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Paper

How does Ownership Structure influence Bank Risk? Analyzing the Role of Managerial Incentives.

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ABSTRACT

This paper analyzes how ownership concentration and managerial incentives influences bank risk for a large sample of US banks over the period 1997-2007. Using 2SLS simultaneous equations models, we show that ownership concentration has a positive total effect on bank risk. This is the result of a positive direct effect, which reflects monitoring and opportunistic behavior, and a negative indirect effect, which works through the design of managerial incentive contracts and reflects shareholder preferences toward risk. Large shareholders reduce bank risk by reducing the sensitivity of CEO wealth to stock volatility (Vega) and by increasing the CEO pay-performance sensitivity (Delta). In addition, we show that the direct and indirect effect of ownership concentration on bank risk depends on the type of the largest shareholder (a family, a bank, a corporation or an institutional investor), as well as, on the total shareholding held by each type as a group. Our results suggest that the positive relation between ownership concentration and risk is not the result of preferences towards more risk. Rather, they point at opportunistic behavior of large shareholders.

Keywords: Ownership Structure, Managerial Incentives; Risk taking, Delta, Vega, Stock Options.

JEL classification: G01, G21, G31; G32; G34; J33

1. Introduction

The recent crisis has raised a number of questions about the adequacy of corporate governance systems and managerial incentives practices in financial institutions. Research attention has been focused in particular on the relationship between executives incentives and bank risk (DeYoung et al. 2012; Armstrong and Vahishtha, 2012; Fahlenbrach and Stulz, 2011). Limited attention has been given, however, to the importance of considering ownership structure to study the effect of executive incentives on bank risk, although theory and evidence suggest that CEO compensation represent the shareholders preferences toward risk (Mehran, Morrison and Sahpiro, 2011). In fact, the say- on- pay votes approved under the Dodd-Frank Act provisions aims to align manager's interest with those of shareholders. However, there is limited evidence on how risk preferences vary among different types of shareholders and on how the ownership structure influences executive incentive contracts to affect bank risk. In this study we provide such evidence.

This paper examines the risk preferences of large shareholders and the mechanisms underlying the relationship between ownership concentration and bank risk for a large sample of US banks over the period 1997-2007. In particular, we decompose the total effect of ownership concentration on bank risk into a direct effect, which reflects monitoring or opportunistic behavior, and an indirect effect, which works through the design of managerial incentive contracts and reflects large shareholders' risk preferences. In terms of incentives, we focus on the sensitivity of CEO wealth to stock return volatility (Vega), and on the sensitivity of CEO wealth to stock price (Delta). To this extent, we combine the literature on bank ownership structures and risk-taking, with the literature on the risk- taking effect of executive compensation, to better assess the determinants of bank risk.

Previous literature has focused on the direct effect of ownership concentration on bank risk, without considering different types of ownership or examining the underlying mechanisms of this relationship (e.g., Saunders et al., 1990; Demsetz et al., 1997; Burkhart et al., 1997; Iannota et al., 2007). In particular, this literature has build on agency theory and, generally, treats shareholders as a uniform group with the important assumption that shareholders are risk neutral and that they all prefer more risk to less, as in any limited liability firm. In contrast, managers with bank-specific human capital skills and private benefits of control are expected to advocate for less risk-taking (Jensen and Meckling, 1976; Demsetz and Lehn, 1985). Under this framework, differences in risk among banks stem from differences in the ability of shareholders to manage the risk-related incentive problem (defined as risk-adverse managers passing up positive but risky net present value (NPV) projects that shareholders would like to undertake). This problem is expected to be lower in firms with concentrated ownership, as controlling shareholders have the ability to discipline managers (Shleifer and Vishny, 1986; Franks et al, 2001). However, the empirical evidence on the effect of ownership concentration on bank risk is mixed, which suggests it may be important to consider differences in ownership types, in addition to concentration. In this sense, Iannota et al. (2007) report a negative effect and conclude that their result deserves further research, as they cannot be explained within an agency framework.

This paper builds on this stream of literature and contributes to it by considering a) differences in risk preferences between different types of shareholders (i.e., families, corporations, banks, and institutional investors), since theoretical and empirical research suggests that agency problems depend on the firm's ownership structure (La Porta et al. 1999, Bebchuk and Hamdani 2009), and b) the mechanisms through which shareholders influence bank risk.

Building on agency theory, we argue that the risk taking behavior of banks is the result of two main agency problems. In line with previous research, the first agency problem that affects bank risk is the owner/ manager agency problem (type I agency problem), which may lead to managers not acting in the best interest of the shareholders, in terms of risk taking. Shareholders, especially controlling owners, can reduce this agency problem by increasing their monitoring effort and by altering managerial compensation[1]. Therefore, as large shareholders have the means to influence the design of executive incentive contracts toward their risk preferences, we use such a design to extracts their risk preferences. While traditional agency theory predicts that large shareholders would always prefer more risk to less, we posit that this may not be the case, if we take into account how much of a major stockholder's wealth is concentrated in the bank. These wealth concentration effects could make a shareholder more risk averse than otherwise would be expected (Sullivan and Spong, 2007; Faccio, Marchica and Mura, 2011).

[1] Both elements are likely to act as complements in the banking industry since the relationship between CEO effort and outcomes such as bank performance or risk-taking are highly uncertain, due to the influence of numerous organizational and environmental contingencies that are outside CEO control (Finkelstein and Hambrick, 1996; Milgrom and Roberts, 1992).

The second agency problem affecting bank risk, that has received less attention, arises from conflicts between controlling and non-controlling shareholders (type II agency problem). Controlling shareholders may seek private benefits at the expense of non-controlling shareholders which may lead to higher bank risk (Shleifer and Vishny 1997). To illustrate, controlling shareholders can seek private benefits through tunneling behavior, incompetent management, placement of relatives in executive positions, inadequate investments, or resistance to value-increasing takeovers (Johnson et al., 2000). These problems may become more severe at banks with concentrated ownership structure, because of large shareholders' control over the banks' board of directors (Anderson and Reeb, 2003).

Considering these two types of agency problems and the possibility of a lack of diversification on the part of a large shareholder, we base our analysis on the following assumptions: first, we assume that shareholders aim to maximize their utility which may vary substantially between shareholders, depending on their ownership stake as well as their portfolio diversification. Second, we assume, in line with previous literature, that large shareholders try to maximize their utility directly, via monitoring or opportunistic behavior, and indirectly via the design of managerial incentive contracts. Thus, we decompose the total effect of ownership concentration on bank risk into a direct and into an indirect effect. Figure 1 illustrates our model.

----------- Insert Figure 1 about here -----------

Ex ante, it is unclear whether concentrated banks are riskier or less risky than banks with a dispersed ownership structure. While large (un)diversified owners may employ monitoring and managerial incentives to motivate managers to take more (less) risk, opportunistic behavior is expected to be positively related to bank risk. Therefore, the relationship between ownership concentration and bank risk is expected to be positive for large diversified owners. For large undiversified owners, however, the sign of this relationship will depend on whether the risk increase due to opportunistic behavior is larger or smaller than the risk reduction through monitoring and managerial incentives.

We examine this issue empirically by using simultaneous equation models that account for the endogenous nature of the relationship between management incentives and bank risk profile. While most, if not all, of the simultaneous equations studies in the area of ownership structure, compensation, and risk analyze the direct effect of the independent variable on the dependent variable in each equation from the structural forms coefficients, these coefficients ignore the indirect effects these independent variables have on dependent variables in other equations. In this study we consider these indirect effects, i.e., we take into account that when risk changes in response to an initial change in the ownership structure variable, the managerial incentives variables also respond to this change in risk as well as to the initial change in ownership structure, thus causing a further change in risk.

Our results show that the ownership structure influences both bank risk and CEO incentive contracts and that CEO incentives influence bank risk. Thus, our findings suggest that CEO compensation is an important mechanism for shareholders to induce their preferred risk-level. In particular, we find that ownership concentration has a total positive effect on bank risk and that this effect can be decomposed into a positive direct effect, and a negative indirect effect. While the positive direct effect is the result of large shareholders opportunistic behavior, the indirect effect works through managerial incentives contracts. Large shareholders reduce bank risk by offering low-Vega and high-Delta executive incentive contracts.

We find that the strength of the positive direct and negative indirect effect depend on the type of the largest shareholder. The positive direct and negative indirect effect is strongest when the largest shareholder is a family and weakest when it concerns a bank or corporation. Finally, we look at the effect of total shareholdings by type on bank risk. We find that institutional shareholdings have a positive direct and indirect effect on bank risk, while family shareholdings show a positive direct effect and a negative indirect effect, which results in a positive total effect. Corporate and bank ownership are very small compared to institutional and family ownership when it concerns a non-controlling stake and, as a result, they do not have a significant direct effect on bank risk although they have an indirect effect via the design of CEO incentives.

Our results on the effect of managerial incentives on bank risk show that Vega has a positive direct effect on bank risk, while the direct effect of Delta on bank risk is negative. In addition, we consider the simultaneous relation between Vega and Delta, and we look at the indirect effect of Vega (Delta) on bank risk via Delta (Vega). We show that an increase in Vega (Delta) has a negative (positive) indirect effect on risk via Delta (Vega). Overall, the positive (negative) direct effect of Vega (Delta) on risk is higher (lower) than the negative (positive) indirect effect of Vega (Delta) on risk via Delta (Vega), which leads to an overall positive relationship between Vega (Delta) and Risk.

Our findings hold for different measures of risk and different measures of ownership structure, and they suggest that that the positive relation between ownership concentration and risk, documented in previous studies, is not the result of higher preferences toward risk. Rather, our results suggest that it may be the result of the opportunistic behavior of large shareholders. Therefore, government intervention to limit risk-taking incentives in financial executive compensation contracts may be insufficient for banks controlled by undiversified shareholders with preferences toward lower risk. Rather, regulation of these types of bank may focus on reducing the type II agency problems.

Our empirical analysis extends the existing literature in four main directions. First, our evidence provides an important step toward a better understanding of the impact of equity ownership and managerial incentives on bank risk. Prior research, generally, focuses on the direct effect of ownership concentration on the level of bank risk, without considering different types of owners[2], or examining the underlying mechanisms of this relationship. In contrast, we investigate the preferences of different types of large shareholders toward risk and we decompose the total effect of ownership concentration on bank risk into a direct and an indirect effect. Accordingly, we apply standard modeling and econometric approaches, including simultaneous equations, suitable control variables, and firm fixed effects, so as to isolate how ownership influence bank risk through the design of managerial incentives contracts.

Second, as far as we know, this is one of the first studies to analyze the role of managerial incentives as an underlying mechanism through which shareholders may attain their desired level of risk. While the underlying assumption of most previous studies is that the relationship between risk-taking and ownership is associated with monitoring, we make an attempt to open the “black box” of governance processes and practices that shareholders use to deal with the risk-related incentive problem.

Third, we contribute to the literature on the link between managerial incentives and financial stability (DeYoung et al. 2012; Mehran and Rosenberg, 2007; Chen et al. 2006) by providing evidence of the relationship between equity incentives and risk. We add to this literature by examining the indirect effect of a change in Vega (Delta) on risk via Delta (Vega).

[2] A great number of studies show that large US corporations tend to be widely dispersed and even if they have large blockholders they are much less common than in other countries (Morck et al., 1988; Shleifer and Vishny, 1986). However, Holderness (2009) questions the dispersion of ownership structure in the US, given that 96% of the firms in his sample have blockholders.

The analysis of these indirect effects is important as it helps to understand the total effect of incentives on risk. The analysis of the direct effect can misstate the magnitude of the total effect and can even misstate the direction of the effect.

Forth, our analysis covers a broad sample of US bank-holding companies over the period 1997-2007, and extends the research into an important segment of the banking industry that has not received much attention previously, in part due to data unavailability. Thus, our sample has a larger variation in ownership structure, managerial incentives and risk. This leads to potentially more powerful tests, and more importantly, it allow us to generalize our inference to a broader segment of the economy. Furthermore, by estimating Delta and Vega for the manager's entire portfolio of stock and options, we obtain a more precise measure of the incentives faced by managers.

The rest of the paper is organized as follows: Section 2 reviews the relevant literature on ownership structure, executive compensation and risk taking, and formulates our hypotheses. Section 3 presents the sample, while section 4 describes the empirical model. Section 5 defines our variables of interest. Section 6 and 7 present the results and the robustness tests. Finally, Section 8 summarizes and concludes the paper.

2. Theoretical background and hypotheses development

In what follows, we provide a detail explanation of each of the mechanisms through which large shareholders can affect bank risk and we build our hypotheses on the effect of ownership concentration on bank risk. Then, we develop our hypothesis on the effect of management incentive contracts on bank risk. Finally, we extend our analysis to different types of controlling shareholders.

2.1 Mechanisms underlying the relationship between ownership structure and bank risk

2.1.1 Monitoring and incentives contracts: mechanisms to induce large shareholder preferences toward risk.

Large shareholders may induce their preferred risk behavior on their managers, *directly* through monitoring *and indirectly* via the design of executive incentive contracts. An important factor influencing large shareholders preferences toward risk is how much of a major shareholder's wealth is concentrated in the bank. On the one hand, diversified large owners would like managers to undertake all positive net present value (NPV) projects regardless of their risk. On the other hand, owners with a large fraction of their personal wealth invested in the bank are less risk tolerant, since they are subject to both systematic and unsystematic risk. Underdiversification may lead shareholders to pass up some profitable projects on the basis of total risk and lead to a preference for less risky positive NPV projects (Smith and Stulz, 1985; Sullivan and Spong, 2007; Shleifer and Vishny, 1997).

Extended liability could be a further motivation of large shareholders to moderate bank risk. If a bank becomes closer to default, a capital increase might be unavoidable for regulatory reasons. In this scenario, the controlling shareholder would be pressured by the regulator and market participants to restore the minimum level of capital. The higher the fraction of the dominant shareholder's stake, the higher the likelihood of his intervention. The unwillingness or inability of the controlling shareholder to inject new capital will likely lead to regulatory actions to prevent the bank's default, which would result in a reduction of the controlling shareholder's power and possibly in the loss of control. Although these measures also apply to a bank with dispersed ownership, their impact on atomistic shareholders is negligible as regulators can exert less pressure on them. Therefore, while the liability of a bank's controlling shareholder is *de jure* limited to the amount of his original capital contribution (as for any other shareholders), it might be *de facto* extended, because of prudential regulation. As a result, an increase in ownership concentration may discourage risk taking (Iannota et al., 2011).

Thus, if an increase in the ownership stake of large shareholders reduces the degree of diversification and produces effects similar to that of an extended liability regime, an increase in ownership concentration may discourage risk taking. In such a case, we may expect large shareholders to provide low-risk sensitive incentives contract to their managers and to monitor management toward the reduction of risk. The reverse would be true if large shareholders are well diversified, i.e., they could provide high-risk sensitive managerial incentives and monitor management to induce more risk taking.

2.1.2 Large shareholders opportunistic behavior and bank risk.

Large shareholders may have a direct positive effect on bank risk via their opportunistic behavior as they may choose risky economic actions to maximize their personal utility at the expense of other shareholders (type II agency problems). For instance, controlling shareholders can seek such private benefits by diverting funds for their own personal benefits in the form of special (hidden) dividends and preferential deals with their other (Anderson and Reeb, 2003), through managerial entrenchment (Shleifer and Vishny, 1997) or by foregoing some risk diversification gains (Demsetz and Lehn, 1985)[3]. Many of these activities increase the probability of costly lower-tail outcomes[4], In this sense, La Porta et al. (2003) show that, in many countries, banks lend to firms controlled by the bank's owner and that these related loans are more likely to default and when they do, they have lower recovery rates.

2.1.3 The direct, indirect and total effect of ownership concentration on bank risk

Considering the mechanisms described previously, we decompose the total effect of ownership concentration on bank risk into a direct and indirect effect. The *direct effect* of large shareholders on bank risk is given by their monitoring effort and opportunistic behavior while the *indirect effect* works through the design of managerial incentive contracts.

Whereas the potential opportunistic behavior of large shareholders may always lead to higher bank risk, the monitoring effort and the design of incentive contracts could aim to induce higher or lower level of risk, depending on the risk preferences of the large shareholders. Thus, the direct effect will be positive if large shareholders are well diversified, as both monitoring and opportunistic behavior will lead to higher bank risk. In this situation the total effect of ownership concentration on bank risk will be positive, as the indirect effect will also lead to higher bank risk. However, the sign of the direct and total effect is not clear when large shareholders are underdiversified. In such a case, the indirect effect is expected to be negative but the sign of the direct effect will depend on whether the opportunistic behavior effect dominates the monitoring effect. Thus, the sign of the total effect will depend on the sign and on the magnitude of the direct effect compared to the indirect effect.

We argue that when large shareholders suffer from underdiversification and from an extended liability effect, large shareholders' and managers' interests toward risk are likely to be more closely aligned. Both perceive high costs associated with financial distress, leading to lower type I agency problems. In such cases, we expect that the risk introduced by the type II agency

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[3] Agency problems related to concentrated ownership include incompetent management, placement of relatives in executive positions, excessive or insufficient investment, resistance to value-increasing takeovers or the exhibition of a tunneling behavior. Different forms of tunneling include the transfer of resources from the firm through self-dealing transactions, asset sales and contracts to the controlling shareholder, excessive executive compensation, loan guarantees, expropriation of corporate opportunities, and so on, as well as minority freeze-outs, insider trading, creeping acquisitions, or other financial transactions that discriminate against minorities (Johnson et al., 2000)

[4] See, for example, Gilson and Villalonga (2009), for a recent case on Adelphia Communications Corporation's bankruptcy, the eleventh largest bankruptcy case in history. The case highlights the potential expropriation of other investors by large, controlling shareholders such as founding families, who retain their controls through the dual-class share structure.

problems to be higher than the reduction of risk achieved through executive incentives and monitoring (as potential type I agency problems are already lower). Thus, in line with previous arguments, we hypothesize, to the extent that large shareholders suffer from under diversification and from an extended liability effect, that:

H1a: Ownership concentration has an indirect negative effect on bank risk, through executive incentives.

H1b: Ownership concentration has a direct positive effect on bank risk.

H1c: Ownership concentration has a total positive effect on bank risk.

2.2 Executive compensation and bank risk

One assumption in our analysis is that large shareholders induce their preferred level of risk through the design of CEO's incentives contracts, which implies that incentive contracts influence bank risk. While previous literature provides some support to the incentives-bank risk relationship (Jensen and Meckling, 1976; Rajgopal and Shevlin, 2002; Coles et al., 2006), we provide additional evidence on this relationship.

Two important measures of those incentives are Vega and Delta (Core and Guay, 2002). Vega captures the change in the dollar value of CEO wealth for a 0.01 change in stock return volatility. Including a large amount of stock option grants in CEO compensation packages, typically, will result in high Vega. Delta measures the change in the dollar value of CEO wealth for a 1% change in stock price. Including a large amount of stock grants (and to a lesser extent, stock option grants) in CEO compensation packages, typically, will result in high Delta.

The impact of high Delta on bank risk is two-fold. On the one hand, high-Delta contracts tie managerial wealth to shareholder value, and reduce the conflict of interest between managers and shareholders. John and John (1993) suggest that higher delta increases the incentive to shift risk to debtholders. In addition, if higher NPV projects tend to be relatively risky, increased delta could provide the incentive to implement higher risk projects. (*risk-increasing effect*). On the other hand, high-Delta contracts concentrate managerial wealth to the firm, exposing managers to more risk. To the extent that managers are undiversified with respect to firm-specific wealth, an increase in the risk faced by managers also reduces their utility. Accordingly, managers with a high-Delta contract may maximize their utility by foregoing some positive net-present-value projects that would increase firm risk (*risk-aversion effect*) (Guay, 1999). Ceteris paribus, the risk-aversion effect is expected to dominate the risk increasing effect (Knopf et al., 2002).

The impact of Vega on manager incentives is clearer. Because it rewards stock return volatility, high-Vega compensation makes risk more valuable to managers and mitigates potential managerial risk aversion (Smith and Stulz 1985; Guay 1999). High-Vega contracts seek to alleviate the risk aversion effect of high-Delta contract problem by increasing their pay-risk sensitivity. Then, option-based compensation, by providing convex payoffs, can potentially reduce CEO preferences for low-risk decisions that may arise from a high-Delta. Thus, we expect a positive relationship between Delta and Vega, and we also analyze the indirect effect of Vega (Delta) on risk via Delta (Vega).

Several recent studies on banking provide evidence that high-Vega compensation encourages riskier policy choices, while high-Delta compensation encourages less risky policy choices (e.g. Beltratti and Stulz, 2009; Cheng et al., 2010; DeYoung et al., 2012; Fahlenbrach and Stulz, 2011). In line with this prior literature and to the extent that stock price sensitivity gives a risk-averse manager an incentive to avoid risk, we hypothesize that:

H2a: Vega has a positive direct effect on bank risk.

H2b: Delta has a negative direct effect on bank risk.

In our research design we take into account that Delta and Vega are simultaneously determined and that their design may not be exogenous; in response to managers' policy choices, and the risk profiles implied by those choices, boards may take action to alter managerial incentives, either to complement or to influence the amount of risk managers take in the implementation of those policies (Guay, 1999; Coles et al., 2006; Crawford et al., 1995; Hubbard and Palia 1995).

2.3 Ownership type

Several researchers, including Barca and Becht (2001) and Aguilera and Jackson (2003), call for a distinction between types of controlling shareholders when studying the ownership structure. Rather than assuming that all types of owners are associated with the exact same agency problems, it is crucial to understand how type I and Type II agency problems vary between different types of shareholders. Following Barca and Becht (2001) and Shleifer and Vishny (1997), we distinguish between families, corporations, banks, and institutional investors when they are the largest shareholder to analyze the relationship between ownership concentration and bank risk. Family owners are expected to show the highest risk aversion, the lowest type I agency problems and the highest type II agency problems followings by corporations, banks and institutional investors.

In terms of risk preferences and type I agency problems, family and large corporate owners may prefer, and have the ability[5], to set low risk-sensitive incentive contracts to their managers as they rarely hold diversified portfolios[6], which reduces their preferences toward risk. However, there is no clear theoretical prediction of the risk preferences of bank and institutional owners as it may depend on their degree of diversification. On the one hand, banks may encourage[7] conservative risk-taking strategies at the individual bank level for both safety-net and extended liability reasons, especially if they hold a disproportionate stake in the bank. On the other hand, banks tend to have diversified investment portfolios which increase their preference for risk when controlling another bank (Barry et al., 2011). Similarly, institutional investors, such as mutual funds, pension funds, hedge funds, and other non-banking organizations, tend to have, on average, well-diversified investment portfolios. However, when they appear as the largest shareholder, they may have a disproportionate stake invested in the bank and may be concerned about extended liability, which could reduce their risk appetite.

To illustrate this point, we briefly describe the case of Well Fargo, one of the largest banks in our sample with a market capitalization of $120 billion in 2007. The total stake of institutional investors in Wells Fargo in 2007 was about 70 percent, distributed over 525 different investors. Bershire Hathaway was the largest shareholders with a stake of 9.24 percent, which represented more than 12 percent of its investment portfolio. In this setting, Bershire Hathaway has a significant part of its wealth tied to the bank, which would lead to a lower risk preference.

In terms of type II agency problems, we expect that the incentives of large shareholders to use their controlling positions in banks to expropriate to vary across different types of owners. As Villalonga and Amit (2006) point out, if the large shareholder is an institution or a bank, the private benefits of control are diluted among many independent owners. As a result, the

[5] Families and corporate owners often hold senior management positions and are long-term investors, which places them in a unique position to influence and monitor the firm (Shleifer and Vishny 1997)

[6] Anderson and Reeb (2003) find that families who appear in both Forbes' Wealthiest Americans Survey and the S&P 500 have over 69% of their wealth invested in their firms

[7] When a bank controls another bank, its insider knowledge of the business, together with a large shareholder position, provides the bank with a strong influence over the strategic choices and governance mechanisms to align management.

tunneling incentives might be weaker for these types of controlling shareholders than for controlling families and corporations[8].

For all shareholder types and to the extent that banks and institutional investors suffer from underdiversification and from an extended liability effect, we expect the risk introduced by the type II agency problem to be larger than the reduction of risk induced through monitoring. Thus, we anticipate a positive direct effect of concentration on banks risk. In terms of the indirect effect, we anticipate a negative effect, weaker than the positive direct effect, leading to a total positive effect. Thus, in line with the previous arguments we hypothesize that:

H3a: The type of the largest owner influences the direct positive relationship between concentration and risk, as well as the indirect negative relationship through compensation. The positive direct and negative indirect effects are expected to be strongest for family owners and weakest for institutional investors.

We also distinguish between the total shareholdings held by each type of shareholders as a group. A main difference between looking at the total shareholdings by type compared to the largest shareholder is that it alters the average degree of diversification and introduces free-riding problems. These differences are fundamentally important for institutional investors.

While controlling institutional investors may face under-diversification or extended liability problems, these problems do not affect the average institutional investor which may have a strong preference for risk[9]. Given these preferences and the ability of institutional investors to influence governance choices, we would expect banks with a large proportion of institutional investors to be associated with more risk. In this sense, Barry et al. (2011) argue that institutional investors can shape the nature of corporate risk taking. Hartzell and Starks (2003) find that institutional ownership concentration is positively related to the pay-for-performance

[8] Previous studies have shown that family-dominated banks may suffer from capital restrictions, executive entrenchment, lack of managerial expertise, and nepotism, which may reduce performance and increase the bank's risk level (Gomez-Mejia et al., 2003; Perez-Gonzalez, 2006). Davidsson (1989) finds that owner-managers deter growth when growth is expected to result in a loss of control. Gomez-Mejia et al. (2003) argue that opportunities for diversification are especially limited in family-owned firms, in part because a decreasing size of the organization reduces the number of possible strategies to choose from. Furthermore, family ownership tends to shield firms from the disciplinary pressures of the market for corporate control (Stulz, 1988), providing family executives with greater freedom to pursue their own agenda. Gomez-Mejia et al. (2001) suggest that entrenched family CEOs may take actions that make family-controlled banks riskier, due to incompetence or the pursuit of non-economically motivated preferences. Finally, Laeven (1999) shows that family banks are likely to suffer from connected lending.

[9] Over time, institutional ownership has largely supplanted individual and family ownership and accounts for the majority of all US listed equity (Daily et al. 2003, Healy and Palepu 2003). While in the 1950s, institutional investors held 6.4 percent of US equities, by 2009, institutional investors held 50.6% percent of U.S. equities, and 73 percent of the equity of the 1000 largest US corporations (Gilson and Gordon, 2011). In contrast, individual investors held 38 percent of US equity in 2009. Institutional shareholders manage enormous amounts of wealth and tend to hold diversified portfolios (the largest institutional investor, BlackRock, manages over $3500 billion).

sensitivity of executive compensation; and Cheng, Hong and Scheinkman (2010) argue that institutional investors are more sophisticated and provide a monitoring service. Regarding the type II agency problems, institutional investors as a group are less likely to expropriate other investors because of coordination problems and their dispersed ownership structure.

To the extent that individual/family shareholders without a controlling stake hold a diversified portfolio, they would also prefer more risk. However, as a consequence of coordination problems between individuals, they are, most often, without voice as a group, lacking the ability to monitor and influence executive compensation. Therefore, we believe individual/family shareholders, as a group, to have limited influence on bank risk and executive compensation, unless it concerns a family-dominated bank. In such a case, we may expect a positive direct effect and a negative effect of family shareholdings on bank risk.

Finally, corporate and bank ownership is relatively small compared to institutional and individual/family ownership when it concerns a non-controlling stake. We, therefore, expect the influence of corporate and bank ownership, as a group, on risk and compensation to be small.

Following the arguments with respect to the influence of different types of shareholders as a group on bank risk and executive compensation, we hypothesize that:

H3b: Institutional shareholdings have a positive direct and indirect effect on bank risk, while Individual/Family, Corporate and Bank shareholdings have no significant effect.

3. Sample Description

Our data covers the period 1997-2007 and is constructed by merging information on four different data sources as follows. First, we extract compensation data from the SNL Financial database. This database tabulates in detail the compensation of top executives for a large sample of banks. Previous studies, based on Execucomp, Compustat, CRSP, and Forbes Survey data, include few medium-sized and smaller banks. Hence, this study extends the research into an important segment of the banking industry that has not received much attention previously, in part due to data unavailability. An additional advantage of SNL data is that the number of options granted in each year is provided with the exact exercise terms, which allows a better estimation of Delta and Vega. We collect CEO compensation data for all U.S. listed bank holding companies that appear on the SNL financial database, for the period January 1997 -

December 2007. Our sample is therefore not contaminated by the exceptional events of the recent financial crisis. Our initial sample consists of 606 different banks and 5,316 bank-year observations.

We impose certain restrictions on the selection of the sample. To be included in the sample, a bank must report CEO compensation for at least three consecutive years. Next, we collect the following CEO information for each bank in each of years: (1) annual base salary, (2) annual cash bonus, (3) annual long-term compensation (non-option awards based on multi-year performance goals, incentive plan award, etc.), (4) non-equity incentives plan compensation (amount earned pursuant to non equity incentives plans) (5) value of new option and stock grants during the year, estimated by SNL using an approximation of the Black–Scholes model. Finally, we collect the total number of both exercisable and non-exercisable stock options along with the exercise price and option expiration date at fiscal year end from the table on Outstanding Equity Awards at fiscal-year end to calculate the option's Black-Scholes value as well as its sensitivity to volatility and stock price changes.

Daily stock price and Treasury bond yield data is derived from Bloomberg Thomson Financial to calculate our risk measures. This data also serves for some of the inputs to estimate Delta and Vega. Similar to Anderson and Fraser (2000), we exclude year-observations when the banks' equity has less than 50 trading days. This reduces our sample to 586 banks and 3,256 bank-year observations.

We, further, restrict the sample to observations with available data on the ownership composition, extracted from the Thomson One Banker Ownership database. We construct a panel of all shareholdings by each shareholder of each bank over our sample period and analyze and correct any significant deviations, using the annual reports and international business media. In addition, we identify family ties between shareholders to determine the total equity stake of each family, using the banks' web sites and international business media.

Finally to construct our control variables, we collect the state-level Coincident Index of economic conditions for each state from the Federal Reserve Bank of Philadelphia's database.; the number of deposits for each bank in each state from the FDIC's database and CEO's and balance sheet information from SNL Financial database. Our final sample contains 446 banks and 2,554 bank-year observations. Table 1 provides the sample selection details.

----------- Insert Table 1 about here -----------

4. Methodology

To test our hypotheses, we estimate a series of equations in which we model the level of bank risk and managerial incentives as a function of the bank's ownership structure. In our research design, we account for endogenous nature of managerial incentives (Vega and Delta) and bank risk using 2SLS simultaneous equation modeling (as in Coles et al., 2006 and DeYoung et al., 2012). Particularly we adapt De Young (2012) model to our purpose and we specify the following system of simultaneous equations:

$$Risk_t = \beta_1 \ln Vega_t + \beta_2 \ln Delta_t + \beta_3 OS_t + \beta_4 \ln Assets_t + \beta_5 \ln Equity\,ratio_t + \beta_6 TobinQ_t + \beta_7 EconCond_t + \beta_8 Market\,Concentration_t \quad (1)$$

$$\ln Vega_t = \gamma_1 Risk_t + \gamma_2 \ln Delta_t + \gamma_3 OS_t + \gamma_4 \ln Assets_t + \gamma_5 \ln Equity\,ratio_t + \gamma_6 TobinQ_t + \gamma_7 Tenure_t + \gamma_8 \ln Base\,Salary_t \quad (2)$$

$$\ln Delta_t = \theta_1 Risk_t + \theta_2 \ln Vega_t + \theta_3 OS_t + \theta_4 \ln Assets_t + \theta_5 \ln Equity\,ratio_t + \theta_6 TobinQ_t + \theta_7 Tenure_t + \theta_8 \ln Base\,Salary_t \quad (3)$$

, where *t* indexes time and the cross-sectional index for individual banks is suppressed for convenience. Risk is specified in alternative versions of the model as *Total Risk, Insolvency Risk, Systematic Risk, or Idiosyncratic Risk. Os,* refers to the bank's ownership structure which is specified in alternative versions of the model as ownership concentration or ownership type. We describe the procedures used to construct these measures in the next section.

We estimate each of the equations in our model using standard two-stage least squares techniques with instrumental variables, fixed effects and clustered standard errors by banks since it is well-known that ordinary least-squares (OLS) estimation will not provide consistent estimates of the coefficients in the structural equations. In the absence of misspecification, the resulting coefficient estimates by 2SLS are consistent, but not necessarily as efficient as full information estimates by 3SLS. However, there are three basic advantages associated with limited information 2SLS procedures relative to full information procedures that motivate its use. First, 2SLS estimations allow us to take advantage of the panel data structure of our data and it may be preferred to full information estimation techniques in smaller samples. Second, the estimation results may be less affected by misspecification in the system, which will be very likely in the early stages of a research inquiry. For example, if the risk equation is misspecified, but the compensation contract equations are correctly specified, the specification error will only affect the risk equation when the system is estimated via 2SLS. However, the misspecification will affect all equations when the system is estimated via full information estimation techniques. Challen and Hagger (1983) perform Monte Carlo simulations and indicate that 2SLS is more robust to multicollinearity and specification problems than full information estimation techniques[10].

To verify that the two-step estimator is warranted, we perform a Durbin-Wu-Hausman test. This test rejects the exogeneity of equity incentives in the risk equation and of risk and Delta (Vega) in the Vega (Delta) equation, confirming the choice of a two-stage estimator.

In setting the time structure of our model, we follow Coles et al (2006) and use contemporaneous values of our endogenous variables to conform to the underlying reasoning of simultaneous equation. Thus, we assume that the incentives established in year t generate risk taking in the same year they are provided[11] and that Vega and Delta are jointly determined. This last assumption reflects the reasonable conjecture that bank board's set the various components of total CEO compensation (salary, bonus, stock grants, stock options, etc.) as a package, and Delta and Vega are elasticities that describe the consequences of that total compensation decision on CEO wealth incentives[12]. This assumption has ramifications for our identification strategy, i.e., we can use the same identification schemes in both, equation (2) and equation (3).

4.1 Control Variables and Identification Strategy

We employ parsimonious specifications. Each equation includes three standard bank-level control variables which are based primarily on previous literature. First, we include firm size, measured as the natural logarithm of total assets, given that previous research (e.g., Guay, 1999; Coles et al., 2006; Low, 2009) has documented that size may be an important determinant of bank risk, although the sign of the relationship is not clear. In addition, we expect firm size to capture variation in the degree of talent and wealth across CEOs. (Smith and Watts, 1992; Core and Guay, 1999). We therefore predict a positive relationship between firm size and the

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[10] For robustness purposes, we have estimated a system of equations by 3sls. Our main results hold under this alternative specification.

[11] In alternative specifications, we lag lnVega and lnDelta to allow time for the incentives established in year t-1 to generate risk taking in year t. Our results are robust to the lag structure of incentives.

[12] The joint determination of Delta and Vega recognizes that infinite increases in risk-taking behavior are not likely to be optimal as a project with infinite risk may not remain a positive NPV project. We assume that compensation committees are likely to provide Stock Options to encourage assumption of risky but positive NPV projects.

level of equity incentives. Next, we include the ratio of book equity to assets (*Equity ratio*) to accounts for differences in financial leverage across firms. On one hand, leverage may have a positive effect on risk and on executive's incentives toward risk if higher leverage provides managers with greater incentives to transfer wealth from bondholders to shareholders (Leland, 1998). On the other hand, a number of studies (e.g., Friend and Lang, 1988; Lewellen, 2006) have argued and found evidence consistent with the hypothesis that riskier firms face a higher probability of financial distress and, therefore, should have less leverage. This finding suggests a negative effect of leverage on risk and on risk-taking incentives since firms may offset the increased risk of financial distress that accompanies any increase in leverage by reducing their risk. Given these conflicting hypotheses and the conflicting evidence in prior studies, we do not make a prediction on the sign of the *Equity ratio*. Finally we include the Tobin's Q ratio (TobinQ) to account for differences in bank-specific investment opportunities. We expect managers of firms with larger investment-opportunity sets and more growth options to take more risk than managers of firms with smaller investment-opportunity sets and fewer growth options (Guay, 1999). We also expect the consequences of excessive managerial risk aversion (i.e., rejecting risky but positive net present value projects) to be more costly to shareholders of firms with more investment opportunities (Smith and Watts, 1992). Therefore, we expect both types of equity incentives to be positively associated with the Tobin's Q ratio.

Our specifications also employ some control variables that are not common across equations. Our instruments for risk (Delta, Vega) in the Delta and Vega equations (risk equation) are based on the determinants identified by prior research that should not have a direct effect on equity incentives (risk profile of the firm), but that should have an indirect relationship through their effect on risk (and of equity incentives).

Following De Young et al. (2012), we include local economic conditions during year *t* (*EconCond*) and a measure of local market concentration (*Market Concentration*) in the risk equation. *EconCond* is the Federal Reserve Bank of Philadelphia's state-level Coincident Index of economic conditions. We weight this measure considering on the distribution of each bank's deposits across the various states; hence, this variable exhibits both time series and cross-sectional variation. We expect that banks facing stronger economic conditions will have more capacity for taking risk. *Market Concentration* is a weighted average of the state herfindahl index of deposits concentration. Weights are computed according to the distribution of each bank's deposits across the various states, allowing this variable both time series and cross-sectional variation. We do not provide a prediction on the sign of market concentration as there is no clear consensus in the literature on the effect of market concentration on bank risk.

The variables, local economic conditions and market concentration, are used as instruments for risk (and are therefore excluded from equations (2) and (3)), because they are expected to directly influence risk, without affecting executive incentives. On the one hand, current economic conditions affect banks' capacities and opportunities to take risk in the short-run. On the other hand, a large body of research has shown that market concentration influences bank risk (Allen and Gale, 2000, 2004, Hellman et al., 2000; Besanko and Thakor, 1993; Boot and Greenbaum, 1993; Matutes and Vives, 2000; Caminal and Matutes, 2002), although with conflicting theoretical predictions about the sign of the relationship. However, transitive aberrations in economic conditions (e.g., a recession) and in market concentration should not be a primary influence on compensation committees, as they put long-run risk-taking incentives for management into place.

Given our assumption that *Delta* and *Vega* are jointly determined, equations (2) and (3) can be identically specified. In line with prior literature, we include in both equations the natural log of CEO salary during year *t* (*lnSalary*) and the number of years the CEO has held his/her position (*Tenure).*We have no *a priori* expectation for the sign on *lnSalary*. On the one hand, cash compensation allows the CEO to diversify outside the firm (Guay 1999), thus reducing risk aversion and permitting lower risk-taking incentives (lower Vega and/or higher Delta). On the other hand, high cash compensation may indicate CEO entrenchment (Berger, Ofek, and Yermack 1997), thus inducing risk aversion and requiring higher risk-taking incentives (higher Vega and/or lower Delta). High values for *Tenure* may signal horizon problems associated with the approach of CEO retirement (Core and Guay 1999); thus, compensation committees may design low-Vega and/or high-Delta contracts to ensure the alignment, prudence, and focus of these long-tenured CEOs. These variables are excluded from equation 1 since they are used as instruments for Delta and Vega as they are not expected to directly influence bank risk. While a CEO's job tenure and base salary are likely to affect the risk preferences and thus require compensation committees to adjust the contractual risk incentives (*Delta*, *Vega*), it is not the job tenure or the salary, but these risk incentives themselves that directly influence risk-taking[13].

[13] In addition, we note that salary is typically determined through competitive benchmarking, based primarily on general industry salary surveys supplemented by detailed analyses of selected industry or market peers (Murphy,1999). Therefore, salary, unlike stock options, is not used to encourage or discourage CEO risk-taking.

As with any study that uses instrumental variables, the validity of the resulting estimates relies on the validity of the exclusion restrictions. The model is reasonably well-identified in all specifications. The F-statistic for the joint significance of the instruments in the first stage regression of each endogenous regressor reject the null hypothesis, at the 1% level, that the instruments *EconCond* and *Market Concentration (Tenure and lnSalary)* are uncorrelated with the endogenous regressors *Total Risk, Insolvency Risk, Systematic Risk* and *Idiosyncratic Risk (Vega, Delta)*. In addition, the Kleibergen–Paap underidentification LM and Wald tests reject the null hypotheses that the instruments may be inadequate to identify the equation at the 95% level. Thus, the specification tests for under-identification suggest that the model is identified, and that the instruments are exogenous. In addition, we also present a weak identification test for the null hypothesis that the instruments are weak, following the procedure laid out by Stock and Yogo (2005). This test supports the idea that our instruments are strong. As for model identification by construction, our set of equations (1), (2) and (3) are exactly identified, i.e., the number of included endogenous variables equals the number of excluded instruments.

5. Measurement of key variables: Risk, Incentives and Ownership Structure.

5.1 Measurement of bank risk

To test our hypotheses, we use four primary measures of bank risk: Total Risk, Insolvency Risk, Systemic Risk and Idiosyncratic Risk.

5.1.1 Total Risk

Following Anderson and Fraser (2000), Total Risk of a bank is calculated as the standard deviation of its daily stock returns (R_{it}) for each fiscal year. The daily stock return is calculated as the natural logarithmic of the ratio of equity return series ($R_{it} = \ln(P_{it}/P_{it-1})$, where P_{it} is the stock price, adjusted for any capital adjustment including dividend and stock splits. Total Risk captures the overall variability in bank stock returns and reflects the market's perceptions about the risks inherent in assets, liabilities, and off-balance-sheet positions. In addition, it also indicates the ability of bank management to control risk exposures and produce steady earnings over time, with high earnings variation implying a more risky bank.

5.1.2 Insolvency Risk

The Z-score is a widely used measure of bank's distance to default (see Boyd and Runkle, 1993; Beck and Laeven, 2006; Laeven and Levine, 2006; and Mercieca, Schaeck, and Wolfe, 2007), which incorporates three factors: capitalization, the level of profitability, and fluctuations in income as follows:

$$Z = \frac{ROA + E / A}{\sigma(ROA)}$$

, where ROA stands from Return on Assets, E/A represents equity capital over total assets and σ(ROA) is the standard deviation (volatility) of ROA[14]. We use a three-year rolling time window for the standard deviation of ROA to allow for time variation in the denominator of the Z-score. This approach avoids that the variation in Z-scores within banks over time is exclusively driven by variation in the levels of capital and profitability (Schaeck, Čihák and Wolfe, 2010).

The Z-Score is defined as a state in which losses surmount equity ($E<-\pi$) (where E represents equity and π profits)[15] and measures the distance from insolvency (Roy, 1952). Thus the Z- score can be viewed as a measure of the likelihood of failure, with a smaller value of the index associated with a greater chance of bank failure (more risk).To facilitate the interpretation when analyzing the effect of bank ownership structure and executive incentives on bank risk, we inverse the Z score to get a measure of the risk of insolvency.

5.1.3 Systemic and Idiosyncratic Risk.

Although prior empirical studies have examined the relationship between the incentives provided by stock options and total firm risk, several recent theoretical studies (e.g., Tian, 2004; Henderson, 2005; Duan and Wei, 2005; Armstrong and Vashishtha, 2012) suggest that it is important to distinguish between the systematic and idiosyncratic component of total risk when studying the relationship between stock options and firm risk. These studies show that for a fixed level of total risk, increasing the proportion of systematic risk unambiguously increases the subjective value of the stock-option holdings of a risk-averse manager who can trade the market portfolio. In particular Armstrong and Vashishtha (2012) show that stock options gives risk-averse managers an incentive to increase total risk by increasing systematic rather than

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[14] Boyd and Graham (1989) consider the question of whether the survival likelihood index computed using accounting data or stock market data is a better measure of bankruptcy risk. They conclude that the accounting-based survival likelihood index conveys "much of the same information that is in commercial paper ratings. The market [survival likelihood] indices do not. To the extent, that commercial paper ratings are useful measures of bankruptcy risk, these findings favor the use of a survival likelihood index computed with accounting data."

[15] The probability of insolvency can be expressed as prob ($-ROA<E/A$), where ROA ($=\pi/A$) is the return on assets. If profits are normally distributed, then the inverse of the probability of insolvency equals ($ROA+E/A)/\sigma(ROA)$, where $\sigma(ROA)$ is the standard deviation of ROA (Leaven and Levine, 2009). Then the Z-score represents the number of standard deviations below the mean by which profits would have to fall so as to just deplete equity. Even if profits are not normally distributed the Z score is the lower bound of the probability of default (by Tchebycheff inequality). A higher Z-score therefore implies a lower probability of insolvency.

idiosyncratic risk, since, for a given level of Vega, an increase in systematic risk always results in a greater increase in a CEO's subjective value of his or her stock-option portfolio than does an equivalent increase in idiosyncratic risk. Thus, the above distinction between the two components of risk is important because it suggests that stock options might not necessarily induce CEOs to undertake positive NPV projects that are primarily characterized by idiosyncratic risk when projects with systematic risk are available as an alternative. We explore this hypothesis by analyzing the effect of stock options and of ownership structure on both systemic and idiosyncratic risk.

Systemic and Idiosyncratic Risk are calculated using the following two-index market model, suggested by Chen et al. (2006) and Anderson and Fraser (2000). This model is estimated for each year, for each bank:

$$R_{it} = \alpha_i + \beta_{S\&P,i}(R_{S\&P,t}) + \beta_{I,i}(I_t) + u_{it} \tag{4}$$

, where the sub indexes *i* and *t* refer to bank and time, respectively. R_{it} is the daily return on bank stock for bank *i*, $R_{S\&P,t}$ is the daily return on S&P 500 Banks index[16], I_t is the daily three-month T-bill yield, and u_{it} is a random error term for bank *i*. Estimation of this equation results in two risk measures, $\beta_{S\&P,i}$ and $\beta_{I,i}$, which are proxies for systematic and interest rate risks respectively. To compute the idiosyncratic risk we calculate the standard deviation of the residuals σu_i from Eq. (1).

5.2 Measurement of Executive Incentives.

To measure managerial equity incentives, we use Delta and Vega, since they are two characteristics of stock option compensation that have shown, theoretically, to influence bank risk (Coles et al., 2006). We define Delta as the change in the dollar value of the executive's wealth for a one percentage point change in stock price. Vega is the change in the dollar value of the executive's wealth for a one percentage point change in the annualized standard deviation of stock returns. Guay (1999) shows that option Vega is many times higher than stock Vega. Following Knopf et al. (2002) and Rajgopal and Shevlin (2002), we use the Vega of the option portfolio as a proxy of the total Vega of the stock and option portfolio. Partial derivatives of the option price with respect to stock price (Delta) and stock return volatility

[16] The model is also estimated using the S&P 500 Index, our main results hold under this alternative computation of systemic and idiosyncratic risk.

(Vega) are based on the Black-Scholes (1973) option pricing model adjusted for dividends by Merton (1977).

We compute Delta and Vega using the full information method (Guay, 1999) for more than 90% of the options grants in our sample. For the other 10%, for which we do not have information on the exercise prices or on maturities, we follow the literature (Yermack, 1995; Hall and Liebman, 1998; Aggarwal and Samwick, 2006; Core and Guay, 2002; Guay, 1999; Cohen et al., 2000; Datta et al., 2005; Rajgopal and Shevlin, 2002) and we use the one year approximation method developed by Core and Guay (2002) to estimate Delta and Vega. We discuss the derivation of Delta and Vega in more detail in Appendix 1.

5.3 Measurement of Ownership Structure.

We consider three characteristics of ownership structure: concentration, type of the largest shareholder and the total shareholdings by type. First, we measure the bank's ownership concentration by the fraction of the bank's equity capital held, either directly or indirectly, by the largest shareholder (SH1). This variable is a proxy for both, the relative power of the dominant shareholder and the degree of ownership concentration. To add robustness to our analysis, we also use two alternatives measures of ownership concentration: the Herfindahl index of concentration and the total shareholding of the three largest shareholders.

Second, we differentiate between different types of the largest shareholders. In doing so, we follow previous literature (Shleifer and Vishny, 1997; Barca and Becht, 2001; Tribó et al., 2007) and we categorize shareholders into four main types: families, corporations, banks, and institutional investors. A family-dominated bank is defined as a bank where an individual investors or a group of individual investors with family ties is the largest shareholder. Corporate-dominated banks and bank-dominated banks are defined as banks where the largest shareholder is a corporation and a bank, respectively. Finally, institutional-dominated banks are banks where investment advisors, hedge funds, pension funds or mutual funds have the largest stake. To analyze how the overall relationship between concentration and bank risk differs by the type of the largest shareholder, we interact our ownership concentration variable (SH1) with the ownership type variable.

Finally in order to captures the amount of concentration for each group of shareholders, we compute the total shareholdings of each type of shareholders.

To produce a more symmetric data distribution we use the log transformation of a) insolvency risk and total risk, b) Delta and Vega, c) ownership structure variables.

6. Results

6.1. Descriptive Statistics

Table 2 presents the summary statistics for the variables in our models. To reduce the influence of extreme values, the distributions of all variables are winsorized at the 1st and 99th percentiles of their sample distributions. Vega has a mean value of $11,765 and Delta has a mean of $90,715, which means that, on average, a CEO enjoys an increase of $11,576 in his/her equity portfolio for a 0.01 increase in stock return volatility, and an increase of $90,715 for a 1% increase in the stock price. The value of Delta is mostly driven by the CEO portfolio of equity. On average, CEOs hold a 2.56% ownership stake and earn approximately $352,822 in salary, $234,498 in bonuses, $282,622 in long term compensation, $56,887 in perk and other compensation, $165,258 in non-equity incentives plans, $231,120 in stock award and $273,485 in option grants.

----------- Insert Table 2 about here -----------

Our sample covers a wide range of banks, from very small to extremely large banks. The smallest bank in our sample is First Capital Bancshares, Inc with a mean total asset of $27 million, while the larger bank in our sample is Citigroup with a mean value of total asset of $ 1,120 billion. The descriptive statistic for our risk measures show that the average bank in our sample has a Total Risk of 2.3, an Insolvency Risk of 2.3, a Systemic Risk of 0.489, and an Idiosyncratic Risk of 0.0318. These values are comparable to those reported by Anderson and Fraser (2000) and by Pathan (2009). In terms of ownership, the average stake by the largest shareholder is 10.5 percent while the Herfindahl index of concentration is 0.029. Furthermore, considerable variability is found in ownership concentration across banks. Regarding the type of the largest shareholders, in 34 percent of our sample the largest shareholder is a family, in 16.5 percent it concerns a corporation, in 7.7 percent it constitutes a bank and in almost 42 percent of our sample it relates to an institutional investor. In terms of total shareholdings by type, on average, family investors hold 12 percent, corporations hold 3.6 percent, banks have 1.3 percent, and institutional investors hold 20.3 percent. The rest of the shares are held by unidentified shareholders with less than 0.01 percent stake.

----------- Insert Table 3 about here -----------

The correlation matrix in table 3 shows, consistent with our expectation, that Vega is positively related with total risk, Insolvency risk and Idiosyncratic risk. Delta, on the other hand, is negatively related with Total Risk and positively related with Insolvency Risk, Systemic Risk and Idiosyncratic Risk. Furthermore, ownership concentration is positively related to Delta and Vega, as well as total risk and idiosyncratic risk and insolvency risk, but negatively related to systemic risk. The stakes by different groups of shareholder are significantly related to Delta, Vega and our risk measures.

----------- Insert Table 4 about here -----------

In table 4, we compare the mean values of risk, executive compensation, ownership structure, size and market value by splitting our sample according to the type of the largest shareholder. We find that Vega is largest in banks were an institutional investor is the largest shareholder, while banks were a family is the largest shareholder provide significantly lower Delta, have a higher total and idiosyncratic risk and a lower systemic risk, compared to all other types.

With respect to differences in the ownership structure, the descriptive statistics show that if corporations and banks hold a considerable stake in a bank, it is mainly as a controlling shareholder (with an average stake above 17%) as they have a very low presence as secondary shareholders. The stake of the largest shareholder when it concerns an institution investor is 7.35 percent and 11.59 percent for family owners. When we relate these stakes to the average market capitalization of these banks, $7.37 billion and $0.283 billion respectively, they represent an average investment of $541 million for institutional investors and $32 million for family owners. If we consider the average and median market value of these large institutional investors, we obtain that a 7.35 stake represents an average investment of 2.1 percent and a median investment of around 18 percent, which represent an important share of their total investment portfolio. For family owners, we do not have data on their total wealth, but we believe family owners to have a substantial part of their wealth invested. Furthermore, institutional investors have an important stake, as a group, in all banks but are especially well represented in those banks where the largest shareholder is an institutional investor with a total stake above 30 percent. In terms of size, banks where the largest shareholder is a family or a corporation tend to be substantially smaller. Banks where another bank is the largest shareholder are about 5 times larger than family banks in market value and total assets, while banks where an institutional investor is the largest shareholder tend to be about 25 times larger.

6.2. Main Results.

Tables 5 to 9 show the second stage regression of equations (1), (2) and (3). In each table, we include one model for each of our four risk measures, along with Delta and Vega, and one measure of ownership structure. In Tables 5 to 7 we analyze the effect of ownership concentration on bank risk, Delta and Vega. In table 5 we define ownership concentration as the fraction of the bank's equity capital held, either directly or indirectly, by the largest shareholder (SH1). In tables 6-7, we repeat our analysis with alternative measures of ownership concentration: the Herfindahl index of concentration (HHI) in table 6, and the total shareholding of the three largest shareholders (sh1-3), in table 7. Then, in table 8, we decompose the effect of SH1 on bank risk by the type of the largest shareholders. In table 9, we look at the effect of the total shareholding held by each type of investor on bank risk. The estimates of these second- stage regression represents the direct effect of each independent variable on the dependent variable in each equation. Finally, for each model in tables 5 to 9, we decompose the total effect of Vega and Delta on risk (table 10) and the total effect of the ownership variables on risk, Vega and Delta (tables 11 -13) into a direct and an indirect effect. See appendix 2 for a description of how the computation of the direct and indirect effect.

6.2.1 Equity Incentives and Bank Risk.

We begin the regression analysis by examining the relationship between equity incentives and bank risk. The estimates displayed in table 5-9 strongly indicate that bank risk is directly influenced by the CEO incentives, but that bank risk does not directly influence CEO incentives. The estimated coefficients of Vega (Delta) are significantly positive (negative) at the 10% (1%) level in all models, with one exception (Vega and Delta does not influence systemic risk in any model). Our findings, that higher Vega (Delta) has a positive (negative) direct effect on risk, are in line with existing literature (e.g., Knopf et al. 2002; Coles et al., 2006; DeYoung et al., 2012) and provide support for our hypothesis H2a and H2b. However, the analysis of the direct effect of Vega and Delta on bank risk (through the structural coefficients in tables 5-9) is incomplete, since it does not take into account the endogenous nature of Vega, Delta and risk. A change in Vega (Delta) leads to a simultaneous change in risk and in Delta (Vega), which feed back through the system to further affect risk. Thus, the total effect of Vega (Delta) on risk is given by the direct effect of Vega (Delta) on bank risk and by the indirect effect that Vega (Delta) has on risk through Delta (Vega).

----------- Insert Tables 5-9 about here -----------

To compute the indirect effect of Vega (Delta) on bank risk, we consider the direct effect of Vega (Delta) on Delta (Vega), as well as the direct effect of Delta (Vega) on bank risk. The result on the effect of Vega on Delta, and vice versa, is consistent across all models (see table 5-9). In particular, we find a positive and significant coefficient of Vega in the Delta regressions and a positive coefficient of Delta in the Vega regressions. Therefore, given that Delta (Vega) has a negative (positive) direct effect on bank risk, an increase in Vega (Delta) leads to a reduction (an increase) of bank risk, through Delta (Vega). Overall, the positive direct effect of Vega on risk is higher than the negative indirect effect of Vega on risk via Delta, leading to an overall positive effect of Vega on bank risk. In contrast, on overall, the direct negative effect of Delta is smaller than the indirect positive effect of Delta on bank risk via Vega, which leads to a total positive effect of Delta on bank risk. These results hold for all our measures of risk except for systemic risk (see table 10). To illustrate our findings, we use the coefficient estimates in table 10, model 1, to compute the magnitude of the relationship between Vega, Delta and bank risk.

----------- Insert Table 10 about here -----------

The direct effect of a one standard deviation increase in ln Vega (8.75) yields a 0.54% increase in total risk (8.75*0.016), while the indirect effect of a one standard deviation increase in ln Vega yields a 0.42% decrease in total risk via Delta (8.75*-0.0484). The sum of the two effects leads to a total increase of risk of 0.12%. In turn, the direct effect of a one standard deviation increase in ln Delta (8.05) yields a 0.58% decrease in total risk (8.05*-0.0718) while the indirect effect of a one standard deviation increase in ln Delta yields a 0.73% increase in total risk via Vega (8.05*0.0913). The sum of the two effects leads to a total increase of risk of 0.15%. Thus, the risk increasing effect of high-Vega contracts dominates the risk aversion effects of high-Delta contracts such that a one standard deviation increase in Delta and Vega yields a 0.27% increase in total risk (0.11%+0.15%).

These results show the importance of looking beyond the direct effect, as the structural form coefficient may misstates the sign of the relation between the variables of interest. Previous studies analyzing the relationship between Vega, Delta and bank risk have based their interpretation on structural form coefficients and conclude that Delta has a negative effect on bank risk and that compensation committees exhibit risk-mitigating responses by balancing high CEO Vegas with complementarily high CEO Deltas. We show that the overall effect of Delta on risk is positive, when taking into account the indirect effect of Delta on risk through

Vega. These findings suggest that shareholder use Vega to mitigate the *risk-reducing effect* of Delta to further increase bank risk.

6.2.2 Ownership Concentration, CEO incentives and bank risk.

The estimates displayed in table 5-7 show the *direct* effect of ownership concentration, on CEO incentives and on the bank's total risk, insolvency risk, systemic risk and idiosyncratic risk. The coefficients of the ownership concentration variable (SH1 in table 5, HHI in table 6 and SH1-3 in table 7) shows, in all our models, a significant negative direct effect on Vega, a significant positive direct effect on Delta and a significant positive effect on all our measures of risk with one exception (SH1 does not affect systemic risk). These results suggest that large shareholders have preferences toward lower risk levels which are reflected in low risk-sensitive CEO incentive contracts (low-Vega, high-Delta contracts) and that the risk increasing effect of opportunistic behavior dominates the risk reducing effect of higher monitoring efforts by undiversified shareholders. We confirm our expectation on the risk preferences of large shareholders by computing the indirect effect of ownership concentration on bank risk via Vega and Delta in table 11.

For all our measures of ownership concentration and bank risk, we find that ownership concentration has a significant negative indirect effect on bank risk via Vega and Delta. These findings provide strong support for our hypothesis 1-a and 1-b, stating that ownership concentration has a negative effect on bank risk via executive incentives, and a positive direct effect through the opportunistic behavior of large shareholders (which dominates the monitoring effect). Overall, the negative indirect effect is dominated by the direct positive effect leading to a total positive effect of ownership concentration on bank risk. This finding provides support to hypothesis 1-c by showing that the increase in risk introduced by higher type II agency problems dominates the reduction in risk due to the reduction of type I agency problems at concentrated banks.

To exemplify these results, we describe the effect of a 10% increase in the stake held by the largest shareholder on total risk. Using the coefficient estimates in table 11, the direct effect of a 10% increase in SH1 leads to a 1.2% increase in total risk. In contrast, the indirect effect of a 10% increase in SH1 leads to a 0.022% decrease in total risk via Vega and to a 0.95% decrease via Delta. Thus, a 10% increase in the total shareholding of the largest shareholder reduces the bank total risk by 0.97 %, through the design of CEO incentives. The sum of the direct and indirect effect show that a 10% increase in SH1 leads to a total increase of risk of 0.23%. Our finding of a positive relation between ownership concentration and bank risk is in line with previous literature (Jensen and Meckling, 1976; John, Litov, and Yeung, 2008, Leaven and Levine, 2009). The magnitude of the relationship reported by this literature is also in line with the magnitude that we obtain for the direct effect of concentration on bank risk. However, previous studies did not consider the indirect effect, which reduces the size of the positive effect of ownership concentration on bank risk.

----------- Insert Table 11 about here -----------

6.2.3 Types of the largest shareholders, CEO incentives and bank risk

Table 8 decomposes the stake held by the largest shareholder by type. When the largest shareholder is a family or an institution, we find that SH1 has a negative (positive) significant direct effect on Vega (Delta), and a positive significant effect on bank risk. These results hold for all our models, with one exception. We do not report a significant relationship between SH1*Institution and Vega, and between SH1*Family and systemic risk in model 3. When a corporation is the largest shareholder, our result show that SH1 has a significant direct positive effect on total risk, insolvency risk and idiosyncratic risk, and a negative (positive) direct effect on Vega (Delta) in models 1 and 3. Finally, when the largest shareholder is a bank, SH1 only has a significant negative effect on systemic risk and on Delta in model 3.

Next, in table 11, we compute the direct, indirect and total effect of SH1 on bank risk, for each type of shareholders and for each measure of risk, to analyze whether the strength of the relationship between SH1 and bank risk depends on the type of the largest shareholder.

Overall, our findings show that, when the largest shareholder is a family, institutional investor or a corporation, SH1 has a positive (negative) direct (indirect) effect on bank risk and that the direct positive effect dominates the indirect negative effect which leads to a total positive effect of SH1 on bank risk. These effects (direct, indirect and total) are strongest for family banks and weakest for institutional investors. Only when a bank is the largest shareholder, we find a negative direct effect of SH1 on systemic risk. These findings provide support to hypothesis H3a[17].

In particular, our results show that when the largest shareholder is a family or an institution, SH1 has both a significant positive direct effect and a significant indirect negative

[17] We also compare between the types of the largest shareholder, to test whether the differences between types are significant. Particularly, we find that the effect of SH1 on bank risk, both directly and through Delta and Vega, is significantly different when the largest shareholder is a family compared to when it concerns an institutional investor or a bank (undisclosed tables).

effect on all our measures of bank risk (with the exception of systemic risk which is not significantly affected by SH1 if the largest shareholder is a family). When a corporation is the largest shareholder, SH1 has both, a significant positive direct and a negative indirect effect on total risk and a direct positive effect on insolvency risk and idiosyncratic risk. Finally, SH1 has a significant negative direct effect on systemic risk and a positive significant indirect effect on insolvency risk, when a bank is the largest shareholder.

To illustrate our findings, we describe the direct and indirect effect of a 10% increase in SH1 by each type of shareholder on total risk. The coefficient estimates in table 12 show that a 10% increase in SH1 yields a 1.8% increase in total risk via the direct effect, when it concerns a family shareholder. However this positive effect is mostly offset by the negative indirect effect. In particular, a 10% increase in SH1 when it concerns a family shareholder yields a 0.25% decrease in total risk through Vega and a 1.4% decrease in total risk via Delta. Thus, the indirect effect reduces the total risk by 1.6% which leads to a total effect of 0.22%, when the largest shareholder is a family. This total effect is lower when the largest shareholder is a corporation or an institutional investor. When the largest shareholder is a corporation a 10% increase on its shareholdings leads to a direct positive and significant increase of 1.3% in total risk and to a negative significant indirect decrease of 1.174% in total risk, which leads to a total effect of 0.16%. Finally, a 10% increase in SH1 for an institutional controlling shareholder leads to a 1.2% increase in total risk via the direct effect and to a decrease in total risk of 1.128 % via the indirect effect. Then, the 10% increase in SH1 for an institutional controlling shareholder leads to a 0.073% increase in total risk. The direct effect of an increase of SH1 when it concerns a bank is not significant.

----------- Insert Table 12 about here -----------

6.2.4 *Total shareholdings by shareholders type, CEO incentives and bank risk*

Finally, we analyze how different types of owners, as a group, influence risk and CEO compensation. Table 9 shows a strong positive direct effect of the total stake held by individuals/families on all measures of bank risk and Delta, and a negative direct effect on Vega. The same effects, although smaller, are found for institutional investors for all measures of risk, except for model 4 where not significant effect is found between the total shareholding of institutional investors and Vega and Delta. Bank and corporate shareholdings have no significant direct effect on any measure of risk. But they have a negative direct effect on Delta in all our models. In addition, bank shareholdings have a positive direct effect on Vega, in all our models, while corporate shareholdings have a positive direct effect on Vega in model 4. To further understand the influence of each type of investor as a group on bank risk, we compute the indirect and total effect of the total stake held by each type of shareholders in table 13. The estimates show that, while family shareholdings have a significant negative indirect effect on bank risk via Vega and Delta, institutional shareholdings aim to induce higher risk via the design of CEO compensation. In particular, we find that institutional shareholdings have a) a positive indirect effect on bank risk via Vega and b) a negative indirect effect via Delta, such that the positive indirect effect via Vega dominates the negative indirect effect via Delta, leading to total positive indirect effect of institutional shareholdings on bank risk. These results hold for all our models, except for model 3 where institutional shareholdings do not have a significant influence on Delta and Vega. The sum of the direct and indirect effect leads to a total positive effect of family and institutional shareholdings on bank risk.

Corporations and banks do not have a significant direct effect on bank risk but they influence total and insolvency risk via the design of CEO incentives. On the one hand, corporate shareholdings increase bank risk via their direct negative effect on Delta. However this negative direct effect feeds back through the system, leading to a negative indirect effect on total and insolvency risk via Vega, which dominates the indirect positive effect via Delta. On the other hand, bank shareholdings increase bank total and insolvency risk through their direct positive (negative) effect on Vega (Delta), which translates into a positive direct effect on risk.

----------- Insert Table 13 about here -----------

To illustrate our results, we describe the effect of a 10% increase in the total shareholding held by family, institutions, banks and corporate shareholdings on total risk. A 10% increase in the shareholdings held by families increases the bank total risk by 2.5% via the direct effect. This increase is offset by the negative indirect effect of family shareholdings on total risk via Vega and Delta which leads to a reduction on bank total risk of 2.4% (0.4% via Vega and 2% via Delta). These results are quite similar to the results obtained for large family owners. This is expected given that family ownership is especially high in those banks where the largest shareholder is a family, and that family shareholders play a much smaller role in other types of banks. A 10% increase in the shareholdings held by institutions increases total risk by 0.13%. This increase is the result of a positive direct effect which leads to a 0.8% increase in total risk and a positive indirect effect which increases the total risk by 0.4% (1.8% via Vega and -1.3% via Delta). These results are expected, given the average degree of diversification of each institutional investor. Finally, a 10% increase in corporate shareholdings leads to a 0.14% reduction in total risk through Delta, while an increase in bank shareholdings leads to a 0.3% increase in total risk, through Delta and Vega.

7. Robustness

Thus far, we have shown that our results are robust to a) alternatives definition of risk and ownership concentration; b) the estimation technique, as our results hold when estimating the system of equations by 3SLS; c) the time structure of the model as our findings hold under alternatives specifications in which we lag Vega and Delta, to allow time for the incentives established in year t-1 to generate risk taking in year t. In addition, we check for the existence of two potential endogeneity problems in our regressions that may affect our results: the endogenous nature of ownership and leverage.

Some studies (Demsetz and Lehn, 1985; Himmelberg et al., 1999, Gugler and Weigland, 2003) raise the problem that ownership might be endogenous as it might be influenced by the level of performance and risk of the firm. In our study, it can be argued that investors can be attracted by banks with different risk levels. Some investors might simply choose to invest in banks with higher risk profiles in order to maximize their utility. Therefore we check whether ownership structure may be treated as an endogenous variable by performing the "GMM distance" test of the endogeneity of regressors. We do so by considering the average shareholding of the largest shareholder in other banking companies by state of operation as instrument for ownership concentration, the average shareholding of the largest shareholder by type in other banking companies by state of operation as instrument for each type of largest shareholder, and the average total shareholdings of each type of shareholders in other banking companies by state of operation as instrument for total shareholdings by type[18]. The test fails to reject the null hypothesis that ownership structure may be treated as exogenous, at the 5% level.

Another concern with the risk-profile equations is that leverage could be endogenous. This concern is particularly acute in any study that examines CEO risk-taking incentives, since both a bank's capital structure and the risk-taking incentives of its CEO are likely to be jointly determined to produce the desired risk profile (Coles et al., 2006; Lewellen, 2006). We, therefore, test whether our research design also needs to account for the endogenous nature of bank leverage, by performing the "GMM distance" test of the endogeneity of regressors. Following Armstrong and Vashistha (2012), we instrument leverage with the bank's recent

[18] We verify the validity of the instruments for each of our ownership variables and they are all valid instruments.

performance, measured as the previous two years' stock returns[19]. The test fails to reject the null hypothesis that leverage may be treated as exogenous, at the 5% level.

8. Conclusions

Most previous studies on the relationship between ownership structure and bank risk focus on the direct effect of concentration on bank risk, with the implicit assumptions that all shareholders are risk neutral and prefer more risk to less. Our paper considers differences in risk preferences and type I and type II agency problems of different types of shareholders (families, institutions, corporations and banks) to analyze the mechanisms underlying the relationship between ownership structure and bank risk, for a large sample of US banks over the period 1997-2007. Using 2SLS simultaneous equations models, we show that ownership concentration has a total positive effect on bank risk and that this effect can be decomposed into a positive direct effect, and a negative indirect effect. While the positive direct effect is the result of large shareholders' opportunistic behavior and monitoring, the indirect effect works through managerial incentive contracts. We find that large shareholders reduce bank risk by designing low-Vega and high-Delta incentive contracts. Thus, our results show that executive incentives are an important mechanism for shareholders to induce their preferred risk-level.

Our findings reveal that not all types of shareholders have the same preferences toward risk, as we find that the strength of the positive direct and negative indirect effect depends on the type of the largest shareholder. The positive direct and negative indirect effects are strongest when the largest shareholder is a family and weakest when it concerns a bank or corporation. Finally, we look at the effect of total shareholdings by type on bank risk. We find that institutional shareholdings have a positive direct and indirect effect on bank risk. In contrast, family shareholdings show a positive direct effect and a negative indirect effect, which results in a positive total effect. Finally, corporate and bank shareholdings are very small compared to institutional and family ownership, when it concerns a non-controlling stakes. As a result, we do not find a significant direct effect on bank risk, although they have an indirect effect via the design of CEO incentives.

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[19] This measure of bank performance should exhibit a positive relationship with a bank's total assets, which is the denominator of our measure of leverage, and are therefore relevant instruments. There is no obvious reason to expect a direct relationship between our measures of a firm's past performance and its current risk profile, other than the effect through equity incentives and the control variables such as leverage, which suggests that these are valid instruments. In addition the F-statistic for the joint significance of the instruments in the first stage regression as well as the Kleibergen–Paap underidentification LM and Wald tests rejects the null hypotheses that the instruments may be inadequate to identify the equation at the 95% level.

Regarding the effect of managerial incentives on bank risk, we show that Vega has a positive direct effect on bank risk, while Delta has a negative direct effect. In addition, we show that an increase in Vega (Delta) has a negative (positive) indirect effect on risk via Delta (Vega). Overall, the positive (negative) direct effect of Vega (Delta) on risk is higher (lower) than the negative (positive) indirect effect of Vega (Delta) on risk via Delta (Vega), which leads to an overall positive relationship between Vega (Delta) and Risk.

Our research has implications for academics, practitioners and policymakers, and contributes to the debate on the influence of corporate governance practices and managerial incentives on bank risk. Our findings suggest that ownership structure is an important factor to be considered when analyzing the relationship between bank risk and the design of managerial incentives. The bank ownership structure may moderate the effect of regulation of corporate governance practices on bank risk. These results are also important for research analyzing the role of other governance mechanisms on risk (or performance), both for financial and non-financial institutions.

While our findings lend some legitimacy to arguments in favor of government intervention to limit executive risk-taking incentives at financial institutions, it may be a necessary, but not a sufficient condition. The final result of such government intervention may depend on the bank's ownership structure. For instance, our results only provides some support to the "say on pay strategy", when the largest shareholders suffer from underdiversification or from extended liability effects. In such case, government intervention to limit CEO risk-taking incentives could, at best strengthen, and at worst interfere with, the compensation-based risk mitigation behavior exhibited by shareholders with preferences toward lower risk-levels. In contrast, regulation at banks with shareholders who are able to diversify, should probably not give more power to shareholders to set CEO risk-taking incentives as they all prefer more to less. In addition, to reduce bank risk, regulation could focus on reducing type II agency problems which, according to our results, lead to higher bank risk.

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Figure 1: Relationship between the Ownership structure, Managerial Incentives and Bank Risk

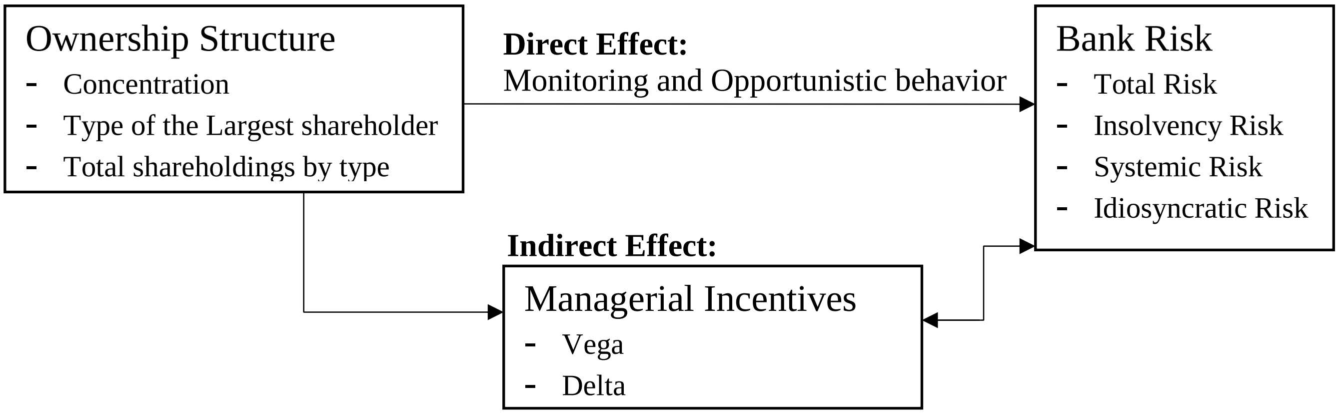

Table 1: Sample selection details

Sample selection criteria	
	# bank-year obs.
Executive compensation on SNL Financial database 1997-2007	5116
Less	
Bank-years without CEO compensation data in the two prior years	953
Bank-years with less than 50 trading days	1139
Bank-years without accurate ownership structure data	655
Bank-years without control variables	45
Total	2324

Sample distribution by year

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
N obs.	66	64	119	170	185	220	230	239	240	390	401

Table 2: Descriptive statistics

Variable	N	Mean	Std. Dev.	Min	Max
Total Risk	2323	0.023	0.014	0.006	0.214
Z-Score	2324	133.382	164.242	-0.290	1867.000
Insolvency Risk	2324	0.023	0.106	-3.493	2.776
Systemic Risk	2321	0.489	0.654	-6.050	8.230
Idiosyncratic Risk	2321	0.032	0.017	0.010	0.490
Vega	2324	11765	111438	0.000	2689574
Delta	2324	90715	406240	0.000	9582742
Stake of the largest shareholder (SH1)	2324	10.573	10.728	0.700	75.210
Stake of the 3 largest shareholder	2324	18.806	12.189	1.750	95.800
HHI of Ownership Concentration	2324	0.029	0.064	0.000	0.590
SH1 is a Family	2324	0.340	0.474	0.000	1.000
SH1 is a Corporation	2324	0.165	0.371	0.000	1.000
SH1 is a bank	2324	0.077	0.266	0.000	1.000
SH1 is a Inst. investor	2324	0.418	0.493	0.000	1.000
SH1*SH1 is a Family	2324	3.946	8.502	0.000	71.860
SH1*SH1 is a Corporation	2324	2.808	9.528	0.000	75.210
SH1*SH1 is a bank	2324	0.748	2.908	0.000	48.480
SH1*SH1 is a Inst. investor	2324	3.071	4.683	0.000	35.560
Total shareholdings of Families	2324	12.047	12.749	0.000	79.760
Total shareholdings of Corporations	2324	3.590	9.957	0.000	77.530
Total shareholdings of Inst. investors	2324	20.289	18.723	0.000	97.560
Total shareholdings of Banks	2324	1.291	3.196	0.000	35.560
Total Assets (in milions)	2324	18800	115000	27.873	1900000
Market Capitalization (in milions)	2324	3379	18754	2.6	273598
Leverage	2324	9.267	3.038	1.670	53.820
Tobin’s Q	2324	0.907	0.030	0.460	0.980
Economic Impact	2324	141.953	12.889	0.000	217.580
Market Concentration	2324	0.109	0.056	0.000	0.570
tenure	2324	4.364	2.858	0.000	11.000
Base salary	2324	352822	238757	0.000	2400000

Table 3: Correlation matrix of our main variables of interest

	Total Risk (ln)	Insolv. Risk (ln)	Systemic Risk	Idios. Risk	Vega (ln)	Delta (ln)	SH1	Tot Banks	Tot Corp.	Tot Instit.
Insolvency Risk	0.022	1.000								
	(0.290)									
Systemic Risk	-0.156	-0.013	1.000							
	(0.000)	(0.529)								
Idiosyncratic	0.272	-0.013	-0.001	1.000						
	(0.000)	(0.516)	(0.955)							
Vega (ln)	0.074	0.046	0.030	0.025	1.000					
	(0.000)	(0.024)	(0.133)	(0.215)						
Delta (ln)	-0.097	0.022	0.136	0.062	0.463	1.000				
	(0.000)	(0.286)	(0.000)	(0.002)	(0.000)					
SH1	0.035	0.023	-0.045	0.041	0.078	0.098	1.000			
	(0.079)	(0.259)	(0.024)	(0.042)	(0.000)	(0.000)				
Tot Banks	-0.060	-0.025	0.107	-0.088	-0.156	-0.173	0.012	1.000		
	(0.003)	(0.214)	(0.000)	(0.000)	(0.000)	(0.000)	(0.547)			
Tot Corporations	0.005	0.022	-0.082	0.043	-0.041	0.040	0.662	-0.084	1.000	
	(0.821)	(0.274)	(0.000)	(0.033)	(0.038)	(0.046)	(0.000)	(0.000)		
Tot Insitutions	-0.295	0.010	0.492	-0.125	0.173	0.170	-0.060	-0.033	-0.115	1.000
	(0.000)	(0.632)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.095)	(0.000)	
Tot Family	0.196	0.033	-0.209	0.170	0.193	0.247	0.368	-0.148	-0.087	-0.341
	(0.000)	(0.107)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

P-values between ( )

Table 4: Difference of means by largest shareholder type

	(1)	(2)	(3)	(4)	Difference of means test		
	SH1 is a Family	SH1 is a Bank	SH1 is a Corporation	SH1 is an Inst. Investor	(1) - (2)	(1) - (3)	(1) - (4)
N	791	178	384	971			
Total Risk	0.0277	0.0212	0.0229	0.0198	0.0064***	0.0047***	0.0079***
Insolvency Risk(ln)	0.0224	0.0134	0.0261	0.0231	0.0090	-0.0037	-0.0007
Systemic Risk	0.3043	0.6255	0.3500	0.6627	-0.3212***	-0.0457	-0.3584***
Idiosyncratic Risk	0.0357	0.0262	0.0331	0.0294	0.0095***	0.0026***	0.0063***
Vega	7583.34	342.06	2420.97	20960.62	7241.27	5162.37	-13377.28***
Delta	124923.70	27836.38	35293.86	96287.27	97087.32***	89629.84***	28636.43*
Stake of the largest shareholder (SH1)	11.592	9.7488	17.0106	7.3495	1.8432*	-5.4186***	4.2425***
Total Family stake	23.2527	5.3891	8.9912	5.3474	17.8636***	14.2615***	17.9053***
Total Corporate stake	0.6727	0.5079	18.1654	0.7732	0.1648	-17.4927***	-0.1005
Total stake of Inst. inv	9.3423	13.2514	15.7962	32.2735	-3.9091**	-6.4539***	-22.9312***
Total Bank stake	0.3338	10.2519	0.7129	0.6552	-9.9181***	-0.3791	-0.3214
Market Capitalization (in milions)	283.4	1646.2	394.7	7367.9	-1362.8***	-111.3***	-7084.5***
Total Assets (in milions)	1725807	7906346	2360300	4.13E+07	-6180539***	-634493	-39574193***

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed test for variable coefficients).

Table 5: Second stage regression estimates of equations (1), (2) and (3) on SH1 shareholdings (* p < 0.10; ** p < 0.05; *** p < 0.01)

		Model 1			Model 2			Model 3			Model 4	
	Total Risk	Ln Vega	Ln Delta	Insolv. Risk	Ln Vega	Ln Delta	Syst. Risk	Ln Vega	Ln Delta	Idio. Risk	Ln Vega	Ln Delta
Ln Vega	0.0616*		0.6743**	0.0138*		0.6587**	0.0328		0.6821***	0.0003*		0.6784***
	(0.0350)		(0.3138)	(0.0078)		(0.3062)	(0.0308)		(0.2339)	(0.0002)		(0.2614)
Ln Delta	-0.0718***	1.4829**		-0.0082**	1.5181**		0.0017	1.4660***		-0.0001*	1.4740***	
	(0.0160)	(0.6901)		(0.0036)	(0.7058)		(0.0139)	(0.5027)		(0.0001)	(0.5678)	
Sh1	0.1194**	-1.9567*	1.3195**	0.0299***	-1.9990*	1.3168*	0.0380	-1.9266*	1.3142**	0.0004**	-1.9758*	1.3405**
	(0.0482)	(1.0978)	(0.5492)	(0.0114)	(1.0715)	(0.7328)	(0.0379)	(1.0280)	(0.5889)	(0.0002)	(1.1171)	(0.6043)
Total Risk		-0.3806	0.2566									
		(7.7060)	(5.1144)									
Insolvency Risk					0.7631	-0.5027						
					(41.1170)	(27.2382)						
Systemic Risk								-0.4434	0.3024			
								(9.2897)	(6.3147)			
Idiosyncratic Risk											96.5616	-65.5122
											(2034.5592)	(1368.1627)
Ln Ta	0.0344	-6.6526	4.4861***	0.0181	-6.9838*	4.6002***	0.5276***	-6.2585	4.2692	0.0015*	-6.5707**	4.4579***
	(0.1205)	(4.6351)	(1.3404)	(0.0297)	(4.0728)	(0.8411)	(0.1048)	(4.9068)	(3.2967)	(0.0008)	(3.3150)	(0.8980)
Leverage	-0.5558***	5.4911	-3.7029	-0.3315	5.0442	-3.3226	0.3276*	5.6770	-3.8726	-0.0003	5.5596	-3.7719*
	(0.2095)	(3.5827)	(2.4362)	(0.4548)	(11.9633)	(8.7664)	(0.1896)	(4.9602)	(2.9365)	(0.0014)	(3.7005)	(2.0741)
Tobin Q	-2.0367	32.4283	-21.8676	-1.9928	22.9791	-15.1364	1.9839	32.6926	-22.3011	-0.0002	32.4891	-22.0422
	(1.9757)	(37.3931)	(21.5666)	(3.6997)	(82.7097)	(57.9294)	(1.6846)	(38.7508)	(23.6066)	(0.0119)	(37.2252)	(21.9005)
Economic Conditions	0.0048			-0.0003			-0.0023			-0.0000		
	(0.0044)			(0.0011)			(0.0038)			(0.0000)		
Market Concentration	-0.8912			0.1970			-1.0750***			0.0020		
	(0.5823)			(0.1391)			(0.4081)			(0.0036)		
tenure		-0.8423	0.5680*		-0.8419	0.5546***		-0.8089*	0.5518***		-0.8219	0.5576***
		(0.8067)	(0.2934)		(0.6756)	(0.1976)		(0.4795)	(0.1744)		(0.5243)	(0.1568)
Ln cash Compensation		-1.9984	1.3476**		-1.9842	1.3070**		-1.9547**	1.3334**		-1.9228**	1.3045*
		(1.4451)	(0.6641)		(1.2980)	(0.5947)		(0.7981)	(0.5363)		(0.8157)	(0.7110)
Nº observations	2323	2323	2323	2324	2324	2324	2321	2321	2321	2321	2321	2321
Nª Banks	444	444	444	446	446	446	443	443	443	443	443	443
F-stat first stage												
Risk		11.98***	11.98***		2.07	2.07		2.90*	2.90*		0.48	0.48
Vega	14.66***		12.34***	14.47***		12.16***	14.64***		12.36***	14.64***		12.36***
Delta	43.29***	4.06**		42.27***	3.67**		43.28***	4.06**		43.28***	4.06**	
Endogeneity test-GMM	54.3920***	19.0677***	5.3374***	7.2179***	20.3135***	1.7942***	1.2157***	20.2462***	2.4488***	7.8928***	20.3469***	2.2705***
Underidentification test												
Kleibergen-Paap rk LM stat	8.6668	4.1993	6.4079	8.6096	2.9251	3.9735	8.6780	5.2296	5.3137	8.6780	0.9026	0.8861
Underidentification-P value	0.0032	0.0404	0.0114	0.0033	0.0872	0.0462	0.0032	0.0222	0.0212	0.0032	0.3421	0.3465
Weak identification test												
Kleibergen-Paap rk Wald F stat	3.511	1.963	3.097	3.504	1.287	1.620	3.515	2.855	2.936	3.515	0.441	0.435
F- second stage	20.5038***	6.8231***	95.4979***	2.5360***	6.5357***	97.5356***	46.1357***	7.0229***	95.9775***	1.4394***	6.8791***	94.9052***

Table 6: Second stage regression estimates of equations (1), (2) and (3) on Herfindahl Index of concentration (* p < 0.10; ** p < 0.05; *** p < 0.01)

	Model 1			Model 2			Model 3			Model 4		
	Total Risk	Ln Vega	Ln Delta	Insolv. Risk	Ln Vega	Ln Delta	Syst. Risk	Ln Vega	Ln Delta	Idio. Risk	Ln Vega	Ln Delta
Ln Vega	0.0570*		0.5909*	0.0129*		0.5011*	0.0305		0.5627**	0.0003*		0.5815**
	(0.0338)		(0.3017)	(0.0074)		(0.2820)	(0.0297)		(0.2280)	(0.0002)		(0.2646)
Ln Delta	-0.0713***	1.6923*		-0.0081**	1.9958*		0.0021	1.7770**		-0.0001*	1.7196**	
	(0.0157)	(0.8640)		(0.0035)	(1.1233)		(0.0136)	(0.7199)		(0.0001)	(0.7826)	
HHI	0.1278***	-2.7240*	1.6096***	0.0283***	-3.0358*	1.5211***	0.0531*	-2.9364**	1.6524***	0.0005***	-2.6567*	1.5449***
	(0.0382)	(1.4450)	(0.3509)	(0.0100)	(1.5941)	(0.5140)	(0.0316)	(1.4716)	(0.4972)	(0.0002)	(1.5055)	(0.4867)
Total Risk		1.2574	-0.7430									
		(7.9386)	(4.9371)									
Insolvency Risk					-8.7950	4.4068						
					(54.2238)	(25.6076)						
Systemic Risk								1.7323	-0.9748			
								(11.2663)	(6.3526)			
Idiosyncratic Risk											-329.3183	191.5044
											(2099.1768)	(1263.9840)
Ln Ta	0.0187	-6.7419	3.9839***	0.0147	-8.8799	4.4493***	0.5196***	-8.2685	4.6530	0.0014*	-7.0039*	4.0729***
	(0.1155)	(5.1425)	(1.3072)	(0.0284)	(6.0129)	(0.8455)	(0.1011)	(6.5496)	(3.2529)	(0.0008)	(3.9916)	(0.8080)
Leverage	-0.5860***	7.4772*	-4.4184*	-0.3410	4.8990	-2.4547	0.3151*	6.9866	-3.9316	-0.0004	7.2633	-4.2237**
	(0.2025)	(4.3656)	(2.3093)	(0.4559)	(15.6267)	(8.5270)	(0.1884)	(5.8221)	(2.7898)	(0.0014)	(4.8086)	(1.9820)
Tobin Q	-2.5032	50.0118	-29.5528	-2.1215	31.7769	-15.9221	1.7611	50.6857	-28.5225	-0.0022	49.6281	-28.8596
	(1.8996)	(45.6720)	(20.0470)	(3.7205)	(107.2971)	(57.3795)	(1.6513)	(46.5247)	(21.3225)	(0.0114)	(47.8731)	(21.0505)
Economic Conditions	0.0041			-0.0005			-0.0026			-0.0000		
	(0.0044)			(0.0011)			(0.0038)			(0.0000)		
Market Concentration	-0.8534			0.2021			-1.0505***			0.0022		
	(0.5677)			(0.1378)			(0.4027)			(0.0035)		
HHI	0.1278***	-2.7240*	1.6096***	0.0283***	-3.0358*	1.5211***	0.0531*	-2.9364**	1.6524***	0.0005***	-2.6567*	1.5449***
	(0.0382)	(1.4450)	(0.3509)	(0.0100)	(1.5941)	(0.5140)	(0.0316)	(1.4716)	(0.4972)	(0.0002)	(1.5055)	(0.4867)
tenure		-0.9289	0.5489*		-1.2132	0.6079***		-1.0664	0.6001***		-0.9969	0.5797***
		(0.9284)	(0.2832)		(1.0341)	(0.1886)		(0.6868)	(0.1789)		(0.6875)	(0.1538)
Ln cash Compensation		-2.0955	1.2383*		-2.6623	1.3340**		-2.2716**	1.2783**		-2.3493**	1.3661**
		(1.6242)	(0.6407)		(1.8643)	(0.5823)		(0.9846)	(0.5317)		(0.9443)	(0.6774)
Nº observations	2323	2323	2323	2324	2324	2324	2321	2321	2321	2321	2321	2321
Nª Banks	444	444	444	446	446	446	443	443	443	443	443	443
F-stat first stage												
Risk		11.60***	11.60***		1.98	1.98		2.58*	2.58*		0.48	0.48
Vega	14.62***		12.53***	14.42***		12.29***	14.60***		12.54***	14.60***		12.54***
Delta	42.25***	2.78*		41.37***	2.45*		42.23***	2.77*		42.23***	2.77**	
Endogeneity test-GMM (est)	55.0150	20.3168	3.0593	7.3449	21.5423	0.6957	1.0638	21.6129	1.2619	7.9745	21.6778	0.9914
Underidentification test Kleibergen-Paap rk LM stat	9.0442	3.6554	6.4627	8.9816	2.3770	4.1916	9.0554	4.5298	4.6836	9.0554	0.9915	0.9715
Underidentification-P value	0.0026	0.0559	0.0110	0.0027	0.1231	0.0406	0.0026	0.0333	0.0305	0.0026	0.3194	0.3243
Weak identification test Kleibergen-Paap rk Wald F stat	3.653	1.697	3.133	3.643	1.087	1.690	3.657	2.479	2.594	3.657	0.483	0.476
F- second stage	21.4404	5.4557	101.9759	2.6150	3.8598	101.9432	47.9193	4.8117	98.8807	2.7583	5.2558	101.6809

Table 7: Second stage regression estimates of equations (1), (2) and (3) on SH1 to 3 shareholdings (* p < 0.10; ** p < 0.05; *** p < 0.01)

	Model 1			Model 2			Model 3			Model 4		
	Total Risk	Ln Vega	Ln Delta	Insolv. Risk	Ln Vega	Ln Delta	Syst. Risk	Ln Vega	Ln Delta	Idio. Risk	Ln Vega	Ln Delta
Ln Vega	0.0572*		0.6062**	0.0126*		0.4973*	0.0303		0.5680**	0.0003*		0.5926**
	(0.0335)		(0.3020)	(0.0072)		(0.2709)	(0.0295)		(0.2268)	(0.0002)		(0.2616)
Ln Delta	-0.0715***	1.6497**		-0.0081**	2.0108*		0.0021	1.7606**		-0.0001*	1.6874**	
	(0.0157)	(0.8218)		(0.0034)	(1.0953)		(0.0135)	(0.7030)		(0.0001)	(0.7450)	
SH1to3	0.2726***	-5.6726**	3.4387***	0.0690***	-6.3794**	3.1726***	0.1196*	-6.2688**	3.5606***	0.0011***	-5.4925*	3.2550***
	(0.0799)	(2.7840)	(0.6706)	(0.0251)	(3.1305)	(1.1745)	(0.0675)	(2.9685)	(1.0205)	(0.0004)	(3.1209)	(0.9432)
Total Risk		1.6862	-1.0221									
		(7.7038)	(5.0020)									
Insolvency Risk					-11.4200	5.6794						
					(53.5578)	(24.7611)						
Systemic Risk								2.3695	-1.3458			
								(11.3654)	(6.4698)			
Idiosyncratic Risk											-437.3926	259.2106
											(2056.6383)	(1273.9102)
Ln Ta	0.0184	-6.4376	3.9024***	0.0137	-8.9935	4.4727***	0.5188***	-8.4954	4.8253	0.0014*	-6.7959*	4.0274***
	(0.1147)	(4.9147)	(1.3242)	(0.0279)	(5.897)	(0.8464)	(0.1002)	(6.5931)	(3.3069)	(0.0007)	(3.8013)	(0.8118)
Leverage	-0.5783***	7.2337*	-4.3850*	-0.3413	3.9628	-1.9708	0.3178*	6.5271	-3.7073	-0.0004	6.9547	-4.1215**
	(0.2005)	(4.1598)	(2.3250)	(0.4555)	(15.8967)	(8.4194)	(0.1869)	(5.7320)	(2.8302)	(0.0014)	(4.5956)	(2.0043)
Tobin Q	-2.4515	47.4078	-28.7381	-2.1493	25.7766	-12.8193	1.7659	47.9995	-27.2631	-0.0020	46.9883	-27.8465
	(1.8869)	(43.5221)	(20.1076)	(3.7296)	(110.9423)	(57.8251)	(1.6364)	(45.4571)	(21.4134)	(0.0114)	(45.8901)	(21.1603)
Economic Conditions	0.0041			-0.0005			-0.0026			-0.0000		
	(0.0044)			(0.0010)			(0.0038)			(0.0000)		
Market Concentration	-0.8271			0.2128			-1.0360***			0.0023		
	(0.5664)			(0.1374)			(0.4010)			(0.0036)		
tenure		-0.8765	0.5313*		-1.2258	0.6096***		-1.0589	0.6014***		-0.9684	0.5739***
		(0.8860)	(0.2865)		(1.0128)	(0.1845)		(0.6759)	(0.1796)		(0.6566)	(0.1533)
Ln cash Compensation		-2.0062	1.2161*		-2.7101	1.3478**		-2.2378**	1.2710**		-2.3463**	1.3905**
		(1.5594)	(0.6404)		(1.8172)	(0.5795)		(0.9685)	(0.5339)		(0.9260)	(0.6793)
Nº observations	2323	2323	2323	2324	2324	2324	2321	2321	2321	2321	2321	2321
Nª Banks	444	444	444	446	446	446	443	443	443	443	443	443
F-stat first stage												
Risk		11.69***	11.69***		2.03	2.03		2.51*	2.51*		0.49	0.49
Vega	14.71***		12.83 ***	14.50***		12.60***	14.69***		12.84***	14.69***		12.84***
Delta	41.98***	2.91*		41.08***	2.56*		41.96***	2.91*		41.96***	2.91*	
Endogeneity test-GMM (est)	55.0067	20.7287	3.0797	7.4305	22.0054	0.7534	1.0597	22.0456	1.3574	8.0696	22.1204	1.0609
Underidentification test												
Kleibergen-Paap rk LM stat	9.2030	3.8626	6.4214	9.1486	2.5696	4.501	9.2143	4.4281	4.5980	9.2143	0.9938	0.9751
Underidentification-P value	0.0024	0.0494	0.0113	0.0025	0.1089	0.0339	0.0024	0.0354	0.0320	0.0024	0.3188	0.3234
Weak identification test												
Kleibergen-Paap rk Wald F stat	3.717	1.802	3.109	3.711	2.408	2.530	3.720	2.479	2.594	3.720	0.485	0.478
F- second stage	21.5055	5.7555	102.5112	2.6752	3.7907	101.7675	48.1792	4.8593	97.9937	2.6681	5.4308	101.5761

Table 8: Types of shareholders (* p < 0.10; ** p < 0.05; *** p < 0.01)

	Model 1			Model 2			Model 3			Model 4		
	Total Risk	Ln Vega	Ln Delta	Insolv. Risk	Ln Vega	Ln Delta	Syst. Risk	Ln Vega	Ln Delta	Idio. Risk	Ln Vega	Ln Delta
Ln Vega	0.0605*		0.7619**	0.0147*		0.5058*	0.0339		0.6575***	0.0003*		0.7319**
	(0.0339)		(0.3320)	(0.0082)		(0.2829)	(0.0300)		(0.2393)	(0.0002)		(0.2909)
Ln Delta	-0.0723***	1.3125**		-0.0091**	1.9772*		0.0002	1.5210***		-0.0001*	1.3662**	
	(0.0160)	(0.5719)		(0.0041)	(1.1061)		(0.0139)	(0.5535)		(0.0001)	(0.5431)	
Sh1 family	0.1814***	-2.9390**	2.2393***	0.0328***	-3.7107*	1.8768***	0.0611	-3.5722**	2.3486***	0.0005*	-2.8474**	2.0841***
	(0.0596)	(1.2222)	(0.5949)	(0.0124)	(1.9727)	(0.6469)	(0.0505)	(1.5095)	(0.7210)	(0.0003)	(1.3394)	(0.5590)
Sh1 Institution	0.1202**	-2.0235*	1.5417***	0.0235**	-2.6587*	1.3447**	0.0660*	-2.8311*	1.8614**	0.0004*	-1.8223	1.3339*
	(0.0508)	(1.1907)	(0.5748)	(0.0103)	(1.5108)	(0.6518)	(0.0373)	(1.6122)	(0.8474)	(0.0002)	(1.4233)	(0.7095)
Sh1 Corporation	0.1336**	-1.9762**	1.5057**	0.0555*	-1.1953	0.6045	0.0566	-2.4089*	1.5838**	0.0008***	-1.3174	0.9643
	(0.0558)	(0.9653)	(0.6380)	(0.0289)	(2.5018)	(1.4330)	(0.0436)	(1.2806)	(0.7260)	(0.0003)	(1.7266)	(1.0559)
Sh1 Bank	-0.0473	1.4909	-1.1359	-0.0020	2.8506	-1.4418*	-0.1204**	2.6852	-1.7654	-0.0003	1.5641	-1.1448
	(0.0641)	(1.3168)	(0.7983)	(0.0127)	(2.4361)	(0.8165)	(0.0579)	(1.9899)	(1.2458)	(0.0003)	(1.3256)	(0.8090)
Total Risk		3.8925	-2.9657									
		(6.0965)	(5.5301)									
Insolvency Risk					-34.6502	17.5250						
					(72.9493)	(30.2108)						
Systemic Risk								6.4101	-4.2146			
								(11.4630)	(7.6254)			
Idiosyncratic Risk											-1113.5312	815.0488
											(2129.5116)	(1715.1001)
Ln Ta	0.0332	-4.6636	3.5532***	0.0251	-9.4418	4.7754***	0.5234***	-9.6025	6.3135*	0.0015*	-5.2622*	3.8517***
	(0.1192)	(3.5449)	(1.3773)	(0.0315)	(6.2540)	(0.8531)	(0.1043)	(6.3246)	(3.8090)	(0.0008)	(2.9711)	(0.9605)
Leverage	-0.4954**	4.9875	-3.8000	-0.3284	-5.9566	3.0127	0.3413*	2.6347	-1.7323	-0.0002	4.2149	-3.0851
	(0.2089)	(3.2418)	(2.4982)	(0.4516)	(25.7906)	(12.1068)	(0.1862)	(5.3848)	(3.3893)	(0.0013)	(3.7461)	(2.3636)
Tobin Q	-1.7155	22.4859	-17.1321	-2.1032	-53.5897	27.1040	2.0948	16.9739	-11.1600	-0.0009	18.6750	-13.6692
	(2.0104)	(32.7364)	(22.6020)	(3.7627)	(195.6497)	(91.4783)	(1.6934)	(40.5659)	(25.4302)	(0.0117)	(38.0225)	(25.5917)
Economic Conditions	0.0043			-0.0006			-0.0029			-0.0000		
	(0.0044)			(0.0011)			(0.0038)			(0.0000)		
Market Concentration	-0.6609			0.2033			-0.9558**			0.0023		
	(0.5697)			(0.1367)			(0.3938)			(0.0037)		
tenure		-0.5358	0.4082		-1.2463	0.6304***		-0.9310*	0.6121***		-0.7207	0.5275***
		(0.6404)	(0.3194)		(1.0587)	(0.1955)		(0.5596)	(0.1871)		(0.4860)	(0.1615)
Ln cash Compensation		-1.4127	1.0763*		-3.0152	1.5250**		-1.8463**	1.2139**		-2.2306***	1.6327**
		(1.1647)	(0.6468)		(2.2410)	(0.6675)		(0.8574)	(0.5654)		(0.8229)	(0.8220)
Nº observations	2323	2323	2323	2324	2324	2324	2321	2321	2321	2321	2321	2321
Nª Banks	444	444	444	446	446	446	443	443	443	443	443	443
F-stat first stage												
Risk		11.99***	11.99***		2.17	2.17		2.26*	2.26*		0.43	0.43
Vega	14.76***		13.08 ***	14.60***		12.86***	14.74***		13.09***	14.74***		13.09***
Delta	44.14***	4.11**		43.15***	3.75**		44.12***	4.11**		44.12***	4.11**	
Endogeneity test-GMM (est)	54.0985	20.6838	4.2895	6.5889	21.9797	1.8916	1.4077	22.0101	2.7201	9.0454	22.1232	2.3185
Underidentification test Kleibergen-Paap rk LM stat	9.1364	5.7563	6.1091	9.0103	1.8431	4.0149	9.1477	3.9880	4.1302	9.1477	0.8703	0.8411
Underidentification-P value	0.0025	0.0164	0.0134	0.0027	0.1746	0.0451	0.0025	0.0458	0.0421	0.0025	0.3509	0.3591
Weak identification test Kleibergen-Paap rk Wald F stat	3.712	2.614	2.912	3.681	0.844	1.613	3.716	2.164	2.287	3.716	0.426	0.412
F- second stage	15.4446	6.8776	69.8033	1.8239	2.7432	62.7099	39.2435	4.5326	62.2740	1.9211	5.5445	60.6208

Table 9: total shareholdings by investor type (* p < 0.10; ** p < 0.05; *** p < 0.01)

	Model 1			Model 2			Model 3			Model 4		
	Total Risk	Ln Vega	Ln Delta	Insolv. Risk	Ln Vega	Ln Delta	Syst. Risk	Ln Vega	Ln Delta	Idio. Risk	Ln Vega	Ln Delta
Ln Vega	0.0833*		0.6598**	0.0176*		0.4920*	0.0476		0.5948***	0.0004*		0.6466**
	(0.0504)		(0.2997)	(0.0099)		(0.2986)	(0.0358)		(0.2208)	(0.0002)		(0.2731)
Ln Delta	-0.0976***	1.5155**		-0.0125**	2.0325*		-0.0151	1.6812***		-0.0002*	1.5466**	
	(0.0292)	(0.6883)		(0.0058)	(1.2336)		(0.0201)	(0.6241)		(0.0001)	(0.6534)	
Family shareholdings	0.2574***	-3.6650**	2.4184***	0.0374**	-4.5283*	2.2279***	0.1268**	-4.2345**	2.5187***	0.0009**	-3.5609**	2.3024***
	(0.0929)	(1.4276)	(0.3338)	(0.0174)	(2.4531)	(0.3282)	(0.0626)	(1.6610)	(0.5499)	(0.0004)	(1.6209)	(0.3196)
Corporate shareholdings	-0.0237	0.5110	-0.3372**	0.0020	0.8892	-0.4375*	-0.0074	0.6451	-0.3837**	0.0000	0.6043*	-0.3907**
	(0.0183)	(0.4075)	(0.1700)	(0.0067)	(0.9214)	(0.2413)	(0.0116)	(0.3960)	(0.1707)	(0.0001)	(0.3433)	(0.1837)
Insitutional shareholdings	0.0862**	-1.7676	1.1664***	0.0159*	-2.4799	1.2201***	0.0941***	-2.4102	1.4336**	0.0006***	-1.6154	1.0445
	(0.0394)	(1.1598)	(0.3105)	(0.0086)	(1.6097)	(0.2393)	(0.0268)	(1.4084)	(0.6090)	(0.0002)	(1.5116)	(0.6359)
Bank shareholdings	-0.0305	0.5504*	-0.3632**	-0.0061	0.7647*	-0.3762**	-0.0207	0.6521**	-0.3879**	-0.0001	0.5997**	-0.3877**
	(0.0231)	(0.3102)	(0.1470)	(0.0055)	(0.4334)	(0.1498)	(0.0158)	(0.2986)	(0.1579)	(0.0001)	(0.2622)	(0.1573)
Total Risk		2.5856	-1.7061									
		(6.7950)	(4.9946)									
Insolvency Risk					-22.1205	10.8833						
					(69.1107)	(29.1710)						
Systemic Risk								3.7894	-2.2540			
								(10.8812)	(6.4585)			
Idiosyncratic Risk											-739.3553	478.0499
											(2120.5700)	(1478.5109)
Ln Ta	0.0290	-3.6718	2.4228**	0.0194	-6.4812	3.1888***	0.5111***	-6.3136	3.7554	0.0014	-4.1367*	2.6747***
	(0.1520)	(3.1396)	(1.1970)	(0.0335)	(5.1042)	(0.8880)	(0.1066)	(5.2052)	(2.8276)	(0.0009)	(2.2835)	(0.6664)
Leverage	-0.5359**	5.2091	-3.4372	-0.3294	-1.5554	0.7652	0.2873	4.0078	-2.3838	-0.0005	4.6800	-3.0260
	(0.2444)	(3.3916)	(2.1354)	(0.4582)	(21.2515)	(10.1634)	(0.1904)	(5.0333)	(2.8005)	(0.0014)	(3.8557)	(2.0072)
Tobin Q	-1.7232	24.2469	-15.9993	-1.9237	-21.3880	10.5229	1.9565	21.8176	-12.9772	-0.0004	22.7307	-14.6971
	(2.3013)	(32.8281)	(18.9768)	(3.7370)	(148.7158)	(69.5920)	(1.7215)	(38.0604)	(21.1645)	(0.0126)	(36.0100)	(20.5834)
Economic Conditions	0.0029			-0.0007			-0.0038			-0.0000		
	(0.0059)			(0.0013)			(0.0043)			(0.0000)		
Market Concentration	-0.7987			0.1865			-1.0609**			0.0019		
	(0.7172)			(0.1507)			(0.4283)			(0.0039)		
tenure		-0.5678	0.3747		-1.0453	0.5143**		-0.8067	0.4799***		-0.6949	0.4493***
		(0.6759)	(0.2863)		(1.0254)	(0.2036)		(0.5345)	(0.1629)		(0.4914)	(0.1495)
Ln cash Compensation		-1.1066	0.7302		-2.0166	0.9922		-1.2931	0.7692		-1.6499*	1.0668
		(1.1452)	(0.6207)		(1.8890)	(0.6248)		(0.9065)	(0.5733)		(0.9193)	(0.7977)
Nº observations	2323	2323	2323	2324	2324	2324	2321	2321	2321	2321	2321	2321
Nª Banks	444	444	444	446	446	446	443	443	443	443	443	443
F-stat first stage												
Risk		12.36***	12.36***		2.10	2.10		2.64*	2.64*		0.44	0.44
Vega	14.81***		13.61 ***	14.55***		13.34***	14.80***		13.61***	14.80***		13.61***
Delta	29.68***	3.43**		29.21***	3.14**		29.65***	3.43**		29.65***	3.43**	
Endogeneity test-GMM	56.6517	21.7153	3.2897	8.4846	23.1623	1.1509	1.8835	23.2956	1.7278	10.4573	23.3725	1.4398
Underidentification test Kleibergen-Paap rk LM stat	6.2714	4.9795	6.6059	6.3010	1.6261	3.4571	6.2768	4.5050	4.7275	6.2768	0.8474	0.8142
Underidentification-P value	0.0123	0.0256	0.0102	0.0121	0.2022	0.0630	0.0122	0.0338	0.0297	0.0122	0.3573	0.3669
Weak identification test Kleibergen-Paap rk Wald F stat	2.621	2.215	3.254	2.638	0.754	1.407	2.623	2.480	2.650	2.623	0.412	0.400
F- second stage	10.4315	5.2593	87.0824	1.4827	2.7876	81.6071	35.6487	4.1027	81.8629	2.1160	4.8258	84.4455

Table 10: Direct and indirect effect of Delta and Vega on bank risk (for all models)

Table 5: Sh1	TR	InsR	SR	IdR	Table 5: Sh1	TR	InsR	SR	IdR
Direct Effect of Vega on risk	0.0616*	0.0138*	0.0328	0.0003*	Direct Effect of Delta on risk	-0.0718***	-0.0082**	0.0017	-0.0001*
Indirect Effect of Vega on risk via Delta	-0.0484***	-0.0054**	0.0012	-0.0001*	Indirect Effect of Delta on risk via Vega	0.0913*	0.0209*	0.0481	0.0004*
Total Effect Vega on risk	0.0132	0.0084	0.0340	0.0002	Total Effect Delta on risk	0.0195	0.0127	0.0498	0.0003
Table 6: HHI	TR	InsR	SR	IdR	Table 6: HHI	TR	InsR	SR	IdR
Direct Effect Vega	0.0570*	0.0129*	0.0305	0.0003*	Direct Effect of Delta on risk	-0.0713***	-0.0081**	0.0021	-0.0001*
Indirect Effect of Vega via Delta	-0.0421***	-0.0041**	0.0012	-0.0001*	Indirect Effect of Delta on risk via Vega	0.0965*	0.0257*	0.0542	0.0005*
Total Effect Vega	0.0149	0.0088	0.0317	0.0002	Total Effect Delta on risk	0.0252	0.0176	0.0563	0.0004
Table 7: sh1to3	TR	InsR	SR	IdR	Table 7: sh1to3	TR	InsR	SR	IdR
Direct Effect Vega	0.0572*	0.0126*	0.0303	0.0003*	Direct Effect of Delta on risk	-0.0715***	-0.0081**	0.0021	-0.0001*
Indirect Effect via Delta	-0.0433***	-0.0040**	0.0012	-0.0001*	Indirect Effect of Delta on risk via Vega	0.0944*	0.0253*	0.0533	0.0005*
Total Effect Vega	0.0139	0.0086	0.0315	0.0002	Total Effect Delta on risk	0.0229	0.0172	0.0554	0.0004
Table 8: Types of shareholders	TR	InsR	SR	IdR	Table 8: Types of shareholders	TR	InsR	SR	IdR
Direct Effect Vega	0.0605*	0.0147*	0.0339	0.0003*	Direct Effect of Delta on risk	-0.0723***	-0.0091**	0.0002	-0.0001*
Indirect Effect of Vega via Delta	-0.0551***	-0.0046**	0.0001	-0.0001*	Indirect Effect of Delta on risk via Vega	0.0794*	0.0291*	0.0516	0.0004*
Total Effect Vega	0.0054	0.0101	0.0340	0.0002	Total Effect Delta on risk	0.0071	0.0200	0.0518	0.0003
Table 9: Total shareholdings by type	TR	InsR	SR	IdR	Table 9: Total shareholdings by type	TR	InsR	SR	IdR
Direct Effect Vega	0.0833*	0.0176*	0.0476	0.0004*	Direct Effect of Delta on risk	-0.0976***	-0.0125**	-0.0151	-0.0002*
Indirect Effect of Vega via Delta	-0.0644***	-0.0062**	-0.0090	-0.0001*	Indirect Effect of Delta on risk via Vega	0.1262*	0.0358*	0.0800	0.0006*
Total Effect Vega	0.0189	0.0115	0.0386	0.0003	Total Effect Delta on risk	0.0286	0.0233	0.0649	0.0004

Table 11: Calculation of direct, indirect and total effect of ownership concentration on bank risk (tables 5-7)

SH1	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	0.1194***	-1.9567*	1.3195**	0.0299***	-1.9990*	1.3168*	0.0380	-1.9266*	1.3142**	0.0004**	-1.9758*	1.3405**
Vega indirect effect	-0.0022*		-0.0305**	-0.0005*		-0.0134**	-0.0009		-0.0308***	0.0000*		-0.0307***
Delta indirect effect	-0.0948***	1.9204**		-0.0112**	1.9641**		0.0013	1.8985***		-0.0002*	1.9089***	
Risk indirect effect		-0.0089	0.0060		0.0146	-0.0096		-0.0172	0.0117		0.0217	-0.0148
∑ indirect sign. effects	-0.0970	1.9204	-0.0305	-0.0117	1.9641	-0.0134	0.0000	1.8985	-0.0308	-0.0002	1.9089	-0.0307
∑ significant effects	0.0224	-0.0363	1.28901	0.0182	-0.0350	1.3034	0.0000	-0.02806	1.2833	0.0002	-0.0669	1.3098
Total effect(RFcoeff)	0.0236	-0.0452	1.2950**	0.0190	-0.0204	1.2938**	0.0000	-0.0452	1.2951	0.0003	-0.0452	1.2951**
HHI	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	0.1278***	-2.724*	1.6096***	0.0283***	-3.0358*	1.5211***	0.0531*	-2.9364**	1.6524***	0.0005***	-2.6567*	1.5449***
Vega indirect effect	-0.0034*		-0.0258*	0.0015*		-0.0086*	-0.0042		-0.0246**	0.0000*		-0.0254**
Delta indirect effect	-0.1129***	2.6639*		-0.0123**	3.1526*		0.0034	2.7972**		-0.0002*	2.7068**	
Risk indirect effect		0.0165	-0.0097		-0.1339	0.0671		0.0955	-0.0537		-0.0938	0.0546
∑ indirect sign. effects	-0.1164	2.6639	-0.0258	-0.0107	3.1526	-0.0086	0.0000	2.7972	-0.0246	-0.0001	2.7068	-0.0254
∑ significant effects	0.0114	-0.0601	1.5838	0.0176	0.1168	1.5126	0.0531	-0.1392	1.6278	0.0004	0.0501	1.5195
Total effect(RFcoeff)	0.0131	-0.0437	1.5741	0.0153	-0.0170	1.5796	0.0551	-0.0437	1.5741	0.0003	-0.0437	1.5741
SH1 to 3	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	0.2726***	-5.6726**	3.4387***	0.0690***	-6.3794**	3.1726***	0.1196*	-6.2688**	3.5607***	0.0011***	-5.4925	3.2552***
Vega indirect effect	-0.0192*		-0.1791**	0.0026**		-0.1201*	-0.0174		-0.1678**	0.0000		-0.1750**
Delta indirect effect	-0.2331***	5.3364**		-0.0247**	6.5883*		0.0071	5.6951**		-0.0003*	5.4584**	
Risk indirect effect		0.0408	-0.0248		-0.4504	0.2239		0.2783	-0.1581		-0.2612	0.1548
∑ indirect sign. effects	-0.2523	5.3364	-0.1791	-0.0221	6.5883	-0.1201	0.0000	5.6951	-0.1678	-0.0003	5.4584	-0.1750
∑ significant effects	0.0203	-0.3362	3.2596	0.0469	0.2090	3.0525	0.1196	-0.5737	3.3928	0.0008	-0.0341	3.0800
Total effect (RFcoeff)	0.0203	-0.2954	3.2348	0.0469	-0.2414	3.2765	0.1093	-0.2954	3.2348	0.0008	-0.2954	3.2348

Table 12: Calculation of direct, indirect and total effect of SH1 on bank risk by type of shareholder (table 8)

SH1*FAMILY	TOTAL RISK	VEGA	DELTA	INSOLVENCY RISK	VEGA	DELTA	SYSTEMIC RISK	VEGA	DELTA	IDIOSYNCRATIC RISK	VEGA	DELTA
Direct effect	0.1814***	-2.939**	2.2393***	0.0328***	-3.7107*	1.8768***	0.0611	-3.5722**	2.3486***	0.0005*	-2.8474**	2.0841***
Vega indirect effect	-0.0255*		-0.25472**	0.00123*		-0.1504*	-0.0222		-0.2198***	-6.8239*		-0.2447**
Delta indirect effect	-0.1434***	2.5169**		-0.0157**	3.7947*		0.00042	2.9168***		-0.0001*	2.6199**	
Risk indirect effect		0.08773	-0.06691		-0.3813	0.1928		0.3210	-0.2111		-0.1069	0.0783
∑ indirect sign. effects	-0.1690	2.5169	-0.2547	-0.0144	3.7947	-0.1504	0.0000	2.9168	-0.2198	-0.0002	2.6199	-0.2447
∑ significant effects	0.0124	-0.4221	1.9846	0.0183	0.0840	1.7264	0.0000	-0.6554	2.1288	0.0002	-0.2275	1.8394
Total effect (RFcoeff)	0.0225	-0.3343	1.9177	0.0110	-0.2973	1.9192	0.0501	-0.3343	1.9177	0.0002	-0.3343	1.9177
SH1*INSTITUTION	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	0.1202**	-2.0235*	1.5417***	0.0235**	-2.6587*	1.3447**	0.066*	-2.8311*	1.8614**	0.0004*	-1.8223	1.3339*
Vega indirect effect	0.0163*		0.2455**	0.0116*		0.1756*	-0.0058		0.2118***	0.0007*		0.2358**
Delta indirect effect	-0.1292***	2.2936**		-0.0138**	3.4473*		0.00041	2.6581***		-0.0001*	2.3876**	
Risk indirect effect		0.0520	-0.03965		-0.4414	0.22321		0.4951	-0.32559		-0.2431	0.17794
∑ indirect sign. effects	-0.1128	2.2936	0.2455	-0.0022	3.4473	0.1756	0.0000	2.6581	0.2118	0.0006	2.3876	0.2358
∑ significant effects	0.0073	0.2702	1.7872	0.0213	0.7886	1.5203	0.0000	-0.1730	2.0732	0.0010	2.3876	1.5697
Total effect (RFcoeff)	0.0073	0.3222	1.7476	0.0213	0.3472	1.7435	0.0606	0.3221	1.7476	0.0010	0.3221	1.7476
SH1*CORPORATION	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	0.1336**	-1.9762**	1.5057**	0.0555*	-1.1953	0.6045	0.0566	-2.4089*	1.5838**	0.0008***	-1.3174	0.9643
Vega indirect effect	-0.0250*		-0.2278**	0		-0.1331	-0.0202		-0.1965***	0		-0.2188
Delta indirect effect	-0.0923***	1.5627**		0	2.3484		0.00027	1.8109***		0	1.6266	
Risk indirect effect		0.1144	-0.08726		-1.4161	0.71631		0.2991	-0.19668		-0.60809	0.44506
∑ indirect sign. effects	-0.1174	1.5627	-0.2278	0	0	0	0.0000	1.8109	-0.1965	0.0008	0	0
∑ significant effects	0.0162	-0.4135	1.2779	0.0555	0	0	0.0000	-0.5980	1.3873	0.0008	0	0
Total effect (RFcoeff)	0.0162	-0.2990	1.1906	0.0912	-0.2631	1.1877	0.0366	-0.2989	1.1906	0.0016	-0.2989	1.1906
SH1*BANK	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	-0.0473	1.4909	-1.1359	-0.002	2.8506	-1.4418*	-0.1204**	2.6852	-1.7654	-0.0003	1.5641	-1.1448
Vega indirect effect	0		0.0333	-0.0357*		0.0349*	0		0.0287	0		0.0319
Delta indirect effect	0	1.5627		0.0128**	-2.4288*		0	-1.8782		0	-1.6869	
Risk indirect effect		-3.0099	-0.1322		-0.3529	0.1785		-0.7634	0.5019		0.1665	-0.1219
∑ indirect sign. effects	0	0.0000	0	0.0229	-2.4288	0.0349	0.0000	0	0	0	0	0
∑ significant effects	0	0.0000	0	0.0229	-2.4288	-1.4069	-0.1204	0	0	0	0	0
Total effect (RFcoeff)	-0.0497	0.0437	-1.2349	-0.0249	0.0689	-1.2284	-0.1840	0.0436	-1.2348	-0.0008	0.0436	-1.2348

Table 13: Calculation of direct, indirect and total effect of total shareholdings by type on bank risk (tables 9)

TOTAL FAMILY	TOTAL RISK	VEGA	DELTA	INSOLVENCY RISK	VEGA	DELTA	SYSTEMIC RISK	VEGA	DELTA	IDIOSYNCRATIC RISK	VEGA	DELTA
Direct effect	0.2574***	-3.665**	2.4184***	0.0374**	-3.665*	2.2279***	0.1268**	-4.2345**	2.5157***	0.0009**	-3.5609**	2.3024***
Vega indirect effect	-0.0478*		-0.3554**	0.00732*		-0.2567*	-0.0383		-0.3204***	-0.0001*		-0.3483**
Delta indirect effect	-0.2012***	3.0914**		-0.0246**	4.0814*		-0.0331	3.4294***		-0.0003*	3.1548**	
Risk indirect effect		0.0349	-0.0231		-0.9380	0.0343		0.2665	-0.1555		-0.1326	0.0857
∑ indirect sign. effects	-0.2490	3.0914	-0.3554	-0.0173	4.0814	-0.2567	0.0000	3.4294	-0.3204	-0.0004	3.1548	-0.3483
∑ significant effects	0.0083	-0.5737	2.0630	0.0201	0.4164	1.9712	0.1268	-0.8051	2.1953	0.0005	-0.4061	1.9541
Total effect (RFcoeff)	0.0083	-0.5387	2.0398	0.0201	-0.5217	2.0056	0.0553	-0.5386	2.0398	0.0003	-0.5386	2.0398
TOTAL INSTITUTIONAL	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	0.0862**	-1.7676*	1.1664***	0.0159*	-2.4799*	1.2201***	0.0941***	-2.4102*	1.4336**	0.0006***	-1.6154	1.0445
Vega indirect effect	0.18259*		0.2375**	0.05193*		0.1825*	0.1157		0.2141***	0		0.2328
Delta indirect effect	-0.1369***	2.1921**		-0.0175**	2.9508*		-0.0248	2.4317***		0	2.2370	
Risk indirect effect		-0.06445	0.04249		-0.0999	0.04738		0.33848	-0.20131		-0.2616	0.1691
∑ indirect sign. effects	0.0456	2.1921	0.2375	0.0344	2.9508	0.1825	0.0000	2.4317	0.2141	0	0	0
∑ significant effects	0.1318	2.1920	1.4039	0.0503	2.9508	1.4026	0.0941	2.4317	1.6477	0	0	0
Total effect (RFcoeff)	0.1318	0.3600	1.4464	0.0503	0.3710	1.4500	0.1850	0.3600	1.4464	0.0014	0.3600	1.4464
TOTAL CORPORATIONS	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	-0.0237	0.511	-0.3372**	0.002	0.8892	-0.4375*	-0.0074	0.6451	-0.3837**	0	0.6043*	-0.3907**
Vega indirect effect	-0.0611*		-0.1361**	-0.0174*		-0.0984*	-0.0387		-0.1227***	-0.0001*		-0.1334**
Delta indirect effect	0.0462***	-0.7336**		0.0067**	-0.9902*		0.0076	-0.8138***		0.0001*	-0.7486**	
Risk indirect effect		0.0163	-0.0108		-0.0990	0.0493		-0.0375	0.02233		-0.0619	0.0400
∑ indirect sign. effects	-0.0149	-0.7336	-0.1361	-0.0107	-0.9902	-0.0984	0.0000	-0.8138	-0.1227	0.0000	-0.7486	-0.1334
∑ significant effects	-0.0149	-0.7336	-0.4733	-0.0107	-0.9902	-0.5359	0.0000	-0.8138	-0.5064	0.0000	-0.1443	-0.5241
Total effect (RFcoeff)	-0.0386	-0.2063	-0.4841	-0.0087	-0.2000	-0.4866	-0.0384	-0.2063	-0.4840	0.0000	-0.2063	-0.4840
TOTAL BANKS	**TOTAL RISK**	**VEGA**	**DELTA**	**INSOLVENCY RISK**	**VEGA**	**DELTA**	**SYSTEMIC RISK**	**VEGA**	**DELTA**	**IDIOSYNCRATIC RISK**	**VEGA**	**DELTA**
Direct effect	-0.0305	0.5504*	-0.3632**	-0.0061	0.7647*	-0.3762**	-0.0207	0.6521**	-0.3879**	-0.0001	0.5997**	-0.3877**
Vega indirect effect	0.01225*		0.1139**	0.00321*		0.0843*	0.00972		0.1024***	0.00007*		0.1113**
Delta indirect effect	0.02432***	-0.4033**		0.00364**	-0.5823*		0.00431	-0.4477***		0.00005*	-0.4119**	
Risk indirect effect		0.02559	-0.01686		-0.0111	0.0058		-0.0323	0.01922		-0.0157	0.0101
∑ indirect sign. effects	0.0366	-0.4033	0.1139	0.0069	-0.5823	0.0843	0.0000	-0.4477	0.1024	0.000012	-0.4119	0.1113
∑ significant effects	0.0366	0.1471	-0.2493	0.0069	0.1824	-0.2919	0.0000	0.2044	-0.2855	0.0001	0.1878	-0.2764
Total effect (RFcoeff)	0.0061	0.1727	-0.2661	0.0008	0.1714	-0.2861	-0.0066	0.1721	-0.2663	0.0000	0.1721	-0.2663

Appendix 1: Measures of incentives provided by company's stock and executive stock options

Estimates of Delta and Vega are based on Black-Scholes option pricing formula as extended by Merton (1973) to account for a dividend flow.

Stock option Delta is the partial derivative of an option value with respect to the stock price. Stock option Vega is the partial derivative of an option price with respect to the standard deviation of a stock return. The formulas are given as follows:

$$Delta = e^{-dT} N(Z)$$

$$Vega = e^{-dT} N'(Z) S\sqrt{T}$$

$$Z = \frac{\ln\left(\frac{S}{K}\right) + T\left(r - d + 0.5\sigma^2\right)}{\sigma\sqrt{T}}$$

where *N(Z)* is the cumulative probability distribution function for the normal distribution, *N'(Z)* is the density function for the normal distribution, *S* is the price of the underlying stock, *K* is the option strike (exercise) price, σ is expected stock-return volatility over the life of the option, *r* is the risk-free interest rate, *T* is time to maturity of the option in years, *d* is the natural logarithm of expected dividend yield over the life of the option.

Previously, the usual method (the full information method) used by scholars to estimate the sensitivities to stock price and volatility of the option portfolio required hand-collection of some of the necessary information from proxy statements. Since a typical executive stock option has a ten year term, the procedure required analyzing every single statement filed over a ten year period. The alternative method proposed by Core and Guay (2002) allows for estimating Delta and Vega using only the information from the latest proxy (The one year approximation method). It relies on the inputs disclosed in the compensation table reporting year-end option exercises as well as quantity and intrinsic values of vested and unvested grants. The reported securities are in-the-money and by definition their intrinsic values are greater than zero. The method treats recently granted, vested and unvested options as three separate grants. The Delta and Vega of recently granted option are computed directly because the proxy statement discloses all the inputs necessary for the Black-Scholes model. The proxy statement discloses separate information on unexercisable and exercisable previously-granted options, which are treated as to single grants. For each grant the exercise price and the time to maturity have to be estimated. The exercise price for the vested and unvested grants is estimated as follows:

$$K_{vested} = S_{year\_end} - \frac{V_{vest}}{N_{vest}}$$

$$K_{unvested} = S_{year\_end} - \frac{V_{unvest}}{N_{unvest}}$$

Where *V* and *N* denote the intrinsic value and number of stock options respectively. Because the value and sensitivities of newly granted options are computed separately as described above, the number and fiscal year-end intrinsic value of new options are deducted from the number and realizable value of unvested options. Option maturities are set in the following way. If stock options are granted in the current fiscal year, the time to maturity of unvested options is equal to the time to maturity of the current grants minus one year. For vested options, the time to maturity is equal to the maturity of the unvested grants minus three years. If there is no recent option award, the time to maturity for unvested and vested grants is set to nine and six years, respectively.

An advantage of using SNL Financial Database to estimate Delta and Vega is that for most option granted it provides complete information for recently granted, vested and unvested options. From the table "Outstanding Equity Awards at FYE" we were able to manually collect for the period 2000-2007 the total number of both exercisable and non-exercisable stock options along with the exercise price and option expiration date at fiscal year end. Therefore we were able to compute Delta and Vega using the full information method for 90% of the options grants in our sample, for the remaining 10% for which we didn't have complete information for vested and unvested options we follow the one year approximation method to estimate the missing data (i.e., exercise prices and/or the time to maturity).

Other information necessary to calculate Deltas and Vegas are readily available in Bloomberg Database. The parameters are calculated as follows. Annualized stock return volatility is estimated over the period of 60 months. The dividend yield is the average yield measured over a three-year period. The risk-free interest rate is the yield on US Treasury Bonds at the end of the fiscal year with maturity comparable to that of an executive stock option. We follow Mazur (2011) and Brockman, Martin and Unlu (2009) and calculate stock option sensitivities as follows:

$$Stock\ option\ Vega = \frac{1}{100}\left(vega_{vest}N_{vest} + vega_{unvest}N_{unvest} + vega_{current}N_{current}\right)$$

$$Stock\ option\ Delta = \frac{S}{100}\left(delta_{vest}N_{vest} + delta_{unvest}N_{unvest} + delta_{current}N_{current} + N_{equity}\right)$$

Appendix 2: computation of indirect and total effects.

To analyze how ownership structure affects bank risk, Vega and Delta on the one hand, and how Vega and Delta affects bank risk on the other hand, we decompose the total effect of each independent variable into a direct effect and into an indirect effect. The direct effect of ownership structure on bank risk (Vega or Delta) is given by the partial derivative of risk (Vega or Delta) with respect to ownership structure. Similarly the direct effect of Vega (Delta) on bank risk is given by the partial derivative of risk with respect to Vega (Delta). That is, direct effects are given by the structural coefficient of each independent variable in the equation of interest. However, to take into account the indirect effect precipitated by a change in ownership structure (Delta or Vega), which feedback through the system to further affect risk in eq. (1), Vega en in eq.(2) or Delta in eq.(3), the total differential of each equation in the system is required. The resulting linear system of total derivatives must then be solved simultaneously to find the total effect for each variable (the sum of the direct and indirect effects after the change has worked its way through the system). This is because any secondary, or feedback, effects that arise from the initial perturbation (in ownership structure, Delta or Vega) cause changes in the endogenous variables of the system. The total effect (which refers to the change in the dependent variable attributable to changes in the independent variable after all implied changes have been considered) is given by the coefficient of the independent variable in the reduced form equation of the dependent variable of interest (Ford and Jackson, 2010).

In what follows we specify the linear system of total derivatives from which we derive the indirect effect of ownership structure on risk, Vega, and Delta as well as the indirect effect of Vega and Delta on bank risk.

Indirect effect of ownership structure on bank risk, Vega and Delta.

The total effect of ownership structure on risk, Vega and Delta is given by the total derivative of each equation in our systems with respect to the ownership structure variable which leads to the following system of total derivatives:

$$\frac{dRisk_t}{dOS_t} = \beta_1 \frac{dVega_t}{dOS_t} + \beta_2 \frac{dDelta_t}{dOS_t} + \beta_5 \quad (A2.1)$$

$$\frac{dVega_t}{dOS_t} = \gamma_1 \frac{dRisk_t}{dOS_t} + \gamma_2 \frac{dDelta_t}{dOS_t} + \gamma_5 \quad (A2.2)$$

$$\frac{dDelta_t}{dOS_t} = \theta_1 \frac{dRisk_t}{dOS_t} + \theta_2 \frac{dVega_t}{dOS_t} + \theta_5 \quad (A2.3)$$

Where $\frac{dRisk_t}{dOS_t};\frac{dVega_t}{dOS_t};\frac{dDelta_t}{dOS_t}$ represents the total effect of a change in the ownership structure variable on risk, Vega and Delta, respectively, after all implied changes have occurred. This total effect is given by the coefficient of the ownership structure variable in the reduced form equation of risk, Vega and Delta, respectively (Ford and Jackson, 2010).

From equations A2.1; A2.2 and A2.3 we obtain that:

The *direct effect of the ownership variables on risk, Vega and Delta* are given by

$$\beta_5, \gamma_5 \text{ and } \theta_5\text{, respectively.}$$

The *indirect effect of the ownership variables on risk* via Vega and Delta is given by:

$$\beta_1 \frac{d \ln Vega_t}{dOS_t},\ \beta_2 \frac{dDelta_t}{dOS_t} \text{ respectively.}$$

The *indirect effect of the ownership variables on Vega, via risk and Delta* is given by:

$$\gamma_1 \frac{dRisk_t}{dOS_t},\ \gamma_2 \frac{dDelta_t}{dOS_t}\text{, respectively}$$

The *indirect effect of ownership structure on Delta, via risk and Vega* is given by:

$$\theta_1 \frac{dRisk_t}{dOS_t}, \theta_2 \frac{dVega_t}{dOS_t}\text{, respectively}$$

Direct effects are considered to be significant when the structural coefficients are significant at the 5% level (our findings are robust to using 1% or 10% significant level), i.e., the *direct effects of the ownership variables on risk, Vega and Delta* are significant when

β_5, γ_5 and θ_5, respectively, are significant.

Similarly, indirect effects of a change in ownership structure on a dependent variable via any of the endogenous explanatory variables in the equation of interest, are considered to be significant when the direct effect of the endogenous explanatory variable (through which the indirect effects works) in the equation of interest is significant. That is:

- The indirect effect of ownership structure on bank risk via Vega (Delta) is considered to be significant when β_1 (β_2) is significant in eq. (1)
- The indirect effect of ownership structure on Vega via risk (Delta) is considered to be significant when $\gamma_1(\gamma_2)$ is significant in eq. (2)
- The indirect effect of ownership structure on Delta via risk (Vega) is considered to be significant when $\theta_1(\theta_2)$ is significant in eq. (3)

To add robustness to our results we compute the indirect effect of ownership structure on risk, via Vega and Delta, considering only those significant direct and indirect effects of ownership structure on Vega and Delta. That is, to compute the indirect effect of ownership structure on bank risk we proceed as follows: First, we decompose the total effect of ownership structure on Vega and Delta into their direct and indirect effect. Second, we compute the significant total effect of ownership structure on Vega and Delta as the sum of those significant direct and indirect effects. Third, we compute the indirect effect of ownership structure on bank risk, via Vega and Delta considering the significant total effects of ownership structure on Vega and Delta, respectively

Indirect effect of Vega on Bank risk

The total effect of Vega on bank risk is given by the total derivative of risk with respect to Vega:

$$\frac{dRisk_t}{dVega_t} = \beta_1 + \beta_2 \frac{dDelta_t}{dVega_t}$$

, where

β_1 and $\beta_2 \frac{dDelta_t}{dVega_t}$

represent the direct and indirect effect (via Delta) of Vega on bank risk, respectively.

And where

$$\frac{dDelta_t}{dVega_t} = \theta_1 \frac{dRisk_t}{dVega_t} + \theta_2$$

represents the total effect of Vega on Delta. To compute the total effect of Vega on Delta, we consider those direct and indirect effects of Vega on Delta that are significant. The direct effect of Vega on Delta is given by θ_2 , therefore the direct effect is significant if θ_2 is significant.

In turn the indirect effects of Vega on Delta via risk ($\theta_1 \frac{dRisk_t}{dVega_t}$) is significant when the direct effect of risk (endogenous variable through which the indirect effects works) on Delta (θ_1) is significant. Our results in table 7-11 show that for all our specifications risk does not has a significant effect on Delta. Thus, the total effect of a change in Vega on Delta is given by the direct effect of Vega on Delta (θ_2). This finding implies that the total effect of Vega on bank risk can be computed as:

$$\frac{dRisk_t}{dVega_t} = \beta_1 + \beta_2 \theta_2$$

, where $\beta_2 \theta_2$ represents the indirect effect of Vega on risk, via Delta.

Indirect effect of Delta on Bank risk

The total effect of Delta on bank risk is given by the total derivative of risk with respect to Delta:

$$\frac{dRisk_t}{dDelta_t} = \beta_1 + \beta_2 \frac{dVega_t}{dDelta_t}$$

, where

$$\beta_1; \beta_2 \frac{dVega_t}{dDelta_t}$$

represent the direct and indirect effect (via Vega) of Delta on bank risk, respectively. And where

$$\frac{dVega_t}{dDelta_t} = \gamma_1 \frac{dRisk_t}{dDelta_t} + \gamma_2$$

represents the total effect of Delta on Vega.

To compute the total effect of Delta on Vega, we consider those direct and indirect effects of Delta on Vega that are significant. The direct effect of Delta on Vega is given by γ_2,therefore the direct effect is significant if γ_2 is significant. In turn the indirect effects of Delta on Vega via risk ($\gamma_1 \frac{dRisk_t}{dDelta_t}$) is significant when the direct effect of risk (endogenous variable through which the indirect effects works) on Vega (γ_1) is significant. Our results in table 7-11 show that for all our specifications, risk does not have a significant effect on Vega. Thus, the total effect of a change in Delta on Vega is given by the direct effect (γ_2). This finding implies that the total effect of Delta on bank risk can be computed as:

$$\frac{dRisk_t}{dDelta_t} = \beta_1 + \beta_2 \gamma_2$$

, where $\beta_2 \gamma_2$ represent the indirect effect that Delta has on risk via Vega.

Robustness tests

We also compute the total and indirect effect of a change in the ownership structure variable on risk, Vega and Delta and the total and indirect effect of a change in Vega Delta on risk, by using the "*Mutatis mutandis*" procedure suggested by Ford and Jackson (2010). This procedure consists in resolving the linear system of total derivatives resulting from a change in a common dependent variable simultaneously to find the total effect for each endogenous variable. Thus, this procedure allows obtaining estimates of the relevant reduced form coefficient directly from the structural coefficients without having to estimate the relevant reduced form coefficients (which cannot be estimated for the case of Vega and Delta). Our results hold under this alternative computation of the direct and indirect effect.

Edicions / Issues:

95/1	*Productividad del trabajo, eficiencia e hipótesis de convergencia en la industria textil-confección europea* Jordi López Sintas
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