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Incentives and Firm Behaviors

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ABSTRACT

My research interests focus on the economic behavior, choices, and actions of organizations as well as individuals given their incentives, and analyze the consequences of such decisions to the financial health of firms and the macro economy. A firm is incentivized by the value investors place on its operations; while employees, particularly the management team, is incentivized by the private benefits the firm gives them. Understanding the impact of such incentives will help alleviate the classic agency costs in modern organizations.

Stock illiquidity raises the cost of share ownership to outside investors. The sizable adverse price impact of trading increases transactions costs and stock volatility. The reduced gains from informed trading discourages the acquisition of private information and impedes the price discovery process. The first essay substantiates that shares of financially constrained firms are significantly more illiquid than shares of similar but financially unconstrained firms. Acting as buyers of last resort for their own shares, share repurchases by financially constrained firms enhance stock liquidity, which alleviates the cost of external financing and underinvestment. Increased stock liquidity improves information efficiency, inducing higher value-added from incremental capital investments. Further, higher stock liquidity lowers stock volatility and allows financially constrained firms to issue equity.

In the second and third essays, I investigate whether the incentives given to the employees and the management team at banks contribute to the financial crisis. I provide evidence that CEO compensation is weakly related to bank risk measures and risky bank activities. However, when looking at banks with regards to their reward cultures, I find that during the 2008 crisis period, banks either at the high or low reward culture groups perform worse, and are more risky than banks in the average reward culture group. The reward culture

score represents the common factor in incentives across all levels of the bank, from CEO, Vice Presidents to all other employees. The findings are consistent with the problems of adverse selection and moral hazard associated with incentive misalignment when incentives are too low or too high. This shows the importance of reward culture in understanding the role of performance-based compensation.

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DEDICATION

To Dad and Mom

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I. Introduction

There is an intensive market microstructure literature focused on stock liquidity. This literature notes two different costs associated with stock illiquidity: adverse selection costs arising from information asymmetry and transactions costs associated with holding inventory. Investors require additional compensation for holding less liquid stocks, either in terms of greater stock returns or risks. Increased stock liquidity that reduces the adverse selection and transaction costs to shareholders reduces the firm's cost of capital. By increasing the marginal value of private information, stock liquidity motivates market participants to engage in private information production. The reduction in information asymmetry contributes to stock price efficiency. If managers wish to maximize firm value, they should pursue financial policies that improve the liquidity of their stock.

In the first essay, I investigate whether firms attempt to enhance their stock liquidity via share repurchase programs, and the implications of this activity on other firm behavior. This is done in the context of firms that face costly external financing and have illiquid stocks and hence, would be expected to value stock liquidity more than other firms. Specifically, I draw upon the existing literature on financial frictions to identify a set of firms that have a higher cost of capital and less stock liquidity: financially constrained firms. I show how financially constrained firms with illiquid stocks utilize share repurchases to improve their liquidity, helping them issue additional equity, increasing investments, increasing value added from market perception per incremental investments, and reducing idiosyncratic risk.

The 2008 financial crisis raised questions about performance-based compensation practices at financial institutions. The public widely believed that excesses in compensation prevalent among banks were a catalyst to the crisis. Since then, academic research has studied the link between compensation practices and risk-taking behaviors extensively, mostly focusing on CEO and the top management team compensation. Their findings are inconclusive. One branch of the literature finds that banks with better shareholder-aligned CEO compensation plans did worse in the crisis, generating significantly lower stock returns and returns on equity. Moreover, CEOs of better shareholder-aligned banks realized larger losses in their stock and option portfolios. But as other branches of the literature point out, the losses that CEOs suffered in the crisis were disproportionately less than the high compensation CEOs received prior to the crisis. There has been evidence about a positive relationship between a CEO's stock and option grants and bank risk.

In the second and third essays of this dissertation, I study whether incentives at banks are a contributing factor to the recent credit crisis. The second paper shows that bank CEO compensation incentives to increase risk, and to increase risk relative to increase stock price, lead to comparatively risky investment and debt policies and increased risk. It shows that the relation between bank CEO compensation risk taking incentives tends to change between non-crisis vs. crisis periods. Bank CEO risk taking incentives lead CEOs to adopt riskier investments, including asset growth, loans to core deposits, and commercial real estate loans, to implement riskier debt policy by increasing leverage, and to increase bank risk, where bank risk is measured by the volatility of stock returns, non-performing loans to assets, and a bank risk factor score. I conclude that recent efforts by the press, politicians, and regulators, to portray bank CEO compensation incentives as the cause of excessive risk taking and financial collapse are premature. In the third paper, I construct and examine whether the "reward culture" of banks was a contributing factor to the 2008 credit crisis. Reward culture reflects three dimensions: (i) CEO incentives – total CEO compensation and the incentive effects of CEO stock and option portfolios; (ii) tournament incentives – pay gap in total compensation between CEOs and Vice Presidents; and (iii) employee incentives – total compensation per employee. A reward culture factor score, constructed by applying factor analysis to the CEO, VP, and employee incentives, represents the common factor in incentives across all levels of the bank. I employ the reward culture factor to examine the impact of reward culture on bank performance and risk. First, I find strong evidence of a nonlinear relationship between reward culture and bank returns and risk. Second, classifying banks into high, average, and low reward culture groups in the pre-crisis year 2006, I find that during the 2008 crisis period, banks either at the high or low reward culture groups performed worse, and were more risky than banks in the average reward culture group. The findings are consistent with the problems of adverse selection and moral hazard associated with incentive misalignment when incentives are too low or too high.

II. Stock Market Liquidity: Financially Constrained Firms and Share Repurchase

Abstract: Stock illiquidity raises the cost of share ownership to outside investors. The sizable adverse price impact of trading increases transactions costs and stock volatility. The reduced gains from informed trading discourages the acquisition of private information and impedes the price discovery process. This study substantiates that shares of financially constrained firms are significantly more illiquid than shares of similar but financially unconstrained firms. Acting as buyers of last resort for their own shares, share repurchases by financially constrained firms enhance stock liquidity, which alleviates the cost of external financing and underinvestment. Increased stock liquidity improves information efficiency, inducing higher value-added from incremental capital investments. Further, higher stock liquidity lowers stock volatility and allows financially constrained firms to issue equity.

A. Introduction

There is an extensive market microstructure literature focused on stock liquidity (see Vayanos and Wang, 2012, for a survey). This literature notes two different costs associated with stock illiquidity: adverse selection costs arising from information asymmetry, and transactions costs associated with holding inventory. Investors require additional compensation for holding less liquid stocks, either in terms of greater stock returns or risks[1]. Increased stock liquidity that reduces the adverse selection and transaction costs to shareholders reduces the firm's cost of capital[2]. By increasing the marginal value of private information, stock liquidity motivates market participants to engage in private information production[3]. The reduction in information asymmetry contributes to stock price efficiency. If managers wish to maximize firm value, they should pursue financial policies that improve the liquidity of their stock[4]. During market downturns, firms can, for instance, utilize share repurchase programs to help increase depth on the sell-side of the market to improve liquidity[5]. The presence of the firm as a buyer gives confidence to other market participants and reduces the number of sellers in the market. Repurchase firms can be thought of as buyers of last resort – supporting their market-makers and

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[1] Brennan and Subramanyam (1996), Datar et al. (1998), Brennan et al. (1998), and Brennan et al. (2012) document a positive relationship between average stock returns and liquidity costs. Amihud (2002), Pastor and Stambaugh (2003) and Acharya and Pedersen (2005) argue that illiquidity is a priced risk factor.

[2] Amihud and Mendelson (1986), Barclay and Smith (1988), and Acharya and Pedersen (2005) provide theoretical models that predict a positive relationship between the cost of capital and the bid-ask spread. Empirical work by Brennan and Subrahmanyam (1996), Easley et al. (2002), Amihud (2002), Pastor and Stambaugh (2003), Bekaert et al. (2007), Hasbrouck (2009), Duarte and Young (2009), and Lee (2011) provides support for this prediction.

[3] Kyle and Vila (1991), Holmstrom and Tirole (1993), and Maug (1998), to name a few.

[4] Amihud and Mendelson (2012) argue that corporate managers should adopt liquidity-increasing corporate financial policies, including lower leverage ratios, the substitutions of dividends for stock repurchases, more effective disclosure, and increases in investor base.

[5] Grullon and Ikenberry (2000) find evidence that repurchases provide liquidity support in a declining market.

adding downside liquidity. In this paper, I investigate whether firms attempt to enhance their stock liquidity via share repurchase programs, and the implications of this activity on other firm behavior. This is done in the context of firms that face costly external financing and have illiquid stocks and hence, would be expected to value stock liquidity more than other firm.

Specifically, I draw upon the existing literature on financial frictions to identify a set of firms that have a higher cost of capital and less stock liquidity: financially constrained firms. Financial constraints arise due to frictions in the supply of capital, the chief source of friction being information asymmetries between investors and the firm (Tirole, 2006). Supply frictions increase costs of raising external capital, and, in the limit, the firm is shut out of the capital markets[6]. Since market liquidity captures information asymmetry among market participants, such firms are more likely to have less liquid stocks (Ascioglu et al., 2008). Researchers hypothesize that these constraints may have substantial effects on a variety of decisions, including firms' investment and capital structure choices[7]. Campello et al. (2010) use the 2007 credit crisis as a natural experiment to survey CFOs about the impact of financial constraints on corporate policies. They find financially constrained firms plan to cut more investment, technology, marketing, and employment relative to financially unconstrained firms during the crisis. Financial constraints also restrict firms' pursuits of attractive projects, or force them to cancel valuable investments.

I hypothesize that financially constrained firms, facing costly external financing and

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[6] As Almeida and Campello (2002) put it, "constrained firms are at the point where the supply of capital becomes inelastic".

[7] See, for example, Fazzari et al. (1988), Whited (1992), Froot et al. (1993), Kaplan and Zingales (1997), Gomes (2001), Almeida et al. (2004), Whited and Wu (2006), Rauh (2006), Almeida and Campello (2007), Hennessy and Whited (2007), Duchin et al. (2010), and Li (2011), among many others.

potential underinvestment, take steps to improve their stock liquidity to reduce information asymmetry and alleviate costs of financial constraint. The more illiquid a firm's stock is ex-ante, the more valuable the enhanced liquidity is ex-post. Liquidity enhancements for such firms are also likely to have greater value than for other firms. As a corollary, if these firms do raise external financing, it is more likely to be equity financing because of a lower cost of equity. They overcome the underinvestment problem with additional financing. Furthermore, since improved liquidity increases price efficiency, the market will place higher value on their incremental investments. Concurrently, reduced liquidity costs could also result in reduced risk for these firms.

The corporate policy of choice in this paper is share repurchase. The existing literature argues that share repurchase programs can both improve and deteriorate stock liquidity. On the one hand, open market repurchase programs should be detrimental to market dynamics because the firm's presence in the market increases the fraction of "informed" traders, which in turn gives rise to an adverse selection cost in the form of reduced stock liquidity[8]. On the other hand, share repurchases may actually improve stock liquidity by increasing depth on the sell-side of the market. Here firms repurchase shares as a form of disbursing cash to shareholders, acting as a market maker in their own stocks supplying additional liquidity[9]. Hillert et al. (2013) shed light on these conflicting results by relying on newly available data on realized share repurchases by

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[8] Barclay and Smith (1988) for U.S. firms, Brockman and Chung (2001) for Hongkong, and Ginglinger and Hamon (2007) for France find that repurchases reduce liquidity. Brockman et al. (2008) study the determinants of repurchases with regard to liquidity and document that firms with more liquid stocks tend to distribute more of their excess cash in the form of stock repurchases than dividends.

[9] Singh et al. (1994), Wiggins (1994), Miller and McConnel (1995), Franz et al. (1995), Cook et al. (2004) for U.S. firms, Chung et al. (2007) for Switzerland, Rasbrant and De Ridder (2013) for Sweden, and De Cesari et al. (2012) for Italy, all find a positive relationship between repurchases and liquidity.

U.S. firms. They find smaller repurchases consume liquidity; whereas larger repurchases provide liquidity, and liquidity provision is more likely for less liquid stocks.

Figure 1.1 plots average U.S. stock market liquidity based on Amihud's (2002) illiquidity measure (the left axis) and the average share repurchase amount and equity issuance amount (the right axis) for all publicly traded firms on the CRSP and Compustat databases from 1989 to 2011. This Figure shows U.S. stock markets became more liquid until 2007, then reached a high point in illiquidity during the financial crisis in 2009. At the same time, the repurchase amount increases substantially until 2007, then decreases dramatically to a low in 2009, and increases thereafter. Equity issuance amount follows a generally similar pattern to that of repurchase amount. There is a positive association between stock market liquidity and each of share repurchase and equity issuance amounts.

Insert Figure 1.1 here.

My research design has three parts. First, I confirm the relationship between financially constraint and illiquidity documented in the literature, and explore the impact of share repurchase on the constraint status. Second, I investigate the relationship between share repurchase and stock liquidity in a sample of financially constrained firms only, controlling for the endogeneity between the two. Finally, I study the impact of additional liquidity on different firm decisions in such firms, such as equity and debt issuance, investment, value added from incremental investments and firm risk.

My sample consists of 183 financially constrained firms from the CRSP and Compustat data over 1992 to 2006. My study starts with 1992 to avoid contaminating effects of the savings and loan crisis that started in 1989, and ends in 2006 to avoid the effects of the credit crisis that started in 2007. Firms selected in the sample must have all data available throughout the sample period in order to alleviate the confounding effects of different factors. I classify firms as financially constrained by Hadlock and Pierce's (2010) index (hereafter, HP index)[10]. I focus on financially constrained firms because the effect of share repurchases on stock liquidity and the value of enhanced liquidity are likely greatest for financially constrained firms. My variable of chief interest in measuring repurchase activity is repurchase intensity, calculated as repurchase amount divided by the total dollar trading volume over the fiscal year. Intuitively, this variable measures repurchase dollars per trading dollar volume. The higher the value, the greater the intensity of the repurchase.

Figure 1.2 plots Amihud's (2002) illiquidity measure against repurchase intensity for unconstrained versus constrained firms. The positive relationship between stock illiquidity and repurchase intensity appears more pronounced for constrained firms, helping motivate my focus on constrained firms in this study.

Insert Figure 1.2 here.

Using Amihud's (2002) illiquidity measure as my primary measure of illiquidity, I first verify that financially constrained firms have less stock liquidity. In 1992, I find a one standard deviation above the mean level of illiquidity decreases the probability of a firm being financially unconstrained from 84.76% to 75.86%, an almost 9% decrease, holding all control variables constant at their mean levels. This is consistent with Ascioglu et al. (2008), who report that the more liquid a company's stock is, the more likely that firm will be financially unconstrained. This finding suggests illiquidity is a characteristic of financial constraint.

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[10] Hadlock and Pierce (2010) point out the endogenous nature of common predictors in previous literature, such as leverage and cash flow, to constraint status, and recommend that researchers rely solely on firm size and age, two relatively exogenous firm characteristics, to identify constrained firms.

Since being financially constrained is potentially detrimental to firm value, I hypothesize that financially constrained firms will engage in corporate policies that enhance their liquidity. In particular, these firms could repurchase shares, and the intensity of their repurchase activity could help determine the probability that they will become unconstrained, ex-post. Consistent with this, I find that of 183 constrained firms in 1992, the intensity of cumulative repurchase activity from 1992 to 2006 is a determinant of the probability that these firms will be unconstrained in 2006. Specifically, a one standard deviation above the mean value of repurchase intensity increases the probability of being unconstrained in 2006 for constrained firms in 1992, from 7.21% to 10.1%, an increase of 2.89%, ceteris paribus.

Firms use share repurchases to improve their stock liquidity to reduce financial constraint. Since financially constrained firms are more likely to have illiquid stocks, share repurchases provide stock liquidity by increasing market depth. Knowing this, firms decide to repurchase when they observe that their stock liquidity is below some threshold. Given that firms make this decision endogenously, I identify evidence of a causal effect of share repurchases on improvements in liquidity by means of a two-stage-least-square (2SLS) model. I also correct for selection bias in decision making using Heckman's (1979) inverse Mill's ratio. Using this methodology, I show that the more illiquid a stock was in the prior year, the more likely the firm will repurchase its shares in the current year. This finding is inconsistent with Brockman et al. (2008), who document that higher market liquidity encourages share repurchases, but their analysis lumps financially unconstrained with constrained firms. Consistent with Hillert et al. (2013), I find that while lagged illiquidity prompts firms to repurchase shares, repurchase intensity enhances contemporaneous stock liquidity.

Enhanced stock liquidity can be beneficial for financially constrained firms through its effects on a variety of corporate decisions. Specifically, improved liquidity firms are more likely to issue equity. Liquidity lowers costs of capital (Amihud and Mendelson, 1986; Pastor and Stambaugh, 2003; and Acharya and Pedersen, 2005), especially in raising equity, because flotation costs and investment banking fees are reduced (Butler et al., 2005). I test for and find evidence of this using Heckman's inverse Mill's ratio to control for selection bias in the decision to issue equity. Further, I find no such effect on debt issuance, suggesting improved stock liquidity is more likely to be beneficial for equity issues than bonds, consistent with Lipson and Mortal (2009) and Bharath et al. (2009).

With improved liquidity, formerly financially constrained firms are able to issue more equity, presumably to fund investments. As a result, improved stock liquidity should be accompanied by increased investments. Higher trading volume, a proxy for liquidity, is associated with higher investment (Munoz, 2013). This relationship is greater for firms with tighter financial constraints and better investment opportunities. Stock liquidity is significantly correlated with R&D activity (Vo, 2013). I find evidence supporting this prediction.

As stock liquidity improves, information asymmetry between informed and uninformed investors decreases, and prices become more informative for managers, investors, and other stakeholders. This implies markets now value the firm's investments more than when their stocks were less liquid. I test for this by constructing a variable called value added (per dollar of incremental investments), measuring the increase in market value of assets, adjusting for net equity issuance and debt issuance, per dollar of investments. The intuition for this variable is that as a firm chooses to invest in different projects, the market observes this and reflects its perception of the values of such investments through stock price. When information asymmetry is reduced, the market is more informed and more likely to place higher value on those investments, increasing the market value of assets. The increase in the market value of assets due to investments will be greater for firms with reduced information asymmetry. In other words, this variable captures value added from the market perception from improved transparency. Since improved liquidity reduces information asymmetry, this variable should be positively correlated with liquidity. I find evidence supporting this prediction.

Finally, improved liquidity should lead to reduced risk owing to lower liquidity costs. However, the effect of improved liquidity may differ for systematic risk and idiosyncratic risk, given that systematic risk can be hedged. Baruch et al. (2007) and Baruch and Saar (2009) argue that when stocks are more liquid, investors rely more on market-wide information, while firm-specific information is more difficult to observe, increasing systematic risk. This implies a positive correlation between systematic risk and improved liquidity. Chan et al (2013) confirm this prediction and demonstrate that this relationship is stronger for stock with higher information asymmetry. I find evidence to confirm my prediction that enhanced liquidity reduces idiosyncratic risk but increases systematic risk.

Overall, this paper shows how financially constrained firms with illiquid stocks utilize share repurchases to improve their liquidity, helping them issue additional equity, increasing investments, increasing value added from market perception per incremental investments, and reducing idiosyncratic risk.

My paper makes several contributions to the corporate finance literature. First, I provide conclusive evidence that firms influence and improve their stock liquidity. Although it has been argued that firms can and should improve their stock liquidity (Amihud and Mendelson, 2012), evidence on this has so far been sparse. As a result, stock liquidity is often regarded as exogenously determined. My results show firms do care about their stock liquidity and take steps to improve it, especially when achieving and maintaining higher stock liquidity is crucial for them. In this respect, my findings are closely related to those reported by Daas et al. (2012) that concludes managers actively influence the liquidity of their companies' shares. Daas et al. (2012) show innovative firms – those primarily holding intangible assets and relying on external financing – have higher liquidity and take a variety of actions (e.g., frequent earnings guidance, stock splits, seasoned equity offerings, etc.) to maintain stock liquidity. My findings are also consistent with those of Balakrishnan et al. (2013), who show managers provide more earnings guidance after the loss of public information producers (analysts) following brokerage-firm closures.

Second, my results materially contribute to the literature on repurchases and liquidity by proving share repurchases improve liquidity, thereby providing a possible explanation why previous research appears inconclusive. I show that the liquidity enhancement effect of share repurchases is most pronounced for financially constrained firms, i.e., firms that value liquidity most. By not separating financially constrained from unconstrained firms, previous studies appear to have missed the effect of stock repurchases on liquidity. My results are consistent with Hillert et al. (2013), who find firms supply liquidity to the market when they repurchase a large number of shares, particularly in illiquid markets. However, my analysis builds on Hillert et al. (2013)'s by employing a 2SLS model to control for endogeneity compared to their lagged illiquidity in an OLS regression that does not control for selection bias. Also, they do not study the impact of improved liquidity on firm behavior, but instead focus on the market microstructure features of share repurchase. My results are inconsistent with Brockman et al. (2008), who find that market liquidity drives the repurchase decision. I find that a lack of stock liquidity drives the repurchase decision.

Third, my study identifies benefits of improving liquidity through its effect on corporate decisions. My paper builds on literature linking stock liquidity and external financing (Lesmond et al., 2008; Lipson and Mortal, 2009; Butler et al., 2005), stock liquidity and investment (Becker-Blease and Paul, 2006; Li, 2011; Vo, 2013), stock liquidity and price efficiency (Grossman and Stiglitz, 1980; Holmstrom and Tirole, 1993; Chordia et al., 2005; Chordia et al., 2008), and stock liquidity and firm risk (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005; Chan et al., 2013) by showing that these benefits are especially valuable to financially constrained firms.

Finally, my study complements the literature on payout decisions in financially constrained firms. Chen and Wang (2012) find that share repurchases by constrained firms lead to reduced cash and cash flow, and increased leverage, reducing investment. These firms also experience significantly weaker abnormal returns and operating performance post-repurchase. Why then do financially constrained firms engage in share repurchases when repurchases do not enhance shareholder wealth? Chen and Wang (2012) propose managerial overconfidence as a possible reason. Managers of these firms tend to overestimate their firms' future investments and returns. I add to this discussion by proving another explanation, i.e., managers of financially constrained firms repurchase shares to improve share liquidity. To my knowledge, my paper is the first to link liquidity to share repurchase among financially constrained firms.

The rest of the paper proceeds as follows. Section B develops my empirical predictions. Section C describes my data collection procedure and details the construction of my main variables. Section D investigates the relation between repurchase intensity and financial constraint status. Section E examines the relation between repurchase intensity and liquidity. Section F examines the effect of liquidity on firms' behaviors. Section G concludes.

B. Testable Hypotheses

Drawing upon the arguments made in the literature, I hypothesize that firms take actions that influence their stock liquidity. To test this, I focus on a set of firms that are expected to most value stock liquidity. Specifically, I argue that financially constrained firms face costly external financing and have illiquid stocks due to high levels of information asymmetry. Since share repurchases provide liquidity for less liquid stocks, firms that repurchase more shares are less likely to remain constrained. This leads me to my first testable hypothesis, stated in alternate form:

> **Hypothesis 1** (H1): *Ex-ante financial constrained firms that have greater share repurchase intensity are more likely to become unconstrained ex-post.*

I build on the notion that firms can influence the level of their stock liquidity. Given their higher cost of capital and underinvestment resulting from financial constraint, these firms will engage in share repurchases to improve their stock liquidity, and only do so when their stock liquidity is below some threshold. Specifically, my second testable hypothesis is:

> **Hypothesis 2** (H2): *Lagged illiquidity increases the probability financially constrained firms will do share repurchase, and consequently, the stock liquidity of firms improves.*

Due to the strong preference of financially constrained firms for liquidity, I expected that the improvement in liquidity would be more valuable for these firms and would be reflected in better corporate decisions and market perceptions. Therefore, my next four testable hypotheses are:

Hypothesis 3 (H3): *Improved liquidity increases the probability firms issue equity and the amount of equity issuance; but such impact is weaker, or nonexistent for debt issuance.*

Hypothesis 4 (H4): *Improved liquidity is associated with increased firm investment.*

Hypothesis 5 (H5): *Improved liquidity is associated with greater value added from market perception per dollar of incremental investments.*

Hypothesis 6 (H6): *Improved liquidity reduces risk via reduced idiosyncratic risk, and increases systematic risk.*

C. Data and Methodology

In this section, I describe my sample selection procedure and primary variables.

1. Sample Design

My sample starts with U.S. publicly traded firms between 1992 and 2006. According to Grullon and Michaely (2000), since the mid-1980s, more and more firms have decided to initiate share repurchase programs as a way to distribute cash flows to their shareholders. I start the sample in 1992 and end in 2006 to capture popularity of share repurchases and at the same time avoid contaminating effects of the savings and loans crisis that started in 1989 and the credit crisis that began in 2007, both of which adversely affect market liquidity. To be included in my sample, firms must be in both the Center for Research in Security Prices (CRSP) and Compustat files. I exclude financials and utilities because they do not report on share repurchases and have essentially unique types of asset and capital structure, leverage, and regulatory supervision. I also require firms to have positive assets and market capitalization.

I collect daily stock returns, prices and trading volumes from CRSP to calculate the Amihud (2002) illiquidity measure, cumulative stock returns, and total risk. I include all ordinary common stocks (share code 10 and 11) traded on NYSE, AMEX and NASDAQ (exchange code 1, 2 and 3). Primes, closed-end funds, REITs, American Depository Receipts (ADRs) and foreign companies are excluded. I obtain firm financial characteristics from Compustat.

I require sample firms to have data available for the entire period 1992 through 2006. Because the focus of the paper is on financially constrained firms, i.e., firms that are already more likely to leave the sample, limiting my study to those that remain allows me to observe the effect of share repurchases via liquidity enhancement on their constraint status without the confounding effects of other factors. My final sample includes 1,082 firms that satisfy all criteria. I further exclude firms that are classified as financially sufficient to avoid contamination of financially unconstrained and constrained groups. My final sample consists of 786 firms, 603 of which are unconstrained and 183 constrained in 1992. In analyses involving financial constrained firms, I only use these 183 firms.

2. *Measuring Stock Market Liquidity*

Although there are numerous studies on liquidity, the stock liquidity concept itself is still evolving (Cholette et al., 2007) because it comprises several dimensions, including trading costs, turnover, bid-ask spread, and price impact. To capture stock liquidity, current finance literature generally examines liquidity in terms of the ability of investors to trade large quantities of stock quickly at low cost with little price impact (Liu, 2006; Chordia et al., 2009). Although this definition of multi-dimensional liquidity is generally accepted, a single liquidity measure may not capture all dimensions of liquidity (Cholette et al., 2007). I use Amihud’s (2002) illiquidity measure because it is widely used to measure liquidity at both the aggregate and the firm level, as in Acharya and Pedersen (2005), Kamara et al. (2008), and Goyenko et al. (2009). This measure is easy to compute, and is highly correlated with other liquidity measures, such as bid-ask spread, LOT, trading volume, and price impact measures. It is defined as the average ratio of the daily absolute return to the dollar trading volume on that day. This ratio gives the absolute (percentage) price change per dollar of daily trading volume, or the daily price impact of the order flow.

In this paper, the Amihud's (2002) illiquidity measure is calculated as follows

$$ILL_{i,t} = \frac{1}{D_{i,t}} \sum_{s=1}^{D_{i,t}} \frac{|R_{i,s}|}{P_{i,s} \times Vol_{i,s}}$$

where $D_{i,t}$ is the number of valid observation days for stock i during fiscal year t, $|R_{i,s}|$ is the absolute return on day s for stock i. $P_{i,s}$ and $Vol_{i,s}$ are respectively the daily price and trading volume of stock i on day s. I multiply the above estimate by 10^6 for practical purposes. This measure is called an illiquidity measure because a high value indicates low liquidity.

I follow Amihud (2002)'s exclusion of firms with less than 200 trading days during the year t. I also require firms to have trading volume and market capitalization in year t to calculate the Amihud's (2002) illiquidity measure. Because the impact of repurchases on liquidity may vary depending on the exchange that the stock is traded, I adjust the Amihud's (2002) illiquidity measure by subtracting exchange illiquidity from raw Amihud's (2002) illiquidity during the period.

3. Measuring Financial Constraint

To study the role of financial constraint on firm behavior, researchers are often in need of a measure of the severity of constraint. The literature suggests many possibilities, but is divided on which measure best captures financial constraint. As a result, empirical studies tend to employ a range of measures for robustness. Judged by Google Scholar citations, the KZ index, as suggested by Kaplan and Zingales (1997), Lamont et al. (2001), Baker et al. (2003), Chen et al. (2007), and Hennessy et al. (2007), is the most popular measure of financial constraints. Other popular measures of financial constraint are the cash-cash flow sensitivity of Almeida et al. (2004), the investment-cash flow sensitivity of Fazzari et al. (1988), the WW index of Whited and Wu (2006), and the HP index of Hadlock and Pierce (2010).

Ascioglu et al. (2008) argue that when a classification scheme for identifying constrained firms is based upon a measure correlated with net worth or internal funds, the characters of those firms, such as investment-cash flow sensitivity, are not consistent with firms with financial constraints. By collecting detailed qualitative information from financial filings to categorize financial constraints for a random sample of firms from 1995 to 2004, Hadlock and Pierce (2010) cast serious doubt on the validity of the KZ index, while offering mixed evidence on the validity of other common measures of constraint[11]. Concerned with the endogenous nature of common predictors such as leverage and cash flow to constraint status, they recommend researchers rely solely on firm size and age, two relatively exogenous firm characteristics, to identify constrained firms. Therefore, in this paper, I use HP index to classify financially constrained firms. The HP index is calculated as

$$HP = (-0.737 \times Size) + (0.043 \times Size^2) - (0.040 \times Age)$$

where $Size$ equals the log of inflation-adjusted book assets, and Age is the number of years the firm is listed with a non-missing stock price on Compustat. In calculating this index, $Size$ is

[11] Hadlock and Pierce (2010) provide evidence that “the only truly new variable from the WW index that offers marginal explanatory power” over the KZ index is firm size.

capped at (the log of) \$4.5 billion, and *Age* is winsorized at 37 years. A firm with a high HP index is considered more financially constrained.

I construct the HP index for each firm in the universe of Compustat firms at the beginning of the sample period 1992, and then again at the end of the sample period 2006. To reduce the effects of a few extreme values, I Winsorize components of the HP index at the 1st and 99th percentiles. For those two years of data, I sort all the firms in Compustat into terciles of 40th and 60th percentiles (40-20-40) according to the value of their HP indexes. Firms with the lowest HP index values are placed in tercile one, and firms with the highest values in tercile three. I then assign my sample firms to these groups based on their HP terciles in 1992 and 2006. I consider firms in the highest HP tercile to be financially constrained, firms in the middle HP tercile to be financially sufficient and firms in the lowest HP tercile to be financially unconstrained.

Insert Table 1.1 here.

Table 1.1, Panel A reports the frequency of firms for three groups: financially unconstrained, financially sufficient, and financially constrained, at the beginning of the sample period 1992, and at the end in 2006. Of my original sample of 1,082 firms, 55.7% are unconstrained in 1992, 21.1% sufficient in 1992, and 23.2% constrained in 1992. Their financial constraint status in 2006 evolves such that all unconstrained firms in 1992 remain unconstrained by 2006, while 86.0% of sufficient firms in 1992 improve to become unconstrained by 2006, while 39.4% of constrained firms in 1992 become unconstrained by 2006, and only 33.6% stay constrained. To some extent, sufficient firms behave more like financially unconstrained firms, potentially diluting the effect of the two extremes. I therefore exclude financially sufficient firms in my subsequent analyses, and report frequencies of only unconstrained vs. constrained firms in

Panel B. Of the 786 firms, all unconstrained firms in 1992 stay unconstrained in 2006, while 54.1% of constrained firms in 1992 move up to being unconstrained in 2006, and the remainder stays the same. The fact that there is no movement from the 1992 unconstrained group suggests share repurchases during the period do little to their status, further motivating my focus on financially constrained firms.

4. *Measuring Share Repurchase*

Measurement of the actual value of shares repurchased is not straightforward. The most accurate measure would be actual shares repurchased multiplied by the average price of repurchased shares as reported in the firm's financial statements. Unfortunately, detailed disclosure of repurchase activity has only been a requirement since 2004. Early studies rely on *Wall Street Journal* announcements of share repurchases, while more recent studies identify repurchases from SDC and estimate the number of shares repurchased using either CRSP or Compustat data. Stephens and Weisbach (1998) discuss various estimates of actual repurchases using CRSP and Compustat data, and subsequent researchers have attempted to improve the accuracy of these estimates. Jagannathan et al. (2000) examine whether monthly decreases in shares outstanding from CRSP or purchases of common and preferred stock reported in Compustat more accurately reflect actual repurchases. They find that the CRSP measure understates actual repurchases, while the Compustat measure overstates them, but their final sample contains only 35 firms with both CRSP and Compustat data available and includes a number of outliers. Grullon and Michaely (2002) and Kahle (2002) adjust Compustat purchases of common and preferred stock by removing changes in the value of preferred stock to better measure purchases of common stock. More recently, Massa et al. (2007) ignore preferred stock adjustments because preferred stock activity is an insignificant portion of firms' share repurchase activity. Fama and French (2001) adjust the Stephens and Weisbach's (1998) measure of changes in the dollar value of treasury stock to account for firms that retire treasury shares. In a hand collected sample of firms, Banyi et al. (2008) horse race various measures of share repurchases against share repurchases reported in firms' financial statements: they find annual and quarterly Compustat purchases of common stock, after adjusting for preferred stock repurchases, are good measures of actual repurchases in the sense that the proportion of extremely inaccurate data points is low.

In this paper, I follow Grinstein and Michaely (2005) and Massa et al. (2007) to calculate repurchase activity. I use data item PRSTKC from Compustat database as a measure of repurchase amount. Although by definition this item includes preferred as well as common stock, preferred stock repurchase activity is a minute fraction of overall repurchases. Furthermore, in some instances this item is reported as zero but there is a significant reduction in the redemption value of preferred stocks (item PSTKRV), suggesting a negative repurchase amount if I adjust for preferred stock repurchases following Grullon and Michaely (2002). Therefore, item PRSTKC best estimates common stock repurchase amount. My main variable measuring intensity of repurchase activity ($RI_{i,t}$) is defined as the amount of share repurchased reported during the fiscal year (item PRSTKC) divided by the total dollar trading volume over the same period (data from CRSP).

$$RI_{i,t} = \frac{PRSTKC_{i,t}}{\sum_{s=1}^{Di,t} P_{i,s} \times Vol_{i,s}}$$

where $D_{i,t}$ is the number of valid observation days for stock i during fiscal year t, $PRSTKC_{i,t}$ is the repurchase amount reported by firm i during fiscal year t. $P_{i,s}$ and $Vol_{i,s}$ are respectively the daily price and trading volume of stock i on day s. I multiply the above estimate by 1000 for practical purposes. This measure is a repurchase intensity measure because a high value indicates greater repurchase dollars per thousand dollar trading volume. Hillert et al. (2013) construct similar measures of repurchase intensity, but use number of shares outstanding as the denominator.

5. *Control Variables and Descriptive Statistics*

To examine the effect of share repurchase on liquidity and subsequent firm behavior, I follow the current literature on financial constraint to control for a set of firm and industry characteristics that may affect their behavior. Specifically, I use the component variables of the KZ index, including cash flow, cash, dividend, leverage and Tobin's Q. Cash flow is defined as cash flow over lagged book assets, cash as cash balances over lagged book assets, dividend as cash dividends over lagged book assets, leverage as sum of long-term debt and current debt over lagged book assets, and Tobin's Q as the ratio of the market-to-book value of the firm's assets. I also use the component variables of the WW index for robustness, including cash flow, dividend dummy, long-term debt, sales growth and industry sales growth. Dividend dummy equals one if the firm pays cash dividends and zero otherwise, long-term debt is defined as long-term debt over lagged book assets, sales growth as the firm's sales growth and industry sales growth as the firm's three-digit industry sales growth. I also include stock volatility and stock returns in selected analyses. Stock volatility is defined as the annualized standard deviation of daily stock returns, and stock returns as the cumulative of daily stock returns over the fiscal year. All the variables are defined in detail in the Appendix.

Insert Table 1.2 here.

Table 1.2 provides summary statistics for firm characteristics for three groups of firms based on their constraint status: financially unconstrained, financially sufficient, and financially constrained firms, as of 1992, and as of 2006. There are significant differences among the three groups. Unconstrained firms are significantly bigger, have more income, more cash flow, less cash, higher leverage, smaller Tobin's Q, and less investment. This is consistent with Hadlock and Pierce (2010), who suggest constrained firms choose to hold more cash and keep leverage low for precautionary reasons. In addition, the fact that constrained firms have higher Tobin's Q, a proxy for growth opportunities, and higher investment, emphasizes the wedge between internal needs and external cost of funds at constrained firms.

D. The Impact of Share Repurchase on Financial Constraint

Hennessy and Whited (2007) suggest the financial constraint status of firms has a substantial effect on a variety of firm decisions, including investment and capital structure choices. Similarly, given their constraints, such firms choose different payout methods with varying intensity. By restricting firms with available data throughout 15 years from 1992 to 2006, I am able to observe a firm's status coming into the period (in 1992), its payout behaviors during the period, and its status coming out of the period (in 2006). While unconstrained firms coming in and going out of the period experience no change in status, more than half of ex-ante constrained firms come out unconstrained. By controlling for other factors that can also affect constraint status, I study the effect of share repurchases on firm financial constraint status and subsequent firm behavior as hypothesized in Hypothesis 1.

1. Univariate Analysis

I start my analysis by looking at three groups of firms based on their constraint status in 1992 and their cumulative payout activity between 1992 and 2006 reported in Table 1.3.

Insert Table 1.3 here.

By classification, unconstrained firms have the lowest HP index, and constrained firms the highest. As a whole, each group's HP index decreases from 1992 to 2006, reflecting improved financial status. This is not surprising given the HP index loads primarily on size and age. As firms grow, they become less constrained. In term of illiquidity, values are negative because they are adjusted by subtracting exchange illiquidity from raw Amihud (2002) illiquidity during the same period. The more negative the value, the more liquid the stock relative to the liquidity of its exchange. In general, unconstrained firms are more liquid than constrained firms. This is consistent with Cleary et al. (2007), who suggest information asymmetry between firms and uninformed investors is a primary root cause of financial constraint, and Ascioglu et al. (2008), who confirm market liquidity captures information asymmetry between informed and uninformed investors and can thus be used to classify financial constraint.

In terms of liquidity trend, market liquidity improves from 1992 to 2006, regardless of firm group. This is consistent with Kamara et al. (2008), who observe that the substantial increase in institutional investing and index trading in in the past 50 years play a key role in increasing trading volume and liquidity in U.S. equity markets. The liquidity of financially sufficient firms more closely resembles that of unconstrained than constrained firms, consistent with the notion that financially sufficient firms behave more like unconstrained firms. This also motivates me to remove financially sufficient firms from my final sample of constrained firms.

Consistent with the free-cash-flow hypothesis of corporate payouts first proposed by Jensen (1986), financially unconstrained firms pay out much more than the other two groups, either in the form of dividends or share repurchases. These firms are more likely to have excess cash and fewer growth opportunities. Sufficient and constrained firms pay out much less, and utilize more share repurchases than dividends. This is in line with Jagannathan et al. (2000) and Guay and Harford (2000), who suggest that share repurchases are used to distribute cash flows unlikely to reoccur.

2. *Cross-sectional Regression Analyses*

Before focusing on constrained firms, I investigate the characteristics of financial constraints as these firms enter my sample in 1992. I limit my sample to 786 firms that are either unconstrained or constrained. I run probit regressions to assess whether the probability of being unconstrained is correlated with different characteristics of firms. The primary test variable here is firm illiquidity. I use the components of KZ index as additional explanatory variables in Column 1, and rerun the regression using WW index's components as a robustness test in Column 2. I do not use log(Total Assets) as one of the WW index's components because of multicolinearity given the HP index is also calculated based on total assets. The results are shown in Table 1.4. Intercepts are not reported.

Insert Table 1.4 here.

All coefficients are statistically significantly different from zero, implying the HP classification is a good measure of financial constraint. Consistent with prior literature, unconstrained firms are more liquid, have more cash flow, pay more dividends, and have less growth opportunities. Hadlock and Pierce (2010) argue constrained firms hold more cash and keep financial slack for precautionary purposes. I also find unconstrained firms have less cash and more leverage. Consistent with Ascioglu et al. (2008), the more liquid a firm's stock, the more likely it is unconstrained. High illiquidity implies high information asymmetry between the firm and the market, increasing costs of external financing and thus constraint. This relationship is statistically and economically significant. Holding all control variables constant at their mean levels, a one standard deviation above mean level of illiquidity decreases the probability of a firm being unconstrained from 84.76% to 75.86%, an almost 9% decrease in likelihood.

Of 786 firms that enter my sample period in 1992, all 603 unconstrained firms come out as still unconstrained in 2006, and there is no significant cross-sectional change in financial constraint among unconstrained firms. However, of 183 constrained firms in 1992, 99 become unconstrained by 2006, and only 84 remain constrained.

Does repurchase intensity play a role in improving the financial status of more than half of the constrained firms? I test for Hypothesis 1 by running probit regressions on the group of constrained firms in 1992 only, modelling the probability of being unconstrained in 2006. The test variables are cumulative repurchase intensity and cumulative dividend ratio. Cumulative repurchase intensity is the repurchase intensity over 15 years, from 1992 to 2006, calculated as the sum of repurchase amount over 15 years divided by the total dollar trading volume over the same period. Cumulative dividend ratio is calculated as the sum of dividends paid throughout 15 years divided by the sum of total assets in the years that dividends are paid. This variable is used to test for the dividend substitution hypothesis (Grullon and Michaely, 2002). The control variables are either all the KZ's components (Column 1) or all the WW's components in 2006 (Column 2). Again, I do not use log(Total Assets) for WW variables. The results are shown in Table 1.5. Intercepts are not reported.

Insert Table 1.5 here.

Similar to Table 1.4, unconstrained firms are more liquid, and have more cash flows and more leverage. The coefficient on Cash is not significant. According to Kaplan and Zingales (1997), constrained firms have less internal funding, e.g. cash, whereas Hadlock and Pierce (2010) argue that constrained firms hold more cash as a precaution. In both of my columns, the coefficients on cumulative repurchase intensity are positive and significant. The higher repurchase intensity, the more likely ex-ante constrained firm become unconstrained ex-post. Repurchase intensity helps reduce financial constraint. Keeping all other control variables at their mean values, a one standard deviation above the mean value of repurchase intensity increases the probability of being unconstrained by 2006 for constrained firms in 1992 from 7.21% to 10.1%, a significant increase of 2.89% in likelihood. In contrast to the impact of repurchase intensity, the coefficients of cumulative dividend ratio are negative and statistically significant. The more dividends firms pay, the more likely they are constrained. This is inconsistent with the dividend substitution hypothesis of share repurchase, which implies that the effect of share repurchase and dividends are analogous. However, it is consistent with Brav et al. (2005), where CFOs acknowledge rigidity of dividends; regardless of the financial status of the firms, firms have to keep paying dividends, or risk sending unfavorable signals to the market; with higher cost of capital, this deteriorates the financial status of the firm, making it more constrained.

In sum, the results here are consistent with Hypothesis 1, showing the positive impact of share repurchase on alleviating firms' constraint status.

E. The Impact of Share Repurchase on Market Liquidity

Section D shows the impact of repurchase intensity on the financial status of a firm, in particular for ex-ante constrained firms. The higher repurchase intensity a firm has, the more likely it becomes unconstrained ex-post. Share repurchases therefore reduce financial constraint, but how? I argue that share repurchases enhance market liquidity, which lowers information asymmetry between the firms and uninformed investors, as stated in Hypothesis 2. By buying back shares, firms increase depth on the sell-side of the market. This effect should be more pronounced for financially constrained firms, of which illiquid stocks benefit more from added market depth. Here, firms can be thought of as buyers of last resort – supporting their market makers and adding downside liquidity in a high information asymmetry environment. Further, the presence of a large buyer in a falling market gives confidence to market participants. Grullon and Ikenberry (2000) find evidence that stock returns of firms that actively repurchase their shares are less sensitive to market-wide movements in declining or bearish markets. In this section, I test for Hypothesis 2 for my sample of ex-ante financially constrained firms from 1992 to 2006. I require all firms to have illiquidity data available throughout the whole period, limiting to 163 constrained firms in 1992, making it 2,445 firm-year observations.

There are two issues to be considered in this analysis. First, share repurchases imply a decision made by managers. Heckman (1979) proposes a two-stage estimation procedure using the inverse Mill's ratio to take account of selection bias. Second, there is possible endogeneity between share repurchases and market liquidity. Brockman et al. (2008) observe that market liquidity plays a significant role in repurchase initiations, as well as recurring payout decisions, while Barclay and Smith (1988) examine liquidity changes following the repurchase decision. To address these two issues, I utilize Heckman-corrected two-stage-least-square (2SLS) regressions. In the first step, I model the probability of doing share repurchases in a given year with a probit model. Firms that do share repurchases are those that have positive repurchase intensity in a given year. Then I calculate the inverse Mill's ratio from this probit estimation and use it in the 2SLS estimation as an exogenous variable.

Table 1.6 reports the results of this approach. Intercepts are not reported. Column 1 reports the results of the probit regression. Column 2 reports the first stage of the 2SLS, and column 3 reports the second stage. The endogenous variables are repurchase intensity and change in illiquidity each year. Change in illiquidity is calculated as the illiquidity of the current year minus the illiquidity of the previous year. The more liquid a stock is, the more negative the change in illiquidity becomes. The instrument variables for repurchase intensity are lagged illiquidity and lagged firm characteristics. Firm characteristics are either KZ components or WW components. The model is:

$$\Pr(\mathrm{Re}\,purchase\ Intensity_{i,t} > 0) = f(Illiquidity_{i,t-1}, Firm\ characteristics_{i,t-1}) \qquad (1)$$

$$\mathrm{Re}\,purchase\ Intensity_{i,t} = g(Illiquidity_{i,t-1}, Firm\ characteristics_{i,t-1}, Inverse\ Mill's\ ratio, Firm\ characteristics_{i,t}) \qquad (2)$$

$$\Delta Illiquidity_{i,t} = h(\mathrm{Re}\,purchase\ Intensity_{i,t}, Inverse\ Mill's\ ratio, Firm\ characteristics_{i,t}) \qquad (3)$$

Insert Table 1.6 here.

In terms of the decision to repurchase shares, the coefficient on lagged illiquidity is statistically significant and positive. This implies that the more illiquid a stock, the more likely the firm repurchases shares. This validates my notion that stock illiquidity motivates firms to repurchase share repurchases in the expectation that doing so increases stock liquidity, consistent with Hypothesis 2. This is inconsistent with Brockman et al. (2008), who suggest higher market liquidity encourages use of repurchases, but their analysis includes unconstrained and constrained firms. Prior literature suggests unconstrained and constrained firms behave differently, so combining both increases the chance that the effect of share repurchases on the liquidity of firms in one group could be masked. Firms with more cash flows, less leverage, less growth opportunities, and less risk, are more likely to repurchase share. The statistically significant negative coefficient on Tobin's Q confirms the investment substitution hypothesis of share repurchase noted in Brav et al. (2005). Firms do share repurchases when they exhaust good investment opportunities.

The 2SLS regressions disentangle the endogenous relationship between share repurchases and market liquidity. The specifications for Table 1.6 Panels A and B are robust to over-identification, valid instruments, and truly endogenous variables restrictions. The key variables here are lagged illiquidity in Column 2 and repurchase intensity in Column 3. Both coefficients are statistically significant and carry predicted signs. The more illiquidity the previous year, the higher the repurchase intensity the current year. Consequently, the higher repurchase intensity, the more negative the change in illiquidity, i.e., the more liquid the stock becomes. In other words, lagged illiquidity prompts firms to repurchase shares, and repurchase intensity enhances market liquidity, consistent with Hypothesis 2. This is also consistent with Hillert et al. (2013), who postulate that firms supply liquidity to the market when they repurchase a large number of shares, and this effect is most pronounced for illiquid markets[12]. My analysis improves upon Hillert et al. (2013) in that I employ 2SLS to control for endogeneity, while they use lagged illiquidity in their OLS regressions and do not control for selection bias.

F. The Impact of Market Liquidity on Corporate Decisions and Market Perception

So far, I have shown that financially constrained firms repurchase shares to enhance their stock liquidity. The more illiquid their stock the prior year, the higher the repurchase intensity the current year, and the more liquid their stock becomes. Why would constrained firms care about market liquidity? Fang et al. (2009) investigate the relation between stock liquidity and firm performance and show that firms with liquid stocks have better performance, as measured

[12] Goettler et al. (2009) argue that limit orders (via share repurchase) are advantageous in illiquid markets because they allow traders to avoid paying the spread.

by the firm market-to-book ratio. This effect is greater for liquid stocks with high business uncertainty (high operating income volatility or high R&D intensity). They suggest stock liquidity improves firm performance through a feedback effect where liquidity stimulates the entry of informed investors who make prices more informative to stakeholders. Liquidity also improves firm performance by increasing the efficiency of performance-sensitive managerial compensation[13]. Additionally, Gopalan et al. (2012) document a positive and economically large relation between stock liquidity and asset liquidity, and the relation is more positive for firms with fewer growth opportunities and financial constraints.

This implies stock liquidity enhancement from share repurchases affect asset liquidity and subsequent financial performance. I test for this argument in the next Section by looking at the impact of improved illiquidity on the characteristics of financially constrained firms, i.e. costly external financing (supply side) and underinvestment (demand side)[14]. Since improved liquidity also implies lower information asymmetry, I also look at market perception of the value added of incremental investments, and firm risk. The predictions for these tests are stated in Section B, Hypothesis 3 through Hypothesis 6.

[13] In Khanna and Sonti (2004), informed traders factor the effect of their trades on managerial behavior into their trading strategy, trading more aggressively, and thus making prices more informative to firm managers and other stakeholders. This feedback effect improves operating performance and relaxes financial constraints. Subrahmanyam and Titman (2001) establish that feedback is more important when the relationship between non-financial stakeholders and the firm is fragile or there is high cash flow uncertainty with respect to existing projects.

[14] Campello et al. (2010) document that constrained firms have deeper cuts in tech spending, employment, and capital spending. They also burn through more cash, draw more heavily on lines of credit, and sell more assets to fund their operations. In additional, the inability to borrow externally causes many firms to bypass attractive investment opportunities.

1. *External Financing*

While financial constraints limit a firm's ability to access external capital, improved stock liquidity reduces transaction costs, reducing the cost of capital. Butler et al. (2005) find that stock liquidity is an important determinant of the cost of raising external capital because both flotation costs and investment banking fees are lower when stock liquidity improves. I examine the effect of improved liquidity on a firm's equity and debt issuances in the period from 1992 to 2006 using Heckman's (1979) two-stage regression to control for selection bias. In the first stage, I model the probability a firm issues equity or debt in a given year with a probit model. Firms that issue equity (debt) are those that have positive equity (debt) issuance. Then I calculate the inverse Mill's ratio from this probit estimation and use it in the OLS estimation as an additional explanatory variable. Specifically, I use the following specification:

$$\begin{aligned} &\Pr(External\,Finance_{i,t} > 0) = f(\Delta Illiquidity_{i,t}, Firm\,characteristics_{i,t-1}) \\ &External\,Finance_{i,t} = g(\Delta Illiquidity_{i,t}, Inverse\,Mill's\,ratio, Firm\,characteristics_{i,t-1}) \end{aligned} \quad (4)$$

where *External Finance* is either equity issuance or debt issuance of firm i in year t. Equity issuance is defined as sales of common and preferred stocks over lagged book assets. Debt issuance is defined as sum of long-term debt issuance and change in current debt over lagged book assets. $\Delta Illiquidity$ is the change in illiquidity, calculated as the illiquidity in the current year minus the illiquidity in the previous year. Firm characteristics are either KZ's components or WW's components.

Table 1.7 reports results of this analysis, predicted by Hypothesis 3. Panel A and B look at equity issuance, while Panel C and D look at debt issuance. The first column in each panel reports results of the first stage of the Heckman model. The second and third columns report the second stage: the second column uses reported change in illiquidity; and the third column uses predicted and residual change in illiquidity. All regressions control for industry fixed effects and cluster by year. Intercepts are not reported.

Insert Table 1.7 here.

For Table 1.7 Panel A of equity issuance, in Column 1, the coefficient on change in illiquidity is negative and statistically significant. The more negative the change in illiquidity, i.e. the more liquidity improves, the more likely a firm issues equity. This is in support of Butler et al. (2005), since the cost of raising equity when liquidity improves is lower. Firms also are more likely to issue equity when they have less cash flow, more cash, pay less dividends. These are the characteristics of constrained firms, the very ones that are in need of external capital. In additional, firms are more likely to issue equity when they have growth opportunities as measured by Tobin's Q, consistent with the notion that firms need more capital to fund their investments. The negative and significant coefficient on stock volatility is in support of Larrain and Varas (2013), who observe that among stocks with high return volatility, those that issue are more likely to have highly negative expected returns. This implies firms are more likely to issue equity when their volatility is low. Column 2 and 3 confirm the probit model in column 1. Firms issue more equity when their liquidity improves.

In Table 1.7, none of the coefficients on change in illiquidity are significant for debt issuance (Panel C and D), implying no relationship between change in illiquidity and debt issuance. There are two caveats to this. First, these are constrained firms only, which tend to be small and less likely to issue public debt. Brown and Petersen (2009) observe that in the last few decades, there has been a sharp increase in the use of public equity finance by young firms, suggesting that stock issues may have become a closer substitute for internal finance. Vo (2013) documents that small firms tend to raise more external equity than debt. Second, improved liquidity is more likely to be beneficial for equity market than debt market. Lipson and Mortal (2009) examine the relation between market liquidity and capital structure and find that firms with more liquid equity have lower leverage and prefer equity financing when raising capital. Similarly, Bharath et al. (2009) show that firms that use a higher percentage of financing through debt, have lower liquidity in the stock market. Firms with higher leverage raise more debt, implying that these are underleveraged firms, consistent with the notion that constrained firms have lower leverage to keep financial slack for precautionary purposes (Hadlock and Pierce, 2010).

In sum, the results shown in this section are consistent with Hypothesis 3.

2. *Internal Investment*

With improved liquidity, constrained firms are able to issue more equity, presumably to fund investment. As a result, their investments should increase with the improved liquidity. Using a panel of Latin American firms, Munoz (2013) find evidence that higher trading volume, a proxy for stock liquidity, is associated with higher firm investment. This relationship is greater for firms with tighter financial constraints and better investment opportunities. Vo (2013) shows that stock liquidity is significantly correlated with R&D activity.

I test for this argument with the following specification:

$$Investments_{i,t} = f(\Delta Illiquidity_{i,t}, Illiquidity_{i,t-1}, Firm\,characteristics_{i,t}) \quad (5)$$

where $Investments$ is defined as the sum of the firm's capital expenditure and R&D expense over lagged book assets. $\Delta Illiquidity$ is the change in illiquidity, calculated as the illiquidity in the current year minus the illiquidity in the previous year. Firm characteristics are either KZ's components or WW's components. Table 1.8 reports the estimates of this panel regression. All regressions are controlled for industry fixed effects and clustered by year. Intercepts are not reported.

Insert Table 1.8 here.

In Table 1.8, the coefficients on change in illiquidity are negative and statistically significant. The more negative the change in illiquidity, i.e. the more liquidity improves, the more investments a firm makes. This result is robust to reported change in illiquidity and predicted and residual change in illiquidity. Lagged illiquidity is included as a control. Its coefficient's sign is negative and significant, implying firms reduce investment if their stock was illiquid the previous year. However, improved liquidity, potentially from stock repurchases, is associated with greater investment, consistent with Hypothesis 4. Signs on control variable coefficients are consistent with the literature. Firms will invest more if they have more cash, less cash flows, more leverage and more growth opportunities.

3. Value Added from Market Perception

Ascioglu et al. (2008) suggest market liquidity captures information asymmetry between informed and uninformed investors. As market liquidity improves, prices become more informative to firm managers and other stakeholders, implying markets now value firm investment more than when their stocks were less liquid. I test for this by constructing a variable called value added (per dollar of incremental investments).

$$Value\,Added_{i,t} = \frac{MVAssets_{i,t} - MVAssets_{i,t-1} - NetEquityIssuance_{i,t} - NetDebtIssuance_{i,t}}{Capex_{i,t} + R\&D_{i,t}}$$

This variable measures the increase in market value of assets, adjusting for net equity issuance and debt issuance, per dollar of investments. The intuition is that as a firm chooses to invest in different projects, the market observes this and reflects its perception of the values of such investments through stock price. When information asymmetry falls, the market is more informed and more likely to place higher value on those investments, increasing the market value of assets. Therefore, changes to the market value of assets due to investments will tend to be greater for firms with reduced information asymmetry. In other words, this is the value added from market perception associated with better transparency. The change in market value of assets needs to be adjusted for net external finance (after share repurchase and/or debt repayment) because market value of assets can also be increased by additional external finance. Since improved liquidity reduces information asymmetry, I anticipate an increase in the value added variable, stated in Hypothesis 5. I test for this prediction using the following specification:

$$Value\ Added_{i,t} = f(\Delta Illiquidity_{i,t}, Firm\ characteristics_{i,t}) \quad (6)$$

Table 1.9 reports estimates of this panel regression, controlling for industry fixed effects and clustering by year. Intercepts are not reported. The sample period is from 1992 to 2006, for a sample of 163 constrained firms in 1992. The control variables are either the KZ's components or the WW's components. The first column uses calculated change in illiquidity, and the second uses predicted and residual changes in illiquidity.

Insert Table 1.9 here.

In Table 1.9, the coefficient on change in illiquidity is negative and statistical significant. The more negative the change in illiquidity, the greater the value added from investments. In other words, as liquidity improves, the market places higher values on firms' investments, consistent with Hypothesis 5. Fang et al. (2009) use Tobin's Q (calculated as market value of assets divided by book value of assets) as the main measure of firm performance and show that a positive relationship between stock market liquidity and Tobin's Q. Since this variable can also be considered to measure how the market values the book assets, their finding is consistent with my results. The signs on control variables are also as predicted. Firms with more cash flows and more cash are viewed more positively by market. Firms that pay dividends are not. This is consistent with the lack of information content of dividends. Firms with more growth opportunities are also viewed more positively.

4. Risk

Investors are concerned about stock liquidity. It affects their ability to trade the quantity of stocks they want to buy or sell within their desired time-framework at low cost and without price impact. Most importantly, investors fear that in the event of a financial crisis, they may not be able to exit the market fast enough to contain their losses. These considerations may lead them to avoid illiquid securities, or require a liquidity-related risk premium to hold them (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005). This implies risk is higher for illiquid stocks. As share repurchases enhance liquidity, I expect reduced risk. However, the effect of improved liquidity may be different for systematic and idiosyncratic risk, given that systematic risk can be hedged. Baruch et al. (2007) and Baruch and Saar (2009) argue that stock return co-movement affects the trading activity of a stock and therefore its liquidity. This is because the correlation of stock returns with the market measures the amount of market-wide information relative to firm-specific information. While market makers can observe the market-wide information easily, it is more difficult for them to observe firm-specific information. When an individual stock is highly correlated with the market, market makers can rely more on the information they observe from market movements, so stock price adjustments are less sensitive to its own order flow. Conversely, when stocks are more liquid, investors rely more on market-wide information, increasing their systematic risk. This implies a positive correlation between systematic risk and improved liquidity. Chan et al (2013) confirm this prediction and demonstrate that this relationship is stronger for stock with a higher degree of information asymmetry. Therefore, I predict enhanced liquidity reduces risk via reduced idiosyncratic risk, and increases systematic risk, as stated in Hypothesis 6.

I test for this prediction using the following specification:

$$Risk_{i,t} = f(\Delta Illiquidity_{i,t}, Illiquidity_{i,t-1}, Firm\,characteristics_{i,t}) \quad (7)$$

where $Risk$ is either total risk, systematic risk or idiosyncratic risk. Total risk is defined as the annualized standard deviation of daily stock returns during the fiscal year. Systematic risk is defined as the market return slope coefficient (beta) estimated from Fama-French's (1993) 3-factor model. Idiosyncratic risk is defined as the annualized standard deviation of the residuals from Fama - French's (1993) 3-factor model. Table 1.10 reports the OLS results for this analysis, controlling for industry fixed effects and clustering by year. Intercepts are not reported. The control variables are either KZ’s components or WW’s components.

Insert Table 1.10 here.

In Table 1.10, signs of coefficients on change in illiquidity confirm my predictions, and are all statistically significant. The more negative the change in illiquidity, the less the total risk and idiosyncratic risk, and the greater the systematic risk. As liquidity improves, total risk and idiosyncratic risk are reduced, and systematic risk increases, consistent with Hypothesis 6. Lagged illiquidity is included as a control for the level of illiquidity in the previous year. The signs of the coefficients on this variable are also consistent with previous literature. Illiquid stocks have more idiosyncratic risk and less systematic risk. Other control variables also show consistent signs. Firms with more cash flows, more dividends and lower leverage have lower risk. Firms with greater growth opportunities have more risk, due to the uncertainty of their future cash flows. Additionally, even after controlling for factors affecting risk, liquidity still shows up as an important factor. This is consistent with the notion of liquidity risk documented in the previous literature (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005; Martinez et al., 2005; Amihud et al., 2006). Lin and Paravisini (2012) argue that financial constraints increase cash flow volatility by making investments sensitive to internal cash and reduce a firm's ability to mitigate the impact of aggregate shocks on dividend streams. As financial constraints increase a firm's risk, share repurchase alleviates this problem by enhancing liquidity, reducing risk.

G. Conclusions

In this paper, I study the liquidity choice of firms. Although many of the firm's actions are known to influence stock liquidity, the literature tends to view stock liquidity as an exogenously determined variable. I directly test for firms' influence on stock liquidity by focusing on firms most likely to value stock liquidity due to their costly external financing and stock illiquidity, i.e., financially constrained firms. The existing literature shows such constraints have substantial effects on a variety of corporate decisions, including investment and capital structure choices. Financially constrained firms take actions that help improve their stock liquidity, notably by engaging in share repurchases.

I find strong empirical evidence in support of this prediction in my sample of 183 financially constrained public U.S. firms between 1992 and 2006. Financially constrained firms have less liquid stocks, but those that have greater repurchase intensity are more likely to become unconstrained ex-post. This suggests these firms take steps to improve stock liquidity. I find lagged illiquidity prompts firms to engage in share repurchase, concurrently improving their stock liquidity. The preference of financially constrained firms for greater liquidity is reflected in a variety of favorable corporate decisions and market perception. I find that increases in liquidity are related to more equity issuance, greater investment, greater value added from market perception per dollar of incremental investments, and reduced idiosyncratic risk.

Overall, I find strong evidence of firms being able to influence stock liquidity by engaging in share repurchases that mitigate information asymmetry. This is especially true for firms that are most vulnerable to and most affected by informational asymmetries. This paper also explains a counter-intuitive fact about share repurchase in constrained firms. While share repurchases reduce cash balances and add financial leverage, constrained firms seem to be especially sensitive to this decline in corporate liquidity. However, by acting as buyers of last resort, these firms see their stock liquidity improves and advance their financial status. These findings show economic meaning linking market microstructure with corporate finance.

H. References

Acharya, Viral V., and Lasse H. Pedersen, 2005, Asset pricing with liquidity risk, *Journal of Financial Economics* 77, 375-410.

Almeida, Heitor, Murillo Campello, and Michael S. Weisbach, 2004, The cash flow sensitivity of cash, *Journal of Finance*, 1777-1804.

Almeida, Heitor, and Murillo Campello, 2002, Financial Constraints and Investment-Cash Flow Sensitivities: New Research Directions, *Unpublished working paper*, New York University.

Almeida, Heitor, and Murillo Campello, 2007, Financial Constraints, Asset Tangibility, and Corporate Investment, *Review of Financial Studies* 20, 1429-1460.

Amihud, Yakov, Haim Mendelson, and Lasse H. Pedersen, 2006, Liquidity and Asset Prices, *Foundations and Trends in Finance* 1, 269-364.

Amihud, Yakov, and Haim Mendelson, 1986, Asset pricing and the bid-ask spread, *Journal of Financial Economics* 17, 223-249.

Amihud, Yakov, and Haim Mendelson, 2012, Liquidity, the Value of the Firm, and Corporate Finance, *Journal of Applied Corporate Finance* 24, 17-32.

Amihud, Yakov, 2002, Illiquidity and stock returns: cross-section and time-series effects, *Journal of Financial Markets* 5, 31-56.

Ascioglu, Asli, Shantaram P. Hegde, and John B. McDermott, 2008, Information asymmetry and investment–cash flow sensitivity, *Journal of Banking & Finance* 32, 1036-1048.

Baker, Malcolm, Jeremy C. Stein, and Jeffrey Wurgler, 2003, When Does the Market Matter? Stock Prices and the Investment of Equity-Dependent Firms, *Quarterly Journal of Economics* 118, 969-1005.

Balakrishnan, Karthik, Mary B. Billings, Bryan T. Kelly, and Alexander Ljungqvist, 2013, Shaping Liquidity: On the Causal Effects of Voluntary Disclosure, *Journal of Finance forthcoming*.

Banyi, Monica L., Edward A. Dyl, and Kathleen M. Kahle, 2008, Errors in estimating share repurchases, *Journal of Corporate Finance* 14, 460-474.

Barclay, Michael J., and Clifford W. Smith Jr., 1988, Corporate payout policy: Cash Dividends versus Open-Market Repurchases, *Journal of Financial Economics* 22, 61-82.

Baruch, Shmuel, G. Andrew Karolyi, and Michael L. Lemmon, 2007, Multimarket Trading and Liquidity: Theory and Evidence, *Journal of Finance* 62, 2169-2200.

Baruch, Shmuel, and Gideon Saar, 2009, Asset Returns and the Listing Choice of Firms, *Review of Financial Studies* 22, 2239-2274.

Becker-Blease, John R., and Donna L. Paul, 2006, Stock Liquidity and Investment Opportunities: Evidence from Index Additions, *Financial Management* 35, 35-51.

Bekaert, Geert, Campbell R. Harvey, and Christian Lundblad, 2007, Liquidity and expected returns: Lessons from emerging markets, *Review of Financial Studies* 20, 1783-1831.

Bharath, Sreedhar T., Paolo Pasquariello, and Guojun Wu, 2009, Does Asymmetric Information Drive Capital Structure Decisions? *Review of Financial Studies* 22, 3211-3243.

Brav, Alon, John R. Graham, Campbell R. Harvey, and Roni Michaely, 2005, Payout policy in the 21st century, *Journal of Financial Economics* 77, 483-527.

Brennan, Michael J., Tarun Chordia, Avanidhar Subrahmanyam, and Qing Tong, 2012, Sell-order liquidity and the cross-section of expected stock returns, *Journal of Financial Economics* 105, 523-541.

Brennan, Michael J., Tarun Chordia, and Avanidhar Subrahmanyam, 1998, Alternative factor specifications, security characteristics, and the cross-section of expected stock returns, *Journal of Financial Economics* 49, 345-373.

Brennan, Michael J., and Avanidhar Subrahmanyam, 1996, Market microstructure and asset pricing: On the compensation for illiquidity in stock returns, *Journal of Financial Economics* 41, 441-464.

Brockman, Paul, and Dennis Y. Chung, 2001, Managerial timing and corporate liquidity: evidence from actual share repurchases, *Journal of Financial Economics* 61, 417-448.

Brockman, Paul, John S. Howe, and Sandra Mortal, 2008, Stock market liquidity and the decision to repurchase, *Journal of Corporate Finance* 14, 446-459.

Brown, James R., and Bruce C. Petersen, 2009, Why has the investment-cash flow sensitivity declined so sharply? Rising R&D and equity market developments, *Journal of Banking & Finance* 33, 971-984.

Butler, Alexander W., Gustavo Grullon, and James P. Weston, 2005, Stock Market Liquidity and the Cost of Issuing Equity, *Journal of Financial and Quantitative Analysis* 40, 331-348.

Campello, Murillo, John R. Graham, and Campbell R. Harvey, 2010, The real effects of financial constraints: Evidence from a financial crisis, *Journal of Financial Economics* 97, 470-487.

Chan, Kalok, Allaudeen Hameed, and Wenjin Kang, 2013, Stock price synchronicity and liquidity, *Journal of Financial Markets* 16, 414-438.

Chen, Qi, Itay Goldstein, and Wei Jiang, 2007, Price Informativeness and Investment Sensitivity to Stock Price, *Review of Financial Studies* 20, 619-650.

Chen, Sheng-Syan, and Yanzhi Wang, 2012, Financial constraints and share repurchases, *Journal of Financial Economics* 105, 311-331.

Chollete, Lorán, Randi Næs, and Johannes A. Skjeltorp, 2007, What captures liquidity risk? A comparison of trade and order based liquidity factors, *Working paper*, Norges Bank, Norway.

Chordia, Tarun, Sahn-Wook Huh, and Avanidhar Subrahmanyam, 2009, Theory-Based Illiquidity and Asset Pricing, *Review of Financial Studies* 22, 3629-3668.

Chordia, Tarun, Richard Roll, and Avanidhar Subrahmanyam, 2005, Evidence on the speed of convergence to market efficiency, *Journal of Financial Economics* 76, 271-292.

Chordia, Tarun, Richard Roll, and Avanidhar Subrahmanyam, 2008, Liquidity and market efficiency, *Journal of Financial Economics* 87, 249-268.

Chung, Dennis Y., Dussan Isakov, and Christophe Pérignon, 2007, Repurchasing Shares on a Second Trading Line, *Review of Finance* 11, 253-285.

Cleary, Sean, Paul Povel, and Michael Raith, 2007, The U-Shaped Investment Curve: Theory and Evidence, *Journal of Financial and Quantitative Analysis* 42, 1-39.

Cook, Douglas O., Laurie Krigman, and J. C. Leach, 2004, On the Timing and Execution of Open Market Repurchases, *Review of Financial Studies* 17, 463-498.

Dass, Nishant, Vikram N, and Steven C. Xiao, 2012, Do Firms Choose Their Stock Liquidity? A Study of Innovative Firms and Their Stock Liquidity, *Working paper,* Georgia Institute of Technology.

Datar, Vinay T., Narayan Y. Naik, and Robert Radcliffe, 1998, Liquidity and stock returns: An alternative test, *Journal of Financial Markets* 1, 203-219.

De Cesari, Amedeo, Susanne Espenlaub, Arif Khurshed, and Michael Simkovic, 2012, The effects of ownership and stock liquidity on the timing of repurchase transactions, *Journal of Corporate Finance* 18, 1023-1050.

Duarte, Jefferson, and Lance Young, 2009, Why is PIN priced?, *Journal of Financial Economics* 91, 119-138.

Duchin, Ran, Oguzhan Ozbas, and Berk A. Sensoy, 2010, Costly external finance, corporate investment, and the subprime mortgage credit crisis, *Journal of Financial Economics* 97, 418-435.

Easley, David, Soeren Hvidkjaer, and Maureen O'Hara, 2002, Is Information Risk a Determinant of Asset Returns? *Journal of Finance* 57, 2185-2221.

Fama, E. F., and K. R. French, 1993, Common Risk-Factors in the Returns on Stocks and Bonds, *Journal of Financial Economics* 33, 3-56.

Fama, Eugene F., and Kenneth R. French, 2001, Disappearing dividends: changing firm characteristics or lower propensity to pay? *Journal of Financial Economics* 60, 3-43.

Fang, Vivian W., Thomas H. Noe, and Sheri Tice, 2009, Stock market liquidity and firm value, *Journal of Financial Economics* 94, 150-169.

Fazzari, Steven, R. G. Hubbard, and Bruce C. Petersen, 1988, Financing Constraints and Corporate Investment, *Brookings Papers on Economic Activity* 1, 141-206 .

Franz, Diana R., Ramesh P. Rao, and Niranjan Tripathy, 1995, Informed Trading Risk and Bid-Ask Spread Changes around Open Market Stock Repurchases in the NASDAQ Market, *Journal of Financial Research* 18, 311-327.

Froot, Kenneth A., David S. Scharfstein, and Jeremy C. Stein, 1993, Risk Management: Coordinating Corporate Investment and Financing Policies, *Journal of Finance* 48, 1629-1658.

Ginglinger, Edith, and Jacques Hamon, 2007, Actual share repurchases, timing and liquidity, *Journal of Banking & Finance* 31, 915-938.

Gomes, Joao F., 2001, Financing Investment, *American Economic Review* 91, 1263-1285.

Gopalan, Radhakrishnan, Ohad Kadan, and Mikhail Pevzner, 2012, Asset Liquidity and Stock Liquidity, *Journal of Financial and Quantitative Analysis* 47, 333-364.

Goyenko, Ruslan Y., Craig W. Holden, and Charles A. Trzcinka, 2009, Do liquidity measures measure liquidity? *Journal of Financial Economics* 92, 153-181.

Grinstein, Yaniv, and Roni Michaely, 2005, Institutional Holdings and Payout Policy, *Journal of Finance* 60, 1389-1426.

Grossman, Sanford J., and Joseph E. Stiglitz, 1980, On the Impossibility of Informationally Efficient Markets, *American Economic Review* 70, 393-408.

Grullon, Gustavo, and David L. Ikenberry, 2000, What do we know about stock repurchase? *Journal of Applied Corporate Finance* 13, 31-51.

Grullon, Gustavo, and Roni Michaely, 2002, Dividends, Share Repurchases, and the Substitution Hypothesis, *Journal of Finance* 57, 1649-1684.

Guay, Wayne, and Jarrad Harford, 2000, The cash-flow permanence and information content of dividend increases versus repurchases, *Journal of Financial Economics* 57, 385-415.

Hadlock, Charles J., and Joshua R. Pierce, 2010, New Evidence on Measuring Financial Constraints: Moving Beyond the KZ Index, *Review of Financial Studies* 23, 1909-1940.

Hasbrouck, Joel, 2009, Trading Costs and Returns for U.S. Equities: Estimating Effective Costs from Daily Data, *Journal of Finance* 64, 1445-1477.

Heckman, James J., 1979, Sample Selection Bias as a Specification Error, *Econometrica* 47, 153-161.

Hennessy, Christopher A., Amnon Levy, and Toni M. Whited, 2007, Testing Q theory with financing frictions, *Journal of Financial Economics* 83, 691-717.

Hennessy, Christopher A., and Toni M. Whited, 2007, How Costly Is External Financing? Evidence from a Structural Estimation, *Journal of Finance* 62, 1705-1745.

Hillert, Alexander, Ernst G. Maug, and Stefan Obernberger, 2013, Stock Repurchases and Liquidity, *Working paper*, University of Mannheim.

Holmström, Bengt, and Jean Tirole, 1993, Market Liquidity and Performance Monitoring, *Journal of Political Economy* 101, 678-709.

Jagannathan, Murali, Clifford P. Stephens, and Michael S. Weisbach, 2000, Financial flexibility and the choice between dividends and stock repurchases, *Journal of Financial Economics* 57, 355-384.

Jensen, M. C., 1986, Agency Costs of Free Cash Flow, Corporate-Finance, and Takeovers, *American Economic Review* 76, 323-329.

Kahle, Kathleen M., 2002, When a buyback isn't a buyback: open market repurchases and employee options, *Journal of Financial Economics* 63, 235-261.

Kamara, Avraham, Xiaoxia Lou, and Ronnie Sadka, 2008, The divergence of liquidity commonality in the cross-section of stocks, *Journal of Financial Economics* 89, 444-466.

Kaplan, Steven N., and Luigi Zingales, 1997, Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints? *The Quarterly Journal of Economics* 112, 169-215.

Kyle, Albert S., and Jean-Luc Vila, 1991, Noise Trading and Takeovers, *RAND journal of economics* 22, 54-71.

Lamont, O., C. Polk, and J. Saá-Requejo, 2001, Financial constraints and stock returns, *Review of Financial Studies* 14, 529-554.

Larrain, Borja, and Felipe Varas, 2013, Equity Issues and Return Volatility, *Review of Finance* 17, 767-808.

Lee, Kuan-Hui, 2011, The world price of liquidity risk, *Journal of Financial Economics* 99, 136-161.

Lesmond, David A., Philip F. O'Connor, and Lemma W. Senbet, 2008, Capital Structure and Equity Liquidity, *Working paper*, Tulane University.

Li, Dongmei, 2011, Financial Constraints, R&D Investment, and Stock Returns, *Review of Financial Studies* 24, 2974-3007.

Lin, Huidan, and Daniel Paravisini, 2013, The Effect of Financing Constraints on Risk, *Review of Finance* 17, 229-259.

Lipson, Marc L., and Sandra Mortal, 2009, Liquidity and capital structure, *Journal of Financial Markets* 12, 611-644.

Liu, Weimin, 2006, A liquidity-augmented capital asset pricing model, *Journal of Financial Economics* 82, 631-671.

Martínez, Miguel A., Belén Nieto, Gonzalo Rubio, and Mikel Tapia, 2005, Asset pricing and systematic liquidity risk: An empirical investigation of the Spanish stock market, *International Review of Economics & Finance* 14, 81-103.

Massa, Massimo, Zahid Rehman, and Theo Vermaelen, 2007, Mimicking repurchases, *Journal of Financial Economics* 84, 624-666.

Maug, Ernst, 1998, Large Shareholders as Monitors: Is There a Trade-Off between Liquidity and Control, *Journal of Finance* 53, 65-98.

Miller, James M., and John J. McConnell, 1995, Open-Market Share Repurchase Programs and Bid-Ask Spreads on the NYSE: Implications for Corporate Payout Policy, *Journal of Financial and Quantitative Analysis* 30, 365-382.

Muñoz, Francisco, 2013, Liquidity and firm investment: Evidence for Latin America, *Journal of Empirical Finance* 20, 18-29.

Pastor, Lubos, and Robert F. Stambaugh, 2003, Liquidity Risk and Expected Stock Returns, *Journal of Political Economy* 111, 642-685.

Rasbrant, Jonas, and Adri De Ridder, 2013, The Liquidity Impact of Open Market Share Repurchases, *Unpublished working paper*, Uppsala University.

Rauh, Joshua D., 2006, Investment and Financing Constraints: Evidence from the Funding of Corporate Pension Plans, *Journal of Finance* 61, 33-71.

Singh, Ajai K., Mir A. Zaman, and Chandrasekhar Krishnamurti, 1994, Liquidity Changes Associated with Open Market Repurchases, *Financial Management* 23, 47-55.

Stephens, Clifford P., and Michael S. Weisbach, 1998, Actual Share Reacquisitions in Open-Market Repurchase Programs, *Journal of Finance* 53, 313-333.

Tirole, Jean, 2006, The theory of corporate finance, *Princeton University Press*, Princeton, NJ.

Vayanos, Dimitri, and Jiang Wang, 2012, Market Liquidity - Theory and Empirical Evidence, *Handbook of the Economics of Finance*, NBER.

Vo, Lai V., 2013, Stock Market Liquidity and Innovation Activity, *Working paper*, Louisiana State University.

Whited, Toni M., and Guojun Wu, 2006, Financial Constraints Risk, *Review of Financial Studies* 19, 531-559.

Whited, Toni M., 1992, Debt, Liquidity Constraints, and Corporate Investment: Evidence from Panel Data, *Journal of Finance* 47, 1425-1460.

Wiggins, James B., 1994, Open Market Stock Repurchase Programs and Liquidity, *Journal of Financial Research* 17, 217-229.

I. Appendix

Variable	Definition
Amihud illiquidity	The average ratio of the daily absolute return to the dollar trading volume on that day.
Cash	Cash balances over lagged book assets
Cash flows	Cash flow over lagged book assets
Debt issuance	Sum of long-term debt issuance and change in current debt over lagged book assets
Dividend	Cash dividends over lagged book assets
Dividend dummy	Equals one if the firm pays cash dividend and zero otherwise
Equity issuance	Sales of common and preferred stock over lagged book assets
HP index	Hadlock and Pierce's (2010) index
Idiosyncratic risk	Annualized standard deviation of the residuals from Fama - French's (1993) 3-factor model
Income	Income before extraordinary items
Industry sales growth	The firm's three-digit industry sales growth
Investment	Sum of capital expenditure and R&D expense over lagged book assets
Leverage	Sum of long-term debt and current debt over lagged book assets
Long-term debt	Long-term debt over lagged book asssets
Market capitalization	Market value of common equity
Repurchase amount	Item PRSTKC in Compustat - purchase of common and preferred stocks
Repurchase intensity	Repurchase amount divided by the total dollar trading volume over the fiscal year
Sales growth	The firm's sales growth
Stock volatility	Annualized standard deviation of daily stock returns
Systematic risk	Market return slope coefficient (beta) estimated from Fama-French's (1993) 3-factor model
Tobin's Q	The ratio of the market-to-book value of the firm's assets
Total assets	Book assets
Value added	Value added per dollar of incremental investment

J. Figures

Figure 1.1 – Stock market liquidity, share repurchase and equity issuance over time

This graph shows the mean values of stock market liquidity against share repurchase and equity issuance amount from 1989 to 2011. Stock market liquidity is based on Amihud (2002)'s illiquidity measure of all firms in the CRSP database during that period. Repurchase amount is the repurchase amount of all firms reported in Compustat. Equity issuance is mean sales of common and preferred stocks of all firms reported in Compustat.

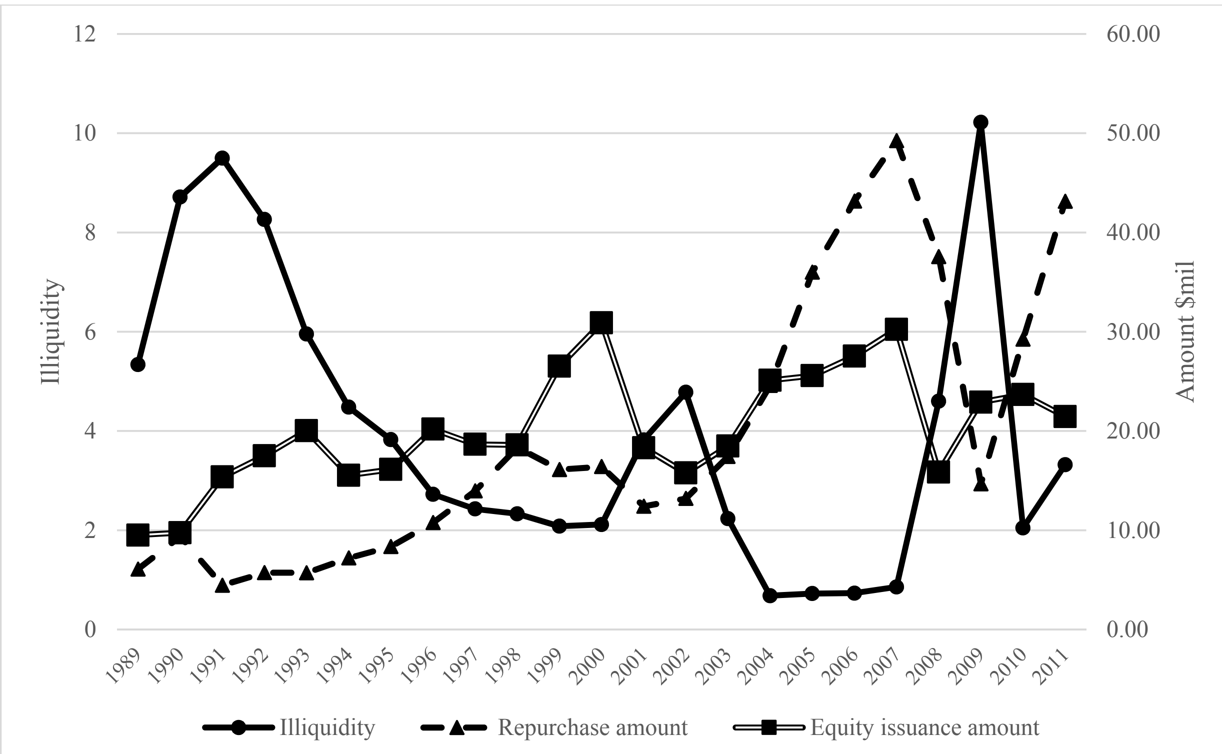
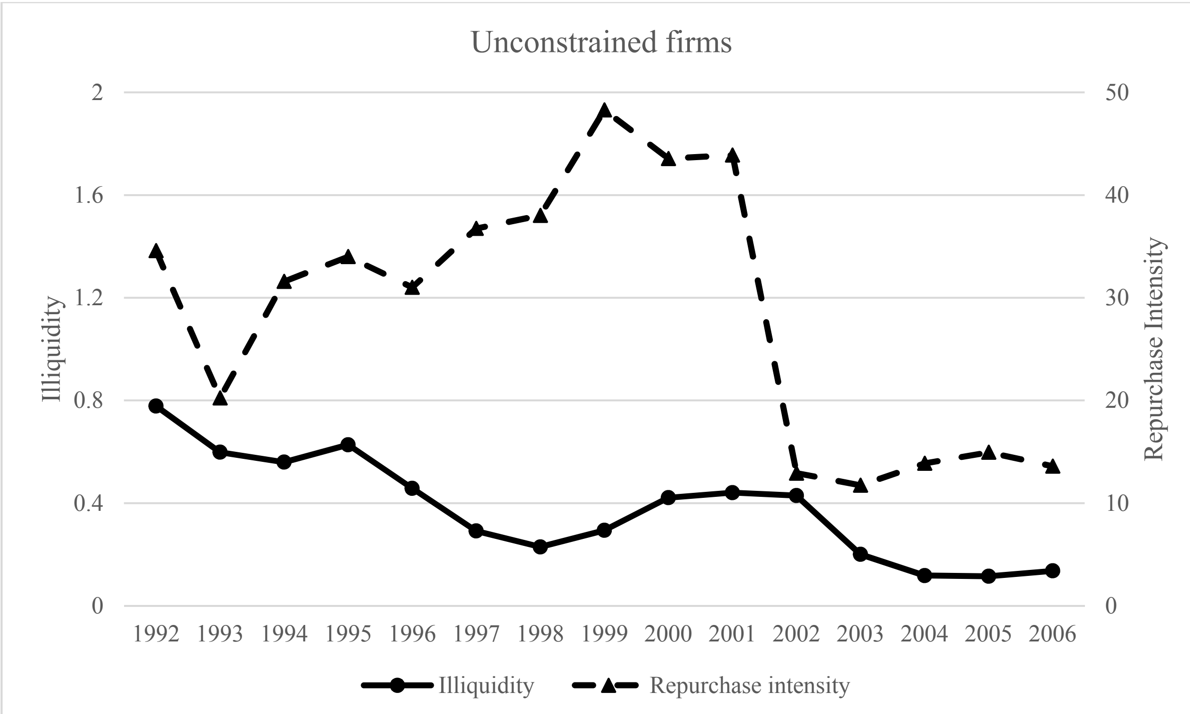
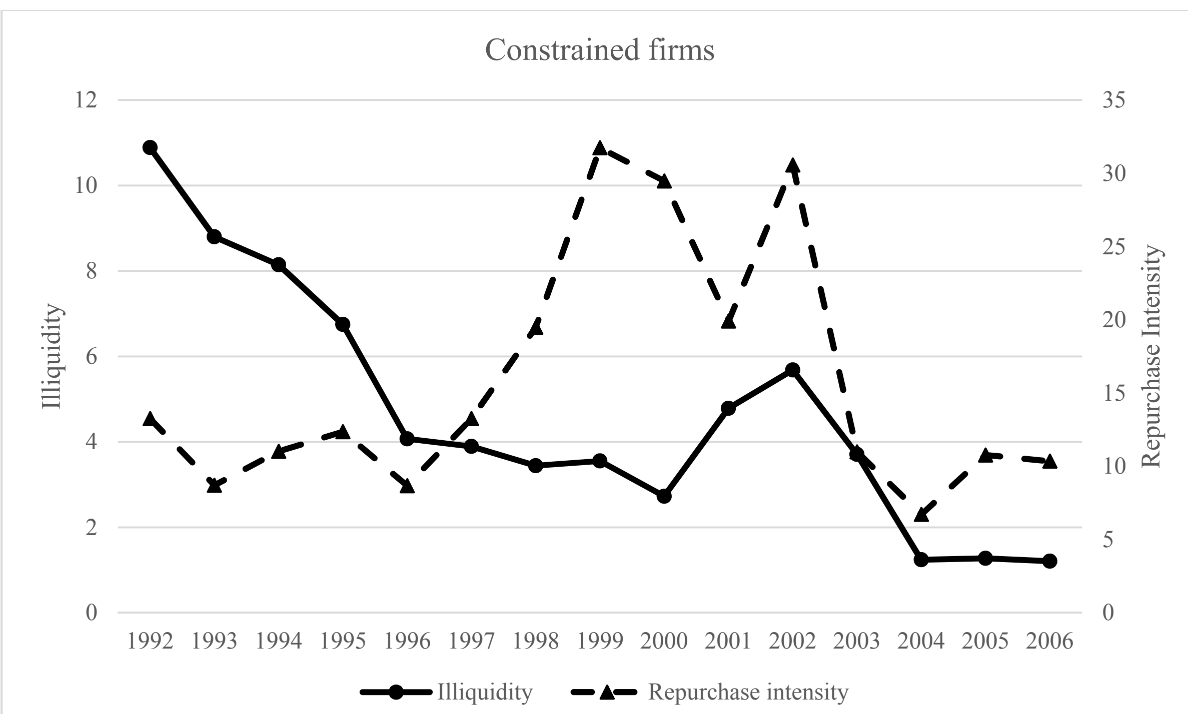


Figure 1.2 – Stock liquidity and repurchase intensity on financial constraint status

This graph plots the mean value of Amihud (2002)'s illiquidity measure against repurchase intensity from 1992 to 2006 for unconstrained vs. constrained firms. Repurchase intensity is measured as repurchase amounts divided by dollar volume trading of repurchase firms.





K. Tables

Table 1.1 – Firm distribution

This table reports the frequency of firms for three groups of firms: financially unconstrained, financially sufficient and financially constrained at the beginning of the sample period 1992 and at the end of the sample period 2006. 1,082 sample firms have to have data available throughout 1992 – 2006. Firms are classified for financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index, and financially unconstrained firms in the 40th tercile. Financially sufficient firms are the remaining firms in the middle tercile.

Panel A: Full Sample

		1992			
		Unconstrained	Sufficient	Constrained	Total
2006	Unconstrained	603	196	99	898
	Sufficient	0	24	68	92
	Constrained	0	8	84	92
	Total	603	228	251	1082

Panel B: Unconstrained vs. Constrained Sample

		1992		
		Unconstrained	Constrained	Total
2006	Unconstrained	603	99	702
	Constrained	0	84	84
	Total	603	183	786

Table 1.2 – Financial constraint and firm characteristics

This table reports mean values of firm characteristics for three groups of firms: financially unconstrained, financially sufficient and financially constrained. 1,082 sample firms have to have data available throughout 1992 – 2006. Firms are classified by financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index, and financially unconstrained firms in the 40th tercile. Financially sufficient firms are the remaining firms in the middle tercile. Variables are described in the Appendix. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Firm characteristics in 1992 per financial constraint status

	Unconstrained	Sufficient	Constrained	Unconstrained vs. Constrained
Market value	4,466.37	283.97	94.71	**4,371.66*** **
Total assets	3,381.30	146.18	31.26	**3,350.04*** **
Income	159.66	5.79	-0.50	**160.16*** **
Cash flows	0.11	0.11	0.02	**0.09*** **
Dividend	0.02	0.01	0.00	**0.02*** **
Cash	0.11	0.20	0.33	**-0.22*** **
Leverage	0.24	0.22	0.14	**0.09*** **
Tobin's Q	2.16	2.20	3.56	**-1.40*** **
Investment	0.10	0.13	0.17	**-0.07*** **
N	603	228	251	

Panel B: Firm characteristics in 2006 per financial constraint status

	Unconstrained	Sufficient	Constrained	Unconstrained vs. Constrained
Market value	5,319.27	133.14	39.63	**5,279.64*** **
Total assets	5,844.74	79.53	21.13	**5,823.61*** **
Income	292.28	-3.98	-1.92	**294.20*** **
Cash flows	0.11	-0.01	-0.05	**0.16*** **
Dividend	0.01	0.01	0.02	0.00
Cash	0.16	0.30	0.32	**-0.16*** **
Leverage	0.20	0.13	0.14	**0.06*** **
Tobin's Q	1.80	1.97	2.40	**-0.60** **
Investment	0.09	0.13	0.16	**-0.07*** **
N	898	92	92	

Table 1.3 – Financial constraint and corporate payouts

This table reports the mean values of firm cumulative payout activity for three groups of firms: financially unconstrained, financially sufficient and financially constrained in 1992. 1,082 sample firms have data available throughout 1992 – 2006. Firms are classified by financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index, and financially unconstrained firms in the 40th tercile. Financially sufficient firms are the remaining firms in the middle tercile. Illiquidity is Amihud's (2002) illiquidity adjusted for the three main exchanges NYSE, AMEX and NASDAQ. Variables are described in the Appendix.

	N	Mean	Standard Deviation	25th percentile	Median	75th percentile
Panel A: Unconstrained firms in 1992						
HP-Index 1992	603	-3.85	0.42	-4.23	-3.89	-3.45
Illiquidity 1992	603	-3.76	5.42	-9.71	-1.03	-1.02
HP-Index 2006	603	-4.37	0.29	-4.63	-4.49	-4.12
Illiquidity 2006	603	-0.13	1.08	-0.02	-0.02	-0.02
Cumulative dividend amount	603	1,254.13	2,589.87	41.40	204.19	920.48
Cumulative dividend ratio	603	1.65%	2.37%	0.64%	1.42%	2.05%
Cumulative repurchase amount	603	1,182.05	2,057.23	31.44	237.54	1,331.31
Cumulative repurchase intensity	603	21.13	30.81	4.32	12.20	25.03
Panel B: Sufficient firms in 1992						
HP-Index 1992	228	-2.87	0.14	-3.00	-2.86	-2.76
Illiquidity 1992	228	-4.10	11.53	-10.58	-8.82	-0.96
HP-Index 2006	228	-3.66	0.30	-3.86	-3.70	-3.49
Illiquidity 2006	228	-0.17	2.20	-1.01	-0.89	-0.02
Cumulative dividend amount	228	51.77	168.00	0.00	3.17	34.06
Cumulative dividend ratio	228	1.43%	3.16%	0.00%	0.44%	1.46%
Cumulative repurchase amount	228	191.24	601.63	2.58	17.54	87.94
Cumulative repurchase intensity	228	16.60	31.98	1.05	5.90	15.27
Panel C: Constrained firms in 1992						
HP-Index 1992	251	-2.10	0.45	-2.48	-2.21	-1.82
Illiquidity 1992	251	-1.96	15.66	-10.54	-8.74	-1.01
HP-Index 2006	251	-3.18	0.49	-3.56	-3.24	-2.88
Illiquidity 2006	251	0.35	3.27	-1.01	-0.94	-0.02
Cumulative dividend amount	251	7.77	26.24	0.00	0.00	4.34
Cumulative dividend ratio	251	0.80%	2.11%	0.00%	0.00%	0.70%
Cumulative repurchase amount	251	37.36	146.01	0.00	1.61	13.85
Cumulative repurchase intensity	251	8.51	19.57	0.00	1.13	8.05

Table 1.4 – Predicting Firms' "Financial Constrained" Status in 1992

This table reports the estimates of probit regressions, predicting whether a firm is financially unconstrained or constrained in 1992 given its firm characteristics and illiquidity measures in 1992. The probability that a firm is unconstrained is modeled. 786 sample firms of either unconstrained or constrained have data available throughout 1992 – 2006. Firms are classified by financial constraint status based on their HP index. Financially constrained firms are firms in the 60^{th} tercile of the HP index, and financially unconstrained firms in the 40^{th} tercile. Illiquidity is Amihud's (2002) illiquidity adjusted for the three main exchanges NYSE, AMEX and NASDAQ. Variables are described in the Appendix. Intercepts not reported. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Predicted signs are indicated in parentheses.

	Prob(Unconstrained in 1992) (1)	*Prob(Unconstrained in 1992)* (2)
Illiquidity 1992 (–)	**-0.035*** **	**-0.02*** **
	(0.01)	**(0.01)**
Cash flows 1992	**2.4*** **	**1.428*** **
	(0.61)	**(0.48)**
Cash 1992	**-1.49*** **	
	(0.36)	
Dividend 1992	**43.648*** **	
	(5.82)	
Leverage 1992	**1.758*** **	
	(0.42)	
Tobin's Q 1992	**-0.222*** **	
	(0.04)	
Dividend Dummy 1992		**1.704*** **
		(0.13)
Long-term Debt 1992		**2.628*** **
		(0.42)
Sales Growth 1992		**-0.566*** **
		(0.17)
Industry Sales Growth 1992		-0.895
		(0.88)
Number of firms	786	786
Prob > chi-square	<.0001	<.0001
Pseudo R^2	0.511	0.529

Table 1.5 – Predicting Firms' "Financial Constrained" Status in 2006

This table reports the estimates of conditional probit regressions, predicting whether a firm is financially unconstrained in 2006 given that it is constrained in 1992. The probability that a firm is unconstrained is modelled. The sample consists of 183 constrained firms in 1992. Firms are classified by financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index, and financially unconstrained firms in the 40th tercile. Illiquidity is Amihud's (2002) illiquidity adjusted for three main exchanges NYSE, AMEX and NASDAQ. Variables are described in the Appendix. Intercepts not reported. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Predicted signs are indicated in parentheses.

Given firms are constrained in 1992		*Prob(Unconstrained in 2006)* (1)	*Prob(Unconstrained in 2006)* (2)
Cumulative repurchase intensity	(+)	**0.019****	**0.018***
		(0.01)	**(0.01)**
Cumulative dividend ratio	(–)	**-0.482*****	**-0.535*****
		(0.16)	**(0.17)**
Illiquidity 2006	(–)	**-1.078*****	**-0.994*****
		(0.25)	**(0.23)**
Cash flows 2006		**1.98*****	**2.174*****
		(0.61)	**(0.52)**
Cash 2006		0.137	
		(0.38)	
Leverage 2006		**2.308*****	
		(0.86)	
Tobin's Q 2006		-0.076	
		(0.08)	
Long-term Debt 2006			**2.122*****
			(0.77)
Sales Growth 2006			**0.965****
			(0.45)
Industry Sales Growth 2006			1.112
			(1.21)
Number of firms		183	183
Prob > chi-square		<.0001	<.0001
Pseudo R^2		0.562	0.596

Table 1.6 – Illiquidity and Repurchase Intensity

This table reports the estimates of Heckman-corrected 2SLS regressions on the relationship between repurchase activity and the exchange-adjusted Amihud's (2002) illiquidity measure. The sample period is from 1992 to 2006 for all 163 financially constrained firms in 1992. The endogenous variables are repurchase intensity and change in illiquidity. Firms are classified by financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index. Illiquidity is Amihud's (2002) illiquidity adjusted for the three main exchanges NYSE, AMEX and NASDAQ. Change in illiquidity is the illiquidity in the current year minus the illiquidity in the previous year. The independent variables are firm characteristics. Variables are described in the Appendix. Intercepts not reported. Robust t-statistics are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Predicted signs are indicated in parentheses.

Given firms are constrained in 1992							
Panel A: KZ variables				**Panel B: WW variables**			
	Probit	2SLS			Probit	2SLS	
	Prob (Repurchase$_{i,t}$) (1)	*Repurchase Intensity$_{i,t}$* (2)	*ΔIlliquidity$_{i,t}$* (3)		*Prob (Repurchase$_{i,t}$)* (4)	*Repurchase Intensity$_{i,t}$* (5)	*ΔIlliquidity$_{i,t}$* (6)
Repurchase Intensity$_{i,t}$ (–)			**-0.556****	*Repurchase Intensity$_{i,t}$* (–)			**-0.572****
			(-2.07)				**(-2.01)**
Illiquidity$_{i,t-1}$ (+)	**0.007****	**1.161****		*Illiquidity$_{i,t-1}$* (+)	**0.00638***	**0.933****	
	(2.12)	**(1.97)**			**(1.94)**	**(2.09)**	
Inverse Mill's ratio		14.890	**-10.820*****	*Inverse Mill's ratio*		-22.32	**-7.235*****
		(1.02)	**(-3.07)**			(-1.13)	**(-2.62)**
Cash Flows$_{i,t-1}$	**1.164*****	29.070		*Cash Flows$_{i,t-1}$*	**1.328*****	-12.39	
	(5.24)	(1.64)			**(5.89)**	(-0.52)	
Cash$_{i,t-1}$	-0.152	**-5.483****		*Dividend Dummy$_{i,t-1}$*	**0.247*****	2.469	
	(-1.32)	**(-2.04)**			**(3.16)**	(0.32)	
Dividend$_{i,t-1}$	-0.0333	-10.800		*Long-term Debt$_{i,t-1}$*	**-0.576*****	9.700	
	(-0.03)	(-0.23)			**(-2.97)**	(0.83)	
Leverage$_{i,t-1}$	**-0.773*****	**-31.970****		*Sales Growth$_{i,t-1}$*	**-0.458*****	5.966	
	(-3.61)	**(-1.96)**			**(-3.88)**	(0.68)	
Tobin's Q$_{i,t-1}$	**-0.070*****	-1.568		*Industry Sales Growth$_{i,t-1}$*	-0.172	-1.674	
	(-4.41)	(-1.58)			(-0.57)	(-0.14)	
Stock Volatility$_{i,t-1}$	**-0.808*****	-30.200		*Stock Volatility$_{i,t-1}$*	**-0.720*****		
	(-6.00)	(-1.50)			**(-5.30)**		
Cash Flows$_{i,t}$		-3.194	-3.097	*Cash Flows$_{i,t}$*		2.568	2.671
		(-0.63)	(-0.98)			(0.57)	(0.73)

Table 1.6 – Illiquidity and Repurchase Intensity (cont.)

Given firms are constrained in 1992							
Panel A: KZ variables				**Panel B: WW variables**			
	Probit	2SLS			Probit	2SLS	
	Prob ($Repurchase_{i,t}$) (1)	*Repurchase $Intensity_{i,t}$* (2)	*$\Delta Illiquidity_{i,t}$* (3)		*Prob ($Repurchase_{i,t}$)* (4)	*Repurchase $Intensity_{i,t}$* (5)	*$\Delta Illiquidity_{i,t}$* (6)
$Cash_{i,t}$		-2.047	-0.939	*Dividend $Dummy_{i,t}$*		4.236	5.505
		(-0.98)	(-0.48)			(0.48)	(1.50)
$Dividend_{i,t}$		113.600	**71.401***	*Long-term $Debt_{i,t}$*		-0.0860	2.150
		(1.56)	**(1.73)**			(-0.01)	(0.48)
$Leverage_{i,t}$		19.060	6.004	*Sales $Growth_{i,t}$*		**-4.177*****	**-3.376****
		(1.22)	(0.97)			**(-2.85)**	**(-2.01)**
Tobin's $Q_{i,t}$		**-0.881*****	-0.546	*Industry Sales $Growth_{i,t}$*		-13.91	-12.13
		(-2.59)	(-1.50)			(-1.37)	(-1.54)
Stock $Volatility_{i,t}$		**-12.340****	-0.578	*Stock $Volatility_{i,t}$*		**-13.42****	0.472
		(-2.28)	(-0.14)			**(-2.44)**	(0.13)
				Stock $Return_{i,t}$		**-1.945*****	**-2.019*****
						(-2.76)	**(-2.88)**
N	2,282	2,282	2,282	N	2,282	2,282	2,282
H0: Under-identification		Chi-square = **14.021****		H0: Under-identification		Chi-square = **10.519***	
H0: Valid instruments		Chi-square = 7.163		H0: Valid instruments		Chi-square = 4.442	
H0: Endogenous variables are exogenous		Chi-square = **11.147*****		H0: Endogenous variables are exogenous		Chi-square = **9.717*****	

Table 1.7 – Illiquidity and External Financing

This table reports the estimates of Heckman-corrected OLS regressions on the relationship between the exchange-adjusted Amihud's (2002) illiquidity measure and external financing. The sample period is from 1992 to 2006 for all 163 financially constrained firms in 1992. External financing is defined as either equity issuance or debt issuance. Firms are classified by financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index. Illiquidity is Amihud's (2002) illiquidity adjusted for the three main exchanges NYSE, AMEX and NASDAQ. Change in illiquidity is the illiquidity in the current year minus the illiquidity in the previous year. The independent variables are firm characteristics. Variables are described in the Appendix. Intercepts not reported. Robust t-statistics are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Predicted signs are indicated in parentheses.

Equity Issuance – *Given firms are constrained in 1992*							
Panel A – KZ Variables				**Panel B – WW Variables**			
	Prob(Equity Issuance$_{i,t}$) (1)	*Equity Issuance$_{i,t}$* (2)	*Equity Issuance$_{i,t}$* (3)		*Prob(Equity Issuance$_{i,t}$)* (1)	*Equity Issuance$_{i,t}$* (2)	*Equity Issuance$_{i,t}$* (3)
ΔIlliquidity$_{i,t}$ (–)	**-0.009*****	**-0.002*****		*ΔIlliquidity$_{i,t}$* (–)	**-0.001*****	**-0.001*****	
	(-2.75)	**(-3.05)**			**(-2.96)**	**(-3.36)**	
Predicted ΔIlliquidity$_{i,t}$ (–)			**-0.002*****	*Predicted ΔIlliquidity$_{i,t}$* (–)			**-0.001*****
			(-3.11)				**(-3.40)**
Residuals ΔIlliquidity$_{i,t}$ (–)			**-0.002*****	*Residuals ΔIlliquidity$_{i,t}$* (–)			**-0.001*****
			(-3.04)				**(-3.32)**
Inverse Mill's ratio		**0.172****	**0.172****	*Inverse Mill's ratio*		0.007	0.008
		(2.51)	**(2.55)**			(0.12)	(0.13)
Cash Flows$_{i,t-1}$	**-0.404***	**-0.378*****	**-0.378*****	*Cash Flows$_{i,t-1}$*	**-0.660*****	**-0.518*****	**-0.519*****
	(-1.92)	**(-4.51)**	**(-4.52)**		**(-3.45)**	**(-4.15)**	**(-4.16)**
Cash$_{i,t-1}$	**0.432*****	-0.028	-0.028	*Dividend Dummy$_{i,t-1}$*	-0.081	**-0.028*****	**-0.028*****
	(3.31)	(-1.30)	(-1.30)		(-0.95)	**(-3.51)**	**(-3.50)**
Dividend$_{i,t-1}$	**-2.232***	**-0.453*****	**-0.453*****	*Long-term Debt$_{i,t-1}$*	-0.246	-0.072	-0.072
	(-1.89)	**(-3.54)**	**(-3.52)**		(-1.57)	(-1.25)	(-1.25)
Leverage$_{i,t-1}$	-0.274	-0.030	-0.030	*Sales Growth$_{i,t-1}$*	**0.424*****	**0.050****	**0.050****
	(-1.42)	(-0.53)	(-0.52)		**(4.32)**	**(2.60)**	**(2.61)**
Tobin's Q$_{i,t-1}$	**0.090*****	**0.052*****	**0.052*****	*Industry Sales Growth$_{i,t-1}$*	**-0.550****	**0.128***	**0.128***
	(5.23)	**(6.62)**	**(6.65)**		**(-2.02)**	**(1.88)**	**(1.88)**
Stock Volatility$_{i,t-1}$	**-0.680*****			*Stock Volatility$_{i,t-1}$*	**-0.748*****		
	(-7.30)				**(-8.04)**		
N	2,282	2,282	2,282	N	2,282	2,282	2,282
Adjusted R-square		0.274	0.274	Adjusted R-square		0.128	0.128
Industry Fixed Effects		YES	YES	Industry Fixed Effects		YES	YES
Cluster by Year		YES	YES	Cluster by Year		YES	YES

Table 1.7 – Illiquidity and External Financing (cont.)

Debt Issuance – *Given firms are constrained in 1992*

Panel C – KZ Variables

		Prob(Debt Issuance$_{i,t}$) (1)	*Debt Issuance$_{i,t}$* (2)	*Debt Issuance$_{i,t}$* (3)
ΔIlliquidity$_{i,t}$	(–)	-0.002	-0.000	
		(-0.61)	(-1.46)	
Predicted ΔIlliquidity$_{i,t}$	(–)			**-0.001***
				(-1.81)
Residuals ΔIlliquidity$_{i,t}$	(–)			-0.0001
				(-1.30)
Inverse Mill's ratio			0.169	0.165
			(0.98)	(0.96)
Cash Flows$_{i,t-1}$		0.166	0.048	0.048
		(1.15)	(1.21)	(1.22)
Cash$_{i,t-1}$		**-0.561*****	-0.104	-0.102
		(-7.12)	(-1.52)	(-1.49)
Dividend$_{i,t-1}$		**-3.298****	-0.662	-0.649
		(-2.46)	(-1.52)	(-1.48)
Leverage$_{i,t-1}$		**2.020*****	**0.487****	**0.482****
		(12.46)	**(2.24)**	**(2.21)**
Tobin's Q$_{i,t-1}$		-0.012	0.000	0.000
		(-1.28)	(0.13)	(0.13)
Stock Volatility$_{i,t-1}$		-0.039		
		(-0.45)		
N		2,282	2,282	2,282
Adjusted R-square			0.096	0.096
Industry Fixed Effects			YES	YES
Cluster by Year			YES	YES

Panel D – WW Variables

		Prob(Debt Issuance$_{i,t}$) (1)	*Debt Issuance$_{i,t}$* (2)	*Debt Issuance$_{i,t}$* (3)
ΔIlliquidity$_{i,t}$	(–)	-0.001	0.000	
		(-0.44)	(1.46)	
Predicted ΔIlliquidity$_{i,t}$	(–)			0.000
				(0.94)
Residuals ΔIlliquidity$_{i,t}$	(–)			0.001
				(1.61)
Inverse Mill's ratio			**-0.507*****	**-0.510*****
			(-4.48)	**(-4.48)**
Cash Flows$_{i,t-1}$		**0.480*****	**-0.123****	**-0.123****
		(3.72)	**(-2.43)**	**(-2.43)**
Dividend Dummy$_{i,t-1}$		**-0.212*****	**0.043***	**0.043***
		(-2.95)	**(1.96)**	**(2.03)**
Long-term Debt$_{i,t-1}$		**1.370*****	**-0.194***	**-0.197***
		(10.64)	**(-1.99)**	**(-2.01)**
Sales Growth$_{i,t-1}$		-0.043	**0.021****	**0.021****
		(-1.08)	**(2.20)**	**(2.16)**
Industry Sales Growth$_{i,t-1}$		-0.219	0.005	0.006
		(-0.93)	(0.11)	(0.12)
Stock Volatility$_{i,t-1}$		0.105		
		(1.26)		
N		2,282	2,282	2,282
Adjusted R-square			0.090	0.091
Industry Fixed Effects			YES	YES
Cluster by Year			YES	YES

Table 1.8 – Illiquidity and Investments

This table reports the estimates of OLS regressions on the relationship between the exchange-adjusted Amihud's (2002) illiquidity measure and the firm's investments. The sample period is from 1992 to 2006 for all 163 financially constrained firms in 1992. Investments is defined as the sum of the firm's capital expenditure and R&D expense over lagged book assets. Firms are classified for financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index. Illiquidity is Amihud's (2002) illiquidity adjusted for the three main exchanges NYSE, AMEX and NASDAQ. Change in illiquidity is the illiquidity in the current year minus the illiquidity in the previous year. The independent variables are firm characteristics. Variables are described in the Appendix. Intercepts not reported. Robust t-statistics are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Predicted signs are in parentheses.

Given firms are constrained in 1992					
Panel A – KZ Variables			**Panel B – WW Variables**		
	$Investment_{i,t}$ (1)	$Investment_{i,t}$ (2)		$Investment_{i,t}$ (3)	$Investment_{i,t}$ (4)
$\Delta Illiquidity_{i,t}$ (–)	**-0.002*****		$\Delta Illiquidity_{i,t}$ (–)	**-0.002*****	
	(-4.88)			**(-5.18)**	
Predicted $\Delta Illiquidity_{i,t}$ (–)		**-0.001*****	*Predicted* $\Delta Illiquidity_{i,t}$ (–)		**-0.002*****
		(-5.35)			**(-5.37)**
Residuals $\Delta Illiquidity_{i,t}$ (–)		**-0.002*****	*Residuals* $\Delta Illiquidity_{i,t}$ (–)		**-0.002*****
		(-4.90)			**(-5.20)**
$Illiquidity_{i,t-1}$	**-0.002*****	**-0.001*****	$Illiquidity_{i,t-1}$	**-0.002*****	**-0.002*****
	(-4.60)	**(-4.66)**		**(-5.62)**	**(-5.53)**
Cash Flows$_{i,t}$	**-0.194*****	**-0.194*****	*Cash Flows*$_{i,t}$	**-0.269*****	**-0.269*****
	(-8.09)	**(-8.11)**		**(-12.36)**	**(-12.37)**
$Cash_{i,ti,r}$	**0.144*****	**0.144*****	*Dividend Dummy*$_{i,t}$	**-0.014***	**-0.014***
	(5.39)	**(5.39)**		**(-1.98)**	**(-2.01)**
$Dividend_{i,t}$	-0.189	-0.190	*Long-term Debt*$_{i,t}$	**0.063*****	**0.063*****
	(-1.68)	(-1.70)		**(3.04)**	**(3.02)**
$Leverage_{i,t}$	**0.043****	**0.042****	*Sales Growth*$_{i,t}$	**0.045*****	**0.045*****
	(2.65)	**(2.64)**		**(3.97)**	**(4.00)**
Tobin's $Q_{i,t}$	**0.010*****	**0.010*****	*Industry Sales Growth*$_{i,t}$	0.023	0.024
	(11.33)	**(11.18)**		(0.67)	(0.69)
N	2,282	2,282	N	2,282	2,282
Adjusted R-square	0.405	0.405	Adjusted R-square	0.290	0.290
Industry Fixed Effects	YES	YES	Industry Fixed Effects	YES	YES
Cluster by Year	YES	YES	Cluster by Year	YES	YES

Table 1.9 – Illiquidity and Value Added

This table reports the estimates of OLS regressions on the relationship between the exchange-adjusted Amihud's (2002) illiquidity measure and Value Added per dollar of incremental investments. The sample period is from 1992 to 2006 for all 163 financially constrained firms in 1992. Value added per dollar of incremental investment is calculated as

$$Value\ Added_{i,t} = \frac{MVAssets_{i,t} - MVAssets_{i,t-1} - NetEquityIssuance_{i,t} - NetDebtIssuance_{i,t}}{Capex_{i,t} + R\&D_{i,t}}$$

Firms are classified by financial constraint status based on their HP index. Financially constrained firms are firms in the 60th tercile of the HP index. Illiquidity is Amihud's (2002) illiquidity adjusted for the three main exchanges NYSE, AMEX and NASDAQ. Change in illiquidity is the illiquidity in the current year minus the illiquidity in the previous year. The independent variables are firm characteristics. Variables are described in the Appendix. Intercepts not reported. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Predicted signs are indicated in parentheses.

Given firms are constrained in 1992								
Panel A – KZ Variables				**Panel B – WW Variables**				
		Value Added$_{i,t}$ (1)	*Value Added$_{i,t}$* (2)			*Value Added$_{i,t}$* (3)	*Value Added$_{i,t}$* (4)
ΔIlliquidity$_{i,t}$	(–)	**-0.671****		*ΔIlliquidity$_{i,t}$*	(–)	**-0.638****	
		(-2.44)				**(-2.23)**	
Predicted ΔIlliquidity$_{i,t}$	(–)		**-0.584****	*Predicted ΔIlliquidity$_{i,t}$*	(–)		**-0.619****
			(-2.19)				**(-2.18)**
Residuals ΔIlliquidity$_{i,t}$	(–)		**-0.682****	*Residuals ΔIlliquidity$_{i,t}$*	(–)		**-0.644****
			(-2.51)				**(-2.27)**
Cash Flows$_{i,t}$		**39.25*****	**39.21*****	*Cash Flows$_{i,t}$*		**24.71*****	**24.64*****
		(7.80)	**(7.83)**			**(4.18)**	**(4.14)**
Cash$_{i,ti,r}$		**23.00****	**23.12****	*Dividend Dummy$_{i,t}$*		-3.106	-3.187
		(2.27)	**(2.28)**			(-1.10)	(-1.11)
Dividend$_{i,t}$		**-92.21****	**-92.83****	*Long-term Debt$_{i,t}$*		1.580	1.569
		(-2.90)	**(-2.98)**			(0.19)	(0.19)
Leverage$_{i,t}$		-7.380	-7.459	*Sales Growth$_{i,t}$*		**5.180****	**5.216****
		(-0.60)	(-0.60)			**(2.18)**	**(2.21)**
Tobin's Q$_{i,t}$		**2.461*****	**2.471*****	*Industry Sales Growth$_{i,t}$*		**40.82***	**41.00***
		(4.04)	**(4.11)**			**(1.82)**	**(1.81)**
N		2,282	2,282	N		2,282	2,282
Adjusted R-square		0.027	0.027	Adjusted R-square		0.013	0.013
Industry Fixed Effects		YES	YES	Industry Fixed Effects		YES	YES
Cluster by Year		YES	YES	Cluster by Year		YES	YES

Table 1.10 – Illiquidity and Risk

This table reports the estimates of OLS regressions on the relationship between the exchange-adjusted Amihud's (2002) illiquidity measure and risk. Risk is defined as either the total risk, measured as annualized standard deviation of daily stock returns, or systematic risk, or idiosyncratic risk. The sample period is from 1992 to 2006 for all 163 financially constrained firms in 1992. Financially constrained firms are identified based on its HP index. Financially constrained firms are firms in the 60^{th} tercile of the HP index. Illiquidity is Amihud's (2002) illiquidity for the three main exchanges NYSE, AMEX and NASDAQ. Change in illiquidity is the illiquidity in the current year minus the illiquidity in the previous year. The independent variables are firm characteristics. Variables are described in the Appendix. Intercepts not reported. Robust t-statistics are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Predicted signs are indicated in parentheses.

Panel A: KZ variables						
Given firms are constrained in 1992	*Total Risk$_{i,t}$* (1)	*Systematic Risk$_{i,t}$* (2)	*Idiosyncratic Risk$_{i,t}$* (3)	*Total Risk$_{i,t}$* (4)	*Systematic Risk$_{i,t}$* (5)	*Idiosyncratic Risk$_{i,t}$* (6)
ΔIlliquidity$_{i,t}$ (±)	**0.015*** **	**-0.014*** **	**0.015*** **			
	(8.30)	**(-3.03)**	**(8.52)**			
Predicted ΔIlliquidity$_{i,t}$ (±)				**0.016*** **	**-0.010** **	**0.016*** **
				(9.31)	**(-2.20)**	**(9.62)**
Residuals ΔIlliquidity$_{i,t}$ (±)				**0.015*** **	**-0.013** **	**0.015*** **
				(8.41)	**(-2.93)**	**(8.63)**
Illiquidity$_{i,t-1}$	**0.020*** **	**-0.016*** **	**0.021*** **	**0.020*** **	**-0.015*** **	**0.021*** **
	(11.90)	**(-5.42)**	**(11.65)**	**(12.63)**	**(-5.02)**	**(12.39)**
Cash Flows$_{i,t}$	**-0.202*** **	0.154	**-0.211*** **	**-0.202*** **	0.156	**-0.211*** **
	(-7.43)	(1.54)	**(-8.89)**	**(-7.40)**	(1.57)	**(-8.85)**
Cash$_{i,t}$	0.027	**0.328*** **	0.002	0.028	0.334***	0.003
	(0.73)	**(9.21)**	(0.08)	(0.75)	(9.25)	(0.11)
Dividend$_{i,t}$	**-1.046*** **	**-2.076*** **	**-0.979*** **	**-1.049*** **	**-2.093*** **	**-0.982*** **
	(-4.12)	**(-3.61)**	**(-4.06)**	**(-4.18)**	**(-3.80)**	**(-4.12)**
Leverage$_{i,t}$	**0.067***	0.177	0.040	**0.066***	0.172	0.039
	(2.11)	(1.73)	(1.34)	**(2.07)**	(1.74)	(1.31)
Tobin's Q$_{i,t}$	**0.004***	**0.040*** **	0.003	**0.004***	**0.040*** **	0.003
	(1.92)	**(4.49)**	(1.43)	**(1.97)**	**(4.60)**	(1.49)
N	2,282	2,282	2,282	2,282	2,282	2,282
Adjusted R-square	0.408	0.164	0.422	0.409	0.172	0.423
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Cluster by Year	YES	YES	YES	YES	YES	YES

Table 1.10 – Illiquidity and Risk (cont.)

Panel B: WW variables						
Given firms are constrained in 1992	*Total Risk$_{i,t}$* (1)	*Systematic Risk$_{i,t}$* (2)	*Idiosyncratic Risk$_{i,t}$* (3)	*Total Risk$_{i,t}$* (4)	*Systematic Risk$_{i,t}$* (5)	*Idiosyncratic Risk$_{i,t}$* (6)
ΔIlliquidity$_{i,t}$ (±)	**0.0150*****	**-0.015*****	**0.015*****			
	(8.78)	**(-3.39)**	**(9.04)**			
Predicted ΔIlliquidity$_{i,t}$ (±)				**0.015*****	**-0.013****	**0.0160*****
				(9.51)	**(-2.92)**	**(9.81)**
Residuals ΔIlliquidity$_{i,t}$ (±)				**0.015*****	**-0.0150*****	**0.015*****
				(8.87)	**(-3.31)**	**(9.14)**
Illiquidity$_{i,t-1}$	**0.020*****	**-0.018*****	**0.020*****	**0.020*****	**-0.017*****	**0.020*****
	(12.89)	**(-6.39)**	**(12.54)**	**(13.77)**	**(-5.80)**	**(13.42)**
Cash Flows$_{i,t}$	**-0.207*****	-0.092	**-0.204*****	**-0.207*****	-0.095	**-0.205*****
	(-8.85)	(-0.88)	**(-8.97)**	**(-8.84)**	(-0.92)	**(-8.95)**
Dividend Dummy$_{i,t}$	**-0.129*****	**-0.088*****	**-0.126*****	**-0.130*****	**-0.092*****	**-0.127*****
	(-11.42)	**(-4.37)**	**(-11.02)**	**(-11.73)**	**(-4.43)**	**(-11.39)**
Long-term Debt$_{i,t}$	-0.036	0.086	**-0.057*****	-0.036	0.087	**-0.057****
	(-1.63)	(0.96)	**(-3.02)**	(-1.62)	(0.98)	**(-3.00)**
Sales Growth$_{i,t}$	0.002	**0.091*****	0.000	0.003	**0.095*****	0.001
	(0.21)	**(3.60)**	(-0.00)	(0.28)	**(3.88)**	(0.06)
Industry Sales Growth$_{i,t}$	0.225	**0.509*****	0.217	0.228	**0.522*****	0.220
	(1.28)	**(3.05)**	(1.44)	(1.31)	**(3.12)**	(1.47)
N	2,282	2,282	2,282	2,282	2,282	2,282
Adjusted R-square	0.425	0.112	0.442	0.427	0.121	0.443
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Cluster by Year	YES	YES	YES	YES	YES	YES

III. Bank CEO Compensation Incentives and Risk: Evidence from Recent Credit Crisis

Abstract: This paper uses the recent financial crisis (2007-08) as a natural experiment to show bank CEO compensation incentives to increase risk, and to increase risk relative to increase stock price, lead to comparatively risky investment and debt policies and increased risk. It shows that the relation between bank CEO compensation risk taking incentives tends to change between non-crisis vs. crisis periods. Bank CEO risk taking incentives lead CEOs to adopt riskier investments, including asset growth, loans to core deposits, and commercial real estate loans, to implement riskier debt policy by increasing leverage, and to increase bank risk, where bank risk is measured by the volatility of stock returns, non-performing loans to assets, and a bank risk factor score. We conclude that recent efforts by the press, politicians, and regulators, to portray bank CEO compensation incentives as the cause of excessive risk taking and financial collapse are premature.

A. Introduction

Two of the most important measures of incentives discussed in the recent academic literature on executive compensation are: (1) the sensitivity of CEO wealth to stock price volatility, typically captured by vega, or the partial derivative of the Black Scholes (1973) option pricing model adjusted for dividends with respect to stock volatility, multiplied by 0.01; and (2) the sensitivity of CEO wealth to changes in stock price, typically captured by delta, or the partial derivative of Black Scholes multiplied by 1% of stock price. In theory, higher vega offsets the underinvestment problem by encouraging risk-averse CEOs to undertake more relatively risky projects. Higher delta better aligns CEO interests with those of shareholders, but exposes CEOs to greater personal risk, potentially leading risk-averse CEOs to reject positive net present value risky projects. This implies shareholders tend to favor CEO compensation structures with higher vega (or perhaps vega-to-delta) to encourage CEOs to adopt value-maximizing risky policies and thereby optimize firm risk. Coles, Daniel, and Naveen (2006) find that vega, after controlling for delta, is positively related to risky investment policy, leverage, and firm risk, among sample industrial firms between 1992 and 2002. Rogers (2002) uses vega-to-delta to show higher relative risk taking to stock price increase incentives leads CEOs to hedge less.

The need for CEO incentive structures with higher vega (or higher vega-to-delta) is arguably greatest in opaque industries like banking. However, surprisingly little empirical evidence currently exists on the association between bank CEO compensation incentives, policy, and risk, and the evidence that does exist is mixed. Bebchuk and Spamann (2009) show bank CEO pay incentives effectively render CEO wealth to be a call option on the value of bank stock, and suggest bank CEOs increase their personal wealth by adopting riskier investment and debt policies, thereby increasing bank risk (measured as standard deviation of stock returns).

Fahlenbrach and Stulz (2010) use a cross-section of banks to show CEO pay that more closely aligns manager and shareholder interests tends to be accompanied by lower bank return on equity and lower stock returns.

The academic literature is silent on CEO incentive changes over time. In Figure 2.1, we show mean CEO total compensation, cash compensation (salary plus bonus), other compensation (including other annual, total value of restricted stock granted, total value of stock options grants, long-term incentive payouts and other), vega, delta and vega-to-delta, by year, for all Execucomp-listed U.S. banks between 1992 and 2010. Bank CEO total and other compensation increase steadily between 1995 and 2000, decrease between 2000 and 2008, and begin increasing again in 2009. Bank CEO salary and bonus increase gradually between 1995 and 2004, decrease between 2005 and 2008, and begin increasing thereafter. Bank CEO vega increases between 1996 and 2002, declines to a low in 2006, increases briefly in 2007, decreases again in 2008, and increases thereafter. Bank CEO delta increases between 1994 and 2000, declines between 2000 and 2001, and steeply declines between 2006 and 2008. Clearly, bank CEO compensation incentives change over time.

This paper uses the financial crisis of 2007-08 as a natural experiment to observe how bank CEO compensation incentives to take risk drive bank investment and debt policy, and bank risk, and how these relations change between non-crisis (2000-06, 2009-10) and crisis (2007-08) periods. We focus on the period 2000-10 owing to the availability of finely detailed FR Y-9C data starting in 2000. Our test sample consists of 866 bank-year observations for 121 U.S. bank holding companies. To control for secular trends among all firms, we use a control sample of 908 firm-year observations for 121 U.S. industrial firms matched to banks on size (prior year market value of equity) and performance (prior year return on assets).We use Compustat-based policy and risk measures for both groups firms, but also use FR Y-9C data for finer measures of bank policy and risk than are typically used in the banking literature. We anticipate bank CEO risk taking incentives, measured by vega, and vega-to-delta, will be positively related to relatively risky investment and debt policy and bank risk. In the absence of theoretical models predicting precisely how some these risk variables act as complements or substitutes, or why they change over time, our results on some of our bank risk measures and changes over time are largely exploratory.

We employ a three-part study design. First, we discuss univariate evidence and trends among banks, and among banks controlling for changes among matched industrial firms, and examine links between CEO compensation risk taking incentives and subsequent investment and debt policy. Second, as an additional control for endogeneity, we investigate whether CEO compensation incentives are determined simultaneously with policy. Third, we explore whether CEO compensation risk taking incentives determine investment and debt policy and bank risk, and check whether these incentives are also simultaneously determined with policy and risk. As a robustness check, we also verify that our results hold when we use of an alternative measure of bank risk, namely a bank risk factor score derived from common rather than total variation in select bank risk variables.

We show that bank CEO compensation risk taking incentives, and risk taking incentives relative to incentives to increase stock price, lead to increased risky investing, leverage, and firm risk. We also show that investment policy, leverage, and firm risk are at least partly contemporaneously determined with CEO risk taking and stock price increasing incentives. Using one standard deviation increases in vega, we show the economic significance of changes in incentives on policy and risk can be substantial.

This paper makes three contributions to the empirical banking and corporate finance literature. First, it is the first to link precise measures of the sensitivity of CEO wealth to changes in stock price volatility (vega), and vega-to-delta, while controlling for CEO wealth to changes in stock price (delta), to bank investment and debt policy and risk for a panel of banks. Coles et al. (2006) work with a panel of industrial firms excluding financials. Fahlenbrach and Stulz (2010) only examine a cross-section of banks for fiscal year 2006.[15] Unlike Fahlenbrach and Stulz, we construct vega and delta using the method of Core and Guay (2002). Our paper also differs from Coles et al. (2006) in that we define investment policy in terms of asset growth (common to banks and industrial firms), or bank loans to core deposits and bank commercial real estate loans to assets that are unique to banks.[16] We also use bank-specific risk measures, including interest paid on large CDs, non-core funding to assets, non-performing loans to loans, and 1-year GAP, consistent with risk measures used by Stojanovic, Vaughan, and Yeager (2008). Our stock return volatility measure follows Coles et al. (2006), but we use annual standard deviation of daily stock returns instead of the natural log of annual variance of stock returns, for consistency with our other measures of bank risk.

Second, this paper is the first to show that the relation between CEO risk taking incentives, policy, and risk, change over time. New CEOs typically receive large amounts of option grants when first hired, as boards of directors seek to quickly align interests of new CEOs to those of shareholders. Subsequent option grants tend to be granted in batches, changing CEO

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[15] Fahlenbrach and Stulz (2010) use measures of CEO compensation incentives somewhat analogous to our vega and delta called "Dollar Equity Risk Sensitivity" and "Dollar Ownership Sensitivity."

[16] We use FR Y-9C data because of the unique nature of banks, and because Coles et al.'s investment policy measures of Capital Expenditures (and R&D Expense) are reported for few (no) banks.

compensation incentives. Changes in investment needs, financing arrangements, asset transparency, and information asymmetry, together with economic, business, and financing risks, also change CEO incentives. Importantly, the financial crisis of 2007-08 affects most firms but especially banks, rendering this event an ideal candidate for a natural experiment to observe how the relation between CEO compensation incentives, policy, and risk, changes over time.

Third, this paper makes methodological contributions to the CEO compensation, policy, and risk literature. It extends Core et al. (2006), Fahlenbrach and Stulz (2010), and others, to include the Rogers (2002, 2005) vega-to-delta measure of relative risk taking. It is one of the first banking papers to use a sample of size- and prior-performance matched industrial firms to control for secular trends in executive compensation. It is one of the first papers to make extensive use of FR Y-9C data for detailed bank policy and risk information. It is also one of the first banking papers to use common factor analysis to generate a parsimonious estimate of bank risk.

Overall, this paper shows bank CEO incentives to take risk (vega, and vega-to-delta) are positively related to risky investment and debt policy and bank risk. Many but not all changes observed among banks are related to secular changes among industrial control firms, highlighting the need for the use of control samples of matched industrial firms when searching for evidence of changes over time. Relations between vega, and vega-to-delta, and bank policy and risk change between non-crisis and crisis periods. Bank risk has many dimensions, not all of which are readily apparent, but common variation among proxies for these dimensions helps capture bank risk. We conclude that recent attempts by the popular press, politicians, and regulators, to portray bank CEO compensation incentives as the cause of recent excessive bank risk taking, and the 2007-08 financial collapse, appear premature.

The rest of this paper proceeds as follows. Section B contains a review of the relevant literature and identifies testable hypotheses. Section C describes sample selection, variable definitions, and methodology. Section D reports empirical results. Section E describes our bank risk factor score. Section F discusses and concludes.

B. Literature Review and Testable Hypotheses

1. *CEO Compensation Incentives, Policy, and Risk*

In theory, shareholders design executive compensation plans to align the interests of risk-averse under-diversified executives with those of shareholders. Jensen and Meckling (1976), Myers (1977), Smith and Stulz (1985), Agrawal and Mandelker (1987), Smith and Watts (1992), Gaver and Gaver (1993), Core and Guay (1999), Guay (1999), and Murphy (1999) all suggest shareholders design compensation contracts to influence managerial behavior. If under-diversified managers' utility functions are concave to wealth, they will tend to be risk-averse. Executive pay packages normally have four components: cash salary; cash bonus (normally tied to accounting measures of performance); stock options; and long-term incentive plans (including restricted stock, and multi-year accounting-based performance plans). Cash compensation (salaries and bonuses) creates incentives for managers to reduce cash flow and earnings variance, whereas stock options and long-term incentive plans can either deter managers from undertaking, or encourage managers to undertake, risky projects. Shareholders can therefore design compensation plans to influence managers to undertake policies that avoid risk, are risk-neutral, or increase risk.

The empirical literature employs several different approaches to estimate CEO compensation-based risk taking and other incentives. Early approaches rely on the proportion of the value of executive holdings to total compensation. Agrawal and Mandelker (1987) study the ratio of the dollar value of common stock and stock options held to total annual compensation, the ratio of the dollar value of common stock and options held to annual salary plus bonus, and the ratio of senior manager owned stock to total stock outstanding. Recent approaches focus on vega, the partial derivative of the Black Scholes (1973) option pricing model adjusted for dividends with respect to the standard deviation of stock returns multiplied by 0.01, where the CEO dollar incentive to increase risk is vega times the number of CEO stock options. Core and Guay (2002), Coles et al. (2006), and Fahlenbrach and Stulz (2010) use vega to measure CEO risk taking incentives. However, CEO compensation also includes incentives to increase stock price, typically measured by delta, the partial derivative of Black Scholes with respect to stock price multiplied by 1% of stock price, where the CEO dollar incentive to increase stock price is total CEO portfolio delta (the sum of his/her deltas of options and stock held) times the number of his/her shares. Jensen and Murphy (1990) and Core and Guay (1999) focus on delta, and Coles et al. (2006) control for it. Vega scaled by delta has also been used by Rogers (2002, 2005) as a measure of CEO relative risk taking incentive, offering the advantages of being parsimonious (a single ratio instead of two separate measures of risk taking and stock price maximizing incentives) and helping mitigate size, CEO risk aversion, illiquidity, early exercise, and other measurement problems associated with the application of Black Scholes-based option pricing models to executive stock options.

CEOs change the risk and value propositions of their firms through investment and debt policy decisions, not just hedging. Coles et al. (2006) suggest shareholders select vega and delta through CEO compensation to encourage CEOs to select risk-optimizing and value-maximizing investment and financing decisions. What constitutes a risk-optimizing or value-maximizing decision depends on market, industry, and firm characteristics. The probability distribution of cash flows and stock returns is determined by the combination of these characteristics and the vega and delta (or in Rogers (2002, 2005) case, vega-to-delta) from CEO compensation. Agrawal and Mandelker (1987) show the value of CEO stock and option holdings is positively related to changes in the variability of firm asset returns and leverage, and relatively higher CEO stock and option holdings lead to higher variance in returns and leverage ratios. Berger et al. (1997) find increases in option holdings rather than stock ownership tend to be associated with higher leverage. Rogers (2002) documents a negative relation between risk taking incentives and hedging. Coles et al. (2006) demonstrate higher vega, while controlling for delta, leads CEOs to increase relatively risky investments (R&D expense or focus (estimated both as a Herfindahl Index and as a reduction in the number of segments), reduce relatively lower risk investments (net capital expenditures), and adopt relatively risky financing (book leverage). Rogers (2002) also finds a negative relation between risk taking incentives and hedging against risk. Firm risk is typically measured among non-banks as the annual standard deviation of stock returns (e.g., Coles et al., 2006).

2. *Bank CEO Compensation, Policy, and Risk*

Banks are relatively more opaque than non-banks, owing to their sometimes "hard to value" financial assets and liabilities, as noted in Morgan (2002). Moreover, the depth of the surprise over the scale of the financial crisis of 2007-08 suggests many bank investment and financing decisions, and thus risk, are not easily observed. Difficulties associated with direct observation of bank risk contribute to the fact that the association between bank CEO compensation, policy, and risk is not yet widely studied.

The literature that does exist on this topic is fairly mixed. Agrawal and Mandelker (1987) and Core and Guay (2002) treat banks like other firms, whereas Coles et al. (2006) exclude financial firms altogether. Houston and James (1995) show bank CEOs receive less cash, and pocket smaller proportions of their pay in options and restricted stock, than CEOs from other industries. Coles et al. (2006) also find that factors affecting banking industry compensation are similar to factors affecting compensation in other industries. John and Qian (2003) find bank CEOs have lower pay-performance sensitivity than non-bank CEOs. Chen, Steiner, and Whyte (2006) document that executive compensation (measured by stock options as a percentage of total compensation) induces risk taking, and that risk affects compensation. Laeven and Levine (2009) analyze bank ownership structures, national banking regulations, and risk, and find that links between bank risk and capital regulations, deposit insurance, and restrictions on bank activities, critically depend upon bank ownership structure and corporate governance. John, Mehran, and Qian (2010) find bank pay-performance sensitivity is positively related to monitoring intensity but negatively related to leverage. Fahlenbrach and Stulz (2010) investigate the relation between bank CEO incentives and bank performance during the recent financial crisis, and find no evidence better alignment of CEO and shareholder incentives leads to better bank performance (higher buy-and-hold returns, return on assets, or return on equity), or that bank CEO option compensation causes poorer performance.

Policy and risk are different for banks than industrial firms. Whereas Coles et al. (2006) describe R&D expense as a relatively high risk investment policy and net capital expenditures to assets as a relatively low risk investment policy procedure, none of the bank holding companies listed in Execucomp between 2000 and 2010 report R&D expense, and less than 25 percent report net capital expenditures. Stojanovic, Vaughan, and Yeager (2008) suggest asset growth is a good measure of bank risky investment, citing the use of asset-growth related variables by FDIC, bank supervisors, analysts, and examiners, and arguing that rapid growth in assets is possible evidence of declining underwriting standards, lax risk management, or fraud. Consequently, we view bank asset growth as a relatively risky bank investment policy, together with bank loans to core deposits and commercial real estate loans to assets. Like Coles et al. (2006), we interpret book leverage to total assets to be a measure of financial risk. Coles et al. (2006) use annual stock return volatility to estimate risk among non-banks, and Houston and James (1995) and Chen, Steiner, and Whyte (2006) use it for banks. Stojanovic, Vaughan, and Yeager (2008) also describe interest paid on large CDs, non-core funding to assets, non-performing loans to loans, and 1-year GAP as measures of bank risk, in addition to loans to core deposits and commercial real estate loans to assets that we interpret to be risky investment policies.

An alternative way to estimate bank risk is to use one or more composite bank risk measures. Composite risk ratios discussed in the banking literature are usually derived from one of two proprietary econometric models of the Federal Reserve, collectively known as the System to Estimate Examination Ratings (SEER). The first model (the SEER risk rank model) combines financial ratios to estimate the probability a bank will fail within the next two years. The second model (the SEER rating model) estimates the bank's composite CAMELS rating, where CAMELS stands for Capital, Asset quality, Management, Earnings, Liquidity, and Sensitivity to market risk. According to the Federal Reserve Commercial Bank Examination Model, CAMELS ratings are used by regulators to identify banks whose financial conditions have changed between on-site examinations. Unfortunately, these composite risk ratios are confidential with the result that research using these measures tends to be restricted to authors linked to the Federal Reserve, as discussed in Stojanovic, Vaughan, and Yeager (2008). Instead, we apply exploratory common factor analysis to some directly observable bank risk measures to develop our own composite bank risk factor score.

3. Testable Hypotheses

The literature contains strong evidence of an association between compensation incentives, policy, and risk, among industrial firms. This includes Coles et al. (2006)'s finding that vega, controlling for delta, is positively related to high risk investment policy, negatively related to low risk investment policy, positively related to high risk leverage, and positively related to firm risk. Similarly, Rogers (2002) shows risk taking incentives are negatively related to hedging. However, evidence among banks is not as clear.

We propose that shareholders of banks select CEO compensation structures with vega and delta, and relative vega-to-delta, to encourage investment and debt policy decisions that optimize risk and maximize value. Similar to the argument put forth in Coles et al. (2006) for non-banks, we suggest higher bank CEO vega (or vega-to-delta), ceteris paribus, encourages bankers to undertake relatively riskier investment projects (asset growth, loans to core deposits, and bank commercial real estate loans to assets), increasing bank risk (as measured by the standard deviation of stock returns or our bank-specific risk measures). This leads to our first two hypotheses, stated in alternate-form as follows:

Hypothesis 1 (H1): *Bank CEO vega (or vega-to-delta), ceteris paribus, is positively related to relatively riskier investment projects (asset growth, bank loans to core deposits, or bank commercial real estate loans to assets), and financial risk (book leverage).*

Hypothesis 2 (H2): *Bank CEO vega (or vega-to-delta), ceteris paribus, is positively related to bank risk (stock return volatility and other measures of bank risk).*

In the absence of theory about how individual components of bank-specific risk, including interest paid on large CDs, non-core funding to assets, non-performing loans to loans, and 1-year GAP, act as compliments or substitutes, discussion of the individual components of bank risk is exploratory.

Not yet studied in the literature is how the relation between CEO compensation incentives to take risk, policy, and risk, changes over time. As our study distinguishes between non-crisis (2000-2006, 2009-10) vs. crisis (2007-08) years, we expect heightened risk associated with rapidly deteriorating economic fundamentals, regulatory problems such as mark-to-market accounting, fixed income market illiquidity, contagion among bank stocks from observed financial services firm declines and failures (Bear Stearns, Lehman Brothers, Washington Mutual, IndyMac, and AIG), and declining real estate values, to seriously affect banks. As bank stock implied volatility soars and stock prices fall during financial crisis, we expect shareholders to want their CEOs to have reduced risk taking and relative risk taking incentives, engage in lower risk investing and reduce leverage, and reduce firm risk. In this environment, the relation between risk taking incentives (or relative risk taking incentives) and policy and risk could change. This leads to our third hypothesis, also stated in alternate-form:

Hypothesis 3 (H3): *The relation between bank CEO vega (and vega-to-delta), investment and debt policy, and risk, varies between the non-crisis (2000-2006, 2009-10) and crisis (2007-08) years.*

Bank CEO and firm characteristics, including CEO Cash Compensation levels, Tenure, Log(Sales), Market to Book, Sales Growth, Stock Returns and Stock Return Volatility, Leverage, Return on Assets, and sector- and time-specific features, also potentially affect investment and debt policy decisions. In the absence of theory about how these relations change, our study of changes in the relation between vega (and vega-to-delta) and policy and risk between periods is also largely exploratory.

C. Sample Selection, Variables, Methodology, and Summary Statistics

1. Sample Selection

For this paper, we draw CEO and managerial compensation incentive data from Standard & Poor's Execucomp database. Execucomp provides details on levels of CEO cash compensation (salary plus bonus), stock options, and total compensation for the five highest paid executives for firms listed in the S&P 1500 (for 2000-10).[17] We obtain financial accounting information from Compustat, and stock returns from the Center for Research in Securities Prices (CRSP). Data necessary to estimate firm risk are obtained from Compustat and the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C Reports).

Our sample period covers 2000 through 2010. It starts in 2000 because of the limited availability of many items in the FR Y-9C reports for bank holding companies in earlier years, and ends in 2010 because of limited availability of later data. To be included in the sample, we require information to be available for banks for at least two years in the sample period. Our test sample includes 877 bank-year observations for 121 U.S. bank holding companies between 2000 and 2010. Almost all observations are from SIC 6020 (Commercial Banks and Financial Institutions), with a handful from SIC 6199 (Finance Services). Our control sample consists of 908 firm-year observations for 121 U.S. industrial firms. Control firms are U.S. firms listed in

[17] Technically, Execucomp also includes a few firms that are not listed in the S&P 1500 that have been added over the years at clients' request.

Compustat SIC 2000-3999 (i.e., industrials) matched to test sample banks based on 90-110% of prior-year market value of equity (in all but two cases, and 80-120% for those two) and closest prior year return on assets. We match on size and prior performance to control for potential bias related to the mean reversion of accounting measures (Barber and Lyon, 1996; Kothari and Warner, 1997). We rely on market value of equity rather than market value of assets for size because of the complexity and opacity of bank assets. We also sub-divide our samples into non-crisis (2000-06, and 2009-10) and crisis (2007-08) periods.

2. *Variable Definitions*

We work with three measures (and one ratio) of CEO compensation: vega is the change in dollar value of the CEO's wealth for a one percent change in annualized standard deviation of returns. This definition is consistent with Core and Guay (1999, 2002) who use the Black-Scholes (1973) option valuation model modified by Merton (1973) to account for dividends when valuing stock options. Delta is the change in dollar value of the CEO's wealth for a one percent change in stock price. This definition is also consistent with Core and Guay (1999, 2002). Vega-to-delta is simply the ratio of vega divided by delta, and captures the relative risk taking to value maximizing incentive of CEO compensation, consistent with Rogers (2002, 2005). CEO cash compensation is the sum of cash salary plus bonus. To differentiate between observations before crisis and during crisis, and between banks and industrial firms, we also define Crisis is an indicator variable set to 1 if the observation occurs in crisis years 2007-08, or 0 if not, and bank is an indicator variable equal to 1 if the observation is a bank holding company, or 0 if not.

We employ three measures of investment policy, and one measure of debt policy: asset growth is the log of total assets at time *t* scaled by total assets at time *t-1*, and is common to banks and industrial firms. Bank loans to core deposits and bank commercial real estate loans to assets are from FR Y-9C reports, and are bank specific. We interpret asset growth, bank loans to core deposits, and bank commercial real estate loans to assets to be relatively risky investment policies. We rely on Coles et al. (2006)'s debt policy variable book leverage, defined as 1 minus the ratio of equity over assets.

We use five measures of risk (see Stojanovic, Vaughan, and Yeager, 2008): stock volatility is annual standard deviation of stock returns, and is common to banks and industrial firms. Interest on large CDs, non-core funding to assets, and non-performing loans to loans are from FR Y-9C Reports. 1-year GAP is the absolute value of the difference between assets and liabilities that reprice within 1 year, scaled by assets.

Consistent with prior literature, we include a variety of control variables in our tests: tenure is the natural log of CEO tenure, where tenure is measured in years. Size is the natural log of the market value of equity, measured as the closing price of the stock times common shares outstanding at the end of the fiscal year. Market to book is our proxy for firm growth opportunities, measured as the market value of assets divided by the book value of assets. Sales growth is our proxy for growth in revenues, and is measured as the log of the ratio of the sum of total interest plus non-interest income scaled by sum of lagged total interest plus lagged non-interest income (all from FR Y-9C reports) for banks, or the log of the ratio of sales to lagged sales for industrials. *Stock Return* is the annual return over the fiscal year. We also include two measures of information asymmetry to control for the opaque environment banks operate in. Analyst dispersion is defined as the standard deviation of analyst forecasts, and forecast error is defined as the difference between reported earnings and forecast earnings. We also utilize the interactive term of these two variables.

3. Methodology

In the first part of our study, we examine univariate statistics and trends among key variables, and investigate whether vega and vega-to-delta are positively related to risky investment (asset growth, bank loans to core deposits, and bank commercial real estate loans to assets) and risky debt (book leverage) for banks, and for banks net of industrial firms, based on:

$$Investment\ or\ Debt\ Policy_{i,t} = b_0 + b_1 Crisis_{i,t} + b_2 Crisis_{i,t} \times Bank_{i,t} + b_3 Vega_{i,t-1} + b_4 Vega_{i,t-1} \times Crisis_{i,t} + b_5 Vega_{i,t-1} \times Crisis_{i,t} \times Bank_{i,t} + b_6 Delta_{i,t-1} + b_7 Delta_{i,t-1} \times Crisis_{i,t} + b_8 Delta_{i,t-1} \times Crisis_{i,t} \times Bank_{i,t} + b_9 Vega\text{-}to\text{-}Delta_{i,t-1} + b_{10} Vega\text{-}to\text{-}Delta_{i,t-1} \times Crisis_{i,t} + b_{11} Vega\text{-}to\text{-}Delta_{i,t-1} \times Crisis_{i,t} \times Bank_{i,t} + b_{12} CEO\ Cash\ Compensation_{i,t} + b_{13} Tenure_{i,t} + b_{14} Size_{i,t} + b_{15} MTB_{i,t} + b_{16} Sales\ Growth_{i,t} + b_{17} Stock\ Return_{i,t} + b_{18} Debt\ or\ Investment\ Policy_{i,t} + \varepsilon_{it}, \quad (1)$$

Regressions based on equation (1) are applied to the full sample for asset growth and book leverage with a bank indicator variable to differentiate between banks and industrial firms. Regressions similar to those described in equation (1) but excluding bank indicator variables are applied only to banks for bank commercial real estate loans to assets and bank loans to core deposits. While vega and vega-to-delta are the variables of primary interest, we include control variables for delta, CEO cash compensation, tenure, size, market to book (MTB), sales growth, stock return, , and other policy variables (see, e.g.: Bizjak et al., 1993; Servaes, 1994; Gaver and Gaver, 1993; Bhagat and Welch, 1995; and Opler et al., 1999; Guay, 1999; Core and Guay, 1999; and Coles et al., 2006). We also include investment and debt policy variables as control variables. To control for omitted variables bias, we include firm fixed effects. While our use of control variables, lagged values of compensation variables, and fixed effects, helps isolate incentive effects on policy, like Coles et al. (2006), we assume compensation incentives and policy are also jointly determined.

In the second part of our study, we use simultaneous equations models to check whether investment and debt policy are jointly determined with vega and delta. This approach has the advantage of eliminating bias that may have been introduced in earlier tests by using endogenously determined regressors along with independent variables. Specifically, we employ a series of 3SLS regressions of the form:

$$Investment\ or\ Debt\ Policy_{it} = b_0 + b_1 Crisis_{i,t} + b_2 Crisis_{i,t} \ x\ Bank_{i,t} + b_3 Vega_{i,t-1} + b_4 Vega_{i,t-1} \ x\ Crisis_{i,t} + b_5 Vega_{i,t-1} \ x\ Crisis_{i,t} \ x\ Bank_{i,t} + b_6 Delta_{i,t-1} + b_7 Delta_{i,t-1} \ x\ Crisis_{i,t} + b_8 Delta_{i,t-1} \ x\ Crisis_{i,t} \ x\ Bank_{i,t} + b_9 Vega\text{-}to\text{-}Delta_{i,t-1} + b_{10} Vega\text{-}to\text{-}Delta_{i,t-1} \ x\ Crisis_{i,t} + b_{11}\ Vega\text{-}to\text{-}Delta_{i,t-1} x\ Crisis_{i,t} \ x\ Bank_{i,t} + b_{12} CEO\ Cash\ Compensation_{i,t} + b_{13} Tenure_{i,t} + b_{14} Size_{i,t} + b_{15} MTB_{i,t} + b_{16}\ Sales\ Growth_{i,t} + b_{17} Stock\ Return_{i,t} + b_{18} Debt\ or\ Investment\ Policy_{i,t} + \varepsilon_{i,t}, \quad (2)$$

$$Vega_{it} = c_0 + c_1 Delta_{i,t} + c_2 Cash\ Compensation_{i,t} + c_3 Size_{i,t} + c_4 MTB_{i,t} + c_5 Asset\ Growth_{i,t} + c_6\ Book\ Leverage_{i,t} + e_{i,t}, \quad (3)$$

$$Delta_{it} = d_0 + d_1 Vega_{i,t} + d_2 Tenure_{i,t} + d_3 Size_{i,t} + d_4 MTB_{i,t} + d_5 Asset\ Growth_{i,t} + d_6 Stock\ Volatility_{i,t} + \beta_7 Book\ Leverage_{i,t} + e_{i,t}. \quad (4)$$

Policy decisions are asset growth, bank loans to core deposits, bank commercial real estate loans, and book leverage for firm *i* at time *t*. Controls are similar to those used in regressions based on equation (1). For asset growth and book leverage, data are available for banks and industrial firms, so we use the entire sample with a bank indicator variable to identify differences in banks from industrial firms. Policy variables exclusive to banks are run only for banks, without the bank indicator variable.

In the third part of our study, we test whether vega and vega-to-delta affect bank risk directly, indirectly through policy, and whether firm risk is determined simultaneously with vega and delta. These regressions resemble those described in equation (1), and the system of simultaneous equations described in equations (2) through (4), except that firm risk is used as the dependent variable instead of investment or debt policy. Firm risk is measured as stock volatility (for banks and industrial firms), interest on large CDs, non-core funding to assets, non-performing loans to loans, and 1-year GAP (for banks).

Finally, we employ factor analysis for the purpose of identifying a parsimonious estimate of common variation in bank risk (the bank risk factor). The bank risk factor is estimated using Compustat and FR Y-9C bank data. We use the best bank risk factor score to verify that CEO compensation incentives, directly and through investment and debt policy, affect bank risk estimated in this manner. We also verify that the bank risk factor is simultaneously determined with vega and delta. Finally, we investigate whether the relation between vega and vega-to-delta and the bank risk factor varies between non-crisis and crisis period.

D. Empirical Results

1. Sample Description

Table 2.1 reports summary statistics on CEO compensation, policy measures, risk measures, and financial characteristics of sample firms. Similar to Guay (1999), Core and Guay (1999), and Coles et al. (2006), we Winsorize vega, delta, vega-to-delta, cash compensation, and market-to-book, at the 1% and 99% levels. Results are generally mixed. Bank mean (median) vega is $201,000 ($57,000) for non-crisis years, falling to $134,000 ($29,000) for crisis years. Industrial mean (median) vega is $170,000 ($68,000) for non-crisis years, falling to $119,000 ($49,000) for crisis years. Differences in means (medians) within sample (i.e., for banks or industrial firms, non-crisis vs. crisis) are statistically significant, but differences between sample (i.e., for non-crisis or crisis, banks vs. industrial firms) are mixed not only in sign but significance. Similar results are shown for mean (median) delta. Bank mean (median) vega-to-delta is 0.309 (0.240) for non-crisis years, and 0.146 (0.311) for crisis years. Industrial mean (median) vega-to-delta is 0.379 (0.326) for non-crisis years, and 0.328 (0.256) for crisis years. The difference in means (medians) within sample (i.e., between non-crisis and crisis periods) for banks is not statistically significant – evidently relative risk taking incentives, not raw vega or delta), is largely unaffected by crisis. Although not reported in Table 2.1 for brevity, we also estimate standard deviation of vega and delta for banks in non-crisis and crisis years as follows: during non-crisis (crisis) years, the standard deviation of vega is 0.344 (0.271), and the standard deviation of delta is 1.637 (0.823).

Additional information on trends in CEO compensation among banks vs. industrial firms is shown in Figures 2.2 through 2.4. Figure 2.2A reports plots of mean CEO total compensation, cash compensation (salary plus bonus), and other compensation (chiefly stock option grants), by year, for sample banks and matched industrial firms. There are downward trends in mean total compensation and other compensation between 2000 and 2004, upward trends between 2004 and 2005-06, and downward trends to lows in 2009 (i.e., after the crisis). Mean total compensation and other compensation increased for industrial firms between 2000 and 2001, decreased between 2002 and 2003, and gradually decreased until 2005, and other compensation increased between 2005 and 2008, and cratered in 2009. Trends in cash compensation are similar for both groups of firms. However, plots of median CEO total compensation, cash compensation, and other compensation shown in Figure 2.2B, when compared with plots in Figure 2A, suggest some skewness in the data. Trends in median bank executive compensation are different from trends in median industrial executive compensation. However, Figure 2.3 plots of mean and median bank and industrial CEO vega, delta, and vega-to-delta, show similar patterns in mean and median vega, delta, and relative CEO risk taking incentives for banks vs. industrial firms. Figure 2.4 plots show similarities in the distribution of vega and delta between banks and industrial firms. We conclude that there are some similarities (especially in vega, delta, vega-to-delta, and cash compensation) but also some differences in trends in CEO compensation between banks and industrial firms.

Information on trends in policy and risk is reported in Figures 2.5 and 2.6. Figure 2.5 indicates substantially different trends in comparatively low risk asset growth for banks vs. industrial firms. Banks reduce asset growth less than industrial firms between 2000 and 2002, but reduce asset growth between 2004 and 2010. Industrial firms increase asset growth between 2002 and 2007, reduce it in 2008, and increase it again in 2009-10. Among bank-only investment policies, banks reduce bank loans to core deposits between 2000 and 2002, and then again between 2008 and 2009, but leave bank commercial real estate loans to assets essentially unchanged. Similarly, banks hardly adjust their typically very high leverage ratios, whereas industrial firms vary leverage somewhat to a low in 2007. Figure 2.6 shows similarities in risk measured by mean stock return volatility between banks and industrial firms, with peaks in the financial crisis year 2008. Among bank-specific risk measures, mean non-performing loans to loans is most closely associated with high stock volatility and the financial crisis, and increases substantially between 2007 and 2009, and decreases only slightly in 2010. We conclude that there are substantially different trends in investment policy between banks and industrial firms, but similar patterns in risk as measured by stock return volatility. Non-performing loans to loans also appears to be a promising bank-specific risk measure.

Overall, the evidence suggests considerable heterogeneity exists within and between bank and industrial firm samples and periods. Some trends, particularly those involving elements of CEO compensation and stock returns volatility, have a potentially strong secular component, whereas others do not. To best understand the complex relations between CEO compensation incentives, firm policy, and firm risk, and how they change over time, we rely on multivariate analysis.

2. CEO Incentives and Investment and Debt Policy

In this section, we investigate whether CEO compensation incentives to take risk affect subsequent investment and debt policy. As stated in section B.3, we anticipate bank CEO vega (or vega-to-delta) to be positively related to risky investment projects (asset growth, bank loans to core deposits, and commercial real estate loans) and financial risk (book leverage). Table 2.2 shows results of regressions of investment and debt policy on lagged vega, lagged delta, lagged vega-to-delta, and contemporaneous controls, for banks, and for banks controlling for industrial firms.

Table 2.2 Columns 1 through 3 show lagged vega, lagged vega x crisis, and lagged vega x crisis x bank, are not statistically significantly different from zero for any investment policy measures. This implies CEO risk taking incentives, measured by raw vega, have no direct effect on subsequent bank or industrial firm investment policy. However, Table 2.2 Column 1 shows the coefficient b_9 (lagged vega-to-delta) is -0.085, statistically significantly different from zero at the 1% level, the coefficient b_{10} (lagged vega-to-delta x crisis) is -0.049, not statistically significant, and the coefficient b_{11} (lagged vega-to-delta x crisis x bank) is 0.167, significant at the 5% level. The effect of bank relative risk taking incentives on subsequent asset growth is $b_9+b_{10}+b_{11}$ and is not statistically significant. The effect of bank relative risk taking incentives on subsequent asset growth during non-crisis years (b_{10}) is -0.085, and the difference in the effect between crisis years and non-crisis years ($b_{10}+b_{11}$) is positive and statistical significant, suggesting that bank relative risk taking affect subsequent asset growth more during the crisis period than the non-crisis period. Also, crisis results for industrials ($b_9 + b_{10}$) are negative and statistically significant, showing the negative relationship between relative risk taking and asset growth. Overall non-crisis results for industrials are consistent with findings in Core et al. (2006), although we find evidence of an association between relative rather than absolute risk taking incentives and asset growth (Core et al. (2006) did not look at relative risk taking incentives).

Table 2.2 Column 4 shows the coefficient b_9 (lagged vega-to-delta) is -0.115, b_{10} (lagged vega-to-delta x crisis) is -0.221, and b_{11} (lagged vega-to-delta x crisis x bank) is 0.416, all statistically significant at the 1% level. The effect of bank relative risk taking incentives on leverage is 0.080, consistent with expectations of a positive relation between relative risk taking incentives and risky debt policy. The effect of bank relative risk taking incentives on leverage is -0.115, during non-crisis years, and 0.195 during crisis years, both significant at the 1% level, and with differences significant at the 1% level. The effect of industrial relative risk taking incentives on leverage is negative overall, during non-crisis years, and during crisis years. The change in bank relative risk taking incentives on leverage after controlling for changes among industrial firms between crisis and non-crisis years is 0.416, significant the 1% level. This result shows bank CEO relative risk taking incentives also become more positively related to risky leverage during crisis years after controlling for trends among industrial firms.

3. CEO Incentives and Simultaneous Determination of Investment and Debt Policy

We suspect bank CEO compensation risk taking and stock price maximizing incentives are simultaneously determined with investment and debt policy. Accordingly, we turn next to simultaneous equations models similar to those described in equations 2 through 4, and report results in Table 2.3.

Table 2.3 Columns 1 through 9 report results of 3SLS regressions involving the simultaneous determination of investment policy (asset growth for banks and industrial firms, and loans to core deposits and commercial real estate loans to assets for banks), vega, and delta. In Column 1, the coefficient b_3 (vega) is not statistically significant, but the coefficient b_4 (vega x crisis) is -1.234, and the coefficient b_5 is -0.217, both significantly different from zero at the 1% level. Recall that $b_4 + b_5$ represents the extra impact of vega on asset growth in crisis period to non-crisis period. The negative coefficients of b_4 and b_5 suggest that during crisis period, the impact of vega on asset growth is less than that during non-crisis period. Industrial vega is negatively related to asset growth in crisis years, and the change in the relation between bank vega between crisis and non-crisis years, after controlling for trends among matched financial firms, is -0.217, significant at the 1 % level. Column 1 coefficients b_9, b_{10}, and b_{11} are -0.109, significant at the 1% level, -0.016, not significant, and 0.165, significant at the 1% level. Results suggest higher relative vega to delta increases asset growth for banks in crisis, consistent with expectations.

In Column 4, the coefficient b_3 (vega) is not statistically significant, but the coefficient b_4 (vega x crisis) is -14.369, significant at the 1 % level. This suggests bank risk taking incentive is unrelated to loans to core deposits during non-crisis years, but becomes negatively related during crisis years. On the other hand, the coefficient b_9 (vega-to-delta) is -7.641, and the coefficient b_{10} is 6.152, both significant at the 1% level. These results suggest bank CEO relative risk taking incentives are negatively related to loans to core deposits during non-crisis periods, but are less negatively related during crisis periods (but the relation is still negative). In Column 7, the coefficient b_3 (vega) is also not statistically significant, but coefficient b_4 (vega x crisis) is 6.102, suggesting a positive relation between bank risk taking incentive and commercial real estate loans during crisis. A positive coefficient b_9 (vega-to-delta) and negative coefficient b_{10} (vega-to-delta x crisis), significant at the 1% level, suggest bank CEO relative risk taking incentives are positively related to commercial real estate loans during non-crisis years, and less positively related during crisis years (the relation is still positive). Overall, the evidence suggests that the crisis period lessens any effect CEO incentives originally had on investment policies.

Table 2.3 Columns 10 through 12 report results of 3SLS regressions on book leverage, vega and delta. In Column 10, the coefficient b_3 (vega) is not significant, thee coefficient b_4 (vega x crisis) is -0.173, significant at the 1% level, and the coefficient b_5 (vega x crisis x bank) is not significant. These results suggest little relationship between bank vega and debt policy. However, the coefficient b_9 (vega-to-delta), b_{10} (vega-to-delta x crisis), and b_{11} (vega-to-delta x crisis x bank) are -0.399, 0.197, and 0.198, all significant at the 1% level. These results suggest bank CEO relative risk taking incentives lead CEOs to adopt higher risk leverage during crisis and bank CEOs tend to adopt higher risk leverage than industrial firm CEOs.

To determine the economic significance of these results, we assess the effects of a one standard deviation increase in bank vega for non-crisis vs. crisis years on the systems of equations reported in Table 2.3. During non-crisis years, a one standard deviation increase in bank CEO vega results in a .288 (310%) increase in asset growth, a 9.549 (474%) increase in loans to core deposits, a 12.072 (6,067%) increase in commercial real estate loans, and a 0.107 (12%) increase in debt, all consistent with the expected positive relation between risk taking incentives and risky investment and debt policy. During crisis years, a one standard deviation increase in bank CEO vega results in a -0.645 (1,289%) change in asset growth, an 11.472 (780%) increase in loans to core deposits, a 6.714 (2,460%) increase in commercial real estate loans, and a 0.298 (33%) increase in debt, in all cases but asset growth still consistent with expectations. However, after taking into account changes in vega-to-delta, the net effect of one standard deviation changes in bank CEO vega during non-crisis (crisis) years on asset growth is 469% (2,371%), loans to core deposits is 906% (915%), commercial real estate loans is 3,867% (2,389%), and debt is 78% (33%). These results are consistent with expectations – incentives to increase risk, and increase risk relative to increase stock price, have the effect of increasing risky investment and debt policy.

4. CEO Incentives and Bank Risk

We also expect bank CEO compensation risk taking and stock price maximizing incentives to take risk to be positively related to bank risk. Table 2.4 shows results of regressions of stock volatility, interest paid on large CDs, non-core funding to assets, non-performing loans to loans, and 1-year GAP on lagged vega, lagged vega-to-delta, and contemporaneous controls.

Table 2.4 Column 1 lagged vega, lagged vega x crisis, and lagged vega x crisis x bank coefficients are not statistically significant, suggesting lagged vega does not directly affect stock volatility. However, the coefficient on vega-to-delta x crisis is 0.010, and the coefficient on vega-to-delta x crisis x bank is 0.020, both significant at the 1% level. The sum b_9 through b_{11} is positive and significant, showing bank CEO relative vega encourages stock volatility during the crisis, consistent with expectations. However, lagged vega-to-delta is not significant, indicating this relation does not hold during non-crisis years. The sum $b_{10} + b_{11}$ is also significant, showing the relation really does change between non-crisis and crisis years, and that relative vega increases stock volatility during crisis more than non-crisis. Column 2 shows little evidence of a relation between bank CEO vega or vega-to-delta and interest paid on large CDs. Column 3 shows evidence of a negative relation between relative risk taking incentives and non-core funding to assets that becomes more negative during crisis years. Importantly, Column 4 shows evidence of a negative relation between vega-to-delta and non-performing loans to loans during non-crisis years, and the expected positive relation between vega-to-delta and non-performing loans during crisis years, with differences statistically significant at the 1 percent level. Column 5 shows no such evidence for vega or vega-to-delta and the 1-year GAP risk measure. We conclude that bank CEO vega-to-delta is positively related to subsequent stock volatility and non-performing loans to loans – our two most promising measures of bank risk based on our Figures reported in Section D.1 - during crisis years, consistent with expectations.

5. *CEO Incentives and Simultaneous Determination of Bank Policies and Risk*

In Section D.3, we show that bank CEO compensation risk taking and stock price maximizing incentives are simultaneously determined with investment and debt policy, and in Section D.4, we show that bank CEO relative risk taking incentives are positively related to stock volatility and non-performing loans to loans during the crisis period. In this Section, we investigate whether firm risk is also jointly determined with vega and delta by means of five additional 3SLS regressions, with results reported in Table 2.5.

Table 2.5 Column 1 results suggest bank CEO vega becomes more positively related to stock volatility during crisis periods, and that vega-to-delta is generally positively related to stock volatility, consistent with expectations. Columns 4 and 7 show evidence of a negative relation between bank CEO vega in non-crisis periods, and risk as measured by interest paid on large CDs and non-core funding to assets. They also show mixed evidence on bank CEO relative risk taking incentives and these two measures of bank risk. Columns 10 and 13 suggest a negative relation between bank CEO vega and risk, as measured by non-performing loans to loans, and 1-year GAP, during the crisis period, and opposite results concerning vega-to-delta during the non-crisis vs. crisis periods. Overall, the evidence suggests that during crisis, vega is selected to decrease risk (b_4), while relative vega increases risks (b_{10}).

To investigate the economic significance of these results, we assess the effects of a one standard deviation increase in bank vega for non-crisis vs. crisis years on the systems of equations reported in Table 2.5. During non-crisis years, a one standard deviation increase in bank CEO vega, after taking into account effects on delta and vega-to-delta, results in a 42% increase in stock volatility and an 1,155% increase in non-performing loans, consistent with our expectation that bank CEO incentives to increase risk, and relative incentives to increase risk, result in increased risk. During crisis years, a one standard deviation increase in bank CEO vega, after taking into account effects on delta and vega-to-delta, results in a 58% increase in stock volatility and a 9% increase in non-performing loans. While these results are consistent with expectations, we note that there is a sharp reduction in sensitivity of bank CEO incentives to increase risk, and relative incentives to increase risk, between the non-crisis and crisis periods.

During non-crisis years, a one standard deviation increase in bank CEO vega is also associated with an 802% decrease in interest on large CDs, 627% increase in non-core funding to assets, and 10,307% increase in 1-year GAP. During crisis years, a one standard deviation increase in bank CEO vega also results in an 832% decrease in interest on large CDs, 600% decrease in non-core funding to assets, and 114% decrease in 1-year GAP.

E. Robustness Tests

1. *Common Factor Analysis Applied to Bank Risk Measures*

The most appropriate measure of risk for a given situation could be the total variation of all dimensions of risk, or the common variation underlying these various dimensions. In this section, we employ exploratory common factor analysis to determine whether a single common factor score that measures bank risk exists.

Results of our factor analysis of bank risk variables are reported in Table 2.6. Correlation coefficients for each of the five bank risk variables are reported in Panel A. Only stock volatility and non-performing loans to loans appear to be highly correlated with one another, with a Pearson correlation coefficient of 0.351, significant at the 1 percent level. Recall from our discussion in Section D.1 that these two risk measures seemed to be the ones that changed most with the onset of the financial crisis. Accordingly, for the remainder of our factor analysis, we look at common variation among all five bank risk measures, and, alternatively, at common variation only among these two correlated measures. Panel B shows factor loading coefficients for factors generated both ways. Panel C shows stock volatility and non-performing loans to loans are both highly correlated (approximately 80%) with both factor scores, suggesting both of these individual measures of bank risk could be used as proxies for the common factors. However, Panel D shows the percentage of variation explained from the factor using all five bank risk variables is only 27.56%, leaving open the question of what else is happening with these variables. On the other hand, the percentage of variation explained from the factor generated from stock volatility and non-performing loans to assets explains 67.55% of the variation in these two variables. Figure 2.7 shows bank risk factor scores by year. Both versions vary similarly, increase during the 2000 recession, but sharply increase during the financial crisis, consistent with expectations. Given the high level of correlation between stock volatility and non-performing loans to loans (82.2%) with this factor (Factor 1B in the Table), we conclude that this factor is indeed a measure of bank risk, and use it in the remainder of our analysis.

2. *Bank CEO Incentives, Bank Investment and Debt Policy, and Bank Risk*

In this section, we investigate whether bank CEO risk taking incentives, and relative risk taking incentives, lead to subsequent increases in bank risk, where bank risk is estimated using the common bank risk factor score generated from stock volatility and non-performing loans to assets in the previous section. We also assess whether bank risk, measured this way, is simultaneously determined with bank CEO vega and delta. Results of two-way fixed effects and 3SLS regressions are reported in Table 2.7.

Table 2.7 Column 1 contains evidence that bank CEO risk taking incentives, and relative risk taking incentives, lead to subsequent increases in bank risk, consistent with expectations. The relation between bank risk taking incentives and subsequent risk in crisis years is summarized by the sum of the coefficients b_1 and b_2, or 1.191, significantly different from zero at the 1% level. This relation in non-crisis years is summarized by the coefficient b_1, 0.516, significant at the 1% level. The coefficient b_2 shows the relation becomes stronger in crisis vs. non-crisis years, also significant at the 1% level. Similarly, the relation between bank relative risk taking incentives and subsequent risk in crisis years is summarized by $b_5 + b_6$, or 0.887, significant at the 5% level. There is no evidence of such a relation in non-crisis years, as the b_5 coefficient is not statistically significantly different from zero. However, the b_6 coefficient captures the change, and shows the sensitivity of bank CEO relative risk taking incentives to subsequent risk increases between non-crisis and crisis years. All of these results are consistent with our expectation that bank CEO risk taking incentives, and relative risk taking incentives, lead to subsequent increases in bank risk, and that these relations change between non-crisis and crisis periods.

Table 2.7 Column 2 shows evidence of a more negative relation between bank CEO vega and contemporaneous bank risk in crisis vs. non-crisis periods. On the other hand, it also shows a more positive relation between bank CEO vega-to-delta and contemporaneous bank risk in crisis vs. non-crisis periods. One limitation of the factor analysis approach is that we cannot assess economic significance in the manner done in Tables 2.3 and 2.5 because the factor score mean is 0. However, our factor score results are certainly consistent with our hypothesis of changes between non-crisis and crisis years.

F. Discussion and Conclusion

In this paper, we provide strong empirical evidence showing bank CEO compensation incentives to take risk, and to take risk relative to increase stock price, are positively related to subsequent bank risky investment and debt policy and bank risk. We demonstrate that bank investment policy, debt policy, and risk, are also determined contemporaneously with CEO vega and delta. Finally, we document that the relation between CEO risk taking incentives, policy, and risk, changes materially between non-crisis and crisis periods.

In the process, this paper makes several contributions. First, it is among the first to link precise measures of bank CEO incentives to change in stock price volatility (vega, and vega-to-delta) to bank policy and risk, extending Coles et al. (2006) and Fahlenbrach and Stulz (2010) to a panel of banks. Second, this paper is the first to show that the relation between CEO risk taking incentives, policy, and risk, change over time. We use the financial crisis of 2007-08 as a natural experiment to demonstrate that the incentive effects of CEO compensation to take risk, especially among banks, changes with changes. Third, this paper makes a number of methodological contributions, including the application of Rogers (2002, 2005)' vega-to-delta measure of relative risk taking to studies of compensation incentives, policy, and risk, the use of size- and prior-performance matched industrial firms to control for secular trends in executive compensation, and the use of FR Y-9C data for detailed information about bank policy and risk, and the use of factor analysis to generate a bank risk factor score as a parsimonious estimate of bank risk.

We note that the popular press, politicians, and regulators, attempt to portray bank CEO compensation incentives, particularly those associated with stock options, as the cause of excessive bank risk taking and thus the 2007-08 financial collapse. In this paper, we show that bank CEO incentives to take risk (as measured by vega, and vega-to-delta), are positively related to subsequent bank risky investment and debt policy, and bank risk. However, we also note that many of the changes in executive compensation that occur among banks also occur for prior-size- and prior-performance matched industrial firms, i.e., they form part of broader secular trends across markets. Importantly, we show that relations between bank CEO risk taking incentives and policy and risk change between non-crisis and crisis periods. Bank risk has many dimensions that we are only just beginning to understand – attempts to blame CEO compensation incentives for financial collapse appear, in our view, to be premature.

G. References

Agrawal, Anup and Gershon Mandelker, 1987, Managerial Incentives and Corporate Investment and Financing Decisions, *Journal of Finance* 42, 823-837.

Barber, Brad M. and John D. Lyon, 1996, Detecting Abnormal Operating Performance: The Empirical Power and Specification of Test Statistics, *Journal of Financial Economics* 41, 359-399.

Bebchuk, Lucian A. and Holger Spamann, 2009, Regulating Bankers' Pay, *Georgetown Law Journal*, Vol.98, No.2, 247-287.

Berger, Philip G.; Eli Ofek and David L. Yermack, 1997, Managerial Entrenchment and Capital Structure Decisions, *Journal of Finance* 52, 1411-1438.

Bhagat, Sanjai and Ivo Welch, 1995, Corporate Research & Development Investments International Comparisons, *Journal of Accounting and Economics* 19, 443-478.

Bizjak, John M.; James A. Brickley and Jeffrey L. Coles, 1993, Stock-Based Incentive Compensation and Investment Behavior, *Journal of Accounting and Economics* 16, 349-372.

Black, Fischer and Myron S. Scholes, 1973, The Pricing of Options and Corporate Liabilities, *Journal of Political Economy* 81, 637-654.

Chen, Carl R.; Thomas L. Steiner and Ann Marie Whyte, 2006, Does Stock Option-Based Executive Compensation Induce Risk taking? An Analysis of the Banking Industry, *Journal of Banking & Finance* 30, 915-950.

Coles, Jeffrey L.; Naveen D. Daniel and Lalitha Naveen, 2006, Managerial Incentives and Risk taking, *Journal of Financial Economics* 79, 431-465.

Core, John, 2002, Estimating the Value of Employee Stock Option Portfolios and their Sensitivities to Price and Volatility, *Journal of Accounting Research 40*, 613-630.

Core, John and Wayne Guay, 1999, The use of Equity Grants to Manage Optimal Equity Incentive Levels, *Journal of Accounting and Economics* 28, 151-184.

Fahlenbrach, Rüdiger and Rene M. Stulz, 2011, Bank CEO Incentives and the Credit Crisis, *Journal of Financial Economics* 99, 11-26 .

Gaver, Jennifer J. and Kenneth M. Gaver, 1993, Additional Evidence on the Association between the Investment Opportunity Set and Corporate Financing, Dividend, and Compensation Policies, *Journal of Accounting and Economics* 16, 125-160.

Guay, Wayne R., 1999, The Sensitivity of CEO Wealth to Equity Risk: An Analysis of the Magnitude and Determinants, *Journal of Financial Economics* 53, 43-71.

Houston, Joel F. and Christopher James, 1995, CEO Compensation and Bank Risk is Compensation in Banking Structured to Promote Risk Taking? *Journal of Monetary Economics* 36, 405-421.

Jensen, Michael C. and William H. Meckling, 1976, Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, *Journal of Financial Economics* 3, 305-360.

Jensen, Michael C. and Kevin J. Murphy, 1990, Performance Pay and Top-Management Incentives, *Journal of Political Economy* 98, 225-264.

John, Kose; Hamid Mehran and Yiming Qian, 2010, Outside Monitoring and CEO Compensation in the Banking Industry, *Journal of Corporate Finance* 16, 383-401.

John, Kose and Yiming Qian, 2003, Incentive Features in CEO Compensation in the Banking Industry, *Economic Policy Review* 10, 109-121.

John, Teresa A. and Kose John, 1993, Top-Management Compensation and Capital Structure, *Journal of Finance* 48, 949-974.

Kothari, S. P. and Jerold B. Warner, 1997, Measuring Long-Horizon Security Price Performance, *Journal of Financial Economics* 43, 301-339.

Laeven, Luc and Ross Levine, 2009, Bank Governance, Regulation and Risk Taking, *Journal of Financial Economics* 93, 259-284.

Merton, Robert C, 1973, Theory of Rational Option Pricing, *Bell Journal of Economics* 4, 141-183.

Morgan, Donald P, 2002, Rating Banks: Risk and Uncertainty in an Opaque Industry, *American Economic Review* 92, 874-888.

Murphy, Kevin J, 1999, Executive Compensation 3, 2485-2563.

Myers, Stewart C, 1977, Determinants of Corporate Borrowing, *Journal of Financial Economics* 5, 147-175.

Opler, Tim; Lee Pinkowitz; Rene Stulz and Rohan Williamson, 1999, The Determinants and Implications of Corporate Cash Holdings, *Journal of Financial Economics* 52, 3-46.

Rogers, Daniel A., 2002, Does Executive Portfolio Structure Affect Risk Management? CEO Risk taking Incentives and Corporate Derivatives Usage, *Journal of Banking & Finance* 26, 271-295.

Rogers, Daniel A., 2005, Managerial Risk taking Incentives and Executive Stock Option Repricing: A Study of US Casino Executives, *Financial Management* 25, 95-121.

Servaes, Henri, 1994, Do Takeover Targets Overinvest? *Review of Financial Studies* 7, 253-277.

Smith, Clifford W. and Rene M. Stulz, 1985, The Determinants of Firms' Hedging Policies, *Journal of Financial and Quantitative Analysis* 20, 391-405.

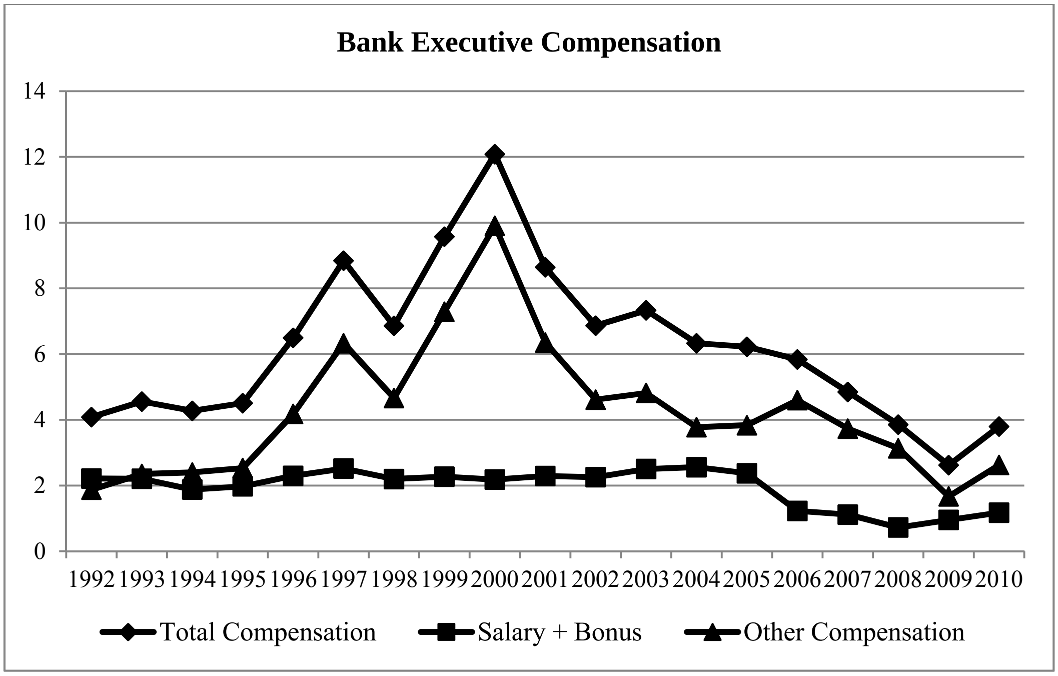
Smith, Clifford W. and Ross Leslie Watts, 1992, The Investment Opportunity Set and Corporate Financing, Dividend, and Compensation Policies, *Journal of Financial Economics* 32, 263-292.

Stojanovic, Dusan; Mark D. Vaughan and Timothy J. Yeager, 2008, Do Federal Home Loan Bank Membership and Advances Increase Bank Risk taking? *Journal of Banking & Finance* 32, 680-698.

H. Figures

Figure 2.1 – Bank Executive Compensation over Time

This figure plots the distribution of the mean of CEO's Vega, Delta and Cash compensation (salary + bonus) in years. Data are from S&P Execucomp for banks between 1992 and 2010. Bank holding companies are listed in Compustat SIC 6020 and 6199. All dollar values are express in millions of 2010 constant dollars, adjusted for changes in CPI.



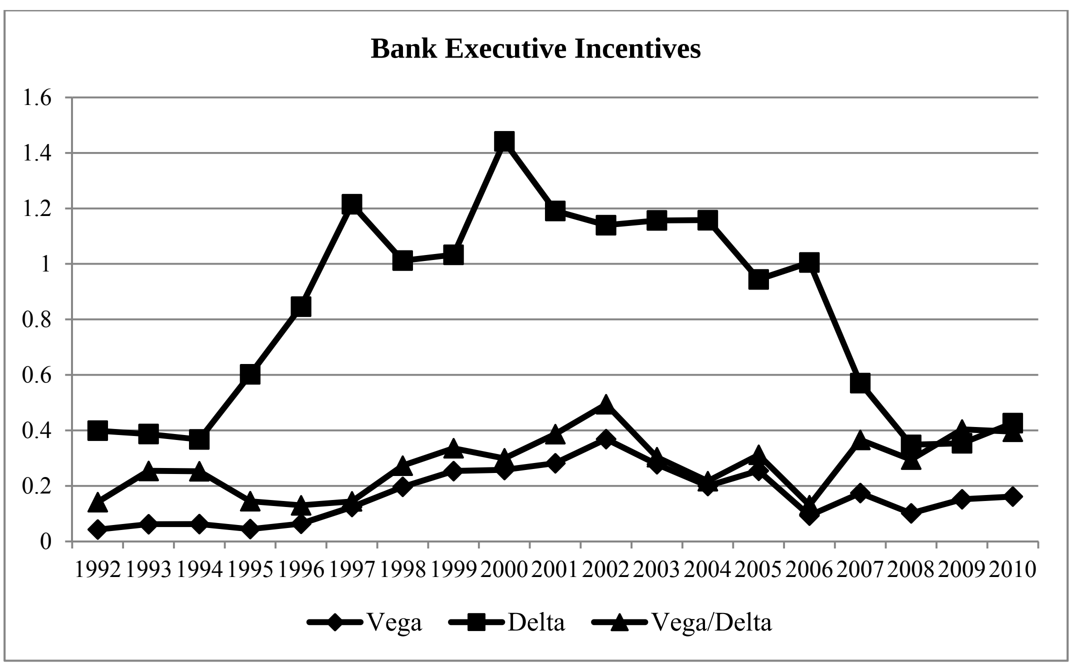
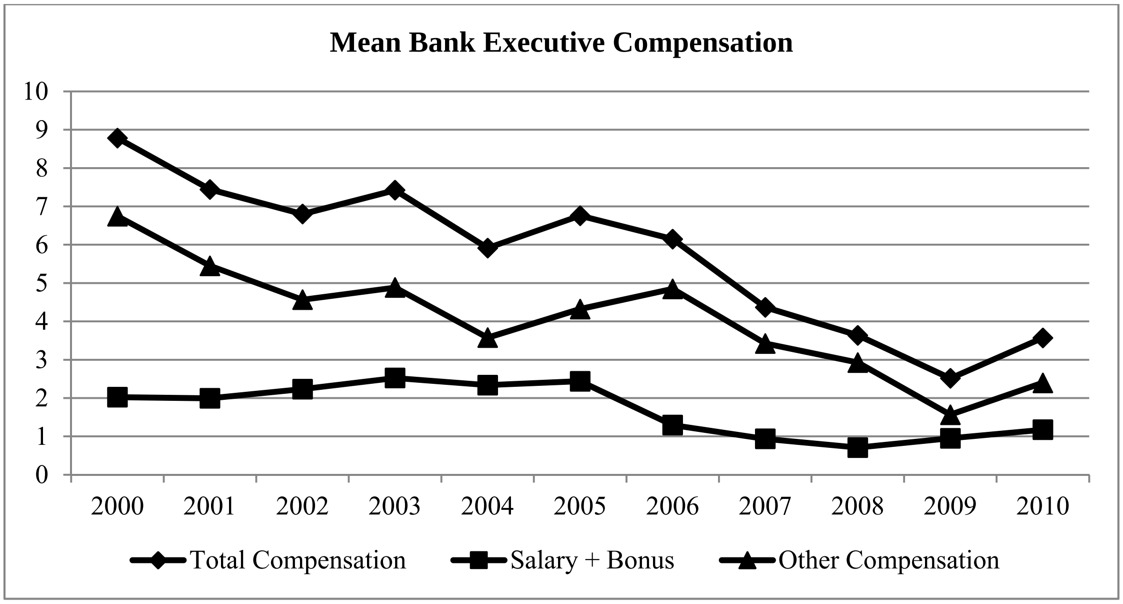


Figure 2.2A – Bank and Industrial Executive Compensation over Time

This figure plots ***mean*** bank CEO's total compensation, cash compensation (salary + bonus) and other compensation by year for sample banks and matched industrial control firms from 2000 to 2010. Data are from S&P Execucomp. All dollar values are express in millions of 2010 constant dollars adjusted for changes in CPI.



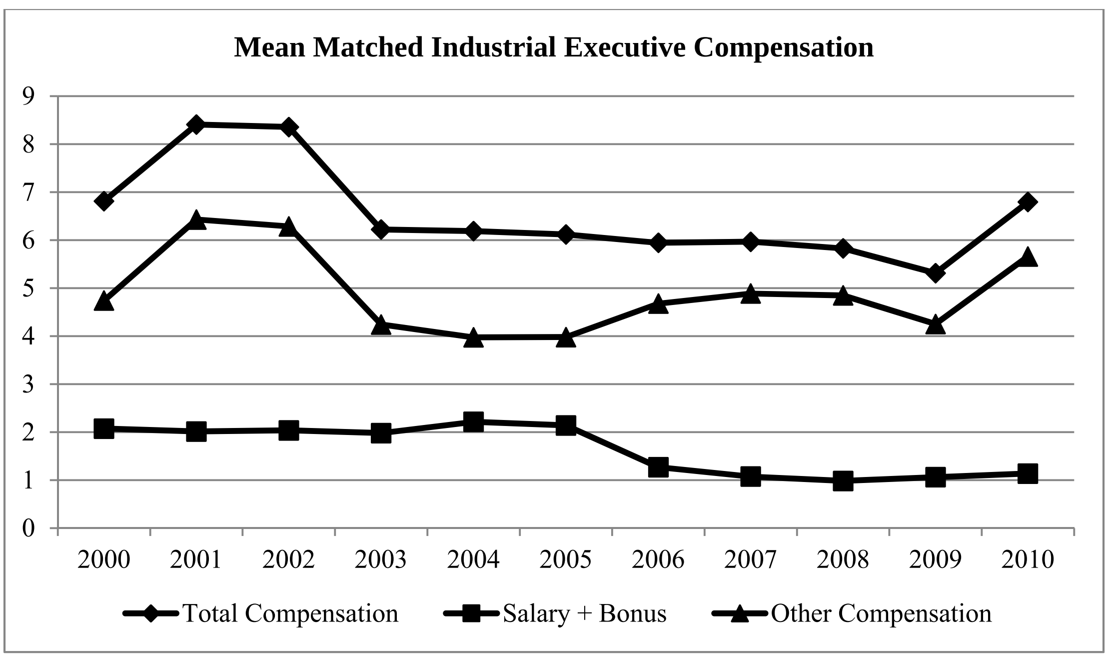
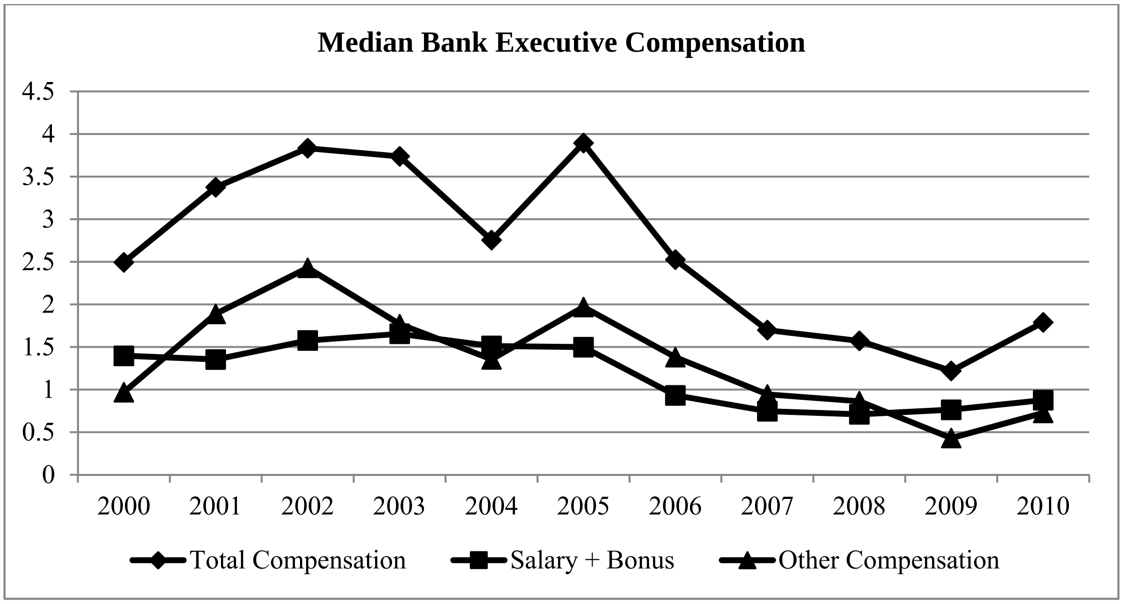


Figure 2.2B – Bank and Industrial Executive Compensation over Time

This figure plots ***median*** bank CEO's total compensation, cash compensation (salary + bonus) and other compensation by year for sample banks and matched industrial control firms from 2000 to 2010. Data are from S&P Execucomp. All dollar values are express in millions of 2010 constant dollars adjusted for changes in CPI.



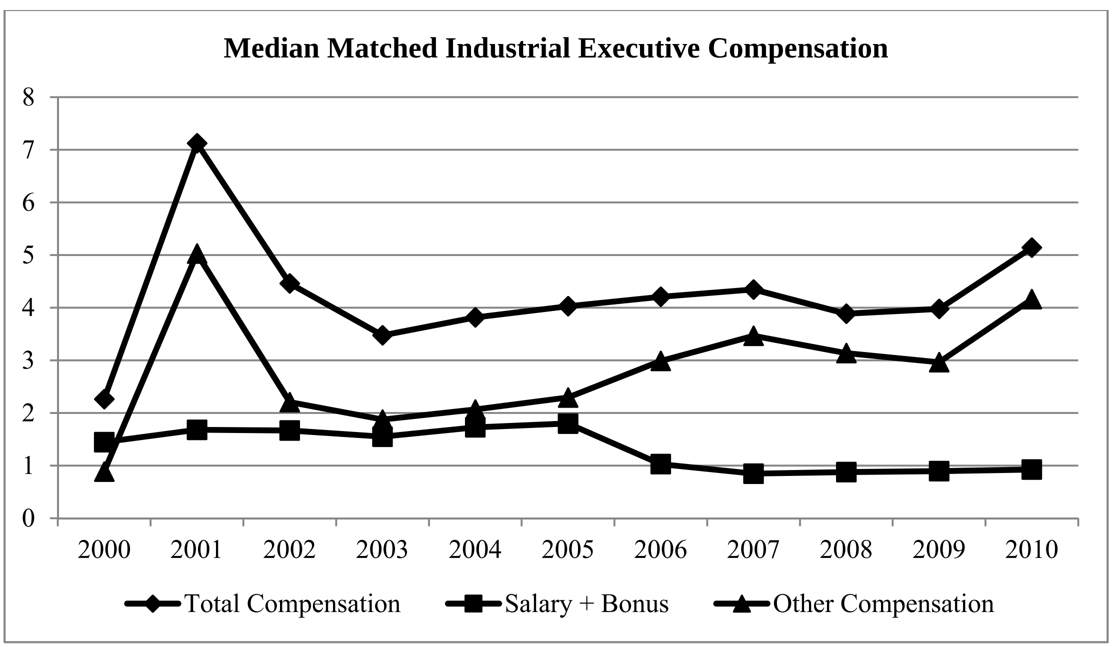
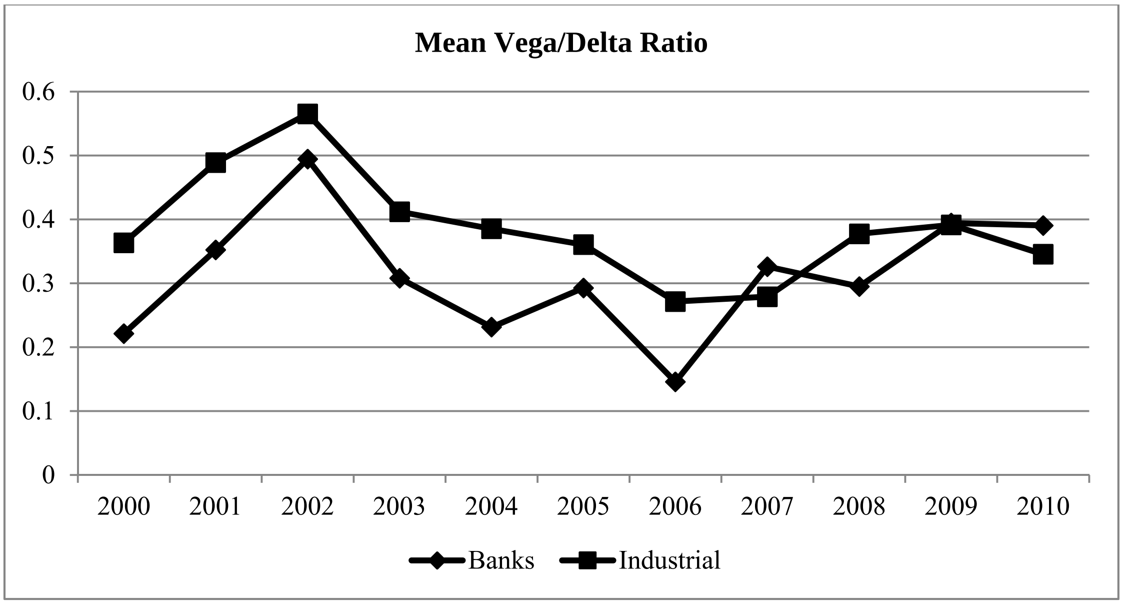


Figure 2.2C – Bank and Industrial Executive Compensation over Time

This figure plots ***mean*** and ***median*** bank CEO's Vega/Delta ratio by year for sample banks and matched industrial control firms from 2000 to 2010. Data are from S&P Execucomp. All dollar values are express in millions of 2010 constant dollars adjusted for changes in CPI.



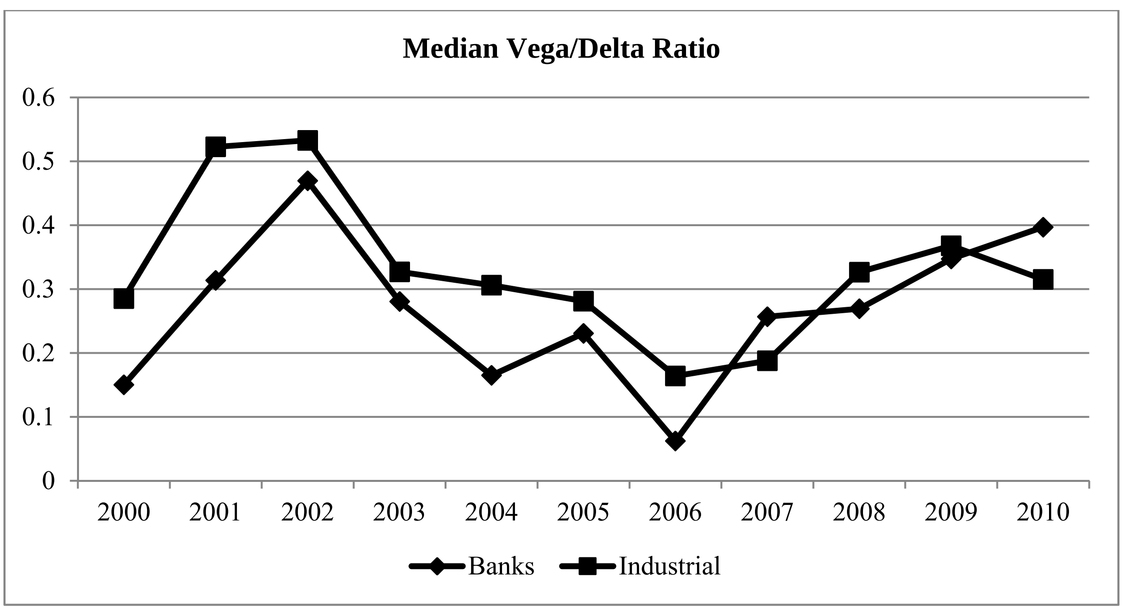


Figure 2.3 – Executive Compensation for Banks and Matched Industrial Firms

This figure plots the distribution of the ***mean*** of CEO's Vega, Delta and Cash compensation (salary + bonus) in years. Data are from S&P Execucomp for banks between 2000 and 2010. Bank holding companies are listed in Compustat SIC 6020 and 6199. All dollar values are express in millions of 2010 constant dollars, adjusted for changes in CPI. Matched industrial firms are public traded U.S. industrial firms listed in Compustat under SIC codes 2000 – 3999. Each industrial firm is matched to each bank on size (90% - 110% of prior year market value of equity) and prior performance (closest prior year return on assets).

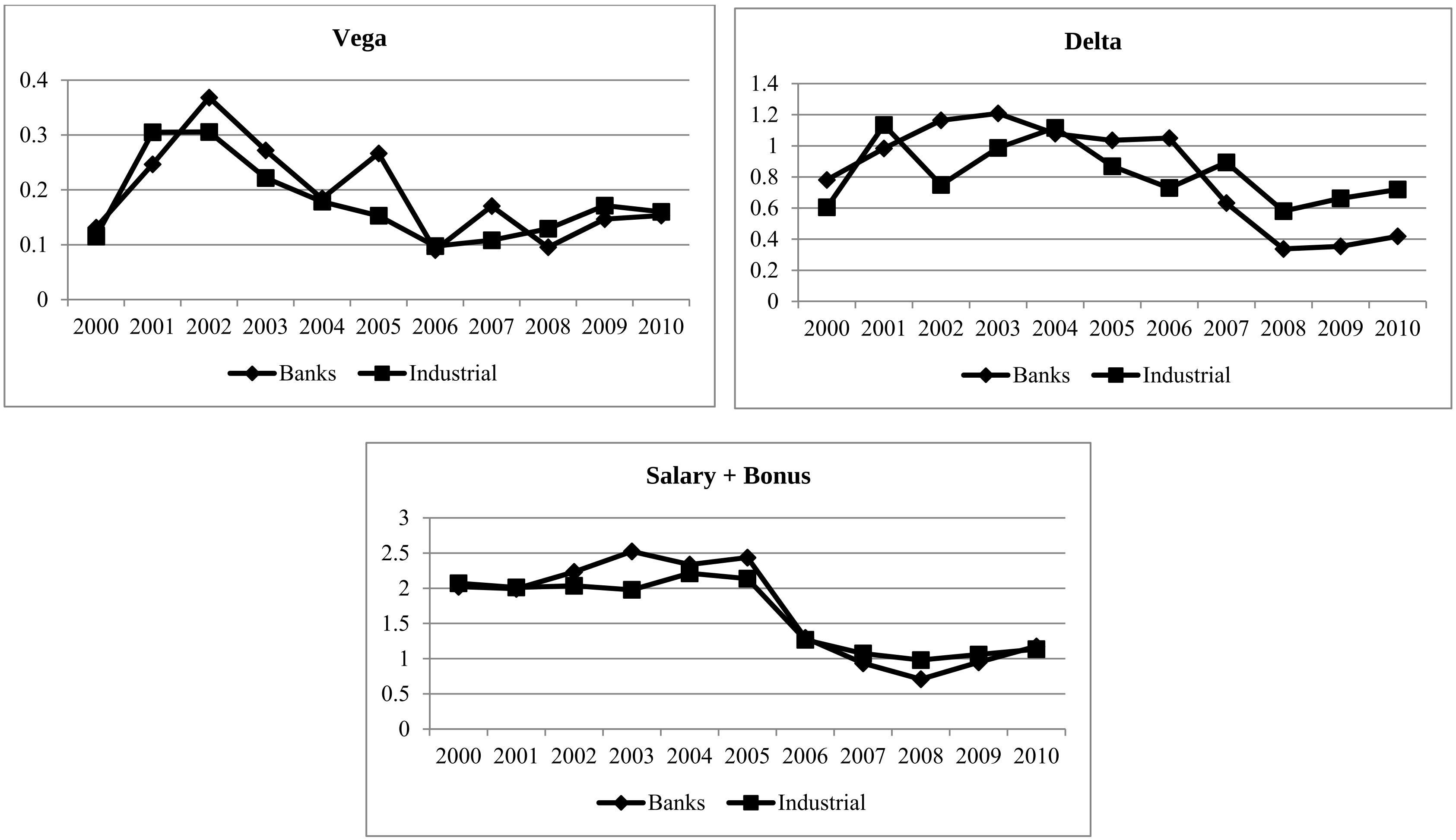
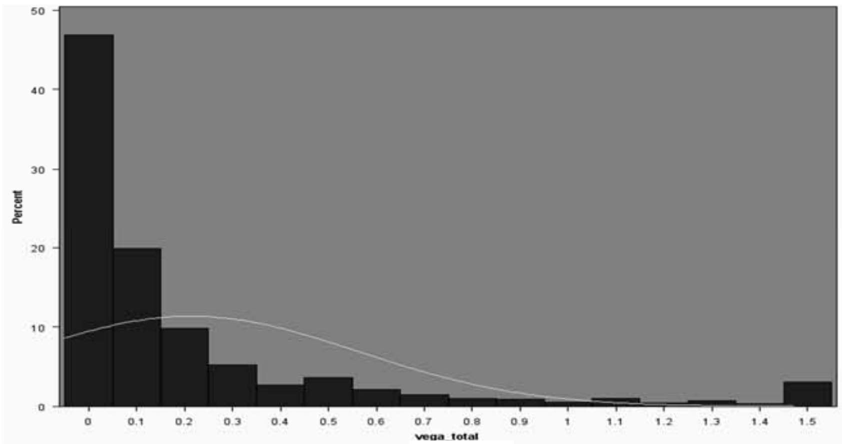


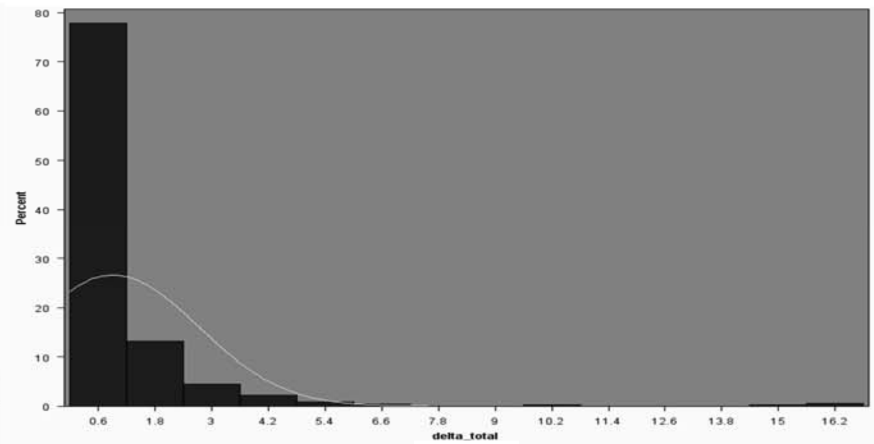
Figure 2.4 – Distribution of CEO Incentives

This figure plots the histograms of bank CEOs' Vega, Delta and cash compensation (salary + bonus), and those of industrial firm CEOs. Data are from S&P Execucomp for banks between 2000 and 2010. Bank holding companies are listed in Compustat SIC 6020 and 6199. All dollar values are express in millions of 2010 constant dollars, adjusted for changes in CPI. Matched industrial firms are public traded U.S. industrial firms listed in Compustat under SIC codes 2000 – 3999. Each industrial firm is matched to each bank on size (90% - 110% of prior year market value of equity) and prior performance (closest prior year return on assets).

Banks

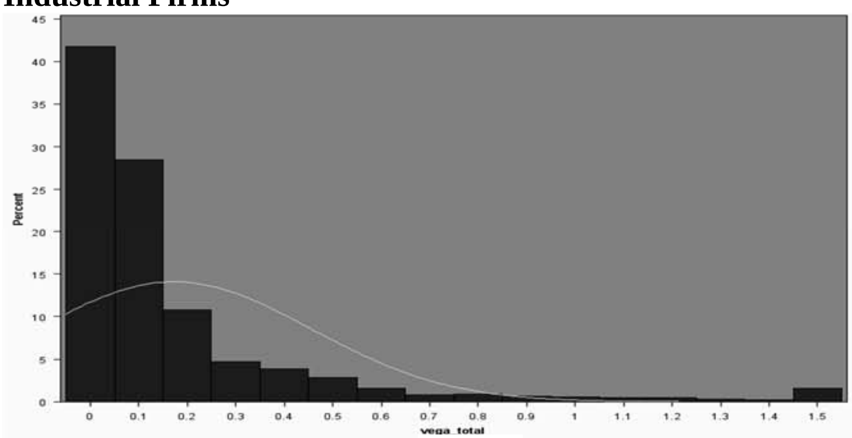


Vega

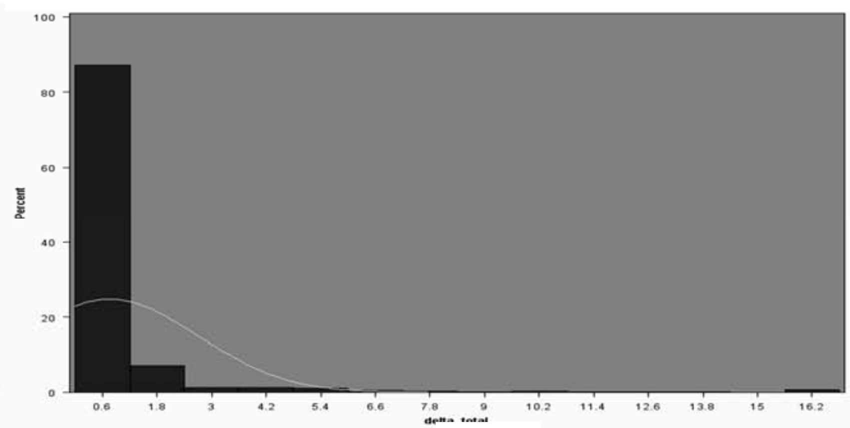


Delta

Industrial Firms



Vega



Delta

Figure 2.5 – Bank Policy Measures over Time

This figure plots the distribution of the mean policy measures from 2000 to 2010. Policy measures include investment policy decisions captured by Asset Growth, Loans to Core Deposits and Commercial Real Estate Loans to Assets, and debt policy decisions captured by Book Leverage. Data are from S&P Execucomp, CRSP, and Consolidated Financial Statements for bank holding companies (FR Y-9C Reports) for banks between 2000 and 2010. Bank holding companies are listed in Compustat SIC 6020 and 6199.

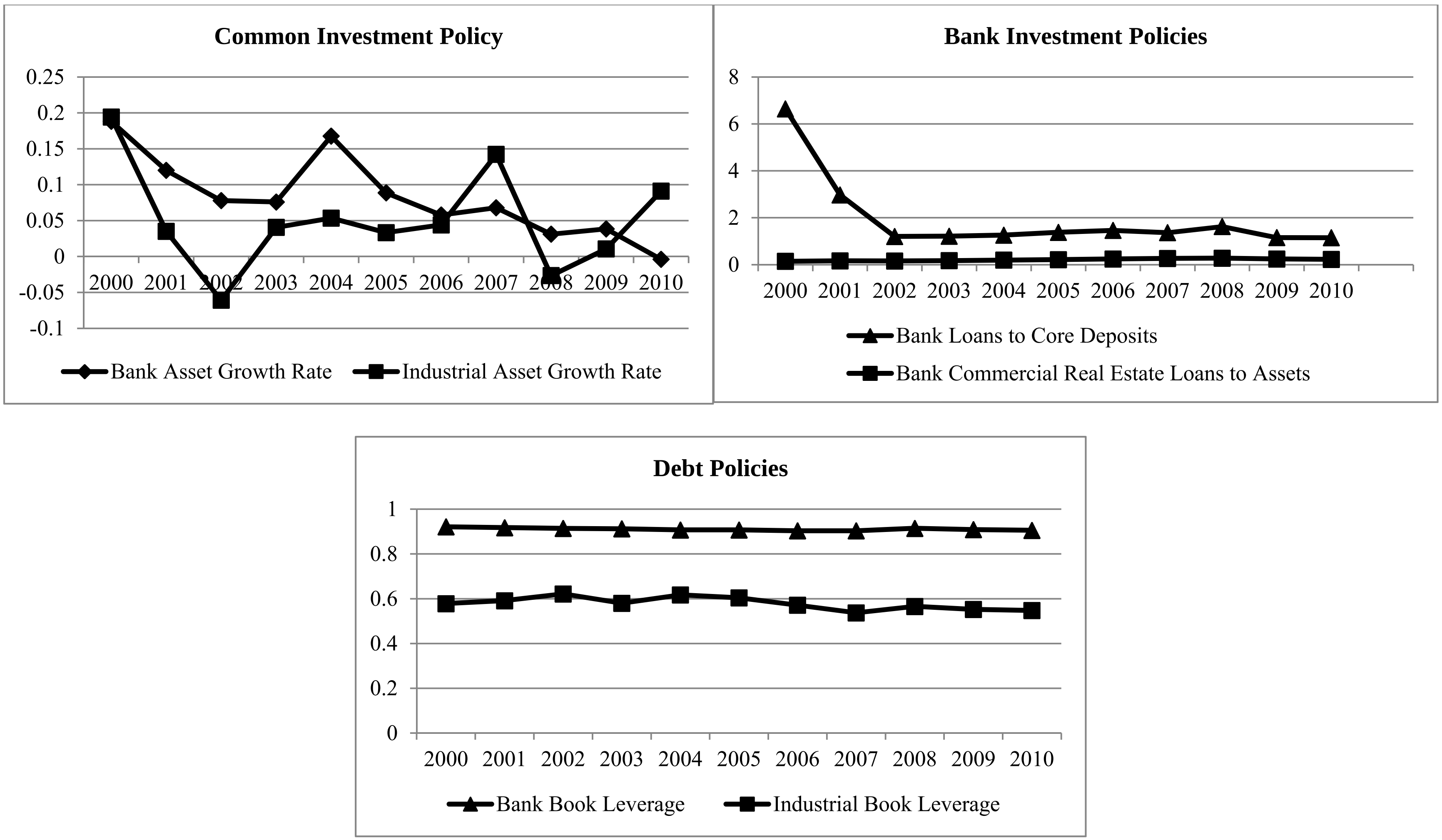


Figure 2.6 – Bank Risk Measures over Time

This figure plots the distribution of the mean risk measures from 2000 to 2010. Risk measures include Stock Return Volatility, Interest Paid on Large CDs, Non-core Funding to Assets, Non-Performing Loans to Loans, and 1-year GAP. Data are from Consolidated Financial Statements for bank holding companies (FR Y-9C Reports) for banks between 2000 and 2010. Bank holding companies are listed in Compustat SIC 6020 and 6199.

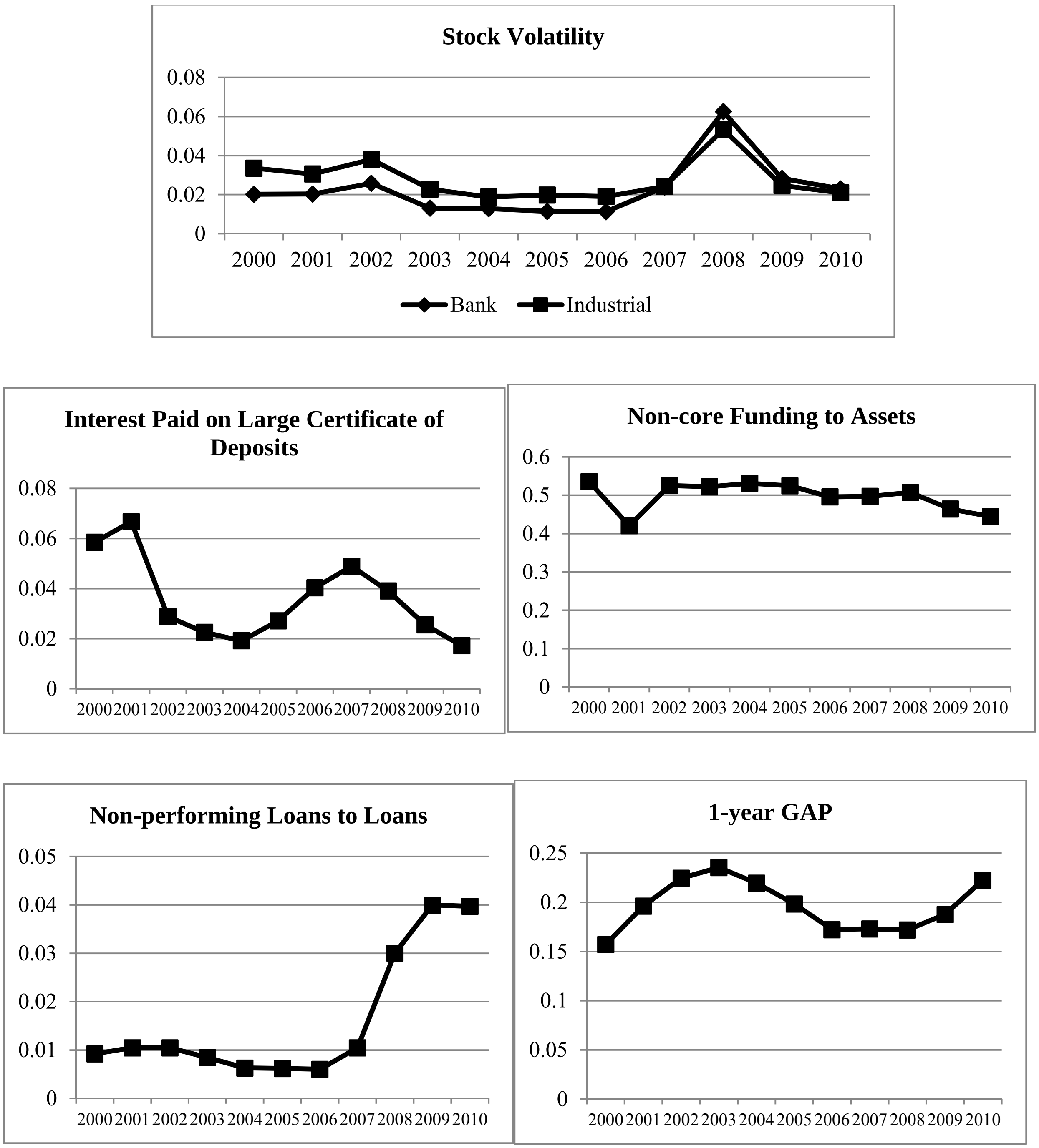
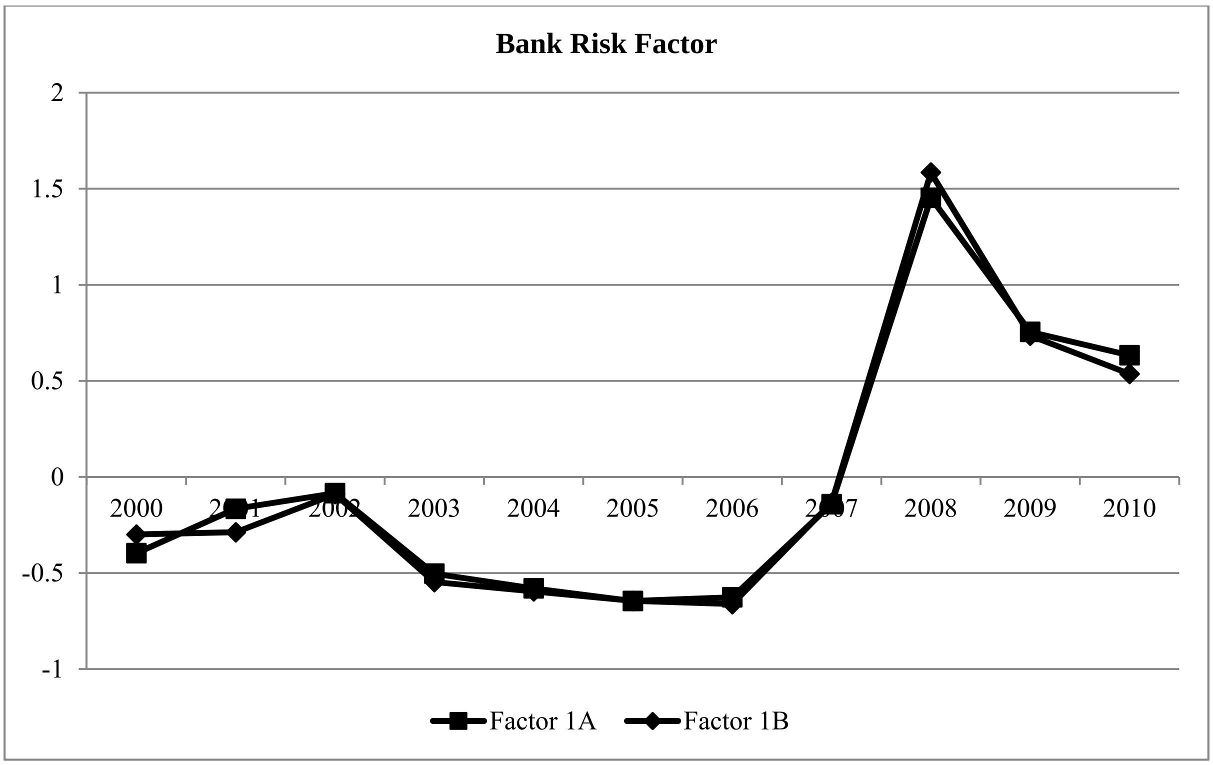


Figure 2.7 – Bank Risk Factors over Time

This figure plots the distribution of the mean Bank Risk Factor 1A and 1B in years. Bank Risk Factor is the result of the exploratory common factor analysis applied to five risk measures, including Stock Return Standard Deviation, Interest Paid on Large CDs, Non-core Funding to Assets, Non-Performing Loans to Loans, and 1-year GAP. Principal factors extraction and the proportion of total variance explained criterion are used in the analysis. Data are from Consolidated Financial Statements for bank holding companies (FR Y-9C Reports) for banks between 2000 and 2010. Bank holding companies are listed in Compustat SIC 6020 and 6199



I. Tables

Table 2.1 – Descriptive Statistics of Banks and Matched Industrial Firms

Mean (median) values of CEO compensation, investment policy measures, debt policy measures, risk measures, and financial characteristics of firms are reported for bank holding companies and matched industrial control firms between 2000 and 2010. To be included in the sample of banks, firms had to have data in S&P Execucomp, Compustat (with SIC 6020 or 6199), and FR Y-9C reports. Industrial firms were from SICs 2000 to 3999, with data in S&P Execucomp and Compustat, matched to individual banks on firm size (90-110% of market value of equity), then on closest prior year return on assets. 119 out of 121 banks were matched on 90-110% of market value of equity. The remaining three were matched on 80-120%, with the result that there are also 121 industrial firms in the control sample. Variables are defined in Section 3.2. All dollar values are reported in millions of 2010 constant dollars, adjusted for changes in CPI. Medians are reported in parentheses below means. p-values for differences in means (medians) within sample or between samples are reported in square brackets.

	Banks		Industrial Firms		Differences within sample		Differences between samples	
	Non-Crisis	Crisis	Non-Crisis	Crisis	Banks Non-Crisis vs. Crisis	Industrials Non-Crisis vs. Crisis	Non-Crisis Banks vs. Industrials	Crisis Banks vs. Industrials
Panel A: CEO compensation								
Vega ($millions)	0.201	0.134	0.170	0.119	[0.067]***	[0.051] ***	[0.031]*	[0.015]
	(0.057)	(0.029)	(0.068)	(0.049)	[0.028] ***	[0.019]**	[-0.011]	[-0.020]*
Delta ($millions)	0.886	0.488	0.805	0.736	[0.398] ***	[0.069]	[0.081]	[-0.248]
	(0.340)	(0.146)	(0.257)	(0.221)	[0.194] ***	[0.035]**	[0.083]**	[-0.075]*
Vega/Delta	0.309	0.311	0.379	0.328	[-0.001]	[0.051] **	[-0.069] ***	[-0.018]
	(0.240)	(0.263)	(0.326)	(0.256)	[-0.023]	[0.070]	[-0.086]***	[0.007]
Cash Compensation ($millions)	0.047	-0.349	0.244	-0.265	[0.396] ***	[0.509] ***	[-0.197]	[-0.084]
	(0.183)	(-0.316)	(0.182)	(-0.142)	[0.499] ***	[0.324] ***	[0.000]	[-0.174] ***
Panel B: Management team compensation								
Management Vega ($millions)	0.220	0.166	0.186	0.136	[0.054] **	[0.049] **	[0.034]*	[0.029]
	(0.066)	(0.043)	(0.075)	(0.057)	[0.023] ***	[0.018]**	[-0.010]	[-0.014]
Management Delta ($millions)	0.900	0.442	0.651	0.530	[0.458]***	[0.121]*	[0.249] ***	[-0.088]
	(0.297)	(0.129)	(0.237)	(0.199)	[0.169] ***	[0.039]**	[0.060] ***	[-0.070]*
Management Vega/Delta	0.316	0.367	0.364	0.322	[-0.051]**	[0.042]*	[-0.048] ***	[0.045]*
	(0.266)	(0.318)	(0.319)	(0.280)	[-0.051] ***	[0.039]	[-0.052] **	[0.038]**
Management Cash Compensation ($millions)	3.968	2.210	3.374	2.313	[1.757] ***	[1.062] ***	[0.593] ***	[-0.102]
	(2.575)	(1.664)	(2.593)	(1.976)	[0.911] ***	[0.617] ***	[-0.019]	[-0.312] ***

Table 2.1 – Descriptive Statistics of Banks and Matched Industrial Firms (cont.)

	Banks		Industrial Firms		Differences within sample		Differences between samples	
	Non-Crisis	Crisis	Non-Crisis	Crisis	Banks Non-Crisis vs. Crisis	Industrials Non-Crisis vs. Crisis	Non-Crisis Banks vs. Industrials	Crisis Banks vs. Industrials
Panel C: Policy measures								
Asset Growth	0.093	0.050	0.059	0.057	**[0.043] *****	[0.002]	**[0.034]****	[-0.008]
	(0.044)	(0.018)	(0.017)	(0.013)	**[0.026] *****	[0.004]	**[0.027] *****	[0.005]
Loans to Core Deposits	2.015	1.470			[0.546]			
	(1.136)	(1.249)			**[-0.113] *****			
Commercial Real Estate Loans to Assets	0.199	0.273			**[-0.074] *****			
	(0.196)	(0.258)			**[-0.062] *****			
Book Leverage	0.911	0.909	0.581	0.552	[0.002]	[0.029]	**[0.330] *****	**[0.357] *****
	(0.911)	(0.909)	(0.574)	(0.548)	[0.002]	[0.026]	**[0.337] *****	**[0.361] *****
Panel E: Risk measures								
Stock Volatility	0.019	0.042	0.023	0.037	**[-0.024] *****	**[-0.014] *****	**[-0.004] *****	**[0.005] ****
	(0.017)	(0.032)	(0.020)	(0.031)	**[-0.015] *****	**[-0.010] *****	**[-0.003] *****	[0.001]
CD Rate	0.035	0.044			**[-0.010] *****			
	(0.029)	(0.043)			**[-0.014] *****			
Non-core Funding to Assets	0.500	0.500			**[0.000]***			
	(0.472)	(0.495)			[-0.023]			
Non-Performing Loans to Loans	0.015	0.020			[-0.005]			
	(0.008)	(0.010)			**[-0.002] *****			
1-year GAP	0.198	0.170			**[0.028] *****			
	(0.182)	(0.167)			**[0.014] ****			
Panel F: Financial Characteristics								
Total Assets ($millions)	95,889	89,859	9,817	8,896	[6,029]	[920]	**[86,071] *****	**[80,962] *****
	(13,652)	(9,386)	(2,265)	(2,114)	**[4,265] *****	[151]	**[11,386] *****	**[7,271] *****
Return on Assets	0.010	0.004	0.097	0.040	**[0.006] *****	[0.057]	[-0.087]	**[-0.036] *****
	(0.012)	(0.009)	(0.038)	(0.053)	**[0.003] *****	**[-0.015] *****	**[-0.027] *****	**[-0.044] *****
Market Value of Equity ($millions)	17,823	8,258	10,638	9,478	**[9,564] *****	[1,160]	**[7,185] *****	[-1,219]
	(2,623)	(1,217)	(1,988)	(1,727)	**[1,405] *****	[261]	**[634] *****	[-510]
Sales Growth	0.070	0.023	0.303	0.286	**[0.048] *****	[0.017]	[-0.232]	[-0.263]
	(0.049)	(0.022)	(0.021)	(0.043)	**[0.027] *****	**[-0.022] ****	**[0.028] *****	[-0.021]
N	676	190	695	213				

Table 2.2 – CEO Incentives and Bank Investment and Debt Policy

Firm investment policy and debt policy variables are regressed in two-way fixed effects regressions on lagged CEO compensation incentives Vega and Delta, with Crisis period and Bank indicator variables, CEO Cash Compensation and other controls. Dependent investment policy variables include Asset Growth, Loans to Core Deposits and Commercial Real Estate Loans to Assets, and the dependent debt policy variable is Book Leverage. Columns (2) and (3) are for banks only. Columns (1) and (4) include industrial control firms. T-test statistics are reported in parentheses below coefficients. Selected F-test statistics for restrictions on sums of coefficients are reported for full sample regressions. Intercepts are not reported.

	Investment Policy			**Debt Policy**
	Asset Growth$_{it}$ (1)	Loans to Core Deposits$_{it}$ (2)	Commercial Real Estate Loans$_{it}$ (3)	Book Leverage$_{it}$ (4)
Crisis (b_1)	-0.003	**0.513*** **	0.019	**-0.114*** **
	(-0.15)	**(2.82)**	(1.46)	**(-6.73)**
Crisis x Bank (b_2)	-0.001			**0.174*** **
	(-0.03)			**(7.90)**
Vega $_{it-1}$ (b_3)	-0.018	-0.253	0.006	0.033
	(-0.55)	(-0.86)	(0.26)	(1.36)
Vega $_{it-1}$ x Crisis (b_4)	-0.084	-0.194	0.019	-0.01
	(-0.93)	(-0.27)	(0.36)	(-0.16)
Vega $_{it-1}$ x Crisis x Bank (b_5)	-0.016			-0.128
	(-0.12)			(-1.32)
Delta $_{it-1}$ (b_6)	0.000	**0.144** **	0.000	-0.006
	(-0.02)	**(2.49)**	(0.02)	(-1.50)
Delta $_{it-1}$ x Crisis (b_7)	-0.001	**-0.221* **	-0.004	0.005
	(-0.06)	**(-1.83)**	(-0.42)	(0.81)
Delta $_{it-1}$ x Crisis x Bank (b_8)	0.004			0.024
	(0.11)			(1.02)
Vega/Delta $_{it-1}$ (b_9)	**-0.085*** **	-0.088	-0.016	**-0.115*** **
	(-2.93)	(-0.30)	(-0.75)	**(-5.52)**
Vega/Delta $_{it-1}$ x Crisis (b_{10})	-0.049	-0.53	-0.008	**-0.221*** **
	(-1.06)	(-1.35)	(-0.29)	**(-6.85)**
Vega/Delta $_{it-1}$ x Crisis x Bank (b_{11})	**0.167** **			**0.416*** **
	(2.22)			**(7.82)**
CEO Cash Compensation $_{it}$	0.004	0.009	0.002	0
	(1.41)	(0.45)	(1.43)	(0.20)
Tenure$_{it}$	-0.001	0.003	0	**-0.004*** **
	(-0.52)	(0.40)	(0.63)	**(-4.51)**
Size$_{it}$	**0.007* **	0.083	**-0.049*** **	**0.014*** **
	(1.69)	(1.43)	**(-11.80)**	**(4.57)**
Market-to-Book$_{it}$	**0.024* **	**-1.497* **	-0.093	**-0.179*** **
	(1.85)	**(-1.66)**	(-1.42)	**(-23.55)**

Table 2.2 – CEO Incentives and Bank Investment and Debt Policy (cont.)

	Investment Policy			**Debt Policy**
	Asset Growth$_{it}$ (1)	Loans to Core Deposits$_{it}$ (2)	Commercial Real Estate Loans$_{it}$ (3)	Book Leverage$_{it}$ (4)
Sales Growth$_{it}$	0.001	0.47	**0.097*** **	-0.001
	(0.46)	(1.19)	**(3.37)**	(-0.66)
Stock Return$_{it}$	**0.019** **	0.082	0.004	**0.016** **
	(2.18)	(0.70)	(0.49)	**(2.49)**
Asset Growth$_{it}$				-0.005
				(-0.24)
Book Leverage$_{it}$	-0.01	**11.403*** **	**-1.09*** **	
	(-0.24)	**(3.94)**	**(-5.19)**	
Analyst Dispersion$_{it}$	-0.021	-0.012	-0.004	0.002
	(-1.61)	(-0.10)	(-0.46)	(0.23)
Forecast Errors$_{it}$	0.006	0.028	0	**-0.008** **
	(1.44)	(0.91)	(-0.14)	**(-2.49)**
Analyst Dispersion$_{it}$ x Forecast Errors$_{it}$	-0.003	-0.012	0	**0.003***
	(-1.16)	(-0.73)	(0.12)	**(1.85)**
F-tests:				
$H_0: b_1 + b_2 = 0$	0.03			**9.80*** **
$H_0: b_3 + b_4 = 0$	1.27	0.39	0.22	0.12
$H_0: b_6 + b_7 = 0$	0.01	0.49	0.20	0.01
$H_0: b_9 + b_{10} = 0$	**7.60*** **	2.57	0.73	**99.33*** **
$H_0: b_3 + b_4 + b_5 = 0$	0.91			1.40
$H_0: b_6 + b_7 + b_8 = 0$	0.01			1.00
$H_0: b_9 + b_{10} + b_{11} = 0$	0.30			**3.22***
$H_0: b_4 + b_5 = 0$	0.61			2.27
$H_0: b_7 + b_8 = 0$	0.01			1.52
$H_0: b_{10} + b_{11} = 0$	**3.53***			**18.46*** **
Sample	FULL SAMPLE	BANKS ONLY	BANKS ONLY	FULL SAMPLE
Adjusted R^2	0.020	0.040	0.390	0.487
F-statistics	**2.15*** **	**2.38*** **	**22.35*** **	**54.09*** **
N	1175	1205	1205	1175

Table 2.3 – CEO Incentives and Investment and Debt Policy Simultaneously

3SLS simultaneous regressions of investment and debt policy decisions, Vega, and Delta, are reported. Crisis and Bank indicator variables, CEO Cash Compensation and other controls are included. Dependent investment policy variables include Asset Growth, Loans to Core Deposits, Commercial Real Estate Loans to Assets, and the dependent debt policy variable is Book Leverage. Columns (4) through (9) are for banks only; Columns (1) through (3) and (10) through (12) are for banks and matched industrial firms. t-test statistics are reported in parentheses below coefficients. Selected F-test statistics for restrictions on sums of coefficients are reported for full sample regressions. Intercepts are not reported.

	Investment Policy									**Debt Policy**		
	Asset Growth (1)	Vega (2)	Delta (3)	Loans to Core Deposits (4)	Vega (5)	Delta (6)	Commercial Real Estate Loans (7)	Vega (8)	Delta (9)	Book Leverage (10)	Vega (11)	Delta (12)
Crisis (b_1)	**0.654***** **(25.96)**			**-3.908***** **(-3.95)**			**2.018***** **(3.87)**			**-0.371***** **(-11.51)**		
Crisis x Bank (b_2)	**-0.09***** **(-6.84)**									**0.224***** **(10.57)**		
Vega $_{it}$ (b_3)	-0.791 (-1.52)		**2.789***** **(3.96)**	-15.048 (-0.16)		3.241 (1.63)	-43.181 (-0.88)		3.2 (1.61)	-0.245 (-0.37)		**3.43**** **(2.26)**
Vega $_{it}$ x Crisis (b_4)	**-1.234***** **(-39.88)**			**-14.369***** **(-19.66)**			**6.103***** **(38.11)**			**-0.173***** **(-3.40)**		
Vega $_{it}$ x Crisis x Bank (b_5)	**-0.217***** **(-4.77)**									0.05 (0.67)		
Delta $_{it}$ (b_6)	**0.584***** **(2.73)**	**0.324***** **(4.10)**		13.208 (0.23)	0.063 (0.21)		24.461 (0.80)	0.059 (0.19)		0.162 (0.46)	0.057 (0.24)	
Delta $_{it}$ x Crisis (b_7)	**-0.661***** **(-255.18)**			**8.93***** **(40.73)**			**-5.131***** **(-106.83)**			**0.289***** **(68.23)**		
Delta $_{it}$ x Crisis x Bank (b_8)	**0.028***** **(2.65)**									-0.023 (-1.32)		
Vega/Delta $_{it}$ (b_9)	**-0.109***** **(-14.35)**			**-7.641***** **(-29.38)**			**2.479***** **(43.50)**			**-0.399***** **(-32.47)**		
Vega/Delta $_{it}$ x Crisis (b_{10})	-0.016 (-0.74)			**6.152***** **(11.07)**			**-2.379***** **(-19.54)**			**0.197***** **(5.55)**		
Vega/Delta $_{it}$ x Crisis x Bank (b_{11})	**0.165***** **(5.31)**									**0.198***** **(3.90)**		
CEO Cash Compensation $_{it}$	-0.01 (-1.25)	0.002 (0.70)		-0.081 (-0.14)	0.006 (0.83)		-0.322 (-1.04)	0.006 (0.84)		0.000 (-0.01)	0.009 (0.93)	

Table 2.3 – CEO Incentives and Investment and Debt Policy Simultaneously (cont.)

	Investment Policy									Debt Policy		
	Asset Growth (1)	Vega (2)	Delta (3)	Loans to Core Deposits (4)	Vega (5)	Delta (6)	Commercial Real Estate Loans (7)	Vega (8)	Delta (9)	Book Leverage (10)	Vega (11)	Delta (12)
$Tenure_{it}$	**0.002***		0.001	-0.038		0.002	-0.06		0.002	**-0.004***		0.012
	(1.89)		(1.27)	(-0.23)		(0.31)	(-0.69)		(0.31)	**(-1.82)**		(0.54)
$Size_{it}$	-0.038	-0.012	0.054	-3.672	0.106	0.021	-5.427	0.107	0.026	-0.024	0.057	-0.017
	(-0.69)	(-0.52)	(0.92)	(-0.27)	(0.76)	(0.08)	(-0.74)	(0.77)	(0.10)	(-0.25)	(0.95)	(-0.12)
$Market\text{-}to\text{-}Book_{it}$	**0.093***	-0.028	0.171	-34.807	0.105	**1.758****	-52.902	0.112	**1.784****	**-0.229*****	0.024	0.642
	(1.81)	(-0.57)	(1.23)	(-0.27)	(0.13)	**(2.33)**	(-0.77)	(0.14)	**(2.36)**	**(-2.82)**	(0.26)	(0.75)
$Stock\ Return_{it}$	-0.001			0.25			**-0.683****			-0.002		
	(-0.16)			(0.40)			**(-2.28)**			(-0.23)		
$Asset\ Growth_{it}$		-1.088	2.955		-0.065	**0.159****		-0.063	0.109	-0.02	**-0.06****	0.262
		(-1.27)	(1.24)		(-1.19)	**(2.39)**		(-1.10)	(1.16)	(-0.36)	**(-2.14)**	(1.37)
$Book\ Leverage_{it}$	**0.316*****	-0.024	**0.504****	-27.932	**0.903****	0.461	**23.187***	**0.906****	0.407		0.261	2.657
	(5.87)	(-0.30)	**(2.17)**	(-1.27)	**(2.24)**	(0.22)	**(1.96)**	**(2.25)**	(0.19)		(0.79)	(0.48)
$Analyst\ Dispersion_{it}$	**0.098*****			**-0.301*****			**0.21*****			-0.007		
	(27.92)			**(-2.60)**			**(8.28)**			(-1.26)		
$Forecast\ Errors_{it}$	**0.04*****			**-0.902*****			**0.589*****			**-0.016*****		
	(31.34)			**(-31.04)**			**(92.62)**			**(-7.86)**		
$Analyst\ Dispersion_{it}$ x $ForecastErrors_{it}$	**-0.016*****			**0.34*****			**-0.218*****			**0.007*****		
	(-23.00)			**(22.38)**			**(-65.61)**			**(6.32)**		
F-tests												
$H_0: b_1 + b_2 = 0$	**2.85***									**3.35***		
$H_0: b_3 + b_4 = 0$	0.09			0.00			0.00			0.07		
$H_0: b_6 + b_7 = 0$	0.00			0.00			0.00			0.28		
$H_0: b_9 + b_{10} = 0$	0.22			0.28			0.00			**6.19****		
$H_0: b_3 + b_4 + b_5 = 0$	0.11									0.05		
$H_0: b_6 + b_7 + b_8 = 0$	0.00									0.25		
$H_0: b_9 + b_{10} + b_{11} = 0$	0.02									0.00		
$H_0: b_4 + b_5 = 0$	**10.65*****									0.83		
$H_0: b_7 + b_8 = 0$	**21.91*****									**41.90*****		
$H_0: b_{10} + b_{11} = 0$	0.22									**16.54*****		
Sample	FULL SAMPLE			BANKS ONLY			BANKS ONLY			FULL SAMPLE		
System Weighted R^2	0.354			0.451			0.482			0.382		
N	1260			615			615			1260		

Table 2.4 – CEO Incentives and Bank Risk

Firm risk variables are regressed in two-way fixed effects regressions on lagged CEO compensation incentives Vega and Delta, with Crisis period and Bank indicator variables, CEO Cash Compensation, other controls, and Investment and Debt Policy variables. Dependent firm risk variables include Stock Volatility, Interest Paid on Large CDs, Non-core Funding to Assets, Non-Performing Loans to Loans, and 1-year GAP. Columns (2) through (5) are for banks only. Column (1) includes banks and industrial control firms. t-test statistics are reported in parentheses below coefficients. Selected F-test statistics for restrictions on sums of coefficients are reported for full sample regressions. Intercepts are not reported.

	Stock Volatility (1)	Interest Paid on Large CDs (2)	Non-core Funding to Assets (3)	Non-Performing Loans to Loans (4)	1-year GAP (5)
Crisis (b_1)	**0.019*** **	**0.02*** **	0.017	**-0.009*** **	**-0.034** **
	(14.18)	**(11.02)**	(0.87)	**(-4.78)**	**(-2.30)**
Crisis x Bank (b_2)	0.001				
	(0.41)				
Vega $_{it-1}$ (b_3)	0.003	0.002	0.008	**0.011*** **	-0.001
	(1.38)	(0.58)	(0.27)	**(3.53)**	(-0.05)
Vega $_{it-1}$ x Crisis (b_4)	-0.008	**-0.017** **	-0.004	-0.003	0.043
	(-1.59)	**(-2.36)**	(-0.06)	(-0.40)	(0.73)
Vega $_{it-1}$ x Crisis x Bank (b_5)	0.01				
	(1.39)				
Delta $_{it-1}$ (b_6)	0.000	0.000	0.000	0.001	**-0.015*** **
	(-0.23)	(0.70)	(0.06)	(1.25)	**(-3.12)**
Delta $_{it-1}$ x Crisis (b_7)	**0.001** **	0.000	-0.008	-0.001	-0.001
	(1.99)	(0.17)	(-0.65)	(-0.98)	(-0.10)
Delta $_{it-1}$ x Crisis x Bank (b_8)	0.003				
	(1.53)				
Vega/Delta $_{it-1}$ (b_9)	0.001	-0.001	**-0.052***	**-0.008*** **	-0.025
	(0.57)	(-0.23)	**(-1.71)**	**(-2.76)**	(-1.04)
Vega/Delta $_{it-1}$ x Crisis (b_{10})	**0.01*** **	-0.004	-0.034	**0.01*** **	-0.032
	(4.08)	(-1.14)	(-0.82)	**(2.61)**	(-1.00)
Vega/Delta $_{it-1}$ x Crisis x Bank (b_{11})	**0.02*** **				
	(4.80)				
CEO Cash Compensation $_{it}$	0.000	0.000	0.001	0.000	0.003
	(0.13)	(0.32)	(0.39)	(-1.35)	(1.51)
Tenure$_{it}$	0.000	0.000	-0.001	0.000	**0.002*** **
	(1.08)	(0.12)	(-0.86)	(-1.10)	**(3.55)**
Size$_{it}$	**-0.002*** **	0.000	-0.003	-0.001	**0.02*** **
	(-8.69)	(-0.08)	(-0.48)	(-1.03)	**(4.32)**
Market-to-Book$_{it}$	**-0.001***	**-0.015***	**0.255*** **	**-0.121*** **	0.076
	(-1.81)	**(-1.67)**	**(2.70)**	**(-13.21)**	(1.02)
Sales Growth$_{it}$	0.000	**0.013*** **	0.054	**-0.013*** **	**-0.107*** **
	(-0.68)	**(3.00)**	(1.13)	**(-2.84)**	**(-2.89)**
Stock Return$_{it}$	0.001	**-0.003** **	**-0.025** **	0.001	0.003
	(1.35)	**(-2.18)**	**(-1.99)**	(1.16)	(0.30)
Asset Growth$_{it}$	**-0.005*** **	**-0.018*** **	0.04	-0.007	-0.008
	(-3.01)	**(-3.80)**	(0.79)	(-1.42)	(-0.19)
Book Leverage$_{it}$	**-0.006*** **	0.004	**2.981*** **	**0.053***	0.239
	(-2.60)	(0.14)	**(9.82)**	**(1.81)**	(1.01)
Analyst Dispersion$_{it}$	**0.004*** **	-0.001	-0.008	**0.004*** **	0.003
	(5.18)	(-0.80)	(-0.63)	**(3.47)**	(0.32)
Forecast Errors$_{it}$	**-0.001** **	0.000	**0.011*** **	**-0.002*** **	-0.001
	(-2.26)	(0.23)	**(3.37)**	**(-5.14)**	(-0.24)

Table 2.4 – CEO Incentives and Bank Risk (cont.)

	Stock Volatility (1)	Interest Paid on Large CDs (2)	Non-core Funding to Assets (3)	Non-Performing Loans to Loans (4)	1-year GAP (5)
Analyst $Dispersion_{it}$ x Forecast $Errors_{it}$	**0.000*****	0.000	**-0.005*****	**0.000****	0.000
	(3.15)	(-0.08)	**(-2.90)**	**(2.20)**	(0.33)
F-tests:					
H_0: $b_1 + b_2 = 0$	**170.41*****				
H_0: $b_3 + b_4 = 0$	1.15	**4.53****	0.00	1.11	0.52
H_0: $b_6 + b_7 = 0$	**4.70****	0.30	0.45	0.17	**2.98***
H_0: $b_9 + b_{10} = 0$	**17.38*****	1.79	**4.51****	0.36	**3.22***
H_0: $b_3 + b_4 + b_5 = 0$	0.53				
H_0: $b_6 + b_7 + b_8 = 0$	**4.19****				
H_0: $b_9 + b_{10} + b_{11} = 0$	**83.82*****				
H_0: $b_4 + b_5 = 0$	0.12				
H_0: $b_7 + b_8 = 0$	**4.23****				
H_0: $b_{10} + b_{11} = 0$	**75.18*****				
Sample	FULL SAMPLE	BANKS ONLY	BANKS ONLY	BANKS ONLY	BANKS ONLY
Adjusted R^2	0.473	0.254	0.162	0.497	0.088
F-statistics	**48.84*****	**11.75*****	**7.12*****	**32.18*****	**4.03*****
N	1174	569	569	569	569

Table 2.5 – CEO Incentives and Investment, Debt Policy and Firm Risk

3SLS simultaneous regressions of firm risk measures, Vega, and Delta, are reported. Crisis and Bank indicator variables, CEO Cash Compensation and other controls are included. Dependent firm risk variables include Stock Volatility, Interest Paid on Large CDs, Non-core Funding to Assets, Non-Performing Loans to Loans, and 1-year GAP. Columns (4) through (15) are for banks only; Columns (1) through (3) are for banks and matched industrial firms. t-test statistics are reported in parentheses below coefficients. Selected F-test statistics for restrictions on sums of coefficients are reported for full sample regressions. Intercepts are not reported.

	Stock Volatility (1)	Vega (2)	Delta (3)	Interest Paid on Large CDs (4)	Vega (5)	Delta (6)	Non-core Funding to Assets (7)	Vega (8)	Delta (9)	Non-performing Loans to Loans (10)	Vega (11)	Delta (12)	1-year GAP (13)	Vega (14)	Delta (15)
Crisis (b_1)	**0.005***			**0.063*****			**-0.146****			**-0.08*****			**-0.507*****		
	(1.91)			**(12.16)**			**(-2.41)**			**(-13.57)**			**(-10.83)**		
Crisis x Bank (b_2)	**0.006****														
	(2.32)														
Vega $_{it}$ (b_3)	-0.006		**4.108****	**-1.388*****		1.904	**-23.805*****		2.187	-0.226		1.445	-2.927		1.67
	(-0.11)		**(2.56)**	**(-5.99)**		(1.09)	**(-7.99)**		(1.28)	(-0.70)		(0.86)	(-1.20)		(0.99)
Vega $_{it}$ x Crisis (b_4)	0.007			**-0.026*****			**-2.388*****			**-0.205*****			**-1.536*****		
	(1.00)			**(-3.50)**			**(-29.85)**			**(-26.38)**			**(-24.91)**		
Vega $_{it}$ x Crisis x Bank (b_5)	**0.027*****														
	(2.82)														
Delta $_{it}$ (b_6)	0.009	0.186		**0.188*****	-0.162		**5.654*****	-0.007		**0.188*****	-0.034		**1.541*****	-0.035	
	(0.51)	(1.28)		**(3.26)**	(-0.71)		**(7.21)**	(-0.03)		**(3.29)**	(-0.15)		**(3.40)**	(-0.15)	
Delta $_{it}$ x Crisis (b_7)	**0.017*****			**-0.027*****			**0.632*****			**0.091*****			**0.633*****		
	(31.16)			**(-11.92)**			**(26.34)**			**(38.76)**			**(34.22)**		
Delta $_{it}$ x Crisis x Bank (b_8)	**-0.006*****														
	(-2.66)														
Vega/Delta $_{it}$ (b_9)	**0.004*****			**-0.025*****			**-1.679*****			**-0.131*****			**-0.878*****		
	(2.79)			**(-9.28)**			**(-58.98)**			**(-47.21)**			**(-40.03)**		
Vega/Delta $_{it}$ x Crisis (b_{10})	-0.004			**0.024*****			**1.589*****			**0.115*****			**0.879*****		
	(-0.86)			**(4.23)**			**(26.12)**			**(19.50)**			**(18.75)**		
Vega/Delta $_{it}$ x Crisis x Bank (b_{11})	-0.004														
	(-0.66)														
CEO Cash Compensation $_{it}$	0.000	0.003		**0.006*****	**0.011***		**0.069*****	0.008		-0.001	0.008		0.003	0.009	
	(-0.50)	(0.45)		**(4.51)**	**(1.72)**		**(3.89)**	(1.21)		(-0.63)	(1.29)		(0.34)	(1.29)	
Tenure $_{it}$	0.000		-0.001	**-0.001*****		0.003	**-0.028*****		0.003	-0.001		0.003	-0.005		0.003
	(0.80)		(-0.24)	**(-3.88)**		(0.55)	**(-5.84)**		(0.53)	(-1.23)		(0.46)	(-1.00)		(0.48)

Table 2.5 – CEO Incentives and Investment, Debt Policy and Firm Risk (cont.)

	Stock Volatility (1)	Vega (2)	Delta (3)	Interest Paid on Large CDs (4)	Vega (5)	Delta (6)	Non-core Funding to Assets (7)	Vega (8)	Delta (9)	Non-performing Loans to Loans (10)	Vega (11)	Delta (12)	1-year GAP (13)	Vega (14)	Delta (15)
$Size_{it}$	-0.005	0.022	-0.032	**0.097*** **	**0.207** **	0.217	**0.614** **	0.136	0.174	**-0.052* **	0.149	0.281	-0.278	0.15	0.249
	(-0.92)	(0.60)	(-0.27)	**(4.51)**	**(2.02)**	(0.95)	**(2.02)**	(1.33)	(0.77)	**(-1.90)**	(1.41)	(1.26)	(-1.46)	(1.41)	(1.12)
Market-to-$Book_{it}$	-0.008	-0.062	**0.324*** **	**-0.323*** **	0.679	**2.667*** **	**-11.541*** **	0.258	**2.449*** **	**-0.637*** **	0.337	**2.863*** **	**-3.971*** **	0.338	**2.737*** **
	(-1.43)	(-1.42)	**(4.94)**	**(-2.66)**	(1.26)	**(4.47)**	**(-6.98)**	(0.48)	**(4.11)**	**(-5.20)**	(0.60)	**(5.02)**	**(-4.26)**	(0.60)	**(4.79)**
Asset $Growth_{it}$	-0.007	**-0.107** **	**0.492** **	**-0.13*** **	-0.056	0.223	**-2.295*** **	-0.068	0.236	-0.06	-0.065	0.192	**-0.526* **	-0.065	0.205
	(-1.06)	**(-2.46)**	**(2.34)**	**(-5.13)**	(-0.82)	(0.72)	**(-6.51)**	(-1.00)	(0.77)	(-1.49)	(-0.96)	(0.62)	**(-1.83)**	(-0.96)	(0.67)
Book $Leverage_{it}$	-0.015	-0.117	**0.595*** **	**1.493*** **	**1.024** **	-1.547	**22.375*** **	**0.932* **	-1.663	-0.117	**0.944* **	-1.168	0.487	**0.944* **	-1.319
	(-1.50)	(-1.44)	**(2.61)**	**(6.17)**	**(2.05)**	(-0.57)	**(6.95)**	**(1.88)**	(-0.62)	(-0.31)	**(1.90)**	(-0.44)	(0.18)	**(1.90)**	(-0.49)
Analyst $Dispersion_{it}$	**0.002*** **			0.001			-0.009			**0.002* **			-0.011		
	(2.74)			(1.13)			(-0.69)			**(1.92)**			(-1.17)		
Forecast $Errors_{it}$	**-0.001*** **			**0.005*** **			**0.006* **			**-0.008*** **			**-0.04*** **		
	(-5.04)			**(17.02)**			**(1.93)**			**(-26.03)**			**(-16.30)**		
Analyst $Dispersion_{it}$ x $ForecastErrors_{it}$	**0.001*** **			**-0.002*** **			-0.001			**0.003*** **			**0.016*** **		
	(5.22)			**(-11.44)**			(-0.62)			**(17.44)**			**(12.17)**		
F-tests															
H_0: $b_1 + b_2 = 0$	**4.29** **														
H_0: $b_3 + b_4 = 0$	0.00			**5.29** **			**10.07*** **			0.08			0.24		
H_0: $b_6 + b_7 = 0$	0.56			1.11			**8.37*** **			1.12			1.61		
H_0: $b_9 + b_{10} = 0$	0.00			0.00			0.36			0.40			0.00		
H_0: $b_3 + b_4 + b_5 = 0$	0.05														
H_0: $b_6 + b_7 + b_8 = 0$	0.32														
H_0: $b_9 + b_{10} + b_{11} = 0$	0.15														
H_0: $b_4 + b_5 = 0$	**5.44** **														
H_0: $b_7 + b_8 = 0$	**6.37** **														
H_0: $b_{10} + b_{11} = 0$	0.64														
Sample	FULL SAMPLE			BANKS ONLY			BANKS ONLY			BANKS ONLY			BANKS ONLY		
System Weighted R^2	0.292			0.538			0.313			0.365			0.398		
N	1260			615			615			615			615		

Table 2.6 – Common Factor Analysis of Bank Risk

Exploratory common factor analysis is applied to five risk measures, including Stock Volatility, Interest Paid on Large CDs, Non-core Funding to Assets, Non-Performing Loans to Loans, and 1-year GAP. Principal factors extraction and the proportion of total variance explained criterion are used to determine the relevant number of factors to retain (one). Panel A shows the correlation matrix of the five risk measures. Panel B shows Factor Loading Coefficients. Panel C reports Pearson Correlation Coefficients (with p-values shown below in parentheses) between the Bank Risk Factor and each of the five risk measures. Panel D summarizes descriptive statistics for the resulting Bank Risk Factor.

Panel A: Correlation Matrix of Risk Measures

	Stock Volatility	Interest Paid on Large CDs	Non-core Funding to Assets	Non-Performing Loans to Loans	1-year GAP
Stock Volatility	1	0.009	**-0.059***	**0.351*****	-0.019
Interest Paid on Large CDs	0.009	1	**-0.069****	-0.021	**-0.101*****
Non-core Funding to Assets	**-0.059***	-0.069**	1	**-0.065***	**-0.157*****
Non-Performing Loans to Loans	**0.351*****	-0.021	**-0.065***	1	0.025
1-year GAP	-0.019	**-0.101*****	**-0.157*****	0.025	1

Panel B: Factor Loading Coefficients

	Stock Volatility (1)	Interest Paid on Large CDs (2)	Non-core Funding to Assets (3)	Non-Performing Loans to Loans (4)	1-year GAP (5)
Risk Factor 1A	0.568	-0.006	-0.238	0.578	0.115
Risk Factor 1B	0.608			0.608	

Table 2.6 – Common Factor Analysis of Bank Risk (cont.)

Panel C: Pearson Correlation Coefficients (p-values) for Risk Measures with the Bank Risk Factor

	Stock Volatility (1)	Interest Paid on Large CDs (2)	Non-core Funding to Assets (3)	Non-Performing Loans to Loans (4)	1-year GAP (5)
Predicted sign	+	+	+	+	+/-
Pearson Correlation Coefficient with the Common Bank Risk Factor 1A	**0.782*** **	-0.008	**-0.328*** **	**0.796*** **	**0.158*** **
(p-values)	**(0.0001)**	(0.821)	**(0.0001)**	**(0.0001)**	**(0.0001)**
Pearson Correlation Coefficient with the Common Bank Risk Factor 1B	**0.822*** **			**0.822*** **	
(p-values)	**(0.0001)**			**(0.0001)**	

Panel D: Descriptive Statistics of Bank Risk Factor

	Median	Mean	Standard Deviation	Min	Max
Bank Risk Factor 1A	-0.252	0.000	1	-1.682	13.969
% Variation Explained	27.56%				
Bank Risk Factor 1B	-0.290	0.000	1	-1.113	14.848
% Variation Explained	67.55%				

Table 2.7 – CEO Incentives and Bank Risk Factor

The Bank Risk Factor is regressed in a one-way fixed effects regression on lagged CEO compensation incentives Vega and Delta, with Crisis period indicator variable, CEO Cash Compensation, other controls, and Investment and Debt Policy variables, in Column (1). 3SLS simultaneous regressions of the Bank Risk Factor 1B, Vega, and Delta, are reported in Columns (2) through (4). Crisis indicator variables, CEO Cash Compensation and other controls are included. All regressions in this Table are for banks only. t-test statistics are reported in parentheses below coefficients. Selected F-test statistics for restrictions on sums of coefficients are reported for full sample regressions. Intercepts are not reported.

	2-way Fixed Effects	3SLS		
	Bank Risk Factor 1B (1)	Bank Risk Factor (2)	Vega (3)	Delta (4)
Crisis	**0.426*** **	**-6.598*** **		
	(5.93)	**(-27.85)**		
Vega $_{it-1}$ (Vega$_{it}$) (b$_1$)	**0.516*** **	-30.222		1.162
	(4.44)	(-1.53)		(0.69)
Vega $_{it-1}$ x Crisis (Vega $_{it}$ x Crisis) (b$_2$)	**0.675** **	**-20.753*** **		
	(2.38)	**(-66.52)**		
Delta $_{it-1}$ (Delta $_{it}$) (b$_3$)	0.027	**18.218*** **	-0.017	
	(1.19)	**(6.88)**	(-0.07)	
Delta $_{it-1}$ x Crisis (Delta $_{it}$ x Crisis) (b$_4$)	**-0.14*** **	**8.56*** **		
	(-2.93)	**(91.47)**		
Vega/Delta $_{it-1}$ (Vega/Delta $_{it}$) (b$_5$)	-0.187	**-12.61*** **		
	(-1.64)	**(-113.58)**		
Vega/Delta $_{it-1}$ x Crisis (Vega/Delta $_{it}$ x Crisis) (b$_6$)	**1.074*** **	**12.211*** **		
	(6.89)	**(51.47)**		
CEO Cash Compensation $_{it}$	0.000	0.042	0.008	
	(-0.05)	(0.77)	(1.23)	
Tenure$_{it}$	-0.002	-0.082		0.002
	(-0.57)	(-1.41)		(0.43)
Size$_{it}$	**-0.113*** **	**-4.036* **	0.141	0.322
	(-4.94)	**(-1.74)**	(1.34)	(1.45)
Market-to-Book$_{it}$	**-4.074*** **	**-54.588*** **	0.287	**3.021*** **
	(-11.44)	**(-7.14)**	(0.51)	**(5.30)**
Sales Growth$_{it}$	**-1.016*** **			
	(-5.69)			
Stock Return$_{it}$	0.066			
	(1.42)			
Asset Growth$_{it}$	0.181	**-5.813* **	-0.067	0.175
	(0.96)	**(-1.82)**	(-0.99)	(0.57)
Book Leverage$_{it}$	**2.326** **	-2.147	**0.936* **	-0.98
	(2.04)	(-0.08)	**(1.89)**	(-0.37)
Analyst Dispersion$_{it}$	**0.167*** **	-0.063		
	(3.41)	(-1.28)		
Forecast Errors$_{it}$	**-0.043*** **	**-0.576*** **		
	(-3.57)	**(-46.49)**		
Analyst Dispersion$_{it}$ x ForecastErrors$_{it}$	**0.016*** **	**0.219*** **		
	(2.63)	**(33.74)**		

Table 2.7 – CEO Incentives and Bank Risk Factor (cont.)

	2-way Fixed Effects	3SLS		
	Bank Risk Factor 1B (1)	Bank Risk Factor (2)	Vega (3)	Delta (4)
F-test:				
H_0: $b_1 + b_2 = 0$	**17.74*** **	0.07		
H_0: $b_3 + b_4 = 0$	**6.61** **	1.02		
H_0: $b_5 + b_6 = 0$	**33.81** **	0.04		
Sample	BANKS ONLY	BANKS ONLY		
Adjusted R^2 / System Weighted R^2	0.607	0.353		
F-statistics	**39.36*** **			
N	569	599		

IV. Reward Culture in Banks and the Financial Crisis

Abstract: In this paper, I construct and examine whether the "reward culture" of banks was a contributing factor to the 2008 credit crisis. Reward culture reflects three dimensions: (i) CEO incentives – total CEO compensation and the incentive effects of CEO stock and option portfolios; (ii) tournament incentives – pay gap in total compensation between CEOs and Vice Presidents; and (iii) employee incentives – total compensation per employee. A reward culture factor score, constructed by applying factor analysis to the CEO, VP, and employee incentives, represents the common factor in incentives across all levels of the bank. I employ the reward culture factor to examine the impact of reward culture on bank performance and risk. First, I find strong evidence of a nonlinear relationship between reward culture and bank returns and risk. Second, classifying banks into high, average, and low reward culture groups in the pre-crisis year 2006, I find that during the 2008 crisis period, banks either at the high or low reward culture groups performed worse, and were more risky than banks in the average reward culture group. The findings are consistent with the problems of adverse selection and moral hazard associated with incentive misalignment when incentives are too low or too high.

A. Introduction

The 2008 financial crisis raised questions about performance-based compensation practices at financial institutions. The public widely believed that excesses in compensation prevalent among banks were a catalyst to the crisis. Since then, academic research has studied the link between compensation practices and risk-taking behaviors extensively, mostly focusing on CEO and the top management team compensation. Their findings are inconclusive (Fahlenbrach and Stulz, 2011; Amstrong and Vashishtha, 2012; DeYoung et al., 2013). Fahlenbrach and Stulz (2011) find that banks with better shareholder-aligned CEO compensation plans did worse in the crisis, generating significantly lower stock returns and returns on equity. Moreover, CEOs of better shareholder-aligned banks realized larger losses in their stock and option portfolios. But as Bebchuk, Cohen and Spamann (2010) point out, the losses that CEOs suffered in the crisis were disproportionately less than the high compensation CEOs received prior to the crisis. DeYoung et al (2013) document a positive relationship between a CEO's stock and option grants and bank risk. However, there is little research on the role of employee compensation and the interaction between CEO compensation and the remaining employee compensation. As critics on Wall Street Journal[18] put it,

> "*Wall Street's pay structure, in which bonuses are based on short-term profits, encouraged employees to act like gamblers at a casino – and let them collect their winnings while the roulette wheel was still spinning. […] To earn bigger bonuses, many traders ignored or played down the risks they took until their bonuses were paid. Their bosses often turned a blind eye because it was in their interest as well.*"

Such bonus structure is arguably necessary when ability is unobservable and the pool of skilled labor relatively small. Bannier et al (2013) show that competition for talent increases the

[18] "*On Wall Street, Bonuses, Not Profits, Were Real*", Wall Street Journal, December 17, 2008.

incidence of performance awards and excessive risk-taking behavior. Benabou and Tirole (2013) suggest that the interaction of talent competition with incentives undermines work ethic. A highly competitive labor market makes it difficult to strike a proper balance between the benefits and costs of high-powered incentives. A pervasive reward culture in the workplace can generate distorted decisions and significant efficiency losses in the long run. In addition, Acharya and Naqvi (2009) conceptually show that when compensation that increases in loan volume is needed to induce effort, investment risks are underpriced to justify extensions of credit. Moral hazard is created when banks are flush with liquidity. To better understand incentives, I suggest it is essential to examine compensation throughout the organization set by top management and sometimes requiring board approval.

In this paper, I propose the notion of "reward culture", which embodies the incentives that encourage performance throughout the organization, and examine whether it played a role in shaping the 2008 credit crisis. Corporate culture at its most basic level is the sum of an organization's behaviors and practices. Typically defined using a combination of corporate personality traits (such as "aggressive", "collaborative", or "results-oriented"), it has been argued that corporate culture is a key driver of corporate performance (Gandossy et al, 2009). My research design has two parts. First, I quantify this culture notion by constructing a reward culture factor score by applying factor analysis on the incentives of CEOs, Vice Presidents (VPs), and all remaining employees. The reward culture factor score represents common variation in the incentives of all employees. Second, I explore the relation between the reward culture factor score and bank performance and risk during the credit crisis.

The test sample consists of 72 financial institutions, including both bank holding companies and investment banks, with data on incentives available in all three years from 2004 to 2006. Bank returns and risk are observed in the 18-month period of the credit crisis – i.e., from July 1, 2007 to December 31, 2008. The incentive measures used to construct the reward culture factor are CEO incentives, VP incentives, and employee incentives. CEO total compensation, CEO delta, and CEO vega are used to proxy for CEO incentives. The pay gap between the total compensation of the CEO and the median VP is used to proxy for the tournament incentives of VPs. Because of data limitations, I employ compensation per employee as a proxy for employee incentives. All incentive measures are standardized to be distributed over the closed interval [-1, +1] to reduce skewness of incentive variables. Factor analysis applied to these incentive measures reveals a single factor that characterizes the reward culture. Next, I explore the relation between the reward culture factor and bank performance and risk by regressing bank performance and risk during the credit crisis on the three-year average reward culture factor from 2004 – 2006. Finally, using predicted factor scores, I classify my sample into high, average, and low reward culture groups to determine whether there is separation in performance and risk among these groups. I find that 13 banks fall into the high reward culture group, 27 into the average reward culture group, and 32 into the low reward culture group.

Evidence in this paper shows that the relation between reward culture and bank returns and risk is nonlinear, implying incentive misalignment and its adverse impact on return and risk can occur when performance-based compensation is too low or too high. More specifically, I find that banks with high or low reward culture experienced significantly more negative buy-and-hold returns in the financial crisis than banks with an average reward culture. The standard deviation of daily stock returns in the financial crisis was also higher for banks with high or low reward culture compared to banks with average reward culture.

These findings are consistent with agency theory, which suggests that the relationship between incentive and firm performance is not necessarily linear. On the one hand, paying agents a fixed wage that insures agents against idiosyncratic risk is optimal when principals are more willing and able to diversify and bear risk. But fixed wages do not encourage effort, and when agents differ in ability, induces adverse selection. Low ability agents prefer fixed wages. Introducing performance-based incentives will not only encourage effort but also attract high ability agents, both of which hopefully raise profit. But exposure to undiversifiable idiosyncratic risk will attract more risk tolerant agents. On the other hand, verification of unobservable effort is costly and outcomes can have a random component unrelated to effort. Performance-based incentives can prompt agents to expropriate shareholder wealth and to rent seeking behaviors that misallocate resources. This implies that incentive misalignment can happen at the two ends of incentives. This problem is most severe in the banking industry because moral hazard is perverse owing to deposit insurance and an implicit too-big-to-fail government guarantee.

This study contributes to the existing literature on bank compensation, risk, and the financial crisis in three ways. First, to my knowledge, this is the first study to consider compensation practices in financial institutions at all levels of the organization via the construction of a latent “reward culture” factor score that embodies common variation in incentives not only of CEOs but also VPs and employees. Second, this study shows that compensation practices at banks created a reward culture that raised the vulnerability of banks to economic shocks, thereby contributing to the financial crisis. And last but not least, this study shows evidence of incentive misalignment and its adverse impact on return and risk when performance-based compensation is too low or too high.

The rest of this paper proceeds as follows. Section B reviews the relevant literature on incentive misalignment and reward culture. Section C details how the reward culture factor score is constructed and describes sample selection. Section D investigates the relation between the reward culture factor and bank performance and risk in the financial crisis. Section E concludes.

B. Literature Review

1. Incentive Misalignment

Incentives are the essence of economics (Prendergast, 1999) and the aim of incentive alignment is to induce agents to act in the best interests of the principal. When firms are risk neutral and employees are risk averse, the optimal allocation of risk implies that firms bear all the risks and fully insure employees (Hart and Holmstrom, 1987). But workers will exert little effort when compensation is not based on output. The moral hazard problem in labor contracting when Pareto-optimal risk sharing is precluded is widely recognized (Holmstrom, 1979). To provide the firm with some amount of effort, the second-best option is to force workers to bear risk.

Lazear (1986) argues that pay for performance deters shirking and improves labor quality when workers have private information about their productivity at the point of hire. High ability workers will self-select into jobs that offer more performance sensitive compensation. Indeed, Lazear (2000) documents that the productivity improvements following introduction of performance contracts can be attributed in approximately equal parts to effort and selection effects. Low pay for performance contracts engenders moral hazard and adverse selection.

There are, however, costs associated with high pay for performance. Moen and Rosen (2005) argue that workers with stronger performance incentives and private information about their own productivity will exploit information asymmetry to extract higher rents. Moreover, when employment contracts encapsulate contributions to the firm imperfectly, workers can ‘game’ the compensation scheme for their benefit. Holmstrom and Milgrom (1991) note that when agents carry out multiple activities, the allocation of activities based on offered contracts will prompt workers to concentrate too much on tasks that give rise to performance pay and neglect tasks that do not, resulting in a misallocation of effort. Quality is neglected when output is measured only in terms of quantity and cooperation is inhibited when private effort forms the sole basis of bonuses.

In short, incentive misalignment arises when there is too little or too much pay for performance. Low pay for performance discourages effort and attracts unproductive labor. High pay for performance induces rent extraction when workers have private information about their type and misallocations of effort when workers are engaged in multiple activities but bonuses are awarded on a limited set of activities.

Furthermore, the costs associated with incentive misalignment are especially severe in financial services. Dewatripont and Tirole (1994) point out that moral hazard is particularly acute in banks because banks, as intermediaries, have widely dispersed creditors – i.e., small depositors who have neither the competence nor incentive to monitor a bank’s risk-taking behavior when deposits are insured by federal agencies. As insurer of deposits in the event of bankruptcy, the government provides a put option that encourages excessive risk-taking (Bebchuk and Spamann, 2010). The systemic importance of the banking system to the real economy also gives rise to an implicit too-big-too-fail guarantee for large financial institutions that insulates them from market discipline.

The impact of executive compensation on risk taking at banks is unsettled. Until recently, federal and state regulations limited competition among banks and restricted bank activities. Absent risk-taking opportunities, incentives that heighten the moral hazard of deposit insurance and too-big-to-fail were not regulatory concerns (Smith and Watts, 1992; Houston and James, 1995). Prior to deregulation, Fields and Fraser (1999) find that CEO compensation at commercial banks was significantly less performance sensitive than CEO compensation at investment banks; and Adams and Mehran (2003), that commercial banks compensated CEOs with relatively large cash salaries and bonuses but with relatively small restricted stock and option grants. More recent studies, however, document linkages between compensation and risk-taking at banks. Chen, Steiner, and Whyte (2006) find that market risks increase with bank CEO option-based compensation; Cheng, Hong, and Scheinkman (2010), that market risks tend to increase with the residual pay of top bank executives, and Minnick, Unal and Yang (2011), that U.S. bank mergers were more likely to be value enhancing, and post-acquisition operating performance more likely to be strong, when CEOs had high pay-for-performance compensation. Fahlenbrach and Stulz (2011) find a negative relationship between the performance of financial intermediaries and CEO delta in the 2008 financial crisis, and DeYoung et al (2013), a positive relationship between CEO vega and bank risk-taking.

2. Reward Culture

Extant research is predominantly focused on the compensation of top executives and their impact on firm performance. To better understand the role of incentives, I argue that it is essential to examine the impact of compensation throughout the organizational hierarchy, where compensation is set by top management and sometimes requires board approval. Reward culture embodies the incentives that encourage performance throughout the organization.

Corporate culture at its most basic level is the sum of an organization's behaviors and practices. It reveals itself in big and small decisions as well as in daily practices that tend to perpetuate themselves. A firm's founder naturally places her stamp on the organization – shaping the culture through early hiring decisions and policies, as well as her own values, communication, and behavior. But most often, as the organization grows organically or through M&As, its culture naturally changes and evolves. Typically defined using a combination of corporate personality traits (such as "aggressive", "collaborative", or "results-oriented"), corporate culture is arguably one of the key drivers of corporate performance (Gandossy et al., 2009). As Gandossy et al. (2009) put it,

> "*[Corporate] culture is easy to put your finger on … understanding its connection to performance is more complex*".

In my paper, "reward culture" is defined and quantified as the common variations in the incentives of CEO, VPs, and all remaining employees. I present a detailed description of reward culture variable estimation in section C.

CEO total compensation, CEO delta and CEO vega are used to proxy for CEO incentives. Delta quantifies the change in dollar values of CEO wealth associated with a 1% change in stock price; and vega, the change in the dollar values of CEO wealth associated with a 0.01 change in stock return volatility. Increases in restricted stock grants (and to a lesser extent, stock option grants) will increase delta; increases in stock option grants will increase vega.

The pay gap between the total compensation of the CEO and the median VP is used to proxy for the tournament incentives of VPs. In a typical rank-order tournament, individuals with the best performance are promoted to the next level in the hierarchy, and others are passed over. Promotion to the next level, which carries higher pay, encourages higher effort by individuals that increase firm output and the chance of promotion. The effort expended by tournament participants will increase with the magnitude of promotion prize (Lazear and Rosen, 1981; Prendergast, 1999); and when individuals view the likelihoods of promotion to be equal, firms can generate greater individual effort by increasing the size of promotion prizes (Bognanno, 2001). Further, Milgrom and Roberts (1992) argue that promotion is the only viable incentive mechanism in situations where there is little or no information about the absolute performance of the employee or when systematic shocks affect an individual's performance.

Because of data limitations, I employ compensation per employee as the best available proxy for employee incentives. This proxy essentially captures bonuses extensively utilized in banking, which sometimes have perverse incentive effects. As Acharya and Naqvi (2009) point out, when managerial compensation that increases in loan volume is needed to induce effort, investment risks are underpriced to justify extensions of credit. Moral hazard is created when banks are flush with liquidity.

C. Sample Selection and Methodology

1. Sample Selection

Banks are identified as financial firms with SIC codes between 6000 and 6300. And as in Fahlenbrach and Stulz (2011), firms primarily engaged in investment advisory, pure brokerage, or wire transfer businesses that do not match well with the definition of lending institutions are excluded. The resulting sample of 95 firms in 2006 includes commercial banks as well as investment banks.

Data on CEO and VP incentives for these banks are obtained from the Standard & Poor's ExecuComp database. For firms listed in the S&P 1500, ExecuComp provides details on CEO cash compensation (salaries plus bonuses), stock options, and total compensation for the five highest paid executives. CEOs are people identified in ExecuComp as *CEOANN* = CEO, and all other executives are labeled as VPs. Employee compensation is extracted from total salary and benefit expenses in Compustat. Companies are not required, however, to disclose employee compensation in financial statements, and sometimes Compustat simply fails to record this data item in its database. For banks that did not have this data item in Compustat, I manually searched their corporate filings with the Securities and Exchange Commission (SEC). There are only three banks where data on employee compensation is unavailable. To be included in my sample, banks are required to have data on incentives for all three years from 2004 to 2006. The final sample contains 72 banks.

CEO total compensation, *CEO delta* and *CEO vega* are used as proxies for CEO incentives. *CEO total compensation*, which includes salaries, bonuses, stock option grants, restricted stock grants, long-term incentive payouts, and other compensation, is listed as item *TDC1* in ExecuComp. *CEO delta* is the total stock and option portfolio delta computed as the dollar increase in portfolio wealth associated with a 1% increase in stock price. *CEO vega* is the total stock and option portfolio vega computed as the dollar increase in option portfolio wealth associated with a 0.01 standard deviation increase in stock volatility. These definitions are consistent with Core and Guay (1999, 2002), who use the Black-Scholes (1973) option valuation model modified by Merton (1973) to account for dividends. Computation of CEO delta and vega follows the Fahlenbrach and Stulz (2011) procedure.

ExecuComp recently changed its reporting on compensation in line with expanded disclosure requirements for pension, severance, change-in-control payouts, and equity based compensation imposed by the SEC. The new rules are designed to improve tabular presentation and to offer material qualitative information regarding the manner and context in which compensation is awarded and earned. Firms have to comply with the new rules when their fiscal years end on or after December 15, 2006. The new table on outstanding equity awards at fiscal year-ends provides detailed information on exercise prices and expiration dates for each outstanding option grant used to calculate CEO delta and vega for the year 2006. For all banks from 2004 to 2005 and those that have fiscal years ending before December 15, 2006, only aggregate information on exercisable and unexercisable past option grants is available. I use the methodology of Core and Guay (2002) to calculate the average characteristics of previously granted unexercisable and exercisable options. Core and Guay (2002) treat all previously granted unexercisable and all previously granted exercisable options as two single grants. The exercise price of each aggregated grant is then derived from the reported average realizable value of the options. In addition, Core and Guay (2002) assume that unexercisable options have a time-to-maturity that is three years greater than that of the exercisable options. I use the two aggregated grants and their imputed characteristics to approximate CEO delta and vega of the previously grants options. Core and Guay (2002) ascertain the validity and robustness of their approximation.

VP pay gap proxies for VP tournament incentives, and consistent with prior literature, is computed as the difference between the CEO and median VP total compensation. In a total of 216 bank-year observations (72 banks and 3 years), there were three negative VP pay gaps because CEO compensation is less than that of the median VP.[19] As in Kale et al. (2009), all VP pay gaps are monotonically transformed by adding a constant equal to the absolute value of the minimum gap.

Compensation per employee used to proxy for all remaining employee incentives is defined as total labor expenses reported in Compustat or SEC 10-Ks minus total executive compensation from ExecuComp divided by the number of employees. When Compustat did not

[19]M&T Bank in 2004, Bank of Hawaii in 2004, and Goldman Sachs in 2006

report the number of employees, I manually searched SEC 10-Ks for this information.

Figure 3.1, 3.2 and 3.3 report the means and medians of: (***i***) the total compensation as well as the delta and vega of CEO stock and option portfolios that proxy for CEO incentives; (***ii***) the gap between the total compensation of CEOs and VPs, that proxy for VP tournament incentives; and (***iii***) compensation per employee, that proxy for employee incentives. Incentives were generally higher in the pre-crisis years 2004-2006 and fell in the years leading to the financial crisis in 2008. Moreover, incentives are significantly right skewed, which suggests high-powered incentives may be concentrated among a few banks.

Insert Figures 3.1, 3.2, and 3.3 here.

2. *Reward Culture Factor*

I utilize factor analysis to estimate the reward culture factor score. Factor analysis seeks to isolate common dimensionality through the clustering together of interrelated variables. It is both an exploratory analysis that seeks to map domains of common influence and a method of data reduction. It outlines common patterns that underlie any large data set. Variables that are highly related cluster onto a factor, while unrelated ones (being orthogonal to one another in factor space) appear as different factors. In my factor analysis, I focus on three dimensions of incentives: CEO incentives, VP incentives and remaining employee incentives. I use three proxies for CEO incentives: CEO total compensation; CEO delta; and CEO vega. I use VP pay gap to proxy for VP incentives. I use compensation per employee to proxy for all remaining employee incentives. All incentive variables are standardized using the transformation

$$z(x) = \frac{2 \times [\ln x - \min(\ln x)]}{\max(\ln x) - \min(\ln x)} - 1 \qquad (1)$$

where $z(x)$ is distributed over the closed interval $[-1,+1]$. Table 3.1 reports the matrix of pairwise correlations in incentives and their z-transforms. The high correlations in incentives and their z-transforms exemplify common factors. Table 3.2 reports summary statistics on incentives and their z-transforms as well as on bank return and risk measures together with other control variables used in subsequent analysis.

Insert Tables 3.1 and 3.2 here.

I construct the reward culture factor score in two steps. First, I apply factor analysis to the three proxies of CEO incentives – CEO total compensation, CEO delta and CEO vega – to generate a single common CEO incentive factor. Previous literature is inconclusive about the effect of these proxies on the risk-taking behavior of the CEO. I posit that by incorporating the common variation of all three proxies, I can estimate the true influence of CEO incentives. Table 3.3 reports results and summary statistics of factor analysis on the three proxies of CEO incentives. A single CEO incentive factor which captures 76.6% of the total variation in CEO incentives is highly correlated with all three individual CEO incentive variables, and is statistically significant. Second, I employ factor analysis on CEO incentive factor, VP pay gap, and compensation per employee, to construct the reward culture factor score. Table 3.4 reports the results and the summary statistics of my factor analysis of these variables. A single factor which explains 82.0% of the total variation in incentives across CEOs, VPs, and employees, is statistically significant, and embodies reward culture.

Insert Tables 3.3 and 3.4 here.

The three-year averages of predicted reward culture factor scores for each bank over the period 2004 to 2006, standardized over the closed interval $[-1,+1]$, are used to classify banks by reward culture. Dividing the interval into three equal partitions, banks are grouped as high, average, and low reward culture banks. Table 3.5 reports the summary statistics on reward culture and incentives by group.

Insert Table 3.5 here.

Table 3.6 lists the banks with high, average, and low reward culture, and their total assets as of 2006 year end. The combined assets of the 13 banks with high reward culture account for 65% of the total assets of all banks in the sample; the combined assets of the 32 banks with low reward cultures, 4% total assets of all banks in the sample. Moreover, most of the banks characterized as high reward culture are banks that were the subject of considerable public attention as a result of severe distress or excessive executive compensation, and half either filed for bankruptcy or were acquired by other banks. The non-random assignment and distribution of banks across reward culture groups suggests that incentives across CEOs, VPs, and employees are endogenously determined. Banks choose their reward cultures.

Insert Table 3.6 here.

D. Bank Return and Risk

In this section, I investigate the impact of the reward culture of banks at the end of fiscal year 2006 on bank return and risk in the 18-month period July 1, 2007 to December 31, 2008.

1. *Univariate Analysis of Bank Return and Bank Risk*

I use two performance measures – buy-and-hold returns and compounded monthly returns. Fahlenbrach and Stulz (2011) argue that buy-and-hold returns are better measures of long-run performance when performance can be affected by many factors. Following Fahlenbrach and Stulz (2011), when banks delist or merge prior to December 2008, proceeds from liquidation or mergers are placed into a cash account until December 2008. Compounded monthly returns are calculated as the natural logarithm of one plus buy-and-hold returns divided by 18 months.

Figure 3.4 graphs the buy-and-hold returns and compounded monthly returns by reward culture. The inverse U-shaped lines indicate that incentive misalignment at both ends of the reward culture has an adverse effect on returns. Figure 3.5 graphs bank risk by reward culture using the standard deviations of daily stock returns in the crisis period as a proxy for risk. Again the U-shape line indicates incentive misalignment at both ends of the reward culture. Banks at both ends of reward culture have higher risk than banks with average reward culture.

Insert Figures 3.4 and 3.5 here.

All control variables are measured at the end of fiscal year 2006. *M/B* is market-to-book ratio of equity. *Equity ratio* is total equity capital over total assets at the end of the year. *High*, ***Average***, and ***Low*** are dummy variables equal 1 if the bank falls into the high, average, or low reward culture groups respectively, and 0 otherwise.

2. Multivariate Analysis of Bank Return

Table 3.7 reports the cross-sectional OLS regression results with buy-and-hold returns and compounded monthly returns as dependent variables with bank characteristics as controls. The test variables are the Low, Average, and High dummy variables that represent reward culture. In columns (1) and (6), the intercepts are the average bank returns in the crisis. Columns (2) and (7) add the natural logarithm of market value, market-to-book equity, and equity ratio to control for bank size, charter value, and capital, respectively. Columns (3) and (8) introduce the dummy variables for reward culture. Columns (4) and (9) add the residuals of market value, market-to-book equity and equity ratio regressions on reward culture. Columns (5) and (10) add the residuals of incentive regressions against reward culture as well as the residuals of market value, market-to-book equity, and equity ratio.

Insert Table 3.7 here.

The coefficients on Low, Average, and High dummy variables are all negative and statistically significant. In general, all banks did poorly in the crisis. But, on average, banks in the average reward culture group did best, followed by banks in the low reward culture group, and banks in the high reward culture group. These effects persist even after controlling for the pure effect of incentives and other bank characteristics. In addition, high CEO delta results in lower bank returns. Consistent with moral hazard, larger banks realize lower returns; banks with higher charter value (M/B) and capital (Equity Ratio) achieve higher returns.

Insert Table 3.8 here

To confirm the non-linear relationship between reward culture and bank return, Table 3.8 reports cross-sectional regression results with buy-and-hold returns and compounded monthly returns as dependent variables and various bank characteristics as controls. The test variable here is *(Reward culture factor)*^{2}. Columns (1) and (4) use the reward culture factor and its square to explain bank returns in the crisis. Columns (2) and (5) add the residuals of market value, market-to-book equity and equity ratio regressions on reward culture. Columns (3) and (6) add the residuals of incentive regressions on reward culture as well as the residuals of market value, market-to-book equity, and equity ratio.

The coefficients on *(Reward culture factor)*^{2} are negative through all specifications, and statistically significant for compounded monthly returns. The relationship between bank return and reward culture is non-monotonic and concave. All the signs on control variables are consistent across all specifications.

3. *Multivariate Analysis of Bank Risk*

Table 3.9 reports cross-sectional OLS regression results with bank risk as the dependent variable. The test variables are three *Low*, *Average*, and *High* dummy variables. In column (1), the intercept is the average bank risk in the crisis. Column (2) adds the natural logarithm of market value, market-to-book equity, and equity ratio to control for bank size, charter value, and capital, respectively. Column (3) uses the dummy variables for high, average, and low reward culture. Column (4) adds the residuals of market value, market-to-book equity and equity ratio regressions on reward culture factor. Column (5) adds the residuals of incentive regressions on reward culture factor as well as the residuals of market value, market-to-book equity, and equity ratio.

Insert Table 9 here.

The coefficients on *Low*, *Average*, and *High* dummy variables are all positive and statistically significant, suggesting that all banks generally have high risk in the crisis. On average, banks in the average reward culture group have the lowest risk, followed by banks in the low reward culture group and banks in the high reward culture group, respectively. The differences in risk persist even after controlling for the pure effect of all incentives and other bank characteristics. Banks with higher charter value (*M/B*) and capital (*Equity Ratio*) experience lower risk.

Insert Table 3.10 here.

To confirm the non-linear relationship between reward culture and bank risk, Table 3.10

reports the cross-sectional regression results with bank risk as a dependent variable and various bank characteristics as controls. The test variable here is (*Reward culture factor*)^2. Column (1) uses the reward culture factor and its square to explain bank risk in the crisis. Column (2) adds the residuals of market value, market-to-book equity and equity ratio regressions on reward culture factor. Column (3) adds the residuals of incentive regressions on reward culture factor as well as the residuals of market value, market-to-book equity, and equity ratio.

The coefficients on (*Reward culture factor*)^2 are positive through all specifications, and statistically significant. The relationship between bank risk and reward culture is non-monotonic and convex. In addition, the pure effect of CEO delta is risk increasing consistent with moral hazard. All the signs on control variables are consistent across all specifications.

E. Conclusion

Incentives are designed to align the interests of principals and agents. Incentives that are not sensitive to performance attract low ability agents and discourage effort. But incentives that are overly sensitive to performance will engender the expropriation of shareholder wealth, rent extraction, and misallocation of effort when agents have private information about their ability and outcomes have random components unrelated to effort. Incentive misalignment can occur with too little and too much performance-based compensation. The incentive misalignment problem is more severe in the banking industry where deposit insurance and an implicit too-big-to-fail government guarantee exacerbate moral hazard.

In the aftermath of the 2008 credit crisis, public attention and academic research focused on high-powered incentives to CEOs and the top management team. In this study, incentives that encourage performance throughout the bank are shown to be important in understanding the role of performance-based compensation. Reward culture captures the latent common factors that underlie the incentives to CEOs, VPs, and employees. The impact of reward culture on performance is non-monotonic because incentive misalignment can result from too little as well as too much performance-based compensation. Furthermore, the non-random distribution suggests that banks choose their reward cultures. Further research is needed to identify the factors that influence the decision on 'how much is too much incentive compensation?'.

F. References

Acharya, Viral, and Hassan Naqvi, 2012, The seeds of a crisis: A theory of bank liquidity and risk taking over the business cycle, *Journal of Financial Economics* 106, 349-366.

Adams, Renee B., and Hamid Mehran, 2003, Board structure, banking firm performance and the bank holding company organizational form, *Federal Reserve Bank of New York Staff Reports*, 408-422.

Armstrong, Christopher S., and Rahul Vashishtha, 2012, Executive stock options, differential risk-taking incentives, and firm value, *Journal of Financial Economics* 104, 70-88.

Bannier, Christina E., Eberhard Feess, and Natalie Packham, 2012, Competition, Bonuses, and Risk-taking in the Banking Industry, *Review of Finance* 17, 653-690.

Bebchuk, Lucian A., Alma Cohen, and Holger Spamann, 2010, The Wages of Failure: Executive Compensation at Bear Stearns and Lehman 2000-2008, *Yale Journal on Regulation* 27, 257-282.

Bebchuk, Lucian A., and Holger Spamann, 2009, Regulating Bankers' Pay, *Georgetown Law Journal* 98, 247-287.

Bénabou, Roland, and Jean Tirole, 2013, Bonus Culture: Competitive Pay, Screening, and Multitasking, NBER Working Paper Series.

Black, F., and M. Scholes, 1973, Pricing of Options and Corporate Liabilities, *Journal of Political Economy* 81, 637-654.

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

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

Core, J., and W. Guay, 2002, Estimating the value of employee stock option portfolios and their sensitivities to price and volatility, *Journal of Accounting Research* 40, 613-630.

Core, J., and W. Guay, 1999, The use of equity grants to manage optimal equity incentive levels, *Journal of Accounting & Economics* 28, 151-184.

Dewatripont, Mathias, and Jean Tirole, 1994, A Theory of Debt and Equity: Diversity of Securities and Manager-Shareholder Congruence, *The Quarterly Journal of Economics* 109, 1027-1054.

DeYoung, Robert, Emma Y. Peng, and Meng Yan, 2013, Executive Compensation and Business Policy Choices at U.S. Commercial Banks, *Journal of Financial and Quantitative Analysis* 48, 165-196.

Fahlenbrach, Rüdiger, and René M. Stulz, 2011, Bank CEO incentives and the credit crisis, *Journal of Financial Economics* 99, 11-26.

Fields, L. P., and Donald R. Fraser, 1999, On the compensation implications of commercial bank entry into investment banking, *Journal of Banking & Finance* 23, 1261-1276.

Gandossy, Robert, Rajeev Peshawaria, Leslie Perlow, Fons Trompenaars, and Daisy W. Dowling, 2009, Driving Performance Through Corporate Culture: Interviews with Four Experts, *Journal of Applied Corporate Finance* 21, 67-73.

Hart, Oliver, and Bengt Holmstrom, 1986, The Theory of Contracts, Working papers 418, Massachusettes Institute of Technology (MIT), Department of Economics.

Holmstrom, Bengt, and Paul Milgrom, 1991, Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design, *Journal of Law, Economics and Organization* 7, 24-52.

Holmstrom, Bengt, 1979, Moral Hazard and Observability, *Bell Journal of Economics* 10, 74-91.

Houston, Joel F., and Christopher James, 1995, CEO compensation and bank risk. Is compensation in banking structured to promote risk taking? *Journal of Monetary Economics* 36, 405-431.

Kale, J. R., E. Reis, and A. Venkateswaran, 2009, Rank-Order Tournaments and Incentive Alignment: The Effect on Firm Performance, *Journal of Finance* 64, 1479-1512.

Lazear, Edward P., and Sherwin Rosen, 1981, Rank-Order Tournaments as Optimum Labor Contracts, *Journal of Political Economy* 89, 841-864.

Lazear, Edward P., 2000, Performance Pay and Productivity, *American Economic Review* 90, 1346-1361.

Lazear, Edward P., 1986, Salaries and Piece Rates, *The Journal of Business* 59, 405-431.

Merton, R. C., 1973, Intertemporal Capital Asset Pricing Model, *Econometrica* 41, 867-887.

Michael L. Bognanno, 2001, Corporate Tournaments, *Journal of Labor Economics* 19, 290-315.

Milgrom, P., and J. Roberts, 1992, *Economics, organization and management* (Prentice-Hall International, Englewood Cliffs, NJ [etc.]).

Minnick, Kristina, Haluk Unal, and Liu Yang, 2011, Pay for Performance? CEO Compensation and Acquirer Returns in BHCs, *Review of Financial Studies* 24, 439-472.

Moen, Espen R., and Asa Rosén, 2005, Performance Pay and Adverse Selection, *Scandinavian Journal of Economics* 107, 279-298.

Prendergast, Canice, 1999, The Provision of Incentives in Firms, *Journal of Economic Literature* 37, 7-63.

Smith, Clifford, and Ross L. Watts, 1992, The investment opportunity set and corporate financing, dividend, and compensation policies, *Journal of Financial Economics* 32, 263-292.

G. Figures

Figure 3.1 – Bank CEO Incentives

This figure reports the mean and median annual incentives of bank CEOs over the period 2000 to 2008 measured in 2006 dollars (thousands). Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. *CEO total compensation* includes salary, bonus, stock option grants, restricted stock grants, long-term incentive payouts, and other compensation. *CEO delta* is a CEO's total portfolio delta computed as the dollar increase in her portfolio wealth associated with a 1% increase in stock price. *CEO vega* is the CEO's total portfolio vega computed as the dollar increase in her option-based portfolio wealth associated with a 0.01 standard deviation increase in stock volatility. All variables are winsorized at the 1st and 99th percentile levels.

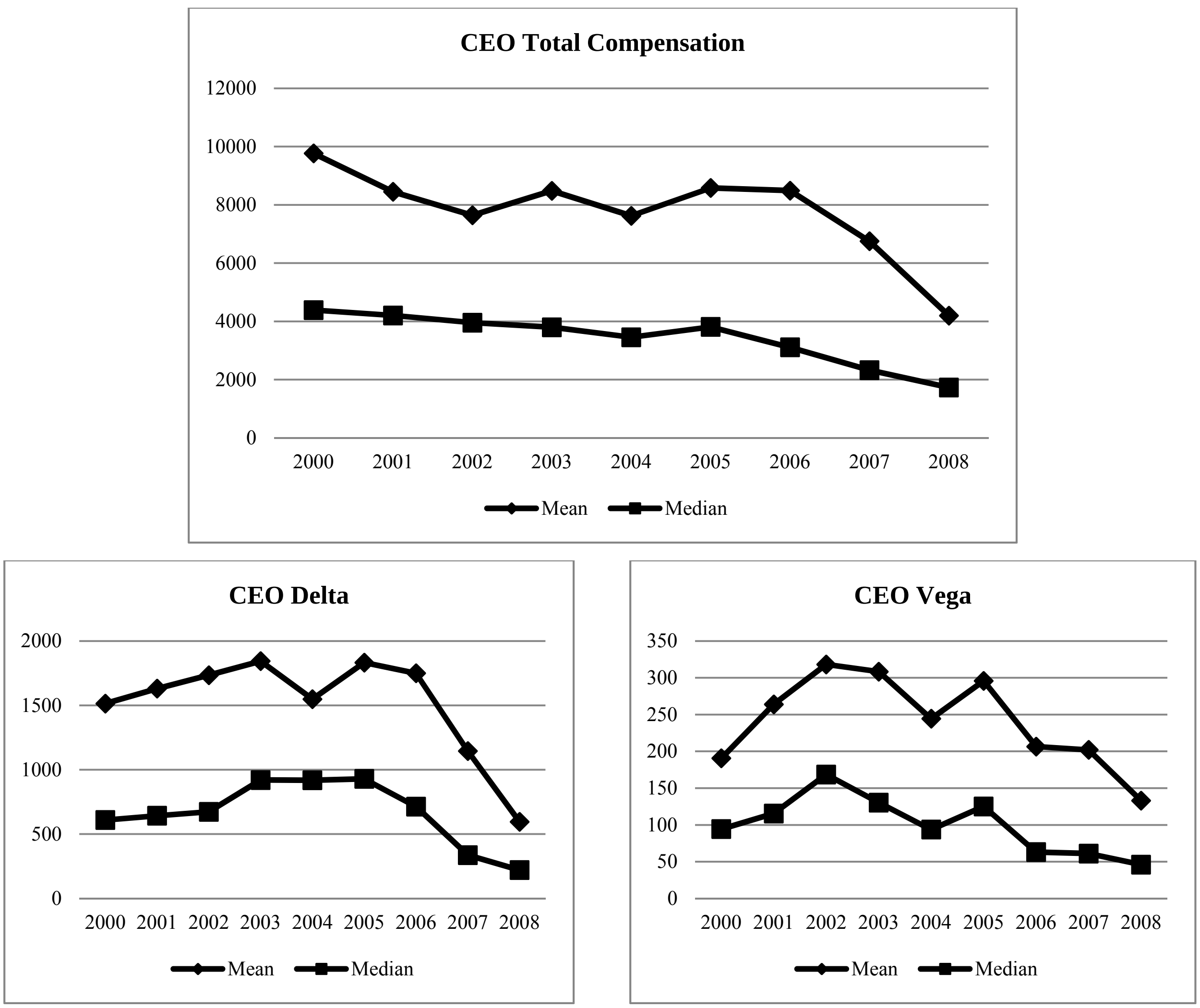


Figure 3.2 – Bank VP Pay Gap

This figure reports the mean and median of bank VP pay gap over the period 2000 to 2008 measured in 2006 dollars (thousands). Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. *VP Pay gap* is the difference between the CEO's total compensation and the total compensation of the median VP. All variables are winsorized at the 1st and 99th percentile levels.

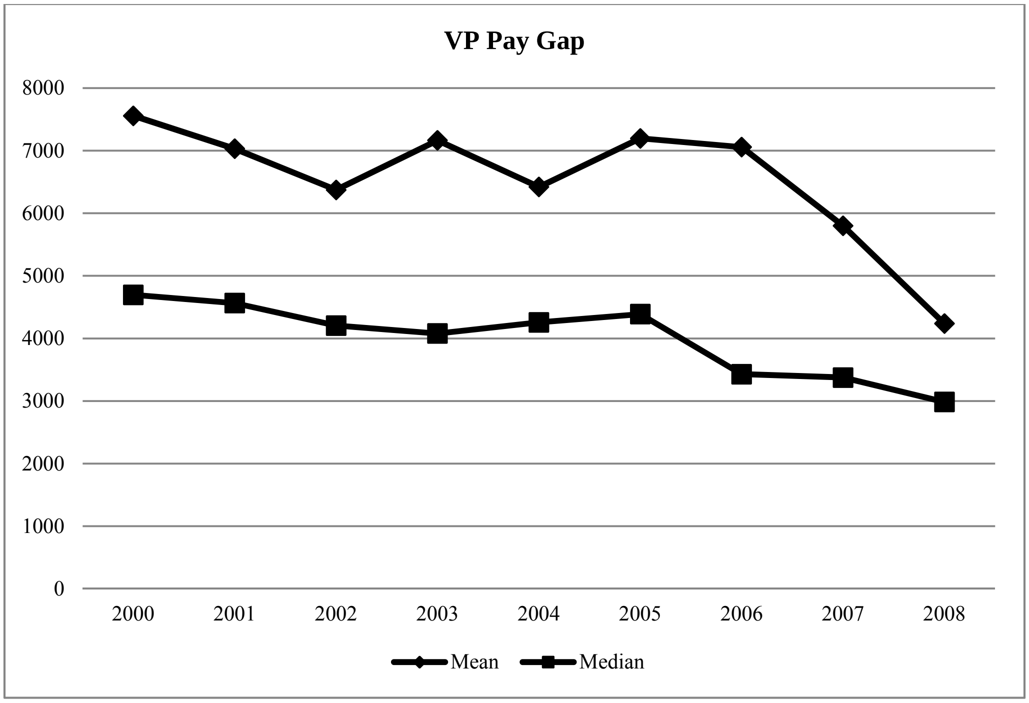


Figure 3.3 – Compensation per Employee

This figure reports the mean and median of compensation per employee at banks over the period 2000 to 2008 measured in 2006 dollars (thousands). Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. *Compensation per employee* is the total labor expense minus annual salaries and bonuses of the top executive team, divided by the number of employees. All variables are winsorized at the 1st and 99th percentile levels.

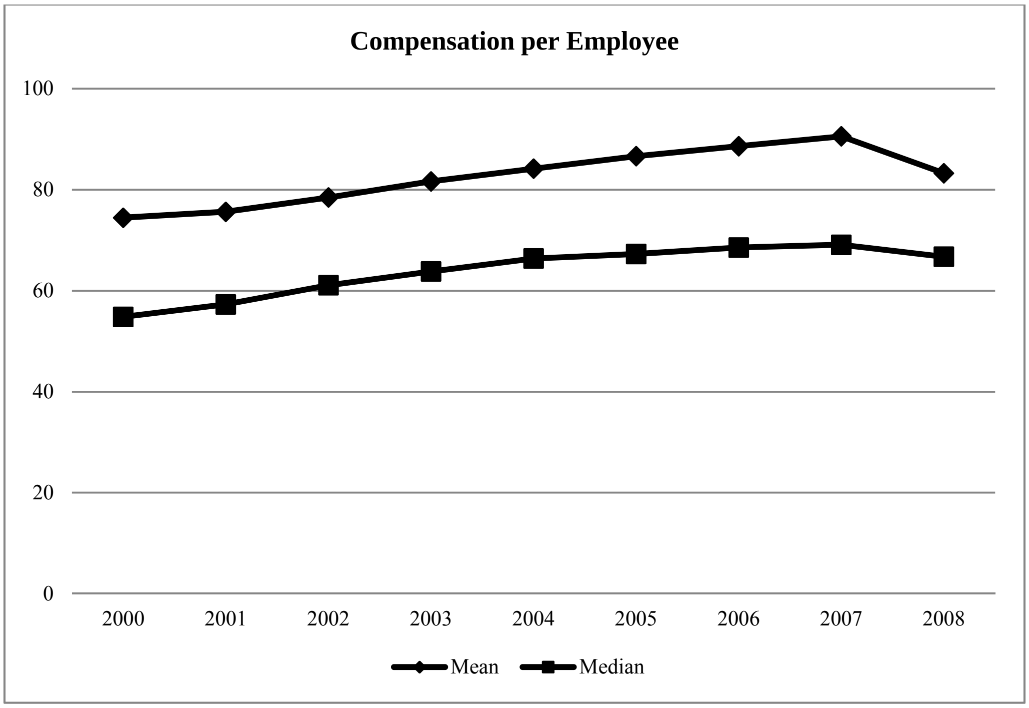
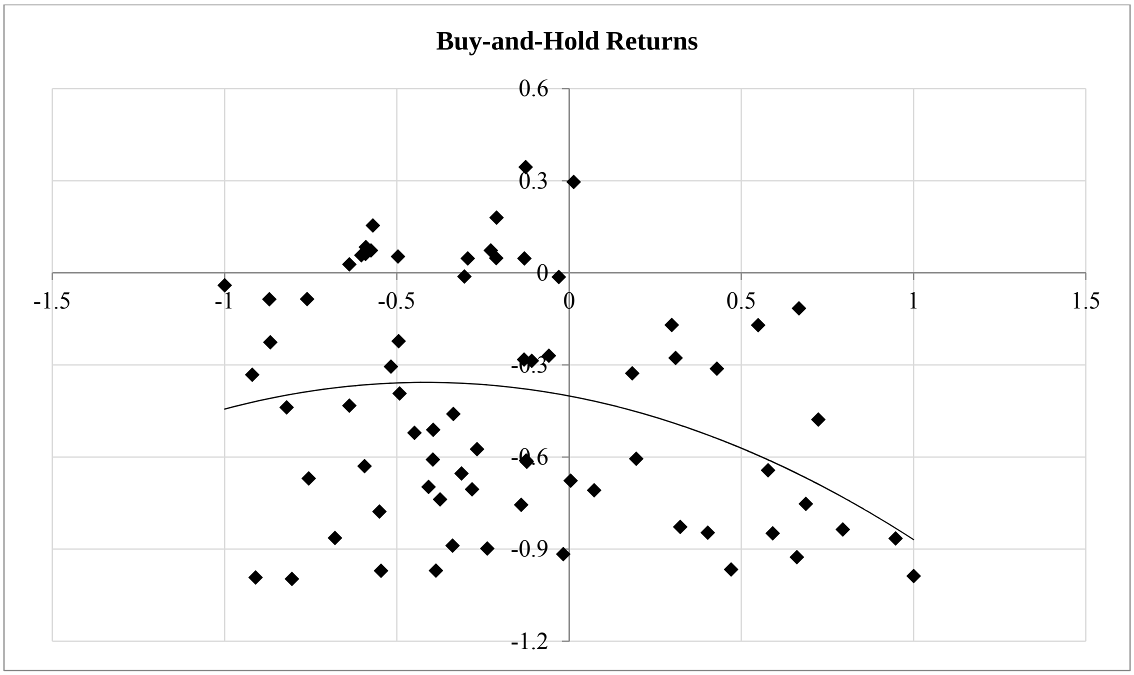


Figure 3.4 – Bank Returns

This figure graphs the buy-and-hold returns and compounded monthly returns on all banks in the sample by their reward culture factor scores. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. *Buy-and-hold returns* are returns from July 1, 2007 to December 31, 2008. *Compounded monthly returns* are calculated as the natural logarithm of one plus buy-and-hold returns divided by the 18 month period – from July 1, 2007 to December 31, 2008.



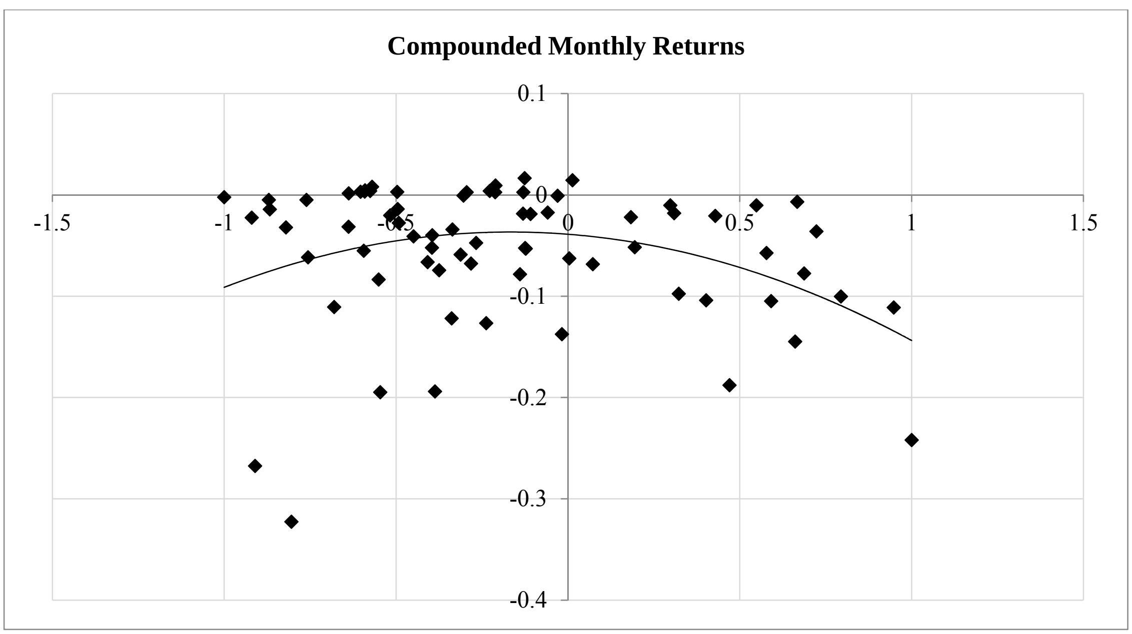
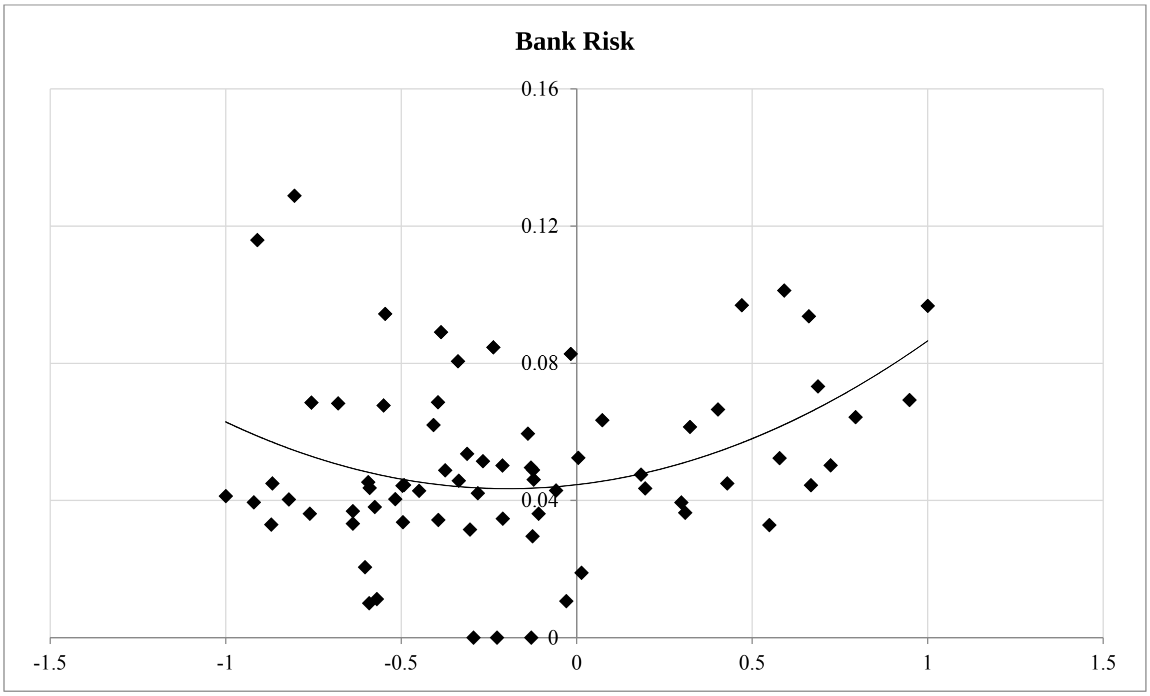


Figure 3.5 – Bank Risks

This figure graphs the risk on all banks in the sample by their reward culture factor scores. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. Bank risk is the standard deviation of daily stock returns from July 1, 2007 to December 31, 2008.



H. Tables

Table 3.1 – Correlation Matrix

This table reports the matrix of pairwise correlations across all incentive variables over the three-year period 2004 to 2006. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. *CEO total compensation* includes salary, bonus, stock option grants, restricted stock grants, long-term incentive payouts, and other compensation. *CEO delta* is a CEO's total portfolio delta computed as the dollar increase in her portfolio wealth associated with a 1% increase in stock price. *CEO vega* is the CEO's total portfolio vega computed as the dollar increase in her option-based portfolio wealth associated with a 0.01 standard deviation increase in stock volatility. *VP Pay gap* is the difference between the CEO's total compensation and total compensation of the median VP. *Compensation per employee* is total labor expenses minus annual salaries and bonuses to the top executive team divided by the number of employees. Logarithmic transforms on all incentive variables are computed as

$$z(x) = 2 \cdot \frac{\ln x - \min(\ln x)}{\max(\ln x) - \min(\ln x)} - 1$$

All variables are winsorized at the 1st and 99th percentile levels. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 3.1 – Correlation Matrix (cont.)

Pearson Correlation Coefficients, N = 216

Prob > |r| under H0: Rho=0

	CEO Total Comp	CEO Delta	CEO Vega	VP Pay Gap	Comp per Emp	z[CEO Total Comp]	z[CEO Delta]	z[CEO Vega]	z[VP Pay Gap]	z[Comp per Emp]
CEO Total Comp	**1.000**	0.789	0.507	0.904	0.661	0.877	0.595	0.293	0.871	0.662
		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
CEO Delta	0.789	**1.000**	0.585	0.725	0.460	0.718	0.773	0.402	0.700	0.464
	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
CEO Vega	0.507	0.585	**1.000**	0.507	0.050	0.605	0.559	0.556	0.579	0.138
	<.0001	<.0001		<.0001	0.463	<.0001	<.0001	<.0001	<.0001	0.043
VP Pay Gap	0.904	0.725	0.507	**1.000**	0.490	0.814	0.582	0.263	0.930	0.492
	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Comp per Emp	0.661	0.460	0.050	0.490	**1.000**	0.548	0.277	0.048	0.454	0.955
	<.0001	<.0001	0.463	<.0001		<.0001	<.0001	0.487	<.0001	<.0001
z[CEO Total Comp]	0.877	0.718	0.605	0.814	0.548	**1.000**	0.697	0.398	0.915	0.597
	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001
z[CEO Delta]	0.595	0.773	0.559	0.582	0.277	0.697	**1.000**	0.557	0.672	0.323
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
z[CEO Vega]	0.293	0.402	0.556	0.263	0.048	0.398	0.557	**1.000**	0.386	0.148
	<.0001	<.0001	<.0001	<.0001	0.487	<.0001	<.0001		<.0001	0.029
z[VP Pay Gap]	0.871	0.700	0.579	0.930	0.454	0.915	0.672	0.386	**1.000**	0.485
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
z[Comp per Emp]	0.662	0.464	0.138	0.492	0.955	0.597	0.323	0.148	0.485	**1.000**
	<.0001	<.0001	0.043	<.0001	<.0001	<.0001	<.0001	0.029	<.0001	

Table 3.2 – Summary Statistics

This table reports summary statistics on incentive variables, firm characteristics, as well as bank returns and risks. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. Compensation variables are from 2004 to 2006. *CEO total compensation* includes salary, bonus, stock option grants, restricted stock grants, long-term incentive payouts, and other compensation. *CEO delta* is a CEO's total portfolio delta computed as her dollar increase in portfolio wealth for a 1% increase in stock price. *CEO vega* is the CEO's total portfolio vega computed as her dollar increase in option-based portfolio wealth for a 0.01 standard deviation increase in stock volatility. *VP Pay gap* is the difference between the CEO's total compensation and total compensation of the median VP. *Compensation per employee* is total labor expenses minus annual salaries and bonuses to the top executive team divided by the number of employees. *Market value* is the market capitalization as of year 2006. *M/B* is market-to-book ratio of equity as of year 2006. *Equity ratio* is total equity capital over total assets at the end of the year as of year 2006. *Buy-and-hold returns* are returns from July 1, 2007 to December 31, 2008. *Monthly compounded returns* are calculated as the natural logarithm of one plus buy-and-hold returns, divided by 18 months – from July 1, 2007 to December 31, 2008. *Bank risk* is the standard deviation of daily stock returns from July 1, 2007 to December 31, 2008. Logarithmic transforms of all incentive variables are computed as

$$z(x) = 2 \cdot \frac{\ln x - \min(\ln x)}{\max(\ln x) - \min(\ln x)} - 1$$

All variables are winsorized at the 1st and 99th percentile levels. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 3.2 – Summary Statistics (cont.)

	N	Mean	Standard Deviation	Minimum	25th Percentile	Median	75th Percentile	Maximum
Incentive Variables: 2004 to 2006								
Total Compensation (000s)	216	8,826.60	11,424.48	371.85	1,732.29	3,558.19	10,572.85	46,375.35
Delta (000s)	216	1,693.17	1,983.23	3.57	320.47	951.26	2,287.42	10,807.70
Vega (000s)	216	265.48	363.43	0.00	21.25	107.13	356.94	1,830.07
VP Pay Gap (000s)	216	7,120.07	7,044.91	1,107.36	2,863.30	4,140.51	7,927.14	34,457.99
Compensation per Employee	216	87.77	68.83	36.19	54.80	66.61	83.65	363.62
z-transform[Total Compensation]	216	0.008	0.505	-1.000	-0.362	-0.064	0.387	1.000
z-transform [Delta]	216	0.338	0.378	-1.000	0.122	0.394	0.612	1.000
z-transform [Vega]	216	0.500	0.442	-1.000	0.382	0.606	0.773	1.000
z-transform [VP Pay Gap]	216	-0.111	0.441	-1.000	-0.447	-0.233	0.145	1.000
z-transform [Comp per Emp]	216	-0.376	0.437	-1.000	-0.640	-0.471	-0.274	1.000
Firm Characteristics at 2006 Yr End								
Market Value (in millions)	72	23,884.42	50,255.87	484.52	1,566.76	4,625.16	20,859.76	273,598.07
Ln[Market Value]	72	8.694	1.623	6.183	7.357	8.439	9.945	12.519
M/B	72	2.090	0.703	0.888	1.584	1.984	2.400	5.277
Ln[M/B]	72	0.689	0.305	-0.119	0.460	0.685	0.875	1.663
Equity Ratio	72	0.092	0.034	0.031	0.073	0.091	0.104	0.246
Return and risk from July 1, 2007 to December 31, 2008								
Buy-and-hold Returns	72	-0.434	0.380	-0.997	-0.754	-0.469	-0.086	0.345
Compounded Monthly Returns	72	-0.056	0.069	-0.323	-0.078	-0.035	-0.005	0.016
Bank Risks	72	0.051	0.026	0.000	0.036	0.045	0.065	0.129

Table 3.3 – Factor Analysis of CEO Incentives

This table reports the results of an exploratory common factor analysis applied to CEO incentive variables over the period 2004 to 2006. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. Principal factors extraction and proportion of total variance explained are used. CEO incentive variables used are CEO total compensation, CEO delta and CEO vega. *CEO total compensation* includes salary, bonus, stock option grants, restricted stock grants, long-term incentive payouts, and other compensation. *CEO delta* is a CEO's total portfolio delta computed as the dollar increase in her portfolio wealth associated with a 1% increase in stock price. *CEO vega* is the CEO's total portfolio vega computed as the dollar increase in her option-based portfolio wealth associated with a 0.01 standard deviation increase in stock volatility. Logarithmic transforms of all incentive variables are computed as

$$z(x) = 2 \cdot \frac{\ln x - \min(\ln x)}{\max(\ln x) - \min(\ln x)} - 1$$

*, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Standardized Scoring Coefficients

	CEO Total Compensation	CEO Delta	CEO Vega
CEO Incentive Factor	0.303	0.522	0.181

Panel B: Pearson Correlation Coefficients (*p*-values) of CEO Incentive Variables with CEO Incentive Factor

	CEO Total Compensation	CEO Delta	CEO Vega
Predicted Sign	+	+	+
Pearson Correlation Coefficient with CEO Incentive Factor	**0.844*** **	**0.953*** **	**0.676*** **
(*p*-values)	(<0.0001)	(<0.0001)	(0.0001)

Panel C: Descriptive Statistics of CEO Incentive Factor Score

	Median	Mean	Standard Deviation	Minimum	Maximum
CEO Incentive Factor	0.130	0.000	0.875	-3.067	1.598
% Variation Explained	76.6%				

Table 3.4 – Factor Analysis of Reward Culture

This table reports the results of an exploratory common factor analysis applied to reward variables over the period 2004 to 2006. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. Principal factors extraction and proportion of total variance explained are used. Reward variables used are CEO incentive factor score, VP pay gap and compensation per employee. *CEO incentive factor score* is the common factor extracted from factor analysis on CEO incentive variables. *VP Pay gap* is the difference between the CEO's total compensation and total compensation of the median VP. *Compensation per employee* is total labor expenses minus annual salaries and bonuses to the top executive team divided by the number of employees. Logarithmic transforms of all incentive variables are computed as

$$z(x) = 2 \cdot \frac{\ln x - \min(\ln x)}{\max(\ln x) - \min(\ln x)} - 1$$

*, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Standardized Scoring Coefficients

	CEO Incentive Factor	VP Pay Gap	Compensation per Employee
Reward Culture Factor	0.398	0.492	0.115

Panel B: Pearson Correlation Coefficients (*p*-values) of Incentive Variables with Reward Culture Factor

	CEO Incentive Factor	VP Pay Gap	Compensation per Employee
Predicted Sign	+	+	+
Pearson Correlation Coefficient with Reward Culture Factor	**0.927*** **	**0.955*** **	**0.580*** **
(*p*-values)	(<0.0001)	(<0.0001)	(0.0001)

Panel C: Descriptive Statistics of Reward Culture Factor Score

	Median	Mean	Standard Deviation	Minimum	Maximum
Reward Culture Factor	-0.181	0.000	0.905	-2.390	2.130
% Variation Explained	82.0%				

Table 3.5 – Reward Culture Factor Score

For each bank, a *reward culture factor score* is computed as the three-year average over the 2004 to 2006 period of the predicted factor scores from a factor analysis of CEO, VP, and employee incentives. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. *CEO total compensation* includes salary, bonus, stock option grants, restricted stock grants, long-term incentive payouts, and other compensation*.* *CEO delta* is a CEO's total portfolio delta computed as the dollar increase in her portfolio wealth associated with a 1% increase in stock price. *CEO vega* is the CEO's total portfolio vega computed as the dollar increase in her option-based portfolio wealth associated with a 0.01 standard deviation increase in stock volatility. *VP Pay gap* is the difference between the CEO's total compensation and total compensation of the median VP. *Compensation per employee* is total labor expenses minus annual salaries and bonuses to the top executive team divided by the number of employees. To classify banks into *high*, *average*, and *low* reward culture groups, the reward culture factor score, which ranges from -1 to +1, is divided into three equal intervals [1,1/3], [1/3, –1/3], and [–1/3, –1]. Table reports summary statistics on reward culture factor scores and incentives by groups.

Table 3.5 – Reward Culture Factor Score (cont.)

Variables	Ranking	N	Mean	Standard Deviation	Minimum	25th Percentile	Median	75th Percentile	Maximum
Reward culture score	Full sample	72	-0.178	0.498	-1.000	-0.560	-0.275	0.128	1.000
	High	13	0.654	0.183	0.402	0.549	0.661	0.723	1.000
	Average	27	-0.072	0.193	-0.312	-0.227	-0.125	0.013	0.322
	Low	32	-0.605	0.186	-1.000	-0.758	-0.583	-0.471	-0.336
Incentives									
CEO total compensation (000s)	High	13	32,730.04	10,382.97	17,890.26	22,850.00	35,337.08	41,153.44	46,375.35
	Average	27	7,320.44	5,597.37	843.61	3,289.74	5,795.71	9,952.12	24,871.61
	Low	32	1,774.53	1,010.84	510.90	1,020.33	1,546.95	2,286.37	4,957.53
CEO delta (000s)	High	13	5,275.37	2,172.37	2,693.16	3,854.35	5,206.50	5,700.76	10,807.70
	Average	27	1,535.55	849.21	3.57	836.07	1,634.33	2,135.92	3,435.18
	Low	32	424.23	473.86	16.11	138.47	304.49	462.07	2,102.63
CEO vega (000s)	High	13	649.51	479.95	0.00	300.83	546.15	845.57	1,640.07
	Average	27	223.64	171.56	0.00	89.88	185.37	304.52	658.27
	Low	32	43.69	58.98	0.00	8.31	25.79	52.30	264.87
VP Pay gaps (000s)	High	13	21,770.98	7,459.54	9,659.48	16,571.68	20,272.42	25,319.31	34,457.99
	Average	27	5,913.91	3,200.06	1,107.36	3,213.27	5,459.19	8,342.81	14,064.61
	Low	32	2,965.41	736.59	2,024.44	2,437.25	2,712.37	3,320.37	5,053.21
Compensation per employee (000s)	High	13	170.41	117.27	59.14	78.67	100.38	301.20	343.34
	Average	27	85.47	58.24	42.90	63.90	70.89	88.61	363.62
	Low	32	66.25	27.94	42.66	51.55	58.32	68.50	162.64

Table 3.6 – List of Banks by Reward Culture Factor

For each bank, a *reward culture factor score* is computed as the three-year average over the 2004 to 2006 period of the predicted factor scores from a factor analysis of CEO, VP, and employee incentives. Sample of 72 banks are firms classified by SIC codes between 6000 and 6300 that are actively engaged in lending. *CEO total compensation* includes salary, bonus, stock option grants, restricted stock grants, long-term incentive payouts, and other compensation. *CEO delta* is a CEO's total portfolio delta computed as the dollar increase in her portfolio wealth associated with a 1% increase in stock price. *CEO vega* is the CEO's total portfolio vega computed as the dollar increase in her option-based portfolio wealth associated with a 0.01 standard deviation increase in stock volatility. *VP Pay gap* is the difference between the CEO's total compensation and total compensation of the median VP. *Compensation per employee* is total labor expenses minus annual salaries and bonuses to the top executive team divided by the number of employees. To classify banks into *high*, *average*, and *low* reward culture groups, the reward culture factor score, which ranges from -1 to +1, is divided into three equal intervals [1,1/3], [1/3, –1/3], and [–1/3, –1]. This table shows the list of banks in each group.

Name	Total Assets 2006 Yr End (in millions)	Notes
High Reward Culture Group – 13 banks		
LEHMAN BROTHERS HOLDINGS INC	503,545	Filed for bankruptcy on September 15, 2008
COUNTRYWIDE FINANCIAL CORP	199,946	Acquired by Bank of America on July 1, 2008
MERRILL LYNCH & CO INC	841,299	Acquired by Bank of America on September 14, 2008
JEFFERIES GROUP INC	17,900	
MORGAN STANLEY	1,120,645	
WELLS FARGO & CO	481,996	
BEAR STEARNS COMPANIES INC	350,433	Acquired by JP Morgan on March 16, 2008
WACHOVIA CORP	707,121	Acquired by Wells Fargo on December 31, 2008
BANK OF AMERICA CORP	1,459,737	
U S BANCORP	219,232	
WASHINGTON MUTUAL INC	346,288	Failed on September 25, 2008
JPMORGAN CHASE & CO	1,351,520	
SLM CORP	116,136	
Average Reward Culture Group – 27 banks		
CITIGROUP INC	1,524,046	
PNC FINANCIAL SVCS GROUP INC	101,820	
NORTHERN TRUST CORP	60,712	
GOLDMAN SACHS GROUP INC	838,201	Merged with Mellon Financial Corp on July 1, 2007
BANK OF NEW YORK MELLON CORP	103,370	
KEYCORP	92,337	
COMMERCE BANCORP INC/NJ	45,272	Acquired by TD Banknorth on April 10, 2008
MARSHALL & ILSLEY CORP	56,230	Acquired by Bank of Montreal on December 17, 2010
NATIONAL CITY CORP	140,191	Acquired by PNC Financial on December 31, 2008
COMPASS BANCSHARES INC	34,200	Acquired by BBVA on September 7, 2007
BB&T CORP	121,351	
ASTORIA FINANCIAL CORP	21,555	
COMERICA INC	58,001	
SUNTRUST BANKS INC	182,202	
HUDSON CITY BANCORP INC	35,507	Acquired by M&T Bank on August 27, 2012
TD BANKNORTH INC	40,159	
CATHAY GENERAL BANCORP	8,027	
FIFTH THIRD BANCORP	100,669	
WESTAMERICA BANCORPORATION	4,769	

Table 3.6 – List of Banks by Reward Culture Factor (cont.)

Name	Total Assets 2006 Yr End (in millions)	Notes
Average Reward Culture Group – 27 banks		
FIRST BANCORP P R	17,390	
INVESTORS FINANCIAL SVCS CP	11,558	Acquired by State Street Corp on February 5, 2007
IRWIN FINANCIAL CORP	6,238	Filed for bankruptcy on September 18, 2009
EAST WEST BANCORP INC	10,824	
SYNOVUS FINANCIAL CORP	31,855	
MERCANTILE BANKSHARES CORP	17,716	Acquired by PNC Financial on March 2, 2007
CULLEN/FROST BANKERS INC	13,224	
ZIONS BANCORPORATION	46,970	
Low Reward Culture Group – 32 banks		
TCF FINANCIAL CORP	14,670	
COLONIAL BANCGROUP	22,784	Failed on August 25, 2009
BOSTON PRIVATE FINL HOLDINGS	5,764	
INDYMAC BANCORP INC	29,495	Filed for bankruptcy on July 11, 2008
SVB FINANCIAL GROUP	6,081	
HUNTINGTON BANCSHARES	35,329	
FIRST HORIZON NATIONAL CORP	37,918	
WINTRUST FINANCIAL CORP	9,572	
FIRST MIDWEST BANCORP INC	8,442	
NEW YORK CMNTY BANCORP INC	28,482	
FIRSTMERIT CORP	10,253	
ASSOCIATED BANC-CORP	20,861	
FIRSTFED FINANCIAL CORP/CA	9,296	Filed for bankruptcy on December 18, 2009
SOUTH FINANCIAL GROUP INC	14,211	Acquired by TD Bank on September 28, 2010
CHITTENDEN CORP	6,432	Merged with People's United Bank on January 1, 2008
DIME COMMUNITY BANCSHARES	3,173	
UNITED BANKSHARES INC/WV	6,718	
GREATER BAY BANCORP	7,371	Acquired by Wells Fargo on October 1, 2007
POPULAR INC	47,404	
MAF BANCORP INC	11,120	Acquired by National City on September 4, 2007
BROOKLINE BANCORP INC	2,373	
M & T BANK CORP	57,065	
ANCHOR BANCORP WISCONSIN INC	4,540	
PROVIDENT BANKSHARES CORP	6,296	Acquired by M&T Bank on December 19, 2008
PROSPERITY BANCSHARES INC	4,587	
FRANKLIN BANK CORP	5,537	Filed for bankruptcy on November 12, 2008
STERLING BANCSHARES INC/TX	4,118	Acquired by Comerica Bank on January 18, 2011
SUSQUEHANNA BANCSHARES INC	8,225	
BANK OF HAWAII CORP	10,572	
DOWNEY FINANCIAL CORP	16,209	Filed for bankruptcy on November 25, 2008

Table 3.7 – Bank Returns and Reward Culture Groups

The table reports the results of cross-sectional OLS regressions of bank returns. For each bank, a *reward culture factor score* is computed as the three-year average over the 2004 to 2006 period of the predicted factor scores from a factor analysis of CEO, VP, and employee incentives. Dependent variables are *Buy-and-hold returns* over the period from July 1, 2007 to December 31, 2008, and *Monthly Compounded monthly returns*, are computed as the natural logarithm of one plus buy-and-hold returns divided by 18 months. *High*, ***Averge***, and ***Low*** are dummy variables equal 1if the bank falls in the high, average, and low reward culture groups respectively, and 0, otherwise. *Market value* is the market capitalization. *M/B* is market-to-book ratio of equity. *Equity ratio* is total equity capital over total assets at the end of the year. *Residual market value, Residual M/B* and ***Equity ratio*** are the residuals of ln[Market value], ln[M/B] and equity ratio regressions on reward culture factor, respectively. *Residual CEO pay*, *CEO delta*, *CEO vega*, *VP pay gap*, *Comp per emp* are the residuals of ln[CEO total compensation], ln[CEO delta], ln[CEO vega], and ln[Compensation per employee] regressions on reward culture factor, residual market value, residual M/B, and residual equity ratio, respectively. To classify banks into *high*, *average*, and *low* reward culture groups, the reward culture factor score, which ranges from -1 to +1, is divided into three equal intervals [1,1/3], [1/3, –1/3], and [–1/3, –1]. *t*-statistics are calculated from heteroskedasticity-consistent standard errors and are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Buy-and-Hold Returns					Compounded Monthly Returns				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept	-0.434***	-0.786**				-0.056***	-0.201**			
	(-9.75)	(-2.05)				(-6.92)	(-2.37)			
Low			-0.417***	-0.394***	-0.393***			-0.058***	-0.053***	-0.054***
			(-6.41)	(-7.33)	(-7.41)			(-4.13)	(-4.94)	(-5.08)
Average			-0.339***	-0.378***	-0.371***			-0.035***	-0.044***	-0.043***
			(-4.67)	(-5.29)	(-5.78)			(-4.45)	(-4.45)	(-4.33)
High			-0.673***	-0.647***	-0.665***			-0.093***	-0.087***	-0.089***
			(-8.30)	(-8.66)	(-7.54)			(-4.97)	(-5.52)	(-5.37)
Ln[Market Value]		-0.052**					-0.002			
		(-2.12)					(-0.42)			
Ln[M/B]		0.467***					0.098***			
		(2.87)					(3.17)			
Equity Ratio		5.202***					1.037***			
		(3.60)					(3.33)			
Residual of CEO Pay					0.027					-0.008
					(0.10)					(-0.15)
Residual of CEO Delta					-0.324**					-0.053*
					(-2.31)					(-1.87)
Residual of CEO Vega					0.089					0.01
					(1.25)					(0.42)
Residual of VP Pay Gap					0.131					0.016
					(0.72)					(0.42)

Table 3.7 – Bank Returns and Reward Culture Groups (cont.)

	Buy-and-Hold Returns					Compounded Monthly Returns				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Residual of Comp per Emp					-0.202					-0.021
					(-1.37)					(-0.82)
Residual of Market Value				**-0.068***	**-0.068***				-0.003	-0.003
				(-1.84)	**(-1.93)**				(-0.45)	(-0.46)
Residual of M/B				**0.448*** **	**0.445*** **				**0.093*** **	**0.093*** **
				(2.80)	**(2.93)**				**(3.12)**	**(3.20)**
Residual of Equity Ratio				**5.151*** **	**5.117*** **				**0.993*** **	**0.986*** **
				(3.79)	**(4.68)**				**(3.27)**	**(3.44)**
N	72	72	72	72	72	72	72	72	72	72
Adjusted R^2	0.563	0.683	0.594	0.677	0.681	0.391	0.556	0.427	0.56	0.546

Table 3.8 – Bank Returns and Reward Culture

The table reports the results of cross-sectional OLS regressions of bank returns. For each bank, a *reward culture factor score* is computed as the three-year average over the 2004 to 2006 period of the predicted factor scores from a factor analysis of CEO, VP, and employee incentives. Dependent variables are *Buy-and-hold returns* over the period from July 1, 2007 to December 31, 2008, and *Monthly Compounded monthly returns*, are computed as the natural logarithm of one plus buy-and-hold returns divided by 18 months. *Market value* is the market capitalization. *M/B* is market-to-book ratio of equity. *Equity ratio* is total equity capital over total assets at the end of the year. *Residual market value, Residual M/B* and ***Equity ratio*** are the residuals of ln[Market value], ln[M/B] and equity ratio regressions on reward culture factor, respectively. *Residual CEO pay*, *CEO delta*, *CEO vega*, *VP pay gap*, *Comp per emp* are the residuals of ln[CEO total compensation], ln[CEO delta], ln[CEO vega], and ln[Compensation per employee] regressions on reward culture factor, residual market value, residual M/B, and residual equity ratio, respectively. *t*-statistics are calculated from heteroskedasticity-consistent standard errors and are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Buy-and-Hold Returns			**Compounded Monthly Returns**		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	**-0.401*** **	**-0.424*** **	**-0.409*** **	**-0.039*** **	**-0.044*** **	**-0.034*** **
	(-6.34)	**(-7.07)**	**(-6.97)**	**(-3.97)**	**(-4.73)**	**(-3.65)**
Reward Culture Factor	**-0.212*** **	**-0.207*** **	**-0.210*** **	-0.026	**-0.025***	**-0.027***
	(-3.01)	**(-3.72)**	**(-3.51)**	(-1.51)	**(-1.75)**	**(-1.96)**
(Reward Culture Factor)^2	**-0.255***	-0.170	-0.225	**-0.079*** **	**-0.060*** **	**-0.096*** **
	(-1.77)	(-1.34)	(-1.40)	**(-2.15)**	**(-2.04)**	**(-2.87)**
Residual of CEO Pay			0.018			-0.064
			(0.06)			(-1.22)
Residual of CEO Delta			**-0.360*** **			**-0.077*** **
			(-2.45)			**(-2.52)**
Residual of CEO Vega			0.095			0.006
			(1.42)			(0.32)
Residual of VP Pay Gap			0.11			**0.062***
			(0.50)			**(1.67)**
Residual of Comp per Emp			-0.182			-0.005
			(-1.18)			(-0.23)
Residual of Market Value		**-0.070***	**-0.071*** **		-0.004	-0.004
		(-1.99)	**(-2.18)**		(-0.58)	(-0.70)
Residual of M/B		**0.457*** **	**0.453*** **		**0.093*** **	**0.09*** **
		(2.82)	**(2.86)**		**(3.13)**	**(3.14)**
Residual of Equity Ratio		**5.196*** **	**5.13*** **		**0.974*** **	**0.930*** **
		(3.78)	**(4.63)**		**(3.43)**	**(3.75)**
N	72	72	72	72	72	72
Adjusted R^2	0.594	0.681	0.684	0.444	0.576	0.581

Table 3.9 – Bank Risk and Reward Culture Groups

The table reports the results of cross-sectional OLS regressions of bank risks. For each bank, a *reward culture factor score* is computed as the three-year average over the 2004 to 2006 period of the predicted factor scores from a factor analysis of CEO, VP, and employee incentives. Dependent variable is *Bank risks,* computed as the standard deviation of daily stock returns from July 1, 2007 to December 31, 2008. *High*, *Average*, and *Low* are dummy variables equal 1 if the bank falls in the high, average, and low reward culture groups respectively, and 0, otherwise. *Market value* is the market capitalization. *M/B* is market-to-book ratio of equity. *Equity ratio* is total equity capital over total assets at the end of the year. *Residual market value, Residual M/B* and *Equity ratio* are the residuals of ln[Market value], ln[M/B] and equity ratio regressions on reward culture factor, respectively. *Residual CEO pay*, *CEO delta*, *CEO vega*, *VP pay gap*, *Comp per emp* are the residuals of ln[CEO total compensation], ln[CEO delta], ln[CEO vega], and ln[Compensation per employee] regressions on reward culture factor, residual market value, residual M/B, and residual equity ratio, respectively. To classify banks into *high*, *average*, and *low* reward culture groups, the reward culture factor score, which ranges from -1 to +1, is divided into three equal intervals [1,1/3], [1/3, –1/3], and [–1/3, –1]. *t*-statistics are calculated from heteroskedasticity-consistent standard errors and are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Bank Risk				
	(1)	(2)	(3)	(4)	(5)
Intercept	**0.051***** **(16.76)**	**0.106***** **(4.17)**			
Low			**0.052***** **(11.01)**	**0.050***** **(13.27)**	**0.050***** **(13.30)**
Average			**0.041***** **(10.05)**	**0.045***** **(11.81)**	**0.044***** **(12.63)**
High			**0.068***** **(11.13)**	**0.066***** **(13.56)**	**0.066***** **(12.69)**
Ln[Market Value]		0.001 (0.69)			
Ln[M/B]		**-0.038***** **(-3.71)**			
Equity Ratio		**-0.419***** **(-3.80)**			
Residual of CEO Pay					0.004 (0.26)
Residual of CEO Delta					0.014 (1.52)
Residual of CEO Vega					-0.002 (-0.22)
Residual of VP Pay Gap					-0.001 (-0.07)
Residual of Comp per Emp					0.003 (0.40)
Residual of Market Value				0.001 (0.59)	0.001 (0.60)
Residual of M/B				**-0.036***** **(-3.79)**	**-0.036***** **(-3.80)**
Residual of Equity Ratio				**-0.392***** **(-3.73)**	**-0.39***** **(-3.80)**
N	72	72	72	72	72
Adjusted R^2	0.793	0.859	0.816	0.866	0.858

Table 3.10 – Bank Risk and Reward Culture

The table reports the results of cross-sectional OLS regression of bank risks. For each bank, a *reward culture factor score* is computed as the three-year average over the 2004 to 2006 period of the predicted factor scores from a factor analysis of CEO, VP, and employee incentives. Dependent variable is *Bank risks,* computed as the standard deviation of daily stock returns from July 1, 2007 to December 31, 2008. *Market value* is the market capitalization. *M/B* is market-to-book ratio of equity. *Equity ratio* is total equity capital over total assets at the end of the year. *Residual market value, Residual M/B* and *Equity ratio* are the residuals of ln[Market value], ln[M/B] and equity ratio regressions on reward culture factor, respectively. *Residual CEO pay*, *CEO delta*, *CEO vega*, *VP pay gap*, *Comp per emp* are the residuals of ln[CEO total compensation], ln[CEO delta], ln[CEO vega], and ln[Compensation per employee] regressions on reward culture factor, residual market value, residual M/B, and residual equity ratio, respectively. *t*-statistics are calculated from heteroskedasticity-consistent standard errors and are in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Bank Risk		
	(1)	(2)	(3)
Intercept	**0.045*** **	**0.047*** **	**0.044*** **
	(11.32)	**(13.77)**	**(12.85)**
Reward Culture Factor	**0.012** **	**0.011** **	**0.012*** **
	(2.14)	**(2.62)**	**(2.79)**
(Reward Culture Factor)^2	**0.030*** **	**0.023*** **	**0.030*** **
	(2.73)	**(2.78)**	**(2.89)**
Residual of CEO Pay			0.016
			(0.79)
Residual of CEO Delta			**0.020* **
			(1.96)
Residual of CEO Vega			-0.001
			(-0.17)
Residual of VP Pay Gap			-0.009
			(-0.58)
Residual of Comp per Emp			-0.001
			(-0.10)
Residual of Market Value		0.002	0.002
		(0.72)	(0.81)
Residual of M/B		**-0.036*** **	**-0.036*** **
		(-3.72)	**(-3.68)**
Residual of Equity Ratio		**-0.392*** **	**-0.382*** **
		(-3.76)	**(-3.92)**
N	72	72	72
Adjusted R^2	0.815	0.866	0.862

V. Conclusion

In the first essay, I show that firms attempt to influence their stock liquidity via share repurchase programs. Acting as buyers of last resort for their own shares, share repurchases by financially constrained firms enhance stock liquidity, which alleviates the cost of external financing and underinvestment. Increased stock liquidity improves information efficiency, including higher value-added from incremental capital investments. Further, higher stock liquidity lowers stock volatility and allows financially constrained firms to issue equity. This essay also explains a counter-intuitive fact about share repurchase in constrained firms. While share repurchases reduce cash balances and add financial leverage, constrained firms seem to be especially sensitive to this decline in corporate liquidity. However, by acting as buyers of last resort, these firms see their stock liquidity improves and advance their financial status. These findings show economic meaning linking market microstructure with corporate finance.

In the second essay, I use the recent financial crisis as a natural experiment to show bank CEO compensation incentives to increase risk, and to increase risk relative to increase stock price, lead to comparatively risky investment and debt policies and increased risk. I show that the relation between bank CEO compensation risk taking incentives tends to change between non-crisis vs. crisis periods. Bank CEO risk taking incentives lead CEOs to adopt riskier investments, including asset growth, loans to core deposits, and commercial real estate loans, to implement riskier debt policy by increasing leverage, and to increase bank risk, where bank risk is measured by the volatility of stock returns, non-performing loans to assets, and a bank risk factor score. I conclude that recent efforts by the press, politicians, and regulators, to portray bank CEO compensation incentives as the cause of excessive risk taking and financial collapse are premature.

In the third essay, I construct and examine whether the "reward culture" of banks was a contributing factor to the 2008 credit crisis. Reward culture reflects three dimensions: (i) CEO incentives – total CEO compensation and the incentive effects of CEO stock and option portfolios; (ii) tournament incentives – pay gap in total compensation between CEOs and Vice Presidents; and (iii) employee incentives – total compensation per employee. A reward culture factor score, constructed by applying factor analysis to the CEO, VP, and employee incentives, represents the common factor in incentives across all levels of the bank. I employ the reward culture factor to examine the impact of reward culture on bank performance and risk. First, I find strong evidence of a nonlinear relationship between reward culture and bank returns and risk. Second, classifying banks into high, average, and low reward culture groups in the pre-crisis year 2006, I find that during the 2008 crisis period, banks either at the high or low reward culture groups performed worse, and were more risky than banks in the average reward culture group. The findings are consistent with the problems of adverse selection and moral hazard associated with incentive misalignment when incentives are too low or too high.