006.
- Equity Bonus: The value of bonus not paid in cash in 2006; it sums up restricted stock awards, stock grant awards, and option awards (the value of options).
- Total Bonus over Salary: Total bonus (cash bonus plus equity bonus) over salary.
- Value of Shares: Number of shares (unrestricted and restricted) held by the CEO multiplied by the price of share at the end of 2006.
- Value of Stock Options: The value of options calculated using the Black and Scholes formula; the exercise price and the share price at the end of the year and the expiration year is provided by Capital IQ. The risk-free interest rate is the ten-year maturity interest rate on U.S. bonds (source: Federal Reserve). The total number of options is given by the sum of exercisable options, unexercisable options, and unearned and unexercised options (that have been excluded from the sum of total options).
- Value of Total Equity Portfolio: Value of shares plus value of stock options.
- Ownership from Shares (% over Total): The ratio between the number of shares held by the CEO (source: Capital IQ) and the total number of shares of the company (source: Datastream) multiplied by 100.
- Ownership from Shares and Options (% over Total): Ownership from shares plus the delta-weighted options (see below) divided by the total number of shares outstanding.

- Delta-Weighted Options: The sum of each option held by the CEO at the end of 2006 multiplied by the delta of the respective option (sensitivity of CEO's option portfolio value to share price calculated using the formula by Core and Guay 2002).
- Percentage Equity Risk (Vega of Options): Sensitivity of the CEO's option portfolio value to stock-return volatility. It is the weighted sum of the vegas of each option held by the CEO at the end of 2006; the weights are determined by the number of each option award divided by the total number of options. It is multiplied by 100.

Stock Returns (Source: Datastream)

- Buy-and-Hold Return 2007–8 (BHR): Buy-and-hold return on stock weekly returns over the period 2007:Q3–2008:Q4.
- Risk Return 2007–8 (SD): Standard deviation of weekly returns over the period 2007:Q3–2008:Q4.

Regulation (Source: Bank Regulation and Supervision Survey, Third Wave)

- Private Monitoring: An index of monitoring on the part of the private sector.
- Official: An index of the power of the commercial bank supervisory agency, including elements such as the rights of the supervisor to meet with and demand information from auditors, to force a bank to change the internal organizational structure, to supersede the rights of shareholders, and to intervene in a bank.
- Deposit Insurance: Dummy variable equal to 1 if the country has an explicit deposit insurance.
- Restrict: An index of regulatory restrictions on the activities of banks, consisting, for example, of limitations on the ability of banks to engage in securities market activities, insurance activities, and real estate activities, and to own non-financial firms.
- Minimum Capital Requirement: This answers the survey question, What is the minimum capital-to-asset ratio requirement?

Appendix 5. List of Banks

Table 10. List of Banks

Country	Name of Bank
Australia	Australia and New Zealand Banking Group Limited
	National Australia Bank Limited
	Bendigo and Adelaide Bank Limited
	Bank of Queensland Ltd.
	Westpac Banking Corporation
	Commonwealth Bank of Australia
Austria	Erste Group Bank AG
Belgium	Dexia SA
Canada	The Toronto-Dominion Bank
	Laurentian Bank of Canada
	Royal Bank of Canada
	The Bank of Nova Scotia
	Home Capital Group Inc.
	Canadian Imperial Bank of Commerce
	National Bank of Canada
	Bank of Montreal
	Canadian Western Bank
China	China Merchants Bank Co. Ltd.
Czech Republic	Komercni Banka AS
Denmark	Danske Bank A/S
France	Credit Agricole S.A.
	BNP Paribas SA
	Societe Generale Group
Germany	Commerzbank AG
	Aareal Bank AG
	Deutsche Postbank AG
	Deutsche Bank AG
Hong Kong	Dah Sing Financial Holdings Limited
	Hang Seng Bank Limited
	The Bank of East Asia, Limited
	Wing Hang Bank Limited
	BOC Hong Kong Holdings Ltd.
	Chong Hing Bank Limited
	Dah Sing Banking Group Limited

(continued)

Table 10. (Continued)

Country	Name of Bank
India	Bank of Baroda
	ICICI Bank Ltd.
	Housing Development Finance Corporation Limited
	Oriental Bank of Commerce
	HDFC Bank Ltd.
Ireland	Allied Irish Banks p.l.c.
	The Governor and Company of the Bank of Ireland
Israel	Israel Discount Bank Limited
	Bank Leumi Le-Israel BM
	First International Bank of Israel Ltd.
	Mizrahi Tefahot Bank, Ltd.
	Union Bank of Israel Ltd.
	Bank Hapoalim B.M.
Italy	Unione di Banche Italiane Scpa
	Banca Popolare di Sondrio
	UniCredit S.p.A.
	Banco Popolare Scarl
	Banca Carige S.p.A.
	Banca popolare dell'Emilia Romagna
Jordan	Arab Bank plc
	Capital Bank of Jordan
	Bank of Jordan
	Cairo Amman Bank
Malaysia	Malayan Banking Berhad
Namibia	FNB Namibia Holdings Limited
Netherlands	Van Lanschot NV
Norway	Dnb Asa
	Helgeland Sparebank
	Sandnes Sparebank
	SpareBank 1 Nord-Norge
	SpareBank 1 SMN
	SpareBank 1 SR-Bank
	SpareBank 1 Buskerud-Vestfold
	Sparebanken M.re
	Sparebanken Pluss

(continued)

Table 10. (Continued)

Country	Name of Bank
Pakistan	NIB Bank Limited
	Faysal Bank Limited
	Habib Metropolitan Bank Limited
	United Bank Ltd.
	Bank Al Habib Limited
	Bank Alfalah Limited
	Allied Bank Limited
	MCB Bank Ltd.
	Askari Bank Limited
Poland	Bank Polska Kasa Opieki
	Bank Millennium Spolka Akcyjna
	BRE Bank SA
	Bank Zachodni WBK SA
	Bank Handlowy W Warszawie SA
South Africa	Absa Group Limited
	Standard Bank Group Limited
	Capitec Bank Holdings Ltd.
	FirstRand Limited
	Sasfin Holdings Limited
	Cadiz Holdings Ltd.
	Nedbank Group Limited
Spain	Banco Popular Espanol S.A.
	Banco Santander, S.A.
	Banco Bilbao Vizcaya Argentaria, S.A.
Sweden	Nordea Bank AB
	Swedbank AB
	Skandinaviska Enskilda Banken AB
	Svenska Handelsbanken AB
United Kingdom	HSBC Holdings plc
	Standard Chartered plc
	Paragon Group of Companies plc
	The Royal Bank of Scotland Group plc
	Arbuthnot Banking Group plc
	Barclays plc
	Lloyds Banking Group plc

(continued)

Table 10. (Continued)

Country	Name of Bank
United States of America	U.S. Bancorp Fifth Third Bancorp SunTrust Banks, Inc. Regions Financial Corporation BBandT Corporation Citigroup, Inc. JPMorgan Chase and Co. Bank of America Corporation The PNC Financial Services Group, Inc. Wells Fargo and Company SLM Corporation The Bank of New York Mellon Corporation

References

Becht, M., P. Bolton, and A. Röell. 2011. "Why Bank Governance Is Different." *Oxford Review of Economic Policy* 27 (3): 437–63.

Beltratti, A., and R. Stulz. 2012. "The Credit Crisis around the Globe: Why Did Some Banks Perform Better?" *Journal of Financial Economics* 105 (1): 1–17.

Benmelech, E., E. Kandel, and P. Veronesi. 2010. "Stock-Based Compensation and CEO (Dis)Incentives." *Quarterly Journal of Economics* 125 (4): 1769–1820.

Berkovitz, E., R. Israel, and Y. Spiegel. 2000. "Managerial Compensation and Capital Structure." *Journal of Economics and Management Strategy* 9 (4): 549–84.

Bolton, P., H. Mehran, and J. Shapiro. 2010. "Executive Compensation and Risk Taking." Staff Report No. 456, Federal Reserve Bank of New York.

Caprio, G., L. Laeven, and R. Levine. 2007. "Governance and Bank Valuation." *Journal of Financial Intermediation* 16 (4): 584–617.

Cerasi, V., and S. Daltung. 2007. "Financial Structure, Managerial Compensation and Monitoring." Research Paper No. 207, Sveriges Riksbank.

Cerasi, V., and J. C. Rochet. 2014. "Rethinking the Regulatory Treatment of Securitization." *Journal of Financial Stability* 10 (1): 20–31.

Cheng, H., H. Hong, and J. Scheinkman. 2010. "Yesterday's Heroes: Compensation and Creative Risk Taking." NBER Working Paper No. 16176.

Chesney, M., J. Stromberg, and A. F. Wagner. 2010. "Risk-Taking Incentives, Governance, and Losses in the Financial Crisis." Research Paper No. 10-18, Swiss Finance Institute.

Chiang, A. C. 1984. *Fundamental Methods of Mathematical Economics.* London: McGraw-Hill International.

Coles, J., D. Naveen, and L. Naveen. 2006. "Managerial Incentives and Risk-Taking." *Journal of Financial Economics* 79 (2): 431–68.

Core, J., and W. Guay. 2002. "Estimating the Value of Employee Stock Options Portfolios and Their Sensitivities to Price and Volatility." *Journal of Accounting Research* 40 (3): 613–30.

Cziraki, P. 2014. "Trading by Bank Insiders Before and During the 2007–2008 Financial Crisis." Unpublished Manuscript. Available at SSRN.

Demirguc-Kunt, A., E. Detragiache, and O. Merrouche. 2013. "Bank Capital: Lessons from the Financial Crisis." *Journal of Money, Credit and Banking* 45 (6): 1147–64.

Demirguc-Kunt, A., B. Karacaovali, and L. Laeven. 2005. "Deposit Insurance around the World: A Comprehensive Database." Policy Research Working Paper No. 3628, World Bank.

Dewatripont, M., and J. Tirole. 1999. *The Prudential Regulation of Banks.* Cambridge, MA: MIT Press.

Diamond, D., and R. Rajan. 2009. "The Credit Crisis: Conjectures about Causes and Remedies." *American Economic Review: Papers and Proceedings* 99 (2): 606–10.

Ellul, A., and V. Yerramilli. 2013. "Stronger Risk Controls, Lower Risk: Evidence from U.S. Bank Holding Companies." *Journal of Finance* 68 (5): 1757–1803.

Fahlenbrach, R., and R. Stulz. 2011. "Bank CEO Incentives and the Credit Crisis." *Journal of Financial Economics* 99 (1): 11–26.

Giannetti, M., and D. Metzger. 2013. "Compensation and Competition for Talent: Talent Scarcity or Incentives?" Unpublished Manuscript. Available at SSRN.

Gropp, R., and M. Kohler. 2010. "Bank Owners or Bank Managers: Who Is Keen on Risk? Evidence from the Financial Crisis." Discussion Paper No. 10-013, ZEW Centre for European Economic Research.

Guay, W. R. 1999. "The Sensitivity of CEO Wealth to Equity Risk: An Analysis of the Magnitude and Determinants." *Journal of Financial Economics* 53 (1): 43–71.

Guo, L., A. Jalal, and S. Khaksari. 2014. "Bank Executive Compensation Structure, Risk Taking and the Financial Crisis." Forthcoming in *Review of Quantitative Finance and Accounting*.

Hughes, J. P., and L. Mester. 2013. "Who Said Large Banks Don't Experience Scale Economies? Evidence from a Risk-Return-Driven Cost Function." *Journal of Financial Intermediation* 22 (4): 559–85.

Jensen, M., and W. H. Meckling. 1976. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics* 3 (4): 305–60.

John, K., H. Mehran, and Y. Quian. 2010. "Outside Monitoring and CEO Compensation in the Banking Industry." *Journal of Corporate Finance* 16 (4): 383–99.

John, K., A. Saunders, and L. W. Senbet. 2000. "A Theory of Bank Regulation and Management Compensation." *Review of Financial Studies* 13 (1): 95–125.

John, T. A., and K. John. 1993. "Top-Management Compensation and Capital Structure." *Journal of Finance* 48 (3): 949–74.

Kolm, J., C. Laux, and G. Loranth. 2014. "Regulating Bank CEO Compensation and Active Boards." Unpublished Manuscript.

Laeven, L., and R. Levine. 2009. "Bank Governance, Regulation and Risk Taking." *Journal of Financial Economics* 93 (2): 259–75.

Mehran, H., A. Morrison, and J. Shapiro. 2011. "Corporate Governance and Banks: What Have We Learned from the Financial Crisis?" Staff Report No. 502, Federal Reserve Bank of New York.

Shleifer, A., and R. Vishny. 1986. "Large Shareholders and Corporate Control." *Journal of Political Economy* 94 (3): 461–88.

Suntheim, F. 2010. "Managerial Compensation in the Financial Service Industry." Unpublished Manuscript. Available at SSRN.