Compensation incentives, deregulation and risk-taking : Lessons from the U.S. banking industry

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December 2008

Abstract

We examine the relation between the sensitivity of CEO stock options to equity risk (Vega), as an incentive to increase risk, and risk-taking in a sample of 156 bank holding companies (BHCs) over the 1993-2006 period. We also analyze the trend over time of the Vega of bank CEOs' stock options, and examine its determinants. Our evidence shows that the incentives to increase risk provided to bank CEOs through compensation have increased significantly as we moved towards a more deregulated banking environment. We also find that BHCs that grant their CEOs stock options with a high Vega take on higher risks.

Keywords: banking, deregulation, executive compensation, stock options, vega, delta, risk-taking.
JEL classification: G21, G32, J33.

1. Introduction and Motivation

The recent financial crisis has underscored once again the dangers associated with excessive risk-taking by banks. It has also revived the urgent necessity of revising bankers' compensation incentives thought to be a factor behind high risk-taking that, ultimately, led to the market disruptions we have witnessed. In his speech at the Global Association of Risk Management Professionals Annual Risk Convention, on February 25, 2008, Governor Randall S. Kroszner stressed the importance of providing managers and traders with the right incentives to ensure sound risk-management at financial institutions[1]. He notes that "Since the fortunes of even the most technically sophisticated financial institutions ultimately depend on the decisions and judgments of individual managers and traders, senior management must ensure that the right incentives are in place so that risk taking is appropriately captured in business-line performance evaluation and employee compensation." The main message of Governor Kroszner is that compensation incentives can be used as a signal about which risk levels are tolerated by the financial institution.

The academic literature has investigated the effect of different sources of managers' incentives on bank-risk taking, among which stock ownership (e.g. Saunders et al., 1990; Gorton and Rosen, 1995; Knopf and Teall, 1996; Anderson and Fraser, 2000) and compensation (e.g. Houston and James, 1995; Hubbard and Palia, 1995; Brewer III et al., 2003, Chen et al., 2006) [2]. In examining the effect of compensation incentives on bank

[1] Governor Kroszner's speech is available on the Federal Reserve's web site: www.federalreserve.gov.

[2] The financial economics literature has recognized a long time ago the potential for a risk-related agency conflict between risk averse managers and risk-neutral shareholders. Shareholders holding well diversified portfolios are interested in undertaking all positive NPV projects regardless of their risk level. However, managers whose personal (human and financial capital) wealth is concentrated in the firm are more exposed to firm specific risk than shareholders. Unlike shareholders, managers can adopt a risk-averse behavior and pass-up some risk-increasing, positive NPV projects.

risk-taking, most studies use raw measures of the incentives to increase risk by managers. Examples of such measures are the ratio of stock-based compensation to total compensation, the value of the stock options' portfolio, and the ratio of stock options to total compensation[3]. In this paper, we contribute to this literature by investigating the relation between the sensitivity of CEO compensation to risk, as a measure of incentives to increase risk, and risk-taking by U.S. bank holding companies (BHCs). We therefore, advance the existing literature by using a measure that captures directly the incentives of executives to increase risk. Indeed, the higher the sensitivity of the manager's compensation to risk the more she gains from increasing risk. In contrast, a higher value of the option portfolio or of the ratio of stock option compensation to total compensation is not a precise indicator of the manager's degree of incentives to take on higher risks[4].

We measure CEOs' incentives to increase risk by the Vega of stock options rather than by the Vega of total stock-based wealth since previous work such as Guay (1999) shows that most of the sensitivity of managers' wealth to risk comes from stock options' portfolios. Rajgopal and Shevlin (2002), Rogers (2002) and Coles et al. (2006) adopt the same approach. Vega is computed as the partial derivative of the Black-Scholes (1973) option pricing model with respect to stock return volatility, and its dollar value measures the magnitude of the incentives provided to the CEO to increase risk. Besides the Vega-risk-taking relation, we also address two other related issues. Specifically, we analyze

[3] Theoretical work suggests that managerial compensation can be used to mitigate the risk-related agency conflict between risk-averse managers and risk-neutral shareholders (Amihud and Lev, 1981; Haugen and Senbet, 1981; Smith and Stulz, 1985; Carpenter, 2000; Ross, 2004, and Lewellen, 2006). In particular, this literature shows that a managerial compensation scheme in which income is a convex function of firm value gives managers incentives to undertake risk-increasing positive net present value (NPV) projects. Stock options are one of the components that contribute the most to the convexity of managers' compensation (Guay, 1999).

[4] See for instance, Lewellen (2006) who shows that the incentives to increase risk depend on whether the manager holds "in the money" or "out of the money" stock options.

how the Vega evolved over the 1993-2005 period and examine its determinants. Our analysis of the pattern of Vega over time sheds thus some light on the effect of deregulation on the incentives of bank managers to increase risk, since our sample period covers a full cycle that includes both episodes of regulation and deregulation.

Our focus on the issues related to the sensitivity of managerial compensation to risk in the banking industry represents a contribution to the banking literature with many respects. First, in the last fifteen years there has been a significant increase in the use of equity-based compensation, in the form of stock shares and stock-options for bank executives and directors. This growth in the use of equity based compensation has increased the sensitivity of total pay to performance or delta (e.g. John and Qian, 2003; Becher et al., 2005). This increase in delta of bank executives' compensation is considered as one of the consequences of deregulation that occurred in the mid and late nineties. While the increase in delta of banking executives' compensation is documented, the literature provides no assessment of the magnitude and evolution over time of the sensitivity of this compensation to volatility. It is therefore, of interest, to investigate how the deregulatory movement has contributed to re-shape bank managers incentives to increase risk, and whether these incentives are a determinant of the riskiness of banking firms. To the best of our knowledge, this is the first paper that addresses this issue.

Second, this study provides an empirical testing of John et al. (2000) theory of bank regulation based on management compensation. In John et al's model, the incentives of the manager to shift risk to the deposit insurance agency (FDIC) depend on the sensitivity of her compensation to performance (delta). The higher the delta is the more the risk-shifting incentives of bank managers. Subsequently, John et al. suggest that the

parameters of executive compensation, such as delta, may be used by regulators to curb the risk-shifting incentives of managers and shareholders. For instance, the FDIC insurance premium may be set as a function of delta of managers' compensation. It is, therefore, important to investigate whether there is an empirical relationship between compensation parameters and risk-taking in the banking industry. This is a crucial preliminary step before moving on in the direction of using compensation parameters as an input of regulatory schemes. Part of this paper provides an insight on the relationship between one of the compensation parameters – Vega – and risk-taking by banking firms. Contrary to John et al. who focus their analysis on delta, we focus on the Vega of compensation because managers' incentives to increase risk are better captured by the latter. The results of this study represent a step forward in the assessment of compensation incentives' effect on the riskiness of banking firms.

Apart from focusing on a compensation parameter that has not received due attention in the prior banking literature, our study is distinguished from the extant literature in several ways. First, in our study of risk-taking by BHCs, we focus mainly on the effect of the sensitivity of managers' compensation to risk. This sensitivity measures managers' incentives to take on higher risks more precisely than any other variable used in the literature so far. We also add to the literature by identifying and discussing a number of factors that may affect the magnitude of the sensitivity of bank managers' compensation to risk. The channels through which these factors may affect this sensitivity are analyzed before formally testing these effects. Previous literature studied the determinants of bank executives' total compensation (Harjoto and Mullineaux, 2003) and delta (John and Qian, 2003). We rather analyze and test the determinants of Vega. Contrary to most of studies

of bank executives' compensation, we construct and use a database that is different from the Standard & Poor's Execucomp database. One of the drawbacks of the Execucomp database is that it contains mostly BHCs that pay stock options to their managers. Our sample includes several BHCs that do not grant stock options to their CEOs. Including them in the sample avoids us drawing conclusion based only on CEOs holding options. Moreover, our sample is much larger than samples drawn from the Execucomp database and contains quite a lot of small size BHCs. It is therefore, more representative of the U.S. banking sector. We also work on a long period of time that covers 13 consecutive years.

Using compensation data for 156 bank CEOs over the 1993-2005 period, or around 1,400 bank-years, we present evidence that the sensitivity to equity risk of individual options as well as of option portfolios held by bank CEOs has increased significantly over time. Our analyses show that the average change in the value of bank CEOs option portfolios for a 10 percentage point change in the annualized standard deviation of stock returns increased from $4,402.4 in 1993 to $140,672 in 2005. Given that the 1993-2005 period coincides with a period of deregulatory measures in the U.S. banking industry, one would argue that deregulation has been a significant factor driving such an upward trend in the convexity of bank CEOs pay-performance relation. This is confirmed by our analysis of the determinants of the Vega. Deregulation appears to be a significant factor driving up the Vega of bank CEOs options and option portfolios. Since deregulation induces a more competitive environment and a larger investment opportunity set for banks, the surge in Vega in the post-deregulation period may be intended to boost

managers' incentives to undertake the newly available investment opportunities, including risk-increasing investments that they could otherwise forego.

We also find that the Vega of bank CEOs compensation is positively related to investment opportunities. Thus, BHCs appear to provide their managers with more incentives to undertake risky investments whenever the potential loss from foregoing risk-increasing projects is highest. Moreover, our results indicate that larger BHCs grant their CEOs stock options with a higher sensitivity to equity risk. A few reasons may drive this positive relationship, among which is the better ability of larger banks to take on additional risks due to their greater diversification. The lack of control due to a diffuse ownership in larger BHCs is another potential reason explaining why Boards of Directors of such BHCs increase the incentives of managers to undertake risky investments through the compensation scheme. Finally, we test for linear and quadratic relations between the Vega of options portfolio and market risk-taking measures, and find evidence of a concave relationship. A higher Vega of options portfolio held by bank CEOs is shown to induce the selection of risk increasing investments, but only up to a certain level. This finding suggests that bank shareholders can induce risk-averse managers to undertake risk-increasing investments through managing the convexity of managers' compensation-performance relation. However, this is limited by numerous factors related to managers themselves and to the banking environment that limit the risk-preference attitude of managers. Examples of such factors are the pressures exerted by regulatory agencies to keep banking risk at moderate levels, and the high costs of bankruptcy that managers may suffer in case of a failure of their bank.

Section 2 presents the procedure followed in selecting the sample, and analyzes the trend over time of the compensation components of bank CEOs. In Section 3, we use descriptive statistics to analyze the evolution over time of Vega and other compensation parameters. Section 4 analyzes and tests the determinants of managerial compensation Vega in the banking industry. Section 5 examines the relation between the sensitivity of bank managers' compensation to equity risk and their risk-taking behavior. Section 6 concludes the study.

2. Data and descriptive statistics

To conduct our study on the sensitivity of stock option compensation to equity risk and on its effect on risk-taking by banks we use a final sample of 156 Bank Holding Companies (BHCs) over the period 1993-2006[5]. Data is collected from three different sources. Data on CEO compensation including stock option parameters, salary, bonus and common stock and restricted stock holdings are collected from the proxy statements filed at the beginning of each fiscal year with the Securities and Exchange Commission (available at the SEC's web site). Data on daily returns used to calculate the risk measures are collected from the CRSP database. Finally, accounting data such as total assets, capital ratios and market-to-book value are obtained from the Compustat database.

2.1. Sample selection

To obtain the sample, we select all the BHCs (SIC: 6021 and 6022) available in both Compustat and CRSP databases over the period of 1993 - 2006. We begin our sample period in 1993 because the oldest proxy statements that we could access on the web site

[5] Our compensation data are collected and calculated for the 1993-2005 period, and our risk measures are calculated for the 1994-2006 period. This is because when we regress our risk measures on Vega and other control variables, we use a one year lag. For example, risk measures of 2006 will be matched with compensation variables of 2005.

of the SEC are of 1993. The sample period ends in 2006 because this is the most recent year for which data on annual stock returns were available on CRSP, when the paper was first drafted. To be included in the sample, the bank has to have at least 4 consecutive years of proxy statements available on the SEC web site. We also double check the SIC code of the bank from the annual proxy statements. A few banks appearing in Compustat as commercial banks file proxy statements indicating that they are savings and loan holding companies (SIC: 6035 and 6036) rather than BHCs (4 banks). We decide to eliminate those banks from our final sample since the relation between compensation structure and risk-taking could differ between the two types of banks. We also exclude BHCs with a CEO holding more than 30% of common stock and banks held by families (12 banks) since it is doubtful that compensation is used by the board of directors as an incentive tool. For a few other banks, there are less than four years of consecutive proxy statements or the CEO changes frequently so that we decide to drop the bank from the sample. We also delete one firm with a fiscal year-end that is different than December 31st. These selection criteria result in a final sample containing 156 BHCs out of an initial sample of 184 BHCs, or a panel of around 1,400 bank-years. This sample is much larger than samples used in most of studies of executives compensation in the banking industry. It is also a representative sample of the U.S. banking sector as it includes several small-size BHCs that do not necessarily grant their executives with stock options. The number of banks varies from one year to another, and the number of observations in the panel varies from one variable to another because of the collection of the data from different sources.

2.2. CEO Compensation components over time

For a given fiscal year, the CEO's option portfolio is constructed using data on options granted in the past years (exercisable and unexercisable) and on options granted during that fiscal year. The total value of the option portfolio at the end of a given fiscal year is the sum of the Black and Scholes values of exercisable, unexercisable and currently granted options. To take into account the effect of inflation, all the monetary values are in dollars of the year 2000. To address the difficulties associated with outliers in the data, we winsorize all variables at the 1st and 99th percentile values. We follow Guay (1999) in the calculation of the Black and Scholes value of stock options, of their Vega and delta.

<< Insert figure 1 here >>

Figure 1 shows that over time, stock options and common stock have become a significant component of bank CEOs incentive schemes. The values of stock option portfolio and common stock have evolved at a much faster pace than cash compensation (salary and bonus) between 1993 and 2005. In the beginning of the nineties, stock options were an insignificant component of CEOs' compensation. Using the Black and Scholes (1993) model, the median stock option portfolio in 1993, has a value of only $ 2,564 compared to median cash compensation of $ 312,280. As we reach the year 2002, the median value of the stock option portfolio becomes higher than the median value of cash compensation for the first time. In recent years, the gap between cash compensation and option portfolio value gets larger in favor of the latter[6]. In 1993, the median value of

[6] Furthermore, the large difference between the mean (not reported) and median of the value of option portfolio suggests that there is a considerable variation in the extent to which banks use stock options to provide their managers with incentives. The large standard deviation (not reported) also suggests that there is a substantial variation in the use of options by banks.

common stockholdings by bank CEOs is almost double the median of their cash compensation. As we move forward in the sample period, the median value of bank CEOs' common stockholdings becomes much larger than the median of their cash compensation. In 2003, 2004 and 2005, the median value of common stock is around five times the median value of cash compensation.

3. Vega of stock options : the magnitude and trend over time

As discussed above, the focus of this paper is on the sensitivity of bank CEOs stock option portfolios to equity risk (Vega). We measure Vega as the change in the value of the option portfolio following a 1% change in the annualized standard deviation of stock returns. The option portfolio Vega can vary widely across CEOs depending on the bank's financial characteristics, the number of options held, and the specific parameters underlying stock options, such as the exercise price and the time to maturity of the options in a manager's portfolio.

We estimate the incentive effects of employee stock options using the Black and Scholes (1973) model for valuing European call options, as modified by Merton (1973) to account for dividend payouts. The sensitivity of an option portfolio's value to equity risk is calculated as follows. First, for each option in the CEO's portfolio, we compute the Black and Scholes partial derivative of option value with respect to 1% change in the annualized standard deviation of stock returns. In other words, this partial derivative is calculated separately for exercisable, unexercisable and currently granted options. Next, the partial derivatives are multiplied by the number of options in the portfolio. For a given year, the total sensitivity of the CEO's option portfolio to equity risk (Vega) is equal to the weighted average of Vega for exercisable options, Vega for unexercisable

options, and Vega for currently granted options in the portfolio. The weights used are the respective proportions of the value of the specific type of options (e.g. exercisable) in the total value of the options' portfolio composed of the three types of options.

The trend over time of the Vega and delta of individual options is presented in figure 2. "Average Vega" is the weighted average of the Vegas of exercisable, unexercisable and currently granted individual options. It measures the average sensitivity of one option in a CEO's option portfolio to equity risk, for the sample of CEOs holding options. As is shown by figure 2, the median value of "Average Vega" kept increasing almost constantly over the sample period to reach $0.098 in 2005. "Vega-cy" measures the sensitivity to equity risk of one option granted to a CEO in the current year, for the sample of CEOs holding options. The median value of "Vega-cy" also kept increasing over the 1993-2005 period to reach $0.17 in 2005 compared to a median value of $0.061 for an option granted in 1994. The comparison between the median values of "Vega-cy" and "Average Vega" in each year reveals that most of the sensitivity in the CEOs' option portfolios is driven by the options granted in the current year. Notice that the median values of "Vega-cy" are higher than the median values of "Average Vega" in each year of the sample period. This may be explained by the fact that compensation Committees and Boards of Directors within BHCs have targets for the sensitivity of a CEO's option portfolio that they manage to reach. Therefore, as the old options (exercisable and unexercisable) become weakly sensitive to equity risk because they become deeply "in the money", they will compensate for this by granting new options with a high sensitivity to equity risk. Besides the convexity of the managers' wealth – performance relation, a positive slope of this relation is also an incentive tool for managers to undertake positive

NPV projects. To illustrate the importance of the slope of bank CEOs' wealth-performance relation, figure 2 also reports the trend over time of the sensitivity of an option to stock price ("Average delta"). "Average delta" is the weighted average of the deltas of exercisable, unexercisable and currently granted individual options. The delta of an individual option is measured as the change in the value of the option for a 1% change in stock price. For the sample of CEOs holding options, the median value of the "Average delta" increased from $0.075 in 1993 to $0.16 in 2005.

<< Insert figure 2 here >>

The upward trend in the Vega of stock options is confirmed when we examine the behavior of the sensitivity of the option portfolio to equity risk, as measured by "total Vega" (figure 3). In 1993, the median change in the value of the option portfolio following a change of 1% in equity risk, for CEOs holding stock options, was $210.65 (mean: $440.2). In 2005, this median change reaches $4,666.95 (mean: 14,067.2).

<< Insert figure 3 here >>

Figures 2 confirms the findings of previous studies that examined the effect of deregulation on the sensitivity of bank executives pay to performance (e.g. Crawford et al., 1995; Hubbard and Palia, 1995; Brewer III et al., 2003; John and Qian, 2003; Becher et al., 2005; Cunat and Guadalupe, 2006). Yet, our main finding in this section is that not only the sensitivity of pay to performance has increased over time, but also the sensitivity of pay to risk has increased over time. Deregulation seems to cause a shift in the structure of incentives provided to bank managers. Besides the incentives to increase performance (delta), CEOs of BHCs are given more incentives to increase risk as we moved towards a more deregulated banking environment.

4. An analysis of the determinants of CEO compensation Vega in the banking industry

We now turn to the analysis of the determinants of the Vega of stock options granted to CEOs of BHCs. We start by identifying and discussing the factors that may affect the Vega of CEO compensation in the banking industry. We, then, specify and test an empirical model of the determinants of the Vega. Based on the theoretical literature on executive compensation, we posit that the sensitivity of bank managers' compensation to equity risk is related to characteristics of the bank, of its CEO, and of the banking environment.

4.1. Investment opportunities

Smith and Stulz (1985) suggest that risk-averse managers whose compensation is not a convex function of firm value have incentives to reduce cash flow variability by rejecting variance-increasing positive NPV projects. Therefore, shareholders need to counter such a behavior. This may be achieved by increasing the convexity of managers' compensation to firm value. Since the cost of foregoing risk-increasing positive NPV projects is expected to be higher for shareholders of firms with more investment opportunities it is likely that these shareholders increase the convexity of their managers' pay-off. Based on this argument, firms with more investment opportunities will increase the convexity of their managers' pay-off structure.

In general, prior empirical studies focused on non-banking firms have reported a positive relationship between investment opportunities and compensation components and the sensitivities of managers' wealth to equity risk and to firm performance. Guay (1999) and Coles et al. (2006) report a positive association between Vega of managers'

compensation and measures of investment opportunities indicating that in the presence of more investment opportunities firms increase the convexity of their managers' compensation structure. In a sample of BHCs, Harjoto and Mullineaux (2003) find a positive relationship between the market-to-book ratio and stock-based compensation (options and restricted stock). They interpret this finding as evidence that BHCs with better growth options reward their CEOs with higher stock-based compensation. Based on the theoretical arguments and prior empirical findings, we hypothesize that BHCs with better investment opportunities will remunerate their CEOs with a more convex pay. In other words, we expect a positive relationship between the market-to-book ratio, as a measure of investment opportunities, and the Vega of options portfolio, as a measure of the convexity of a CEO's pay-performance relation.

4.2. Bank size

Bliss and Rosen (2001) show that an increase in bank size increases fixed and stock based compensation, whether this increase is internal or through mergers and acquisitions. We argue that besides increasing the value of CEO compensation, an increase in bank size is also likely to increase the sensitivity of managers' compensation to equity risk and to performance. Corporate governance concerns may explain why the sensitivity of managers' wealth to firm risk and performance need to increase as bank size grows. Larger banks tend to have a more diffuse ownership. As the ownership becomes more diffuse, managers have a greater ability to consume perquisites and to act in their self-interest, including reducing the variability of the bank's cash flows, with lower capacities for the shareholders to monitor them. This may be detrimental to shareholders' value if it implies passing up risk-increasing, but positive NPV

investments. Recognizing this, Boards of Directors may choose to enhance managers' incentives through increasing their exposure to risk and performance changes.

Another channel through which bank size may affect the sensitivity of managerial compensation to risk is diversification. Akhavein et al. (1997) and Demsetz and Strahan (1997) find that larger banks are better diversified. A better diversified bank has greater capabilities to take on more risk. Boards of Directors at larger-better diversified banks have, therefore, better possibilities to enhance managers' incentives to take on higher risk. Increasing the convexity of managers' pay-performance relation is one way to enhance such incentives. Hence, our second hypothesis, related to the determinants of the convexity of CEOs pay-performance relation, states that larger banks have a higher Vega of CEOs' options portfolio. We use total assets as a measure of bank size. Our results are qualitatively the same if we use the market value of equity to measure bank size.

4.3. Leverage

The theoretical literature hypothesizes that the debt ratio should be a determinant of a firm's incentive features included in the compensation of its top managers (John and John. 1993). When a firm's capital structure includes risky debt, managers whose interests are closely aligned with those of shareholders will have incentives to adopt a risk-shifting behavior that is detrimental to debt holders. In particular, John and John (1993) argue that the optimal compensation structure serves as a commitment device to reduce the agency costs of debt. Their theory predicts that the pay-performance sensitivity in an optimal compensation scheme will be decreasing with a firm's debt ratio. John et al. (2000) extend this argument and suggest that incentive features of top management compensation, such as the sensitivity of pay to performance, be used as an

input in bank regulation and in the calculation of FDIC insurance premiums. They argue that a regulatory framework that takes into account the incentives of top managers will be more efficient than capital regulation in curbing their risk-shifting incentives.

Our focus here is on the determinants of the sensitivity of pay to equity risk rather than of the pay-performance sensitivity. We argue that the sensitivity of CEO compensation to equity risk will be declining in the debt ratio. In banking firms, the risk-shifting problem is exacerbated by higher debt ratios than those observed in non banking firms and by the presence of small-uninformed depositors. Meanwhile, the costs of bank failures due to high risk-taking are considerable for bank stakeholders. If regulators, whose objective is to protect bank stakeholders from shareholders and managers' self-interest behavior, believe that banks granting their managers a compensation that is highly sensitive to equity risk take on a high risk, they will focus their regulatory and control activities on such banks. This regulatory and control focus will be even higher as the bank's debt ratio increases because the likelihood of default and the loss given default are higher. On the other hand, investors may ask for a higher risk premium on bonds issued by banks that compensate their managers with a pay that is highly sensitive to risk. This risk premium will be even higher as the bank's debt ratio increases, increasing, hence, the agency costs of debt. Therefore, we expect that CEOs of banks with high debt ratios will get a compensation that has a low sensitivity to equity risk. We measure leverage by the percentage of total debt in total assets.

4.4. CEO stock ownership

Executives' stock ownership is considered as a means of inducing managers to maximize shareholders' value (Jensen and Meckling, 1976). However, the more stock

managers hold and the more they are exposed to firm specific risk, giving them incentives to pass up risk-increasing positive NPV projects. Hence, the Board of Directors, whose role is to protect shareholders' interests, needs to increase managers' incentives to adopt a risk-taking behavior that is aligned with shareholders' interests. Increasing the sensitivity of executives pay to equity risk may be one way to achieve this objective. Based on this argument, CEOs with high stock ownership in their banks will have a high sensitivity of their compensation to equity risk. Yet, this supposes that the Board of Directors is playing his governance role in a perfect way, even as CEO stock ownership – and, hence, influence – increases.

Prior literature suggests that CEOs may become more influential, or entrenched, as their stock ownership grows to high levels, undermining the effectiveness of the Board of Directors in protecting outside shareholders' interests (Morck et al., 1988; McConnell and Servaes, 1990). In a firm where the Board of Directors is dominated by the CEO, the sensitivity of CEO compensation to equity risk is expected to decline as CEO stock ownership increases. The nature of the ownership-sensitivity of CEO compensation to equity risk will depend on whether the Board of Directors is effective in aligning managers interests with those of shareholders (at least at low levels of CEO ownership), and on whether CEOs become entrenched as their equity ownership reaches sufficiently high levels. We test for both a linear and a quadratic relationship between CEO ownership and the sensitivity of compensation to equity risk. CEO stock ownership is measured as the percentage of outstanding common equity held by the CEO.

4.5. CEO tenure

As the number of years the CEO has been in office increases, the likelihood that his/her control over internal governance mechanisms becomes higher. Numerous prior studies have used the length of CEO tenure as a measure of CEO entrenchment (e.g., Berger et al., 1997; Bebchuk et al., 2006). For instance, Berger et al. (1997) report a negative association between the length of CEO tenure and the leverage ratio, and suggest that this may be interpreted as evidence that entrenched CEOs – who have a long tenure – prefer low debt ratios to avoid performance pressures that accompany high debt. We argue that entrenched CEOs will prefer compensation schemes with low incentives to take on high risks. The reason is that a high risk level increases the likelihood of default and thus the threat for the CEO's job. An entrenched CEO is likely to extract more private benefits from his firm than a CEO who is controlled appropriately by the internal and external governance mechanisms. Hence, an entrenched CEO will be more risk-averse as his loss in case of default is high. The Board of Directors operating in the presence of an entrenched CEO will likely be unable to adjust the CEO's compensation to induce high risk-taking. Assuming that a longer tenure is an indicator of CEO entrenchment, we predict that CEO tenure will be negatively associated with the sensitivity of CEO compensation to equity risk.

However, a longer tenure may be an indicator of higher managerial skill or quality, rather than of entrenchment. High quality CEOs are able to keep their job in the same bank for longer years. These CEOs may be more willing to undertake high risks since they have the skills to manage them appropriately and to generate a positive outcome. The Board of Directors has more incentives to provide high quality CEOs with a

compensation that is highly sensitive to risk, in order to encourage them to undertake all available positive NPV investments. Assuming that a longer CEO tenure is an indicator of better managerial skills, CEO tenure will be positively correlated with the sensitivity of CEO compensation to equity risk. Based on the two arguments introduced above, we are unable to make an unambiguous prediction about the relation between CEO tenure and the sensitivity of CEO compensation to equity risk. CEO tenure is measured as the number of years that the CEO has spent in office.

4.6. Deregulation

During the 1990s, the banking industry underwent substantial deregulations that modified significantly the environment in which banks operate. The first deregulation occurred in 1994, when the Riegle-Neal Interstate banking and Branching Efficiency Act was enacted. This Act eliminated all restrictions to interstate banking and enabled banks to operate, without restrictions, in any State. The second deregulation occurred in 1999, with the adoption of the Gramm-Leach-Bliley Financial Modernization Act. This deregulatory measure eliminated the barriers between the different financial industries, such as insurance, securities underwriting, and traditional commercial banking.

These two deregulatory events are considered in the banking literature as shocks that increased competition among banking firms and created a larger investment opportunity set. For instance, Rajan (2005) notes that "deregulation has removed artificial barriers preventing entry, or competition between products, institutions, markets, and jurisdictions." (p.1). In the new, deregulated, competitive environment, with more growth opportunities, bank managers need to be provided incentives to search for good investments. Hence, the compensation of bank managers is expected to be more sensitive

to risk than it was when banks operated under tight regulation. We use the passage of the Gramm-Leach_Bliley Act as a focal point to test for the effect of deregulation on the sensitivity of bank CEO compensation to equity risk. We create a dummy variable that takes on 1 for the years following this deregulatory measure and 0 otherwise. In other words, the dummy variable takes the value of 1 starting in 2000. We expect a positive effect of deregulation on the sensitivity of CEO compensation to equity risk.

4.7. Empirical model

To test the effect of investment opportunities, bank size, CEO ownership, leverage, CEO tenure, and deregulation on the sensitivity of bank CEO compensation to equity risk, we estimate the following regression model:

$$\begin{aligned} Vega_{i,t} &= b_1 MB_{i,t-1} + b_2 Banksize_{i,t-1} + b_3 Leverage_{i,t-1} + b_4 Stockownership_{i,t-1} \\ &+ b_5 CEOtenure_{i,t-1} + b_6 Deregulation_{i,t} + m_i + e_{i,t}, \end{aligned} \quad (1)$$

where i denotes the bank, and t denotes the year. We estimate separate models for total Vega and Vega of an individual option granted in the current year (Vega-cy). Using Vega-cy as an alternative dependent variable has the advantage of showing the effect of our explanatory variables on the incentives per option provided to CEOs to take on risk. Actually, total Vega is affected by the number of options held by the CEO, which may be influenced by many other factors. For instance, two CEOs provided the same Vega-cy may have different total Vegas because of the difference in the total number of options they hold. The total number of options held by a CEO may depend on many factors, including the size of the bank, the CEO's expectations of the future price of his bank's stock, whether the CEO is in need to exercise his options or could hold them for a long time, etc. By estimating the Vega-cy model, we ensure that we are not interpreting relations between our explanatory variables and the sensitivity of bank CEO

compensation to equity risk that are due only the effect of other factors (non controlled) on the number of options held and on the explanatory variables.

The Vega models are estimated with firm fixed effects, m_i . Fixed effects are intended to control for bank specific unobservable factors. To address the difficulties associated with outliers in the data, we winsorize all variables at the 1st and 99th percentile values. The reported regressions adjust the standard error estimates for heteroskedasticity and within-bank correlation in the error, $e_{i,t}$.

<< Insert table 1 here >>

Table 1 reports summary statistics for the variables used in the multivariate analysis. As discussed earlier in the paper, our variable of interest, Vega, measures the sensitivity of a CEO's option portfolio to a 1% change in equity risk. Vega has a median of $1,052.2 and exhibits a considerable variation as shown by the high standard deviation ($14,925.18). Vega-cy which measures the sensitivity of one option granted in the current year to a 1% change in equity risk has a median of $0.0699, with a high standard deviation (0.087). Delta is measured as the sensitivity of a CEO's stock-based wealth to a 1% change in stock price. The median delta is equal to $16,844.93 (mean: $60,586.69) and exhibits a high variation as shown by its standard deviation. The median bank CEO holds 1.46% of outstanding common stock, receives $311,155.5 of salary and bonus per year, and has been holding the title of CEO for 7 years. The median bank has total assets of $1,093.35 million, has a market-to-book ratio of 1.07, and a leverage ratio of 91.2%.

4.8. Results

The results of the estimation of the Vega models are reported in table 2. The coefficient estimates on the market-to-book ratio are positive across the four columns of

table 2, although statistically significant at the 1% level only in the Vega-cy model. This suggests that stock options granted to CEOs of BHCs with better investment opportunities are highly sensitive to equity risk. This result is consistent with prior literature on non-banking firms and is in favor of the hypothesis that BHCs with more to loose because of CEO risk-aversion provide higher incentives for risk-taking. An increase in the market-to-book ratio by 0.059 (S.D of MB) increases the Vega-cy of a bank CEO by $0.020 (0.35*0.059). Consistent with our predictions, larger BHCs grant their CEOs options with a higher sensitivity to equity risk, all else equal. Across the four models in table 2, the coefficient estimates on Bank Size are positive and statistically significant at the 1% level. According to the Total Vega model, an increase in BHCs total assets of $4,642.4 millions (S.D of total assets) increases the options' portfolio Vega by around $14,855 ((0.0032*1000)*4,642.4). Based on the estimation of the Vega-cy model, an increase in BHCs total assets of $4,642.4 million increases the Vega of an individual option granted in the current year by $0.03 (4,642.4*6.62e-06). We also estimate the four models in table 2 using log (total assets), as a measure of bank size, instead of total assets. Again, the coefficient estimates on log (total assets) are positive and statistically significant at the 1% level across the four models. The same conclusion holds if we use the market value of equity or the log (market value of equity) as proxies for bank size.

<< Insert table 2 here >>

Leverage and CEO tenure appear to be not significantly related to the sensitivity of stock options to equity risk. The percentage of common stock held by CEOs appears to have an effect on the Vega. However, the nature of this effect depends upon whether we use the Vega-cy of the total Vega as a dependent variable. In the total Vega model with a

quadratic term on CEO ownership, there appears to be a concave effect of CEO stock ownership on the Vega of options portfolio. The coefficient estimates on CEO ownership and (CEO ownership)^2 are respectively positive and negative, and are both statistically significant at the 5% level. This result suggests that an increase in the percentage of common stock held by the CEO increases the sensitivity of the latter's option portfolio, but only up to a certain level. Once stock ownership reaches high levels, the sensitivity of the CEO's option portfolio starts decreasing. Based on the coefficient estimates of CEO ownership and CEO ownership, total Vega increases following an increase in CEO ownership up to 12% of common stock. Beyond 12%, total Vega starts a decreasing move as CEO ownership increases. We interpret this result as evidence of entrenchment of CEOs holding a sufficiently high percentage of their bank's common stock. At low levels of CEO stock ownership, Boards of Directors have the capability to influence the incentives of their CEOs through a highly sensitive option portfolio to equity risk. However, as CEOs ownership of stock becomes very high she acquires control of the Board and decreases her total Vega. Although statistically significant, the coefficient estimates suggesting a convex effect of CEO ownership on Vega-cy are very small.

Across the four models in table 2, the coefficient estimate on Deregulation is positive and statistically significant at better than the 5% level. Thus the passage to a period of deregulation has contributed to the increase in the incentives of bank CEOs to take on higher risks. Consistent with our hypothesis, the sensitivity of bank CEOs' individual options and option portfolios to equity risk have increased when the banking environment became more competitive and the investment opportunity set broadened. We also test for the four models in table 2 using the log (Total Vega) and the log (Vega-cy) as dependent

variable and log (total assets) and the other variables as independent ones. Again, the market-to-book ratio, log (total assets), and Deregulation appear with positive and statistically significant coefficient estimates.

5. The relation between the sensitivity of bank CEOs' option portfolio to equity risk and risk-taking

The results of the analysis presented in Section 5 suggest that the sensitivity of bank CEOs' option portfolio and of individual options to equity risk increase in the presence of better investment opportunities and in a deregulated environment. We interpret these results as evidence that BHCs with better investment opportunities and operating in a deregulated environment have more to loose from the risk-aversion attitude of their managers. Such BHCs choose a compensation policy whereby their CEOs are provided more incentives to take on higher risks. It is, hence, of interest to examine whether a higher sensitivity in the CEO's option portfolio to equity risk induces a higher risk level for banks.

5.1. Hypothesis development and empirical model

Our predictions of the relation between compensation Vega and risk-taking are drawn from the managerial risk-aversion model presented in the agency literature. In this model, risk-neutral shareholders whose objective is to maximize firm value are interested in undertaking all positive NPV projects regardless of their risk level. However, risk-averse managers prefer to avoid risk-increasing projects even when their NPV is positive. This conflict of interest is referred to in the literature as the risk-related agency problem. A considerable body of literature suggests that managerial compensation contracts can serve to mitigate this problem. In particular, it suggests that option-like contracts such as stock

options involving a convex relation between managers' income and stock price provide managers with incentives to take on higher risks.

In theory, stock options help in mitigating the risk-related agency problem because their value increases with the volatility of stock returns (positive Vega). Hence, managers holding stock options with greater Vega are expected to take on higher risks – increasing the volatility of stock returns – in order to increase their income. In other words, a greater convexity in the stock option value (managerial wealth) – stock price (performance) relationship induces higher risk-taking by managers. This is because a higher convexity in the manager's wealth-performance relation tends to improve his welfare (Certainty Equivalent) by increasing his wealth and reducing his risk aversion (e.g. Guay, 1999). Stock options with a higher Vega (greater convexity) are thus expected to reduce the magnitude of the risk-related agency problem. If the managerial risk-aversion model is descriptive of the CEOs attitude in the banking industry and if increasing the Vega of stock options is an effective tool of reducing the risk-related agency problem, we expect to observe a positive relationship between the Vega of stock options and measures of bank risk. We therefore posit the following hypothesis:

H1: There is a positive relationship between the Vega of CEO stock options and risk measures in the banking industry.

The null hypothesis is that there is no relationship between the Vega of CEO stock options and risk-taking in the banking industry. This means that increasing the sensitivity of stock options to the volatility of stock returns by shareholders is not an effective way to reduce managers' risk-aversion.

In order to test the above hypothesis we specify an empirical model in which bank risk at time t is a function of CEO stock option Vega at time $t - 1$ and other control variables. Our model of bank risk-taking can thus be specified as follows:

$$\textit{Bank Risk}_t = f(\textit{Vega of CEO stock options}_{t-1}, \textit{control variables}) \quad (2)$$

5.2. Risk measures and Methodology

Based on the conceptual model in eq (2), we construct regression models and estimate them using panel data techniques. We use four different market-based risk measures in our regression models. The risk measures are obtained from the two-index market model. For each year, we use daily data obtained from the Center for Research in Security Prices (CRSP) and estimate the following model:

$$R_j = a + b_{mj}(R_m) + b_{Ij}(I) + u_j \quad (3)$$

Where R_j is the daily stock return of bank j, R_m is the daily return on the CRSP equally-weighted index, I is the daily three month T-bill yield obtained from the Federal Reserve Bank of Saint Louis, and u_j is a random error term. The estimation of this equation using the Ordinary Least Squares technique provides two risk measures, b_{mj} and b_{Ij}, which are proxies for systematic risk and interest rate risk, respectively. We also generate two additional risk measures, s_j and s_{uj} which are the standard deviation of daily stock returns and the standard deviation of the residuals from Eq. (3), respectively. Sample descriptive statistics for the four risk measures are presented in panel B of table 1. Total risk (s_j), measured by the standard deviation of daily stock returns for a given year has a mean of 0.0221 (median: 0.0208) with a standard deviation of 0.0077, whereas idiosyncratic risk (s_{uj}) has a mean of 0.0213 (median: 0.200) with a standard deviation of

0.008. The average systematic risk (b_{mj}) is 0.5523 (median: 0.4232) while the average interest rate risk (b_{Ij}) is 0.3582 (median: 0.2131).

Each risk measure is then regressed on the Vega of CEO stock options in the previous year and control variables. We control for a number of factors that may have an effect on bank risk-taking. In choosing the control variables we rely on important prior contributions, such as Guay (1999), Chen et al. (2006), Coles et al. (2006), Lewellen (2006), and Saunders et al. (1990). Our set of control variables includes the delta of the CEO's stock-based wealth since it is argued in the literature that besides the convexity of the pay-performance relation, the slope of managers' pay-performance relation is an important incentive tool to align managers' incentives with those of shareholders. CEO cash compensation is included in the regression model as a proxy for the CEO's degree of risk aversion. The greater the CEO's cash compensation and the higher the wealth that he can invest outside the bank. The greater the wealth invested outside the bank and the better diversified the CEO is likely to be. A better diversified manager is expected to have a lower risk aversion. CEO stock ownership is included to control for the degree of alignment of the CEO's interests with those of managers. Several studies document a positive effect of CEO stock ownership on risk-taking in the banking industry. The natural logarithm of total assets is included as a control for bank size. The market-to-book ratio controls for the effect of investment opportunities on risk-taking in the banking industry. Finally, we use the ratio of total debt to total assets to control for the potential effect of leverage on risk-taking.

The risk models are estimated with firm fixed effects. Annual dummy variables are also included in each regression model in order to control for possible shifts in the

average risk level from one year to another due to unobserved factors. The reported regressions adjust the standard error estimates for heteroskedasticity and within-bank correlation in the error, $e_{i,t}$.

5.3. Results of the regression analysis

Our regression model of risk measures on Vega and control variables is described by equation (4). For each risk measure, we estimate two specifications. In the first specification, we regress the risk measure on Vega and annual dummy variables. In the second specification, we include other control variables. Equation (4) is estimated using OLS techniques in the presence of firm fixed effects (m_i). The results are shown in tables 3 and 4.

$$\begin{aligned} Risk_{i,t} &= b_0 + b_1\, vega_{i,t-1} + b_2\, delta_{i,t-1} + b_3\, CashCompensation_{i,t-1} \\ &+ b_4\, Stockownership_{i,t-1} + b_5\, \ln(Totalassets)_{i,t-1} \\ &+ b_6\, Leverageratio_{i,t-1} + b_7\, Markettobook_{i,t-1} + \sum_{j=1994}^{2005} b_j\, Dummy_j + m_i + e_{i,t} \end{aligned} \quad (4)$$

<< Insert tables 3 and 4 here >>

Table 3 shows that the coefficient estimate on Vega is positive and statistically significant, at least at the 5% level, whether we measure risk as total risk or firm specific risk. In table 4, the coefficient estimate on Vega is positive across the two specifications whether risk is measured by systematic risk or by interest rate risk. However, it is statistically significant at the 10% level only in the second specification of the Systematic risk model. These results suggest that as the sensitivity of the CEO's option portfolio to equity risk increases the bank's market risk, idiosyncratic risk and total risk increase. This finding supports the hypothesis that a more convex pay-performance relation in the banking industry contributes to reduce the risk aversion of managers, inducing them to

select risk-increasing investments. For instance, a $10,000 increase in the Vega increases Total risk by 0.05% (5.05e-08*10,000), idiosyncratic risk by 0.035% (3.48e-08*10,000), and systematic risk by 0.0225 (2.25e-06*10,000).

Among the control variables measuring CEO incentives, delta is included in the regression equation to control for the slope of the CEO compensation-performance relation. As previously argued, a higher slope in the managers' compensation-performance relation is another incentive tool that induces managers to select risk-increasing positive NPV investments. The positive and statistically significant coefficient estimates on delta in the Total risk and Firm specific risk models is consistent with this argument. This result suggests that a higher sensitivity of the CEO's wealth to stock price change induces higher idiosyncratic and total risks. The coefficient estimate on Cash compensation is negative across the four risk models but is statistically significant at conventional levels only in the Total risk and Firm specific risk models. Contrary to the argument that higher cash compensation induces a higher risk taking because it enables managers to hold a better diversified personal portfolio, we find that a high cash compensation for CEOs is associated with lower idiosyncratic and total risks[7]. CEO ownership has no statistically significant effect on risk-taking by banks. We also test for a possible quadratic relationship between CEO ownership and risk-taking but find no evidence for that.

[7] We investigate whether the nature of the relationship between our risk measures and cash compensation changes at high levels of cash compensation by including a quadratic term of cash compensation. Only in the systematic risk model, there appears to be evidence of a quadratic relationship between CEO cash compensation and risk-taking, suggesting that market risk increases with cash compensation up to a certain level and then decreases as cash compensation reaches high levels. The coefficient estimate on cash compensation in this model is positive and statistically significant at the 5% level and the coefficient estimate on (Cash compensation)^2 is negative and statistically significant at the 1% level.

Log (total assets) is included as a control for bank size. Consistent with previous studies, log (total assets) has a negative coefficient estimate in the Total risk and in the Firm specific risk models (table 3), although it is statistically significant only the latter model, suggesting a lower idiosyncratic risk in larger BHCs. The positive coefficient estimate in the Systematic risk model (table 4) is consistent with previous studies such as Chen et al. (2006), and suggests that larger banks are more exposed to the market fluctuations[8]. The market-to-book ratio exhibits a positive coefficient estimate across the four risk models, but is statistically significant at the 10% level only in the Interest rate risk model (table 4). Financial leverage is not statistically significantly related to our risk measures.

5.4. Testing for a quadratic relationship between Vega and risk-taking

The results reported in table 3 and 4 indicate that there is a positive linear relationship between the sensitivity of CEOs' option portfolio to equity risk and total risk, idiosyncratic risk and market risk. These findings suggest that certain types of bank risk rise with the increase in the CEOs incentives to take on higher risks. Yet, it is of interest to explore whether this positive effect of the Vega of CEOs' option portfolio to equity risk on total risk, idiosyncratic risk and market risk holds as Vega reaches high levels. Indeed, it is possible that managers increase risk following an increase in their options portfolio Vega but only up to a certain level since the expected costs of bankruptcy might outweigh the expected benefits once bank risk reaches very high levels. Based on this argument, it is expected that the slope of the Vega-risk-taking relationship changes at

[8] It is expected that larger banks have a lower beta since they have a better ability to diversify their risks. However, given that most of the banks in our sample have a beta lower than 1 (median: 0.42), it may be that larger banks are trying to adopt a more aggressive investment strategy in order to catch up the market.

sufficiently high levels of Vega. We examine whether the nature of the effect of Vega on risk-taking changes at high levels of Vega by testing for a quadratic relationship between Vega and our four risk measures. We estimate the regression model presented in equation (4) including a quadratic term, $(Vega)^2$, among the explanatory variables.

<< Insert tables 5 and 6 here >>

The estimates of our four regression models of bank risk on Vega, $(Vega)^2$ and other control variables are reported in tables 5 and 6. Across the four models and in both specifications, the coefficient estimate on Vega is positive and the coefficient estimate on $(Vega)^2$ is negative. Both coefficient estimates are statistically significant at least at the 5% level across the four models. This finding suggests the presence of a quadratic relationship between Vega and risk-taking, where risk declines at high levels of Vega. The reported non-statistically significant coefficient on Vega in the Interest rate risk model in table 4 results therefore only from the misspecification of the Vega-interest rate risk relation. Once we include a quadratic term in the regression equation, the coefficient estimate on Vega (in both specifications, table 6) becomes statistically significant suggesting that interest rate risk rises as a result of an increase in Vega, but only up to a certain level. Once Vega becomes sufficiently high, the effect of Vega on interest rate risk becomes negative. This quadratic relation is also observed for the idiosyncratic risk, the total risk, and the market risk. The coefficient estimates on Vega and $(Vega)^2$ in the Total risk model suggest that, subsequent to an increase in Vega, total risk rises at a decreasing pace to reach its highest level when Vega is equal to \$71,000 (table 5, specification 2). Beyond a Vega of \$71,000, total risk starts decreasing. The result for the Firm specific risk model is similar since the coefficient estimates are close to the ones in

the Total risk model. In the Systematic and Interest rate risk models, market risk and interest rate risk reach their highest levels at Vega of $61,000 and $51,000, respectively (table 6, specification 2). Results in tables 5 and 6 suggest that bank CEOs limit themselves to a certain level of risk even though they have high incentives to take on higher risks.

6. Conclusions

The effect of executive ownership and compensation structure on performance and risk-taking in the banking industry is a topic of importance to academics, practitioners, and particularly to regulators. While the effect of managers' stock ownership on bank risk-taking has been examined in considerable detail, only a few studies have explored the effect of the slope of managers' pay-performance relation on risk-taking in the banking industry. Furthermore, as much as is known, no study has explored the magnitude of the convexity of this relation and its effect on risk-taking. We argue that to align risk-averse managers' incentives with those of stockholders, bank shareholders are expected to manage the convexity, in addition to the slope, of the relation between managers' compensation and bank performance. A higher convexity in this relation, as measured by the sensitivity of option portfolios to equity risk can induce risk-averse managers to invest in risk-increasing positive NPV projects that they could otherwise pass up.

Our findings indicate that the sensitivity of CEOs' option portfolios to equity risk (Vega) is potentially large enough in some BHCs to influence their risk-taking behavior. Based on a sample of 156 BHCs over a thirteen-year period, or around 1,400 bank-years, we find that the sensitivity of CEOs' option portfolios to equity risk varies widely among

bank CEOs. Most importantly, we find that this sensitivity has increased significantly over time. Our analyses of the determinants of the Vega show that deregulation has contributed significantly to this increase. Using a fixed effects model, we find that Vega has increased significantly in the post-deregulation period. This finding supports the idea that deregulation that has increased competition and enlarged the banking opportunity set led bank shareholders to increase managers' incentives to take on higher risks. We also find that investment opportunities are an important determinant of the Vega of bank CEOs option portfolios. This finding is consistent with the idea that bank shareholders with more to loose from managers' risk aversion grant CEOs a compensation that is highly sensitive to equity risk. Bank size and CEO stock ownership are also shown to be determinants of the sensitivity of bank CEOs option portfolios to equity risk.

Finally, consistent with the argument that managers make investment decisions in accordance with their own risk-taking incentives, we find that bank risk is positively related to the sensitivity of CEOs' option portfolios to equity risk. Using panel data techniques, we report a positive linear and statistically significant relationship between Vega of CEOs' option portfolios and idiosyncratic risk, market risk and total risk. We also test for a quadratic relationship between Vega and bank risk measures. The results indicate the presence of a concave effect of Vega on risk-taking in the banking industry, suggesting that bank CEOs limit themselves to a certain level of risk even if they have very high incentives to take on high risks.

This study contributes to the banking literature in two important ways. First, we examine an incentive provided by stock-based compensation other than the incentive to improve performance, or increase stock price. In particular, we examine the incentives

provided by stock-options to increase risk, and find evidence consistent with banks increasing the sensitivity of their CEOs' option portfolios to equity risk when the losses from managerial risk-aversion is the greatest. Second, our findings suggest that stock option-based compensation might play a role in determining the riskiness of banking firms through its sensitivity to equity risk rather than through its sensitivity to stock price. In addition to the slope of the managers' compensation-performance relation, regulatory agencies interested in controlling the incentives of bank managers to take on high risks might also need to examine the magnitude of the convexity of this relation.

References

Adams, R., Mehran, H., 2003. Is corporate governance different for bank holding companies? FRBNY Economic Policy Review, April, 123-142.

Altman, E., 1968. Financial ratios, discriminant analysis, and the prediction of corporate bankruptcy. Journal of Finance 23, 589-609.

Akhavein, J., Berger, A., Humphrey, D., 1997. The effects of megamergers on efficiency and prices: evidence from a bank profit function. Review of Industrial Organization 12, 95-138.

Amihud, Y., Lev, B., 1981. Risk reduction as a managerial motive for conglomerate mergers. The Bell Journal of Economics 12 (2), 605-617.

Anderson, C.R., Fraser, D.R., 2000. Corporate control, bank risk taking and the health of the banking industry. Journal of Banking and Finance 24, 1383-1398.

Bebchuk, L.A., Grinstein, Y., Peyer, U., 2006. Lucky CEOs. NBER Working Paper No. 12771.

Becher, D. A., Campbell II, T.L., Frye, M.B., 2005. Incentive compensation for bank directors: the impact of deregulation. Journal of Business, vol 78, no. 5, 1753-1778.

Berger, P.G., Ofek, E., Yermack, D.L., 1997. Managerial entrenchment and capital structure decisions. Journal of Finance 52, No.4, 1411-1438.

Black, F., Scholes, M., 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81, 637-659.

Bliss, R., T., Rosen, R.J., 2001. CEO compensation and bank mergers. Journal of Financial Economics 61, 107-138.

Brewer III, E., Curt Hunter, W., Jackson III, W., 2003. Deregulation and the relationship between bank CEO compensation and risk-taking. Federal Reserve Bank of Chicago WP 2003-32.

Carpenter, J.N., 2000. Does option compensation increase managerial risk appetite? Journal of Finance 55 (5), 2311-2331.

Chen, C.R., Steiner, T.L., Whyte, A.M., 1998. Risk taking behavior and management ownership in depository institutions. Journal of Financial Research XXI, 1-16.

Chen, C.R., Steiner, T.L., Whyte, A.M., 2006. Does stock option-based executive compensation induce risk-taking? An analysis of the banking industry. Journal of Banking and Finance 30, 915-945.

Coles, J.L., Daniel, N.D., Naveen, L. 2006. Managerial incentives and risk-taking. Journal of Financial Economics 79, 431 – 468.

Crawford, A.J., Ezzell, J.R., Miles, J.A., 1995. bank CEO pay-performance and the effects of deregulation. Journal of Business, vol. 68, No. 2. (Apr), pp. 231-256.

Cunat, V., Guadalupe, M., 2004. Executive compensation and competition in the banking and financial sectors. CEPR Discussion paper no. 4425, June.

Demsetz, R.S., Strahan, P.E., 1997. Diversification, size, and risk at bank holding companies. Journal of Money, Credit, and Banking 29, 300-313.

Gorton, G., Rosen, R., 1995. Corporate control, portfolio choice, and the decline of banking. Journal of Finance 50, 1377-1420.

Guay, W.R. 1999. The sensitivity of CEO wealth to equity risk: an analysis of the magnitude and determinants. Journal of Financial Economics 53, 43 – 71.

Harjoto, M.A., Mullineaux, D.J., 2003. CEO compensation and the transformation of banking. Journal of Financial Research 26 (3), 341-354.

Haugen, R.A., Senbet, L.W., 1981. Resolving the agency problems of external capital through options. Journal of Finance 36 (3), 629-647.

Houston, J.F., James, C., 1995. CEO compensation and bank risk: Is compensation in banking structured to promote risk taking? Journal of Monetary Economics, vol. 36, no. 2, pp. 405-431(27)

Hubbard, G., Palia, D., 1995. Executive pay and performance: Evidence from the U.S. Banking Industry. Journal of Financial Economics 39, 105-130.

Jensen, M.C., Meckling., W.H., 1976. Theory of the firm: managerial behavior, agency costs and ownership structure. Journal of Financial Economics 3, 305-360.

Jin, L., 2002. CEO compensation, diversification, and incentives. Journal of Financial Economics 66, 29-63.

John, T.A., John, K., 1993. Top-management compensation and capital structure. Journal of Finance 48, no.3, pp. 947-974.

John, K., Qian, Y., 2003. Incentive features in CEO compensation in the banking industry. FRBNY Economic Policy Review, April, 101-121.

John, K., Saunders, A., Senbet, L., 2000. A theory of bank regulation and management compensation. Review of Financial Studies, vol. 13, No.1. (spring, 2000), pp. 95-125.

Ju, Nengjiu, Leland, Hayne E. and Senbet, Lemma W., 2002. Options, option repricing and severance packages in managerial compensation: Their effects on corporate risk. Available at SSRN: http://ssrn.com/abstract=346920

Knopf, J.D., Teall, J.L., 1996. Risk-taking behavior in the U.S. Thrift industry: ownership structure and regulatory changes. Journal of Banking and Finance 20, 1329-1350.

Lewellen, K, 2006. Financing decisions when managers are risk averse. Journal of Financial Economics 82 (3), 551-589.

Mc Connell, J., Servaes, H., 1990. Additional evidence on equity ownership and corporate value. Journal of Financial Economics 27, 595-612.

Merton, R., 1973. Theory of rational option pricing. Bell Journal of Economics and Management Science 4, 141-183.

Milgrom, P., Roberts, J., 1992. Economics, Organization and Management. Prentice-Hall Inc, Englewood Cliffs, NJ.

Morck, R., Shleifer, A., Vishny, R., 1988. Management ownership and Market Valuation: An Empirical Analysis. Journal of Financial Economics 20, 293-315.

Rajan, R.G., 2005. Has financial development made the world riskier? NBER Working Paper No. 11728, issued in November 2005.

Rajgopal, S., Shevlin, T., 2002. Empirical evidence on the relation between stock option compensation and risk taking. Journal of Accounting and Economics 33, 145-171.

Rogers, D., 2002. Does executive portfolio structure affect risk management? CEO risk-taking incentives and corporate derivative usage. Journal of Banking and Finance 26, 271-295.

Ross, S.A., 2004. Compensation, incentives, and the duality of risk aversion and riskiness. Journal of Finance, vol. 59 (1), 207-225.

Saunders, A., Strock, E., Travlos, N.G., 1990. Ownership structure, deregulation, and bank risk taking. Journal of Finance, vol. 45, no. 2 (June), pp. 643-654.

Smith, C.W., Stulz, R.M., 1985. The determinants of firms' hedging policies. Journal of Financial and Quantitative Analysis 20, (4), 391-405.

Smith, C.W., Watts, R., 1992. The investment opportunity set and corporate financing, dividend and compensation policies. Journal of Financial Economics 32, 263-292.

Williams, M.A., Rao, R.P., 2006. CEO Stock options and equity risk incentives. Journal of Business Finance & Accounting, 33 (1) & (2), January-March, 26-44.

Table 1. Summary statistics for variables used in the regression analyses

The sample consists of 156 BHCs selected from the Compustat and CRSP databases, over the 1993-2006 period. The sample selection procedure is detailed in Section 2. CEO–related variables, including compensation, ownership and tenure as well as BHC-related variables, including total assets, Market-to-book, and leverage are collected and calculated over the 1993-2005 period. Risk variables are collected and calculated over the 1994-2006 period. Total risk is calculated as the standard deviation of daily stock returns for a given fiscal year. Firm risk is calculated as the standard deviation of the residuals resulting from the regression of daily stock returns on the daily return on the CRSP equally weighted index and the daily three month T-bill interest rate. Systematic risk is a proxy for market risk and is the coefficient estimate on the CRSP equally weighted index in the regression described above. Interest rate risk is the coefficient estimate on the daily three month T-bill in the regression described above. Vega is the dollar value of the sensitivity of a CEO's option portfolio to equity risk. Delta is the dollar value of the sensitivity of the CEO's stock-based wealth to stock price change. Cash compensation is the sum of salary and bonus received by the CEO in a given year. CEO stock ownership is the percentage of outstanding common stock held by the bank's CEO. CEO tenure is the number of years the CEO has spent in office. Total assets is the book value of total assets of a bank at the end of a given fiscal year. Market-to-book ratio is the book value of liabilities plus the market value of equity divided by the book value of assets. Leverage ratio is the book value of debt divided by the book value of total assets at the end of a fiscal year. All variables are winsorized at their 1st and 99th percentile values. Monetary figures are in dollars of the year 2000.

Variable	Obs	Mean	SD	Min	Median	Max
Panel A						
Vega ($)	1,494	5,934.71	14,925.18	0	1,052.2	109,915.5
Vega – cy ($)	1,471	0.0820	0.0870	0	0.0699	0.3449
Delta ($)	1,512	60,586.69	127,857.3	0	16,844.93	786,849.2
Cash compensation ($)	1,520	430,335.7	340,784.8	106,550.7	311,155.5	1,938,938
CEO stock ownership (%)	1,520	2.987	4.49	0	1.46	22.34
CEO tenure	1,516	8.46	5.96	1	7	26
Total assets ($Millions)	1,487	2,668.31	4,642.40	170.258	1,093.347	29,331.14
Market-to-book ratio	1,487	1.079	0.0595	0.958	1.070	1.262
Leverage ratio	1,481	0.911	0.0196	0.850	0.912	0.956
Panel B						
Total risk (s_j)	1,496	0.0221	0.0077	0.0097	0.0208	0.0494
Firm risk (s_{uj})	1,496	0.0213	0.0080	0.0084	0.0200	0.0480
Systematic risk (b_{mj})	1,496	0.5523	0.5240	-0.3263	0.4232	2.1129
Interest rate risk (b_{Ij})	1,496	0.3582	0.4214	0.0016	0.2131	2.3673

Table 2. Analysis of the determinants of Total Vega and Vega-cy

The sample consists of 156 BHCs selected from the Compustat and CRSP databases. The sample selection procedure is detailed in Section 2. Since we work with a one year lag, the dependent variables used are for the period of 1994-2005, and the independent variables are for the period of 1993-2004. Total Vega is the sensitivity of a CEO's option portfolio to equity risk. It is measured as the change in the Black and Scholes (1973) value of a CEO's option portfolio due to a 1% change in the annualized standard deviation of the bank's stock returns. Vega-cy is the the sensitivity of a CEO's option granted in the current year to equity risk. MB is a proxy for investment opportunities, and is calculated as the book value of liabilities plus the market value of equity divided by the book value of assets. Total assets is the book value of total assets of a bank at the end of a given fiscal year. Leverage is the book value of equity divided by the book value of total assets at the end of a fiscal year. CEO stock ownership is the percentage of outstanding common stock held by the bank's CEO. CEO tenure is the number of years since the CEO has taken office. Deregulation is a dummy variable that takes on 1 for years during the period 2000-2005 and 0 otherwise (years 1994-1999). All variables, except Deregulation, are winsorized at the 1st and 99th percentile values. Monetary figures are in dollars of the year 2000. All models are estimated with firm fixed effects. The reported regressions adjust the standard error estimates for heteroskedasticity and within-bank correlation in the error. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1% level, at the 5% level and at the 10% level, respectively.

	Total Vega ($000)		**Vega – cy ($)**	
Variable	1	2	1	2
MB	21.759 (1.41)	23.136 (1.48)	**0.3510***** **(6.57)**	**0.3453***** **(6.37)**
Bank Size	**0.0032***** **(2.74)**	**0.0033***** **(2.82)**	**6.62e-06***** **(2.93)**	**6.29e-06***** **(2.81)**
Leverage	-3.712 (-0.08)	-7.230 (-0.15)	0.0387 (0.17)	0.0513 (0.23)
CEO Ownership	0.299 (1.49)	**1.622**** **(2.17)**	-0.0019 (-1.53)	**-0.0077**** **(-2.43)**
(CEO Ownership)^2		**-0.070**** **(-2.06)**		**0.0003*** **(1.94)**
CEO tenure	0.060 (0.51)	-0.0048 (-0.04)	-0.0003 (-0.48)	-0.00004 (-0.06)
Deregulation	**4.257**** **(2.36)**	**4.120**** **(2.36)**	**0.0225***** **(3.27)**	**0.0230***** **(3.45)**
Individual effects	Yes	Yes	Yes	Yes
Observations	1,190	1,190	1,180	1,180
Adjusted R^2	0.5591	0.5628	0.5330	0.501

Table 3. Regression analysis of Total risk and Firm specific risk on Vega and control variables

The sample consists of 156 BHCs selected from the Compustat and CRSP databases, over the 1993-2006 period. The sample selection procedure is detailed in Section 2. Risk variables are collected and calculated over the 1994-2006 period. All the other variables are for the period of 1993-2005. Total risk is calculated as the standard deviation of daily stock returns for a given fiscal year. Firm specific risk is calculated as the standard deviation of the residuals resulting from the regression of daily stock returns on the daily return on the CRSP equally weighted index and the daily three month T-bill. Vega is the dollar value of the sensitivity of a CEO's option portfolio to equity risk. Delta is the dollar value of the sensitivity of the CEO's stock-based wealth to stock price change. CEO stock ownership is the percentage of outstanding common stock held by the bank's CEO. Cash compensation is the sum of salary and bonus received by the CEO in a given year. Total assets is the book value of total assets of a bank at the end of a given fiscal year. Market-to-book ratio is the book value of liabilities plus the market value of equity divided by the book value of assets. Capital ratio is the book value of equity divided by the book value of total assets at the end of a fiscal year. DUM1994 is a dummy variable that takes on 1 if the year is 1994 and 0 otherwise. The same description holds for the remaining annual dummy variables. All variables are winsorized at the 1st and 99th percentile values. Monetary figures are in dollars of the year 2000. All models are estimated with firm fixed effects. The reported regressions adjust the standard error estimates for heteroskedasticity and within-bank correlation in the error. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	Total risk		**Firm specific risk**	
Model	**1**	**2**	**1**	**2**
Vega	**5.77e-08*** (4.40)**	**5.05e-08*** (3.42)**	**4.57e-08*** (3.67)**	**3.48e-08** (2.31)**
Delta		**4.70e-09* (1.78)**		**5.93e-09** (2.54)**
Cash compensation		**-2.63e-09* (-1.82)**		**-2.50e-09** (-2.00)**
CEO Ownership		-.00007 (-0.47)		-0.00008 (-0.50)
Log (tot assets)		- 0.0014 (-1.27)		**-0.0020* (-1.81)**
MB		0.0087 (1.19)		0.0086 (1.26)
Leverage		0.0061 (0.26)		0.0079 (0.34)
DUM1994	-0.0029 (-1.45)	-0.0031 (-1.55)	-0.0028 (-1.42)	-0.0031 (-1.55)
DUM1995	-0.0026 (-1.19)	-0.0031 (-1.42)	-0.0027 (-1.26)	-0.0031 (-1.50)
DUM1996	**-0.0051** (-2.07)**	**-0.0055** (-2.26)**	**-0.0052** (-2.19)**	**-0.0055** (-2.37)**
DUM1997	**-0.0043* (-1.77)**	**-0.0055** (-2.13)**	**-0.0046** (-2.00)**	**-0.0057** (-2.30)**
DUM1998	-0.0022 (-0.89)	-0.0024 (-0.90)	-0.0034 (-1.45)	-0.0034 (-1.38)
DUM1999	-0.0038 (-1.50)	-0.0033 (-1.19)	-0.0042 (-1.73)	-0.0035 (-1.31)
DUM2000	0.0012 (0.48)	0.0020 (0.70)	0.0007 (0.30)	0.0017 (0.65)
DUM2001	-0.0041 (-1.60)	-0.0033 (-1.14)	**-0.0050** (-2.08)**	-0.0039 (-1.42)
DUM2002	**-0.0074*** (-2.93)**	**-0.0063** (-2.11)**	**-0.0092*** (-3.85)**	**-0.0076*** (-2.72)**
DUM2003	**-0.0104*** (-4.18)**	**-0.0096*** (-3.13)**	**-0.0121*** (-5.10)**	**-0.0108*** (-3.73)**
DUM2004	**-0.0119*** (-4.80)**	**-0.0111*** (-3.54)**	**-0.0137*** (-5.80)**	**-0.0124*** (-4.19)**
DUM2005	**-0.0118*** (-4.67)**	**-0.0105*** (-3.28)**	**-0.0139*** (-5.77)**	**-0.0121*** (-3.99)**
Individual effects	Yes	Yes	Yes	Yes
Observations	1447	1378	1447	1378
Adjusted R^2	0.5036	0.5115	0.5723	0.5821

Table 4. Regression analysis of Systematic risk and Interest rate risk on Vega and control variables

The sample consists of 156 BHCs selected from the Compustat and CRSP databases, over the 1993-2006 period. The sample selection procedure is detailed in Section 2. Risk variables are collected and calculated over the 1994-2006 period. All the other variables are for the period of 1993-2005. Systematic risk is a proxy for market risk and is the coefficient estimate on the CRSP equally weighted index resulting from the regression of daily stock returns on the daily return on the CRSP equally weighted index and the daily three month T-bill. Interest rate risk is the coefficient estimate on the daily three month T-bill in the regression described above. Vega is the dollar value of the sensitivity of a CEO's option portfolio to equity risk. Delta is the dollar value of the sensitivity of the CEO's stock-based wealth to stock price change. CEO stock ownership is the percentage of outstanding common stock held by the bank's CEO. Cash compensation is the sum of salary and bonus received by the CEO in a given year. Total assets is the book value of total assets of a bank at the end of a given fiscal year. Market-to-book ratio is the book value of liabilities plus the market value of equity divided by the book value of assets. Capital ratio is the book value of equity divided by the book value of total assets at the end of a fiscal year. DUM1994 is a dummy variable that takes on 1 if the year is 1994 and 0 otherwise. The same description holds for the remaining annual dummy variables. All variables are winsorized at the 1st and 99th percentile values. Monetary figures are in dollars of the year 2000. All models are estimated with firm fixed effects. The reported regressions adjust the standard error estimates for heteroskedasticity and within-bank correlation in the error. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	Systematic risk		**Interest rate risk**	
Model	**1**	**2**	**1**	**2**
Vega	1.90e-06 (1.42)	**2.25e-06*** **(1.93)**	1.21e-06 (1.34)	5.94e-07 (0.66)
Delta		-1.33e-07 (-0.74)		2.33e-08 (0.20)
Cash compensation		-8.93e-08 (-0.88)		-1.42e-07 (-1.40)
CEO Ownership		-0.0024 (-0.31)		0.0045 (0.93)
Log (tot assets)		**0.2760***** **(4.44)**		-0.0154 (-0.28)
MB		0.4106 (1.02)		**0.7529*** **(1.79)**
Leverage		-0.2437 (-0.21)		-0.2912 (-0.36)
DUM1994	-0.1232 (-1.13)	-0.1017 (-0.97)	**-0.8286***** **(-4.72)**	**-0.8223***** **(-4.75)**
DUM1995	**-0.2137*** **(-1.72)**	**-0.2247*** **(-1.85)**	**-0.6264***** **(-3.43)**	**-0.6623***** **(-3.65)**
DUM1996	**-0.2614**** **(-2.23)**	**-0.2925***** **(-2.59)**	**-0.3031*** **(-1.62)**	**-0.3434*** **(-1.83)**
DUM1997	-0.1261 (-0.10)	-0.1386 (-1.08)	-0.2024 (-1.12)	**-0.3751**** **(-2.02)**
DUM1998	**0.2071*** **(1.72)**	0.0803 (0.64)	**-0.6065***** **(-3.38)**	**-0.6582***** **(-3.51)**
DUM1999	0.0084 (0.07)	-0.1342 (-1.05)	**-0.6560***** **(-3.71)**	**-0.6423***** **(-3.67)**
DUM2000	-0.1054 (0.86)	**-0.2699**** **(-2.10)**	**-0.5094***** **(-2.85)**	**-0.4779***** **(-2.71)**
DUM2001	0.0422 (0.34)	-0.1580 (-1.18)	**-0.8745***** **(-4.98)**	**-0.8488***** **(-4.81)**
DUM2002	**0.2579**** **(2.05)**	0.0320 (0.23)	**-0.4674***** **(-2.66)**	**-0.4354**** **(-2.45)**
DUM2003	**0.4409***** **(3.39)**	0.1797 (1.21)	**-0.3874**** **(-2.16)**	**-0.3793**** **(-2.03)**
DUM2004	**0.4695***** **(3.59)**	0.1901 (1.24)	**-0.8335***** **(-4.71)**	**-0.8260***** **(-4.43)**
DUM2005	**0.6625***** **(4.43)**	**0.3730**** **(2.18)**	**-0.8790***** **(-4.97)**	**-0.8469***** **(-4.61)**
Individual effects	Yes	Yes	Yes	Yes
Observations	1447	1378	1447	1378
Adjusted R^2	0.5705	0.5788	0.2686	0.2782

Table 5. Regression analysis of Total risk and Firm specific risk on Vega, $(Vega)^2$ and control variables

The sample consists of 156 BHCs selected from the Compustat and CRSP databases, over the 1993-2006 period. The sample selection procedure is detailed in Section 2. Risk variables are collected and calculated over the 1994-2006 period. All the other variables are for the period of 1993-2005. Total risk is calculated as the standard deviation of daily stock returns for a given fiscal year. Firm specific risk is calculated as the standard deviation of the residuals resulting from the regression of daily stock returns on the daily return on the CRSP equally weighted index and the daily three month T-bill. Vega is the dollar value of the sensitivity of a CEO's option portfolio to equity risk. Delta is the dollar value of the sensitivity of the CEO's stock-based wealth to stock price change. CEO stock ownership is the percentage of outstanding common stock held by the bank's CEO. Cash compensation is the sum of salary and bonus received by the CEO in a given year. Total assets is the book value of total assets of a bank at the end of a given fiscal year. Market-to-book ratio is the book value of liabilities plus the market value of equity divided by the book value of assets. Capital ratio is the book value of equity divided by the book value of total assets at the end of a fiscal year. DUM1994 is a dummy variable that takes on 1 if the year is 1994 and 0 otherwise. The same description holds for the remaining annual dummy variables. All variables are winsorized at the 1st and 99th percentile values. Monetary figures are in dollars of the year 2000. All models are estimated with firm fixed effects. The reported regressions adjust the standard error estimates for heteroskedasticity and within-bank correlation in the error. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	Total risk		**Firm specific risk**	
Model	**1**	**2**	**1**	**2**
Vega	**1.63e-07*** (4.10)**	**1.68e-07*** (4.34)**	**1.27e-07*** (3.42)**	**1.34e-07*** (3.74)**
$(Vega)^2$	**-1.09e-12*** (-3.43)**	**-1.24e-12*** (3.77)**	**-8.39e-13*** (-2.77)**	**-1.04e-12*** (-3.28)**
Delta		**5.18e-09*** (2.19)**		**6.33e-09*** (2.99)**
Cash compensation		**-2.54e-09* (-1.76)**		**-2.43e-09* (-1.93)**
CEO Ownership		-.00008 (-0.49)		-0.00008 (-0.52)
Log (tot assets)		- 0.0017 (-1.51)		**-0.0022** (-2.00)**
MB		0.0083 (1.17)		0.0083 (1.25)
Leverage		0.0065 (0.27)		0.0082 (0.35)
DUM1994	-0.0030 (-1.45)	-0.0032 (-1.58)	-0.0029 (-1.42)	-0.0031 (-1.57)
DUM1995	-0.0027 (-1.21)	-0.0031 (-1.43)	-0.0027 (-1.27)	-0.0032 (-1.51)
DUM1996	**-0.0052** (-2.12)**	**-0.0056** (-2.29)**	**-0.0053** (-2.23)**	**-0.0056** (-2.39)**
DUM1997	**-0.0045* (-1.87)**	**-0.0057** (-2.19)**	**-0.0048** (-2.07)**	**-0.0058** (-2.35)**
DUM1998	-0.0026 (-1.07)	-0.0027 (-1.03)	0.0037 (-1.59)	-0.0037 (-1.50)
DUM1999	-0.0042* (-1.66)	-0.0037 (-1.31)	**-0.0045* (-1.86)**	-0.0038 (-1.42)
DUM2000	0.0007 (0.28)	0.0016 (0.55)	0.0003 (0.14)	0.0014 (0.51)
DUM2001	-0.0046* (-1.810	-0.0037 (-1.28)	**-0.0054** (-2.23)**	-0.0043 (-1.55)
DUM2002	**-0.0081*** (-3.15)**	**-0.0068** (-2.27)**	**-0.0097*** (-4.00)**	**-0.0081*** (-2.86)**
DUM2003	**-0.0111*** (-4.39)**	**-0.0100*** (-3.27)**	**-0.0126*** (-5.24)**	**-0.0112*** (-3.84)**
DUM2004	**-0.0126*** (-5.00)**	**-0.0115*** (-3.68)**	**-0.0142*** (-5.94)**	**-0.0128*** (-4.31)**
DUM2005	**-0.0125*** (-4.88)**	**-0.0110*** (-3.43)**	-0.0144*** (-5.91)	**-0.0126*** (-4.11)**
Individual effects	Yes	Yes	Yes	Yes
Observations	1447	1378	1447	1378
Adjusted R^2	0.5068	0.5156	0.5739	0.5847

Table 6. Regression analysis of Systematic risk and Interest rate risk on Vega, $(Vega)^2$ and control variables

The sample consists of 156 BHCs selected from the Compustat and CRSP databases, over the 1993-2006 period. The sample selection procedure is detailed in Section 2. Risk variables are collected and calculated over the 1994-2006 period. All the other variables are for the period of 1993-2005. Systematic risk is a proxy for market risk and is the coefficient estimate on the CRSP equally weighted index resulting from the regression of daily stock returns on the daily return on the CRSP equally weighted index and the daily three month T-bill. Interest rate risk is the coefficient estimate on the daily three month T-bill in the regression described above. Vega is the dollar value of the sensitivity of a CEO's option portfolio to equity risk. Delta is the dollar value of the sensitivity of the CEO's stock-based wealth to stock price change. CEO stock ownership is the percentage of outstanding common stock held by the bank's CEO. Cash compensation is the sum of salary and bonus received by the CEO in a given year. Total assets is the book value of total assets of a bank at the end of a given fiscal year. Market-to-book ratio is the book value of liabilities plus the market value of equity divided by the book value of assets. Capital ratio is the book value of equity divided by the book value of total assets at the end of a fiscal year. DUM1994 is a dummy variable that takes on 1 if the year is 1994 and 0 otherwise. The same description holds for the remaining annual dummy variables. All variables are winsorized at the 1st and 99th percentile values. Monetary figures are in dollars of the year 2000. All models are estimated with firm fixed effects. The reported regressions adjust the standard error estimates for heteroskedasticity and within-bank correlation in the error. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	Systematic risk		**Interest rate risk**	
Model	**1**	**2**	**1**	**2**
Vega	**9.70e-06*** (2.95)**	**8.82e-06*** (2.56)**	**6.58e-06*** (2.81)**	**4.99e-06** (2.26)**
$(Vega)^2$	**-8.08e-11*** (-2.74)**	**-6.91e-11** (-2.34)**	**-5.57e-11*** (-2.71)**	**-4.62e-11** (-2.41)**
Delta		-1.07e-07 (-0.59)		4.10e-08 (0.35)
Cash compensation		-8.47e-08 (-0.84)		-1.39e-07 (-1.40)
CEO Ownership		-0.0026 (-0.33)		0.0044 (0.90)
Log (tot assets)		**0.2595*** (4.13)**		-0.0264 (-0.48)
MB		0.3870 (0.97)		**0.7371* (1.78)**
Leverage		-0.2187 (-0.19)		-0.0264 (-0.35)
DUM1994	-0.1253 (-1.14)	-0.1055 (-1.00)	**-0.8300*** (-4.74)**	**-0.8248*** (-4.78)**
DUM1995	-0.2173* (-1.73)	**-0.2265* (-1.84)**	**-0.6289*** (-3.47)**	**-0.6635*** (-3.68)**
DUM1996	**-0.2714** (-2.31)**	**-0.2976*** (-2.62)**	**-0.3100* (-1.67)**	**-0.3468* (-1.86)**
DUM1997	-0.0317 (-0.26)	-0.1472 (-1.15)	-0.2156 (-1.21)	**-0.3809** (-2.07)**
DUM1998	0.1740 (1.45)	0.0599 (0.48)	**-0.6293*** (-3.54)**	**-0.6718*** (-3.61)**
DUM1999	-0.0238 (-0.20)	-0.1544 (-1.21)	**-0.6782*** (-3.87)**	**-0.6558*** (-3.78)**
DUM2000	-0.1437 (-1.48)	**-0.2938** (-2.27)**	**-0.5359*** (-3.03)**	**-0.4939*** (-2.82)**
DUM2001	-0.00002 (-0.01)	-0.1832 (-1.36)	**-0.9036*** (-5.20)**	**-0.8657*** (-4.96)**
DUM2002	**0.2094* (1.66)**	0.0032 (0.02)	**-0.5008*** (-2.87)**	**-0.4546*** (-2.58)**
DUM2003	**0.3929*** (3.01)**	0.1530 (1.03)	**-0.4205** (-2.36)**	**-0.3972** (-2.15)**
DUM2004	**0.4209*** (3.21)**	0.1636 (1.08)	**-0.8669*** (-4.94)**	**-0.8437*** (-4.57)**
DUM2005	**0.6108*** (4.08)**	**0.3436** (2.01)**	**-0.9146*** (-5.20)**	**-0.8665*** (-4.76)**
Individual effects	Yes	Yes	Yes	Yes
Observations	1447	1378	1447	1378
Adjusted R^2	0.5744	0.5814	0.2712	0.28

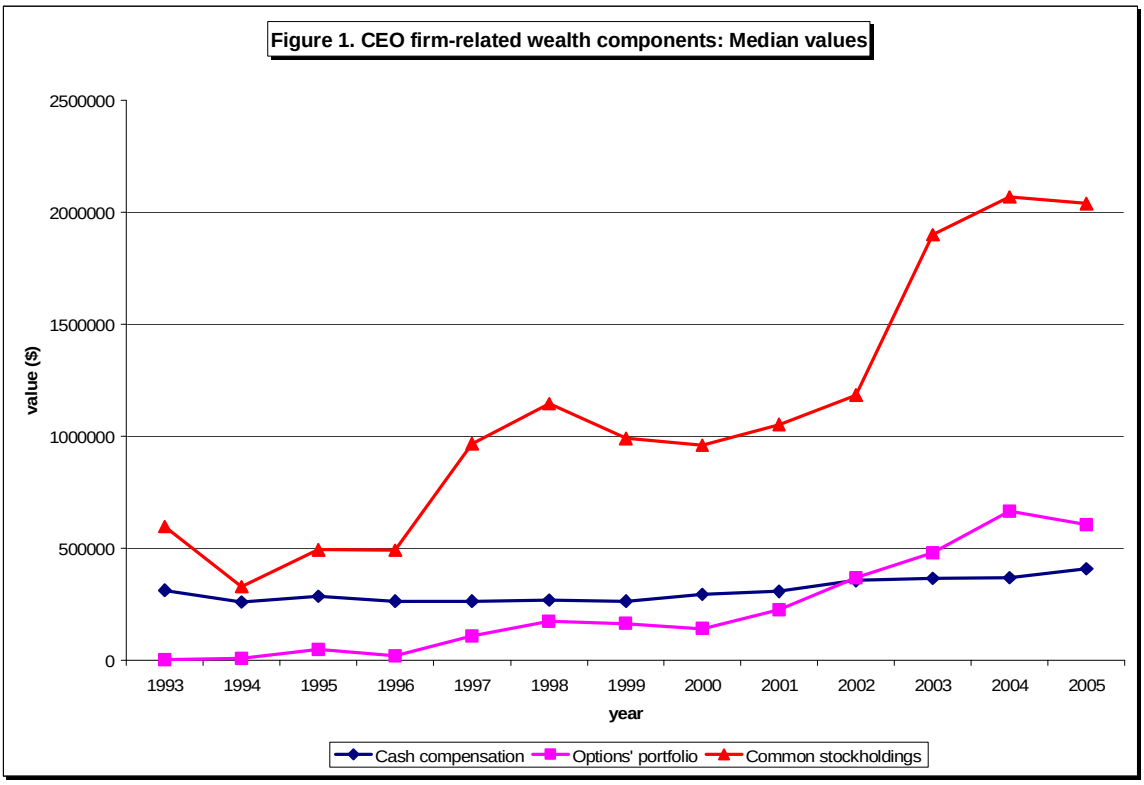
Figure 1. CEO firm-related wealth components: Median values
2500000
2000000
1500000
1000000
500000
0
value ($)
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
year
Cash compensation
Options' portfolio
Common stockholdings

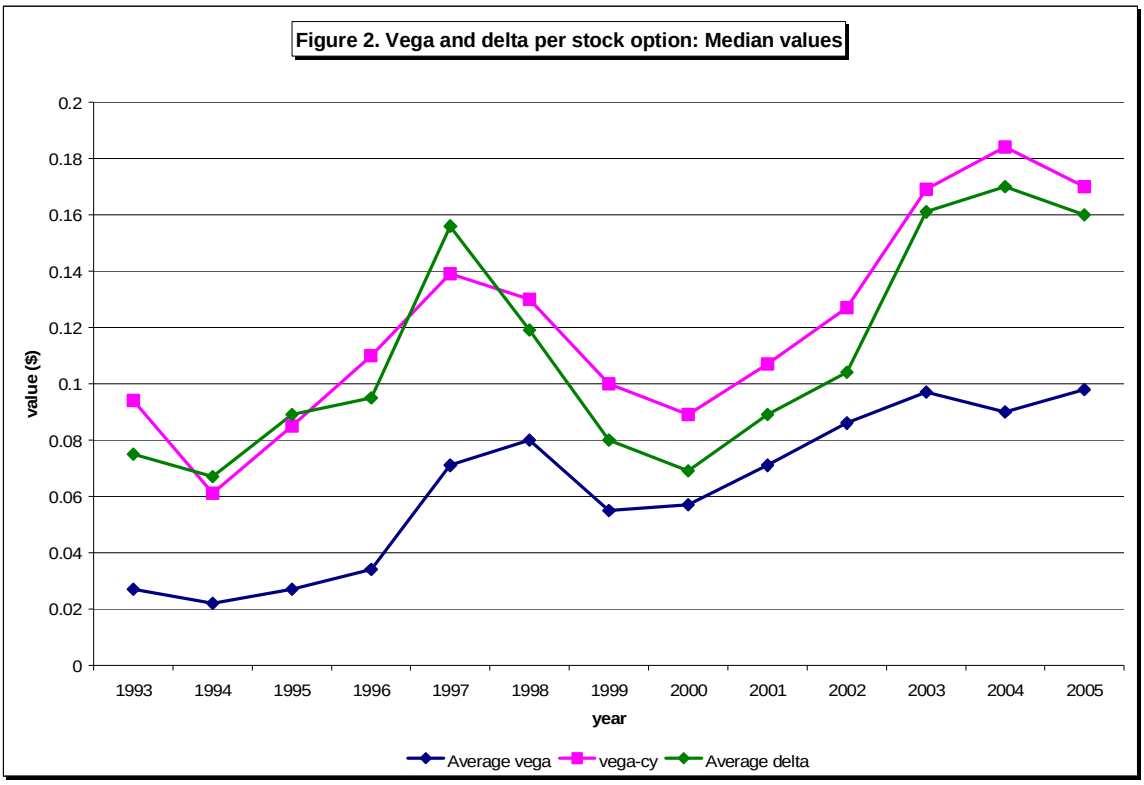
Figure 2. Vega and delta per stock option: Median values
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
value ($)
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
year
Average vega
vega-cy
Average delta

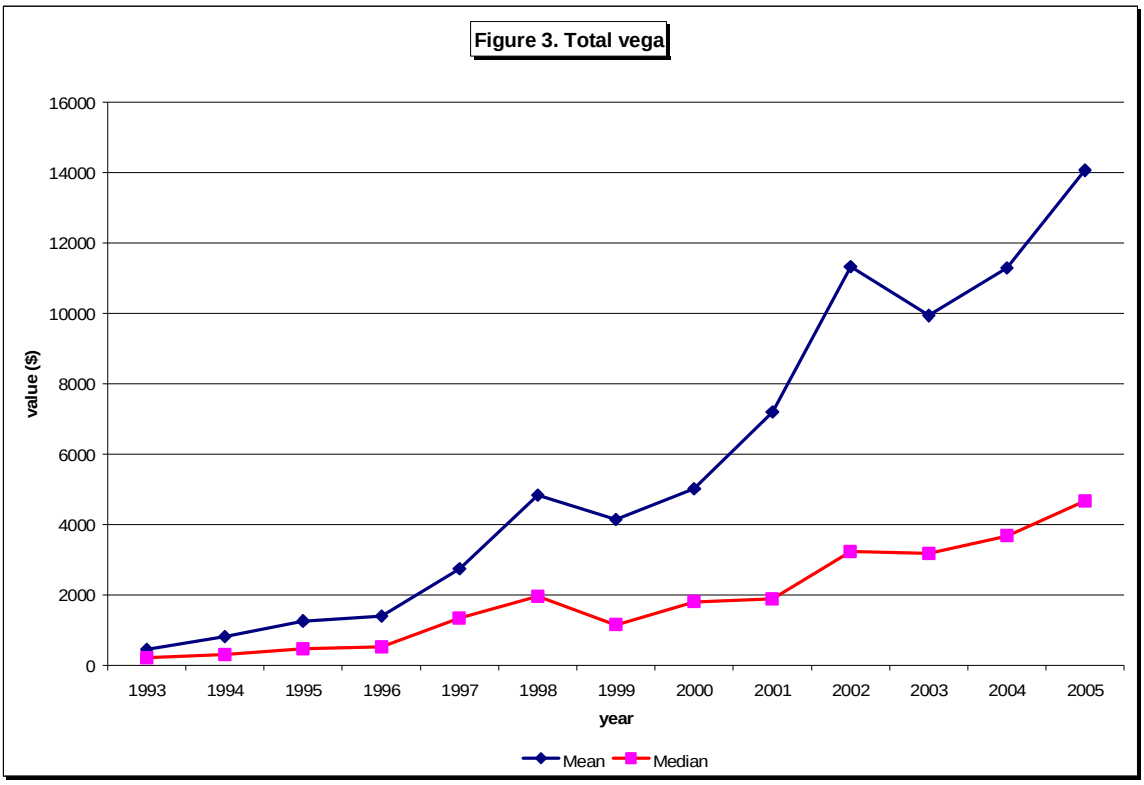
Figure 3. Total vega
16000
14000
12000
10000
8000
6000
4000
2000
0
value ($)
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
year
Mean
Median