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Inside Debt and Bank Risk

Sjoerd van Bekkum*

Abstract

Inside debt compensation held by top officers of U.S. banks is negatively related to risk and risk taking. The evidence reveals a robust and strongly negative relation between end-of-2006 inside debt and 2007–2009 bank-specific risk exposures in terms of lost stock market value, volatility, tail risk, and the probability of financial distress. Banks with managers having large inside debt holdings are also characterized by better-quality assets, more conservative balance sheet management, and a stronger tendency toward traditional banking activities. The results suggest that debt-based compensation limits bank risk and risk taking by encouraging more conservative decision making.

I. Introduction

The poor incentives from executive compensation are frequently named as a cause for the near collapse of the U.S. banking industry between July 2007 and Mar. 2009. As a result, new legislation has expanded the rights of shareholders in approving compensation practices, appointing directors on compensation committees, and designing compensation proposals.[1] However, notwithstanding increased scrutiny by media, regulators, and legislators, the academic evidence on whether shareholder governance actually limits bank risk is not convincing.

*Van Bekkum (corresponding author), vanbekkum@ese.eur.nl, Erasmus University, Erasmus School of Economics, Rotterdam, 3000 DR, Netherlands. I am indebted to David Yermack, Viral Acharya, Giuseppe Corvasce, Ingolf Dittmann, Marc Gabarro, Jarrad Harford (the editor) and an anonymous referee, David Oesch, Anjolein Schmeits, Patrick Verwijmeren, Soojin Yim, and Dan Zhang for valuable comments and suggestions. I also thank discussants and conference participants at the 2014 Financial Intermediation Research Society meetings; the 2014 International Banking, Economics, and Finance Association meetings; the 2012 Dutch Central Bank's Conference on Governance of Financial Institutions; and the 2012 Eastern Finance Association Meetings, as well as seminar participants at Erasmus University and New York University. Financial support by the Niels Stensen Foundation, Erasmus Trustfonds, and the Tinbergen Institute is gratefully acknowledged.

[1]For instance, the Corporate and Financial Institution Compensation Fairness Act of 2009 expanded the rights of shareholders in approving compensation practices and appointing directors on compensation committees. One year later, the Dodd–Frank Wall Street Reform and Consumer Protection Act of 2010 mandated shareholders to vote on executive compensation and empowered shareholders to design their own compensation proposals. Similar international initiatives also adopt a shareholder-friendly governance perspective, such as the "Principles and Implementations Standards for Sound Compensation Practices" by the Financial Stability Forum, which represents the G-20 finance ministries and central bankers.

Leading examples of this literature are the articles by Beltratti and Stulz (2012), who actually show that banks with more shareholder-friendly boards performed worse during the crisis than other banks, and Fahlenbrach and Stulz (2011), who find no evidence that better-aligned equity incentives are related to better shareholder performance for banks during the financial crisis. If anything, Fahlenbrach and Stulz find the contrary.

These results are not surprising from a theoretical perspective because bank shareholders worry about executives taking too *little* risk. By preventing underinvestment, contingent stock-based and options-based compensation create shareholder value by encouraging managers to increase volatility (Guay (1999)). Therefore, bank executives may have suffered great losses during the crisis *and* acted in the best interest of their shareholders (see Cheng, Hong, and Scheinkman (2012) for empirical evidence in support of this view).

A topic that has received much less attention in previous literature is agency problems between managers and other investors such as debtholders. Equity-based incentives encourage the shifting of risk to debtholders, so that shareholders do not bear the full losses from the "downside" of the corporation's risk taking (Jensen and Meckling (1976), Bolton, Mehran, and Shapiro (2015)). These risk-inducing effects are reduced by debt-based compensation, such as defined benefit pensions and deferred compensation (inside debt), which consists of the promise of fixed sums of cash in the future. Because such commitments are unsecured and unfunded liabilities of the firm, executives would stand in line with other unsecured creditors in the event of default (Sundaram and Yermack (2007)). The idea that managers with debt-based incentives manage their firms more conservatively is formalized by Edmans and Liu (2011).

Using a sample of chief executive officers (CEOs) and chief financial officers (CFOs) from small and large U.S.-listed banks, this study examines whether variations in inside debt are associated with meaningful differences in bank risk during the 2007–2009 financial crisis. Although risk is typically defined from the perspective of shareholders, this paper takes the perspective of both shareholders and debtholders. This seems useful for banks that are funded primarily by depositors and other debtholders and much less by shareholder capital, and that build their business around debt and credit: The importance of leverage in banks causes debt agency problems to be particularly severe. Because market assessments of debtholder risk can be observed directly for only about 20 of the very largest banks that have publicly traded debt instruments, this study describes bank shareholder and debtholder risk using tail risk. The idea is that the lower tail of the stock returns distribution represents problems that are shared by both shareholders and debtholders. The paper also investigates the link between inside debt and several policy mechanisms that are unique to banks and generally considered important in the recent financial crisis.

Consistent with theoretical predictions, the results indicate that banks with larger inside debt holdings at the end of 2006 have lower risk exposures from July 1, 2007, to Mar. 31, 2009, in terms of lost stock market value, return volatility, and tail risk. Furthermore, inside debt is associated with more conservative investment decisions (i.e., a smaller fraction of nonperforming real estate and asset write-downs), more conservative financing decisions (i.e., less short-term market

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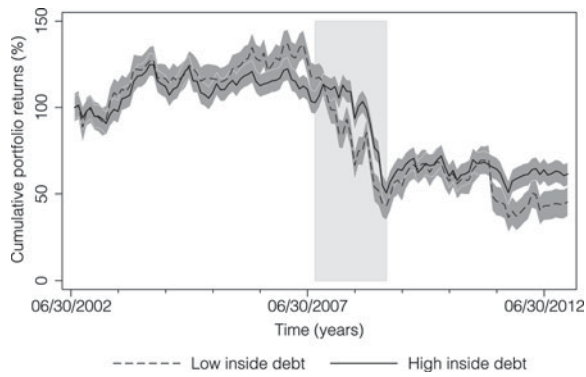
borrowing to fund bank assets in the run-up to the crisis), and more conservative business decisions (i.e., a smaller fraction of nontraditional banking activities). Collectively, the results indicate that inside debt holdings limit bank risk by encouraging more conservative decision making. The negative relation between inside debt and bank risk remains strong after controlling for survivorship bias and a series of variables. Throughout the paper, untabulated analyses verify that the negative relation is robust to several definitions of inside debt and bank risk, at the executive level and the firm level, across bank risk definitions in levels or first differences, across several tail risk thresholds, before and after winsorizing, and either with or without systemically important banks. Although the sample has relatively few observations, the results are confirmed by an instrumental variable analysis and extend to a sample of CEOs and CFOs with and without any inside debt.

An illustration of the main result can be seen in Figure 1, which represents bank risk conventionally in terms of lost equity market value. Banks are sorted into three portfolios according to their relative inside debt holdings in 2006, and the graph shows how stock market losses evolve for portfolios 1 and 3.[2] The notable features in the figure are that banks with low levels of inside debt gained significantly more market value before the crisis, but also lost significantly more during the crisis. It can also be seen that low-inside-debt banks lost ground both faster and earlier over the crisis period examined in this study: Banks with high levels of inside debt seem to have retained much of their market value until the Lehman collapse caused problems to spread across the entire financial sector.

FIGURE 1

Evolution of Lost Equity Market Value for Varying Inside Debt Holdings

Figure 1 demonstrates how stock market losses accumulate for two portfolios constructed by sorting banks according to their inside debt holdings. In Dec. 2006, banks are sorted into three portfolios according to the average inside debt ratio of their top five executives. Each executive's ratio is weighted by the size of debt holdings of each executive. Tercile portfolios are constructed by cutting the sample at the 30th and 70th percentiles. Next, the figure plots the evolution of cumulative value-weighted returns on portfolios 1 ("Low inside debt") and 3 ("High inside debt") in a 21-month moving window from mid-2002 up to the end of 2012. Returns are normalized to 100% at the start of the sample. The light-shaded area corresponds to this study's sample period. The dark-shaded areas represent 95% confidence intervals.



[2]Specifically, the portfolios are constructed by cutting the sample at the 30th and 70th percentiles according to the earliest available inside debt ratio in Dec. 2006. Next, bank stocks are sorted into the first and third quantiles to create a high-inside-debt portfolio and a low-inside-debt portfolio. Figure 1 plots each portfolio's cumulative returns from 2002 onward.

Figure 1 illustrates the central claim of this paper that large inside debt holdings encourage managers to act conservatively, resulting in lower risk and smaller losses during the crisis.

This paper's focus on debt-based compensation adds to recent work that studies the role of nondebt incentives and risk taking in the financial sector's problems (e.g., Cheng et al. (2012), Balachandran, Kogut, and Harnal (2010), DeYoung, Peng, and Yan (2013), and Fahlenbrach and Stulz (2011)), in particular, risk-shifting problems (e.g., Chesney, Stromberg, and Wagner (2012)). It also complements previous proposals to shift compensation away from equity-based incentives by tying it directly to the federal deposit insurance premium (John, Saunders, and Senbet (2000)), the value of debt-like instruments (Bebchuk and Spamann (2010)), a bank's credit default swap spread (Bolton et al. (2015)), or the pricing of government guarantees (Carpenter, Cooley, and Walter (2011)). Furthermore, several contributions are made to the literature on inside debt. First, most previous work has examined the impact of inside debt only within *non*financial firms,[3] and this study on the financial sector examines a particularly clear and important case of risk taking by identifying several risk-taking mechanisms unique to the financial sector. Second, this paper contributes to currently existing working papers on inside debt and bank risk (e.g., Tung and Wang (2010), Bennett, Güntay, and Unal (2015)) by its attempts to address empirical issues related to attrition bias, selection bias, and identification problems arising from the endogenous nature of compensation. In addition, this paper examines both CEO and CFO incentives because both may be important for bank risk management. Third, exploring the market implications of debt-based pay during the recent financial crisis leads to new insights. Although previous studies demonstrate that debt-based pay generally leads to lower equity returns under favorable economic circumstances (Wei and Yermack (2011)), the results in this paper suggest that it also moderates losses under unfavorable circumstances.

Finally, the results presented in this study have strong implications for the broader issue of how to best regulate compensation within financial institutions. It is true that the results do not address whether banks should limit risks or pursue high returns from a societal point of view, and they do not justify any welfare claims. However, if the purpose is to limit risk, then the public discussion about aligning managerial incentives could benefit from considering debt-based compensation. More specifically, the reforms mentioned in footnote 1 indicate that a widespread assumption gained ground that risks will be more effectively monitored once more power is assigned to shareholders. However, the results in this paper suggest that, for the purpose of limiting risk, power should be shifted to debtholders rather than shareholders.

[3] After the U.S. Securities and Exchange Commission (SEC) adopted new rules in 2006 that required disclosure about defined benefit pensions and deferred compensation, several studies found that inside debt reduces the agency problem of debt. For instance, inside debt has been associated with more favorable debt contracts (Anantharaman, Fang, and Gong (2014), Wang, Xie, and Xin (2010)), more conservative financial and investment policies (Cassell, Huang, Sanchez, and Stuart (2012)), less restrictive covenants in debt contracting (Chen, Dou, and Wang (2010), Anantharaman et al. (2014), Wang et al. (2010), and Chava, Kumar, and Warga (2010)), more prudent accounting (Chen et al. (2010), Wang et al. (2010)), diversifying acquisitions (Liu, Mauer, and Zhang (2012)), and higher bond prices (Wei and Yermack (2011)).

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The remainder of this paper is organized as follows: Section II explains how the data and variables in this study are constructed and describes the empirical model. Section III describes how inside debt contracts in 2006 affect bank risk in 2007–2009. Section IV examines the several risk-taking policies through which bank managers can manage their firms more conservatively. Section V presents attempts to alleviate concerns about endogeneity and selection bias. Section VI concludes.

II. Data and Variables

The construction of the data starts with collecting information on all financial institutions (i.e., firms with Standard Industrial Classification (SIC) codes between 6000 and 6300) among the largest 3,000 U.S. companies, which represent approximately 98% of the investable U.S. equity market. The compensation data of these companies are obtained from Equilar, an executive compensation data firm, and hand-collected whenever necessary. Compared to 129 of the very largest banks that are members of the Standard & Poor's (S&P) 1500 and analyzed in most studies, this number almost quadruples to an initial list of 542 eligible financial institutions.[4]

In 2006, the SEC adopted new disclosure guidelines that require mandatory disclosure of the accumulated present value of pension benefits and the fiscal year-end balance of deferred compensation. Because firms had to comply with the new rules if their fiscal year ended on or after Dec. 15, 2006, the analysis excludes all banks that end the 2006 fiscal year before that date. I collect compensation data and other explanatory variables only for the year 2006 because the crisis induced a discrete, exogenous, and unanticipated increase in bank risk in Aug. 2007.[5] Bank stocks lost substantial ground until the first quarter of 2009, after which a partial recovery set in (see also Figure 1). Because of these structural breaks, I calculate the main dependent variables over a period from July 2007 to Mar. 2009.

I exclude banks that, as of Dec. 31, 2006, are listed abroad, privately held, or traded on an over-the-counter (OTC) listing service such as Pink Sheets or OTC Bulletin Board. Next, by browsing through each company's public Web site, I determine whether a firm (or a substantial part of it) is in the lending business. This includes lending institutions such as consumer finance companies (e.g., cars, boats, credit cards, and mortgages) and partial banks, but excludes firms specializing in nonlending services, such as pure brokerage houses, investment management services, and trading platforms. Finally, following the existing literature on inside debt, this paper initially focuses on executives who have nonzero inside debt. Because prior work suggests that CFO incentives may arguably be more important for decisions that require specialized knowledge, such as bank risk management (Chava and Purnanandam (2010), Anantharaman and Lee (2014)),

[4]It is verified that Equilar data are equivalent to Compustat's ExecuComp data except for the broader coverage.

[5]On Aug. 9, 2007, BNP Paribas announced the suspension of three investment funds because "the complete evaporation of liquidity in [the subprime segment] of the U.S. securitization market has made it impossible to value certain assets [. . .] regardless of their quality or credit rating" (*BBC News* (Aug. 9, 2007)).

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I examine both CEO and CFO incentives. Collectively, these requirements result in a sample of 319 banks having a CEO and/or CFO who holds inside debt as of Dec. 2006. Section V also discusses results after considering banks that do not award any inside debt, which increases the sample size to 429 banks. Using Committee on Uniform Security Identification Procedures (CUSIP)/ticker/name combinations, the compensation data are matched to pricing data from the Center for Research in Security Prices (CRSP) and accounting data from Compustat. Duplicate matches are combined or removed, and nonmatches are verified manually.

A. Measuring Inside Debt

Jensen and Meckling (1976) argue that when an executive's debt-to-equity (D/E) ratio is similar to that of the firm, the executive would have no incentives to transfer wealth from debtholders to equity holders because the reallocation would have no effect on the value of his or her holdings in the firm. More recently, Edmans and Liu (2011) show that increases in the value of a CEO's inside debt lead to conservative investment choices, which in turn lead to increases (decreases) in the value of the firm's debt (equity). Therefore, inside debt holdings are generally measured by the D/E ratio of the executive's wealth that is invested in the firm, relative to that of the firm. I follow Edmans and Liu (2011), who derive the following inside debt ratio:

$$(1) \quad k = \frac{D^I/E^I}{D^F/E^F} = \frac{(\text{PENSION} + \text{NQDC}) / (\text{STOCK} + \text{OPTIONS})}{(\text{LTDEBT} + \text{CDEBT}) / (P \times \text{CSHO})},$$

where inside debt (D^I) comprises the present value from accumulated pension benefits (PENSION) and the fiscal year-end balance nonqualified deferred compensation (NQDC), both taken from the firm's proxy statements. Inside equity (E^I) is defined as the value of stock and option holdings, with stock ownership value (STOCK) calculated by multiplying shares held times the stock price on Dec. 29, 2006. These shares include unvested stock and equity incentive plan awards. I deduct options that become exercisable within 60 days after the proxy statement to avoid double counting the options in the outstanding equity table. The value of stock options (OPTIONS) is calculated from the Black–Scholes (1973) value of each individual tranche of outstanding options and summing the tranche values to a grand total for each executive. This is described in more detail in Table 1. Firm debt (D^F) is long-term debt (LTDEBT) plus current debt (CDEBT), and firm equity (E^F) is the number of shares outstanding times the stock price on Dec. 29, 2006.[6]

B. Measuring Total Shareholder and Debtholder Risk

In contrast to bank shareholders whose levered equity may increase in value with volatility, unsecured debtholders have no upside potential other than the periodic interest payments and the payout of face value when the debt matures.

[6]It is verified that the results in this paper are robust to alternative measures such as the k^*-ratio proposed by Wei and Yermack (2011) or the measures in Section V.

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Because debtholders lose only a portion of their principal when daily stock returns are sufficiently negative, debtholder risk is not so much captured by volatility as by the lower tail of the returns distribution. Hence, a bank risk measure that matters for shareholder and debtholders alike needs to capture downside risk.

In addition, because the empirical distribution of such gains and losses is probably skewed and has fat tails, an appropriate risk measure does not assume normality. The measure should also minimize the role of managerial discretion and account for off-balance-sheet items that may distort many important financial performance measures (Altman (2000)). These items include the structured finance instruments that played a key role during the 2007–2008 crisis, such as asset-backed securities, mortgage-backed securities, and many credit derivative products. Therefore, I represent shareholder and debtholder risk by value at risk (VaR), expected shortfall (ES), and conditional value at risk (CoVaR). These measures are designed for measuring and managing risk within financial institutions.

VaR (Guldimann, Zangari, Longerstaey, Matero, and Howard (1994)) is a widely used quantity for corporate control that focuses on the largest likely loss. Given a probability level α that indicates the difference between "likely" and "extreme" loss, VaR is defined as the maximum (firm-wide) loss in $100(1-\alpha)\%$ of the time:

$$\mathrm{VaR}_{it}^{1-\alpha}\left(R_{it}\right) \quad = \quad -\sup\left\{z \mid \Pr\left[R_{it} < z\right] < \alpha\right\},$$

where R_{it} is firm i's return at time t, and z is a percentile corresponding to the prespecified parameter α. Because risk is calculated ex post, it is straightforward to obtain $100(1-\alpha)\%$ daily VaR by selecting the lowest $100\alpha\%$ of daily observations for each firm for a given time period. Assuming that realized returns are an accurate description of the underlying data-generating process, VaR is simply the largest (i.e., least negative) of these observations. Bali, Demirtas, and Levy (2009) demonstrate that this straightforward nonparametric definition of VaR yields results very similar to more sophisticated definitions.

VaR represents the largest likely loss and is fully uninformative about the size of the actual loss if extreme, unlikely events occur, such as the mortgage crisis starting in 2007. In that respect, ES (Artzner, Delbaen, Eber, and Heath (1999)) gives a better impression of the worst $100\alpha\%$ of the cases by describing the mean of the lower tail of the returns distribution:

$$\mathrm{ES}_{it}^{\alpha}\left(R_{it}\right) \quad = \quad -\mathbb{E}\left[R_{it} \mid R_{it} \leq \mathrm{VaR}_{it}^{1-\alpha}\left(R_{it}\right)\right].$$

This definition can be interpreted as the average loss suffered in the worst $100\alpha\%$ of the time.

Shleifer and Vishny (1992) demonstrate that losses might also occur because other institutions face similar constraints at the same time. This is important to the 2007–2009 crisis: Many banks could no longer roll over their short-term debt in 2008, which is considered a direct consequence of sector-wide increased margin and collateral requirements and a general tightening of lending (Brunnermeier and Pedersen (2008)). To capture risk spillovers, CoVaR (Brunnermeier and Adrian (2009)) measures how financial institutions are exposed to problems at their industry peers. Specifically, define R_t^* as the return on the Morgan Stanley Capital

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International (MSCI) U.S. Financial Services index. Next, an institution's vulnerability to the spreading of industry problems is captured by:

$$\text{CoVaR}_{it}^{\alpha}\left(R_{it}\right) \quad = \quad -\text{VaR}_{it}^{1-\alpha}\left(R_{it}|R_{it}^{*} \leq \text{VaR}_{t}^{1-\alpha}\left(R_{it}^{*}\right)\right).$$

In words, CoVaR measures the sensitivity of overall exposure to losses from other financial firms by calculating the value-at-risk of a stock, given that the industry return is below its 100α-th percentile.[7] CoVaR represents the largest likely loss when losses of industry peers become quite large, measuring exposure to severe industry problems. Therefore, it captures risk spillovers and an institution's vulnerability to the spreading of losses such as the credit and liquidity freezes in 2008.

Because all returns in the lower tail are negative, VaR, ES, and CoVaR are multiplied by -1 in the previous equations. This facilitates interpretation with a positive coefficient indicating a positive effect on bank risk. I examine within-firm VaR, ES, and CoVaR over the crisis period from July 2007 to Mar. 2009. A threshold level of $\alpha = 0.05$ is assumed in the following results, but it is verified that assigning different values to α yields similar results.

Because market assessments of debtholder risk can be observed directly for only about 20 of the very largest banks that have publicly traded debt instruments, bank shareholder and debtholder risk is measured using stock returns. However, of the 319 banks in the sample, about 17% were acquired by other firms or delisted due to a violation of listing requirements or bankruptcy. Table A1 in the Appendix shows how many banks survived, entered bankruptcy, merged, or were acquired during the sample period. Consequently, the possibility exists that banks with large inside debt holdings may seemingly fare better during the crisis, simply because I ignore other banks that got into trouble and disappeared from the sample.

To alleviate this concern, I make use of CRSP's delisting prices. If a security is removed from the exchange, CRSP calculates its price after delisting from an off-exchange price or bid–ask spread (i.e., the average of the bid and ask quotes), and the sum of a series of distribution payments. Hence, returns from delisted firms can be calculated using the share price on Dec. 29, 2006, and the delisting price on the date of delisting. If banks are near bankruptcy when they delist or are taken over, returns are near -100% and are captured by VaR, ES, CoVaR, and volatility. However, if healthy banks are taken over, the delisting return includes the takeover premium paid by the acquirer. Thus, bank risk increases only when banks delist or are taken over due to bankruptcy.

C. Empirical Model

To test whether variations in inside debt holdings of an executive at bank i at the end of 2006 (DEC06) are associated with meaningful differences in bank risk during the crisis ending in Mar. 2009 (MAR09), a simple cross-sectional regression model is estimated:

$$Y_{i,\text{MAR09}} \quad = \quad \beta_0 + \beta_1 D_{i,\text{DEC06}} + \beta_2 X_{i,\text{DEC06}} + \varepsilon_{i,\text{MAR09}}, \tag{2}$$

[7] Note that the CoVaR definition is different from that of Brunnermeier and Adrian (2009), who are interested in the VaR of the financial system given the distress of a particular financial institution.

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where $Y_{i,\text{MAR09}}$ is bank risk represented by stock market losses, volatility, VaR, ES, CoVaR, and the probability of financial distress; $D_{i,\text{DEC06}}$ is inside debt as measured by the *k*-ratio; $X_{i,\text{DEC06}}$ is a collection of control variables measured at the end of 2006; and $\varepsilon_{i,\text{MAR09}}$ is an error term that is adjusted for heteroskedasticity. Because CFO incentives may matter more for decisions requiring specialized financial knowledge, such as bank risk management (Chava and Purnanandam (2010), Anantharaman and Lee (2014)), I report results on CEO and CFO incentives separately.[8] I follow the previous literature on inside debt (e.g., Cassell et al. (2012)) and report *p*-values that are 2-tailed except for the variable of interest, $D_{i,\text{DEC06}}$. I discuss the endogeneity issues related to this empirical setup in Section V.

Because bank risk during the crisis can be affected by many factors, several control variables are included (see Table 1 for their definitions). First, I include EQUITY_DELTA and EQUITY_VEGA because equity incentives and debt incentives are likely to be set simultaneously, and shareholders implement compensation policies that have a positive effect on firm risk (e.g., Jensen and Murphy (1990), Guay (1999)). Second, I include TOTAL_ANNUAL_COMPENSATION because riskier firms may need to pay their managers more when managerial effort is more difficult to monitor (Prendergast (2002)), when managers have a stronger influence in riskier firms (Cheng et al. (2012)), and when it is more difficult for riskier firms to attract optimal talent (Edmans and Gabaix (2011)). At the same time, high levels of pay may also indicate entrenchment problems, as in Bebchuk, Fried, and Walker (2002), and indicate weak corporate governance. Third, FIRM_SIZE and MARKET-TO-BOOK are canonical determinants of future returns that also affect risk (Coles, Daniel, and Naveen (2006)) and compensation (Gabaix and Landier (2008)). Fourth, RETURN_ON_ASSETS may be indicative of risk taking before the crisis. Fifth, (market) LEVERAGE controls for the amount of balance sheet expansion that allows banks to increase profitability by taking more risk. Finally, DEPOSITORY_BANKS are more strictly regulated than nondepository institutions and protected from a bank run by deposit insurance, which provides them with different incentives for taking risk. Hence, I also include an indicator variable relative to whether tier 1 capital is reported; this item is reported only by depository banks.

III. Main Results

A. Inside Debt at the End of 2006

Panel A of Table 1 presents summary statistics for the sample at the bank level. The banks have a total sum of assets of $14 trillion and consist of some very large institutions.[9] The mean leverage ratio equals 0.83, but varies between 0.55 and 0.95. The average tier 1 capital ratio of 11% indicates that the banks are

[8]Results are similar when incentives are combined at the firm level (e.g., after firm-averaging all top five executives).

[9]For all results presented in this paper, it is verified that results are very similar after excluding financial institutions that are systemically important (as designated by the Bank of International Settlements).

well capitalized, although the sample contains four banks with a tier 1 capital ratio below the regulatory minimum of 4%. Mean (median) survivorship-adjusted buy-and-hold returns around the crisis period are −53% (−57%) and vary widely from

TABLE 1

Summary Statistics

Table 1 presents summary statistics of key variables for the sample of banks, taken from Compustat and Equilar after applying the sample selection criteria described in Section II. Unless stated otherwise, data items are collected for Dec. 2006. Panel A presents summary statistics at the bank level with variables taken directly from Compustat or defined as follows (Compustat item codes in square brackets): MARKET-TO-BOOK is equity market value [CSHO × PRCC_F] divided by equity book value [CEQ]. RETURN_ON_ASSETS is operating income before depreciation [OIBDP] divided by total assets [AT]. MARKET_LEVERAGE is total assets minus equity book value, divided by total assets plus equity market value minus equity book value. The measures BUY-AND-HOLD_RETURNS, ANNUALIZED_VOLATILITY, VALUE-AT-RISK, EXPECTED_SHORTFALL, and COVAR are calculated using daily stock price data over 21 months and defined in Section II.B. LOW-QUALITY_REAL_ESTATE is nonperforming assets on real estate [NPAORE] plus other real estate owned assets [OREO] in Dec. 2008, relative to total assets. WRITE-DOWNS is provisions for credit losses [PCL] and other provisions [PVON], pretax write-downs [WDP], losses on investment securities [INVSGL], and allowances or reserves for other losses [AROL], all summed over 2007 and 2008 and scaled by total assets. PRECRISIS_GROWTH_IN_REPO is the proportional change in repurchase agreements [RPAGQ] from Dec. 2006 to July 2007. NONINTEREST_INCOME is total noninterest income [NIINT] divided by net operating income (noninterest income + interest income [TNII] − interest expense [XINT]). Panel B presents summary statistics at the CEO/CFO level with variables taken directly from Equilar or defined as follows: VALUE_OF_SHARES is the total value of shares owned plus the total value of unvested shares. VALUE_OF_OPTIONS is the total value of exercisable options plus the total value of unexercisable options, with option values based upon Black–Scholes (1973) estimates using data for each individual option tranche outstanding. CASH_BONUS is the annual bonus plus nonequity incentive plan payouts. EQUITY_DELTA (EQUITY_VEGA) is the percentage change in value of each executive's stock portfolio and all of his or her individual tranches of options held, summed to an aggregate total, for a $1 increase in the stock price (1% increase in stock volatility). Awarded stock is assumed to have a vega of 0 and a delta of 1 and equals the number of (unearned or unvested) shares, plus those that are owned or have been awarded through an equity incentive plan. The Black–Scholes value of each option tranche is estimated using the exercise price and remaining option life from Equilar, the stock price from Compustat, the risk-free rate that best corresponds to the option's time to maturity from CRSP, annualized daily volatility estimated over 3 years, and the dividend yield defined as annual cash dividends divided by share price. The value of inside debt is accumulated pensions plus the balance of nonqualified deferred compensation (BALANCE_NQDC). The executives' inside D/E ratio (EXECUTIVE_D/E_RATIO) equals the value of inside debt divided by the total value of shares and options owned. The *k*-ratio equals the executive's personal D/E ratio divided by the firm's external D/E ratio. Panel C presents correlations among inside debt and the control variables.

Panel A. Bank Data Summary Statistics

				Percentiles		
Variables	*N*	Mean	Std. Dev.	25th	50th	75th
TOTAL_ASSETS (bln $)	319	44.7	209.4	1.0	2.1	6.7
ln(TOTAL_ASSETS) (mln $)	319	8.1	1.8	6.9	7.6	8.8
TOTAL_LIABILITIES (bln $)	319	41.5	196.7	0.9	1.9	6.0
ln(TOTAL_LIABILITIES) (mln $)	319	8.0	1.8	6.8	7.5	8.7
EQUITY_MARKET_VALUE (bln $)	319	6.2	26.0	0.1	0.4	1.4
ln(EQUITY_MARKET_VALUE) (mln $)	319	6.4	1.8	5.0	6.0	7.2
TOTAL_DEBT (bln $)	319	17.1	91.0	0.1	0.3	1.0
ln(TOTAL_DEBT) (mln $)	318	6.0	2.2	4.7	5.5	6.9
NET_INCOME/TOTAL_ASSETS	319	0.01	0.00	0.01	0.01	0.01
NET_INCOME/BOOK_EQUITY	319	0.11	0.05	0.08	0.12	0.14
Control Variables						
MARKET-TO-BOOK	319	1.97	0.71	1.46	1.86	2.28
RETURN_ON_ASSETS	319	0.02	0.01	0.02	0.02	0.03
MARKET_LEVERAGE (%)	319	83.14	5.53	80.26	83.73	86.65
TIER_1_CAPITAL_RATIO	281	0.11	0.03	0.09	0.11	0.12
Bank Risk (in percentages)						
BUY-AND-HOLD_RETURN_2006	314	5.0	18.5	−4.0	4.6	15.5
BUY-AND-HOLD_RETURN_2007–2009	319	−52.6	31.9	−77.7	−57.0	−29.3
ANNUALIZED_VOLATILITY_2006	319	23.1	6.8	18.0	22.3	27.5
ANNUALIZED_VOLATILITY_2007–2009	319	79.6	32.9	58.3	72.3	94.7
VALUE-AT-RISK_2006	319	2.5	0.7	1.9	2.5	3.0
VALUE-AT-RISK_2007–2009	319	7.3	2.7	5.5	6.9	8.6
EXPECTED_SHORTFALL_2006	319	3.6	1.0	2.9	3.5	4.1
EXPECTED_SHORTFALL_2007–2009	319	11.1	4.5	8.1	10.2	13.2
COVAR_2006	319	4.0	1.6	2.8	3.9	4.9
COVAR_2007–2009	319	14.2	6.9	9.2	13.9	17.9
LOW-QUALITY_REAL_ESTATE	155	0.55	0.86	0.07	0.31	0.66
WRITE-DOWNS	282	3.3	3.6	1.0	2.1	4.4
PRECRISIS_GROWTH_IN_REPO	103	11.2	67.2	−10.6	4.7	27.5
ln(NONINTEREST_INCOME)	232	−11.4	81.4	−61.2	−21.6	29.3

(continued on next page)

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TABLE 1 (continued)
Summary Statistics

Panel B. Executive Data Summary Statistics

	N		Mean		Std. Dev.		Percentiles 25th		50th		75th	
Variables	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO
AGE	284	226	54	48	7	7	49	43	55	48	59	53
VALUE_OF_SHARES (mln $)	286	228	58.50	6.50	280.0	14.40	2.80	0.84	5.99	1.86	31.50	5.45
VALUE_OF_OPTIONS (mln $)	286	228	8.09	1.37	25.60	3.38	0.17	0.07	0.83	0.27	4.02	1.07
CASH_BONUS (mln $)	286	228	0.79	0.28	2.24	0.74	0.05	0.02	0.14	0.07	0.47	0.17
Control Variables												
EQUITY_DELTA (%)	286	228	5.0	5.0	2.6	2.7	3.2	3.2	4.5	4.6	6.1	6.1
EQUITY_VEGA (%)	286	228	0.3	0.4	1.0	0.9	0.1	0.1	0.2	0.3	0.3	0.4
TOTAL_ANNUAL_ COMPENSATION (mln $)	286	228	3.33	1.05	8.36	2.40	0.54	0.27	0.86	0.38	2.21	0.79
Inside Debt												
ACCUMULATED_PENSIONS (mln $)	234	183	2.80	0.52	5.70	1.23	0.33	0.06	0.81	0.15	2.62	0.39
BALANCE_NQDC (mln $)	177	131	3.22	0.65	8.71	1.68	0.19	0.05	0.47	0.17	1.73	0.46
VALUE_OF_INSIDE_DEBT (mln $)	286	228	4.28	0.79	10.80	1.98	0.41	0.07	0.94	0.23	3.24	0.62
INSIDE_DEBT/SALARY	285	228	5.89	2.39	10.10	4.39	1.08	0.38	2.63	1.09	6.42	2.33
EXECUTIVE_D/E_RATIO	286	228	0.25	0.27	0.64	0.84	0.04	0.04	0.12	0.10	0.27	0.20
ln(INSIDE_DEBT_RATIO)	286	228	−1.01	−1.16	2.19	2.08	−2.35	−2.37	−1.07	−1.20	0.01	−0.07

Panel C. Correlations Table for the Main Explanatory Variables

	ln(INSIDE_ DEBT_ RATIO)	EQUITY_ VEGA	EQUITY_ DELTA	ln(TOTAL_ ANNUAL_ COMPENSATION)	ln(EQUITY_ MARKET_ VALUE)	MARKET-TO-BOOK_ RATIO	RETURN_ ON_ ASSETS	MARKET_ LEVERAGE
EQUITY_VEGA	0.02							
EQUITY_DELTA	0.06	0.24						
ln(TOTAL_ANNUAL_ COMPENSATION)	−0.17	−0.01	−0.35					
ln(EQUITY_MARKET_ VALUE)	−0.19	0.11	−0.44	0.84				
MARKET-TO-BOOK_ RATIO	0.22	−0.13	−0.28	0.24	0.29			
RETURN_ON_ASSETS	0.08	−0.10	−0.37	0.44	0.45	0.51		
MARKET_LEVERAGE	−0.36	0.10	0.14	−0.20	−0.23	−0.62	−0.41	
DEPOSITORY_BANK (0/1)	0.22	0.04	0.14	−0.40	−0.30	−0.18	−0.50	0.06

−100% to +67%. Average annualized volatility over 2006 is 23% and increases dramatically to 80% during the crisis.

Panel B of Table 1 presents summary statistics at the executive level and describes CEOs and CFOs in terms of personal characteristics and several compensation statistics at the end of 2006. Some CEOs hold large amounts of shares, options, and inside debt, and median CEO ownership is about three times median CFO ownership. However, CEO and CFO incentives as measured by equity delta, equity vega, and the *k*-ratio are similar. Importantly, the median value of inside debt for bank CEOs (CFOs) is $0.94 million ($0.23 million), which is similar to the median value of executive stock options of $0.83 million ($0.27 million). Hence, in terms of dollar value, inside debt is of similar importance to stock option holdings and more important than executive cash bonuses. Because the risk-taking incentives from executive stock options are positive, whereas those from inside debt are negative, and shares have a vega of 0, one may expect that inside debt has an economically important impact on bank risk.

The median "inside" CEO (CFO) D/E ratio is 0.12 (0.10), but the incentives from inside debt vary widely across executives. For example, several banks

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have *out*side debt amounting to less than 0.3% of equity value, which leads to very large *in*side debt ratios. Following conventions in the literature, I apply a natural log transformation to the *k*-ratio and winsorize at the 2.5th and 97.5th percentiles.[10] The median *k*-ratio for CEOs (for CFOs) is $e^{-1.07}=0.34$ ($e^{-1.20}=0.30$). This number is comparable to studies for large nonfinancial firms but indicates that banks have a somewhat larger potential for risk shifting (the median *k*-ratio is 0.51 in Wei and Yermack (2011) and 0.47 in Cassell et al. (2012)).

Panel C of Table 1 presents correlations between inside debt and control variables to check for collinearity issues. For instance, leverage is a key variable in banking but also implicitly captured by the *k*-ratio, and total annual compensation features in several prior studies but correlates strongly with bank size (Gabaix and Landier (2008)). The correlation between inside debt and leverage is around 0.3, and correlations are quite high between book-to-market and leverage (0.62), and firm size and total annual compensation (0.84). To balance the removal of potentially important variables against the problem of collinearity, I include leverage and total annual compensation in the following analysis but also present the results after excluding these variables in an Internet Appendix, available from the author's Web site (http://people.few.eur.nl/vanbekkum/).

B. Inside Debt and Bank Shareholders in 2007–2009

The majority of studies examining firm risk focus on shareholder risk. Therefore, I first examine the impact of inside debt on shareholder losses and shareholder risk before turning to an examination of total (i.e., shareholder and debtholder) bank risk.

1. Inside Debt and Shareholder Losses

Columns 1 and 2 of Table 2 reexamine Figure 1 in a multivariate context.[11] Shareholder losses are represented by average (rather than cumulative) buy-and-hold stock returns, multiplied by -1 to facilitate an interpretation in the context of bank risk.

The coefficient on inside debt is negative and statistically significant for CEOs and CFOs ($p < 0.01$), indicating that banks with larger inside debt holdings suffered smaller stock market losses during the crisis after controlling for other return drivers. The coefficient on the natural log total compensation is significant for CEOs ($p < 0.05$) but not for CFOs, in favor of stories on CEO entrenchment (as in Bebchuk et al. (2002)) or stories that higher CEO pay is optimal for riskier financial firms (as in Cheng et al. (2012)). The coefficients on the natural log equity market value differ between the sample of CEOs and the sample of CFOs, but this difference disappears once collinear variables are removed. The negative coefficient on CEO equity delta appears in contrast with Fahlenbrach

[10] The results that follow are similar without the natural log transformations and winsorizing.

[11] Because inside debt is measured in 2006, the *k*-ratio may be mechanically smaller for banks that had enjoyed strong performance in the years prior to the crisis. Consequently, one may wonder whether the results depicted in Figure 1 continue to hold after controlling for pre-2006 stock returns. Unreported results show that precrisis stock returns are not significantly different from 0 when included in equation (2), and do not affect the results.

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TABLE 2

End-of-2006 Inside Debt and Bank Shareholder Risk during the Crisis

Table 2 presents results of robust regression analysis of stock market losses, total return volatility, idiosyncratic volatility, and systematic volatility, all calculated from July 2007 to Mar. 2009 and regressed against CEO or CFO inside debt and control variables. Equity market losses are represented by buy-and-hold returns multiplied by −1, and constructed as described in Section II.B. Idiosyncratic volatility (systematic volatility) is defined as the standard deviation from residuals (fitted values) of the Fama–French (1993) 3-factor model. All dependent variables are in percentages and all independent variables are measured at the end of 2006 and defined in Table 1. *p*-values (2-tailed except for the variable of interest, in italics) are reported in parentheses and based on standard errors adjusted for heteroskedasticity. * and ** indicate significance at the 5% and 1% levels, respectively.

	Stock Market Losses		Total Volatility		Idiosyncratic Volatility		Systematic Volatility	
Variables	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO
ln(INSIDE_DEBT_RATIO)	−3.650**	−3.745**	−0.150**	−0.139*	−0.158**	−0.147*	−0.028	−0.009
	(0.000)	(0.001)	(0.007)	(0.042)	(0.003)	(0.023)	(0.226)	(0.430)
EQUITY_VEGA	0.988	1.484	−0.020	0.021	−0.033	−0.020	0.036	0.053
	(0.255)	(0.346)	(0.779)	(0.851)	(0.666)	(0.852)	(0.223)	(0.295)
EQUITY_DELTA	−1.936**	−0.894	−0.134**	−0.045	−0.091*	−0.011	−0.117**	−0.083*
	(0.007)	(0.294)	(0.004)	(0.369)	(0.045)	(0.803)	(0.000)	(0.027)
ln(TOTAL_ANNUAL_ COMPENSATION)	11.624**	5.927	0.498*	0.257	0.508*	0.326	0.040	−0.228*
	(0.000)	(0.190)	(0.010)	(0.479)	(0.011)	(0.406)	(0.737)	(0.042)
ln(EQUITY_ MARKET_VALUE)	−6.136**	−1.900	−0.156	0.058	−0.505**	−0.310	0.570**	0.683**
	(0.001)	(0.404)	(0.216)	(0.786)	(0.000)	(0.176)	(0.000)	(0.000)
MARKET-TO-BOOK_RATIO	−0.394	−0.309	0.078	0.142	0.094	0.081	0.005	0.133
	(0.890)	(0.925)	(0.604)	(0.434)	(0.528)	(0.637)	(0.964)	(0.341)
RETURN_ON_ASSETS	4.210	6.657*	0.050	0.226	0.118	0.333	−0.100	−0.124
	(0.074)	(0.016)	(0.790)	(0.218)	(0.528)	(0.062)	(0.349)	(0.314)
MARKET_LEVERAGE	1.298**	1.273**	0.105**	0.112**	0.123**	0.129**	−0.010	−0.004
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.553)	(0.841)
DEPOSITORY_BANK (0/1)	8.650	9.458	−0.047	0.220	−0.534	−0.247	0.699**	0.545
	(0.216)	(0.300)	(0.932)	(0.720)	(0.383)	(0.704)	(0.035)	(0.185)
Intercept	−188.946**	−142.544*	−9.319**	−8.936	−9.697**	−9.799	−0.710	1.461
	(0.000)	(0.038)	(0.005)	(0.078)	(0.004)	(0.069)	(0.722)	(0.548)
No. of obs.	286	228	286	228	286	228	286	228
Adj. R^2	0.212	0.137	0.165	0.120	0.182	0.135	0.555	0.536

and Stulz (2011), who find a negative relation between stock performance and the CEO's shares and options owned as a fraction of shares outstanding, but unreported results confirm the negative relation in Fahlenbrach and Stulz (2011) when using their measure. Other important control variables are return on assets (ROA) ($p < 0.10$) and market leverage ($p < 0.01$).

The economic importance of inside debt can be assessed using Panel B of Table 1, which shows that the standard deviation of the *k*-ratio equals 2.19 for CEOs (2.08 for CFOs). Therefore, a 1-standard-deviation increase in the *k*-ratio is associated with a loss that is $2.19 \times 3.650 = 8.0\%$ ($2.08 \times 3.745 = 7.8\%$) lower during the 21-month crisis period. This is equivalent to an average annualized difference of $8.0^{12/21} = 3.3\%$ ($7.8^{12/21} = 3.2\%$) per crisis year.

These wealth losses by bank shareholders complement previous empirical findings that more inside debt is generally associated with lower returns. For instance, Wei and Yermack (2011) find that more inside debt is generally associated with lower stock returns during noncrisis times, whereas the negative coefficients on inside debt in Table 2 indicate that inside debt has also limited stock market losses during crisis times. Although pre-2006 data on inside debt are unavailable, Table 2 is consistent with this idea to the extent that shareholder losses *during* the crisis result from shareholder gains *before* the crisis, as in Figure 1.

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2. Inside Debt and Shareholder Risk

It is difficult to discuss bank risk without looking at volatility. One reason for this is that, strictly speaking, VaR, ES, and CoVaR do not measure risk: If the full distribution of returns moves to the left, then both expected returns and returns in the tails will be lower. Therefore, I investigate whether idiosyncratic, systematic, and total volatility are lower for banks that issue more inside debt. Idiosyncratic risk is the standard deviation of daily residuals from the Fama–French (1993) 3-factor model. Systematic risk is the standard deviation of the fitted values from the 3-factor model.

In columns 3–8 of Table 2, the coefficients on CEO and CFO inside debt suggest a negative and highly significant effect on total volatility and idiosyncratic volatility. CEO equity delta is negatively related to total volatility (as in, e.g., Lambert and Larcker (1987) and Aggarwal and Samwick (2003)) and idiosyncratic volatility (as in, e.g., Jin (2002)). Coefficients on CEO and CFO equity vega are insignificant, as in Fahlenbrach and Stulz (2011). As before, the coefficients on total annual compensation are significant for CEOs but less so for CFOs. As expected, shareholder risk for banks with larger inside debt holdings was lower during the crisis.[12]

The results so far indicate that larger inside debt holdings are associated with a limited decrease in stock market prices, and a limited increase in volatility, after economic conditions unexpectedly deteriorated during the crisis. Because managerial conservatism pays off when economic conditions develop unfavorably, this suggests that inside debt discourages managers to take decisions that involve more risk.

C. Inside Debt and Total Bank Risk in 2007–2009

The previous results demonstrate that inside debt is significantly associated with shareholder losses and limits risk when economic conditions deteriorate. However, it is not clear how these results relate to the interests of depositors, bondholders, and other creditors of the bank. Therefore, I measure total bank risk using the lower tail of the returns distribution, because debt repayment is jeopardized only when daily stock returns are sufficiently negative.

1. Inside Debt and VaR, ES, and CoVaR

Columns 1 and 2 of Table 3 present estimation results with VaR as the dependent variable. The results are not very different from those in Table 2, with the coefficients on inside debt negative and significant for both CEOs and CFOs ($p < 0.03$). Interestingly, VaR estimates are disclosed by financial institutions in external reports, used as an internal control standard for audit ratings or self-assessment, and required by law in regulatory reporting. Therefore, although financial firms have some discretion in calculating VaR and use ex ante calculations of expected VaR (this number is not reported publicly for all firms and

[12]Results on shareholder losses or shareholder risk using a sample that excludes (non-)depositary institutions or systemically important banks are very similar, but omitted to conserve space.

TABLE 3

End-of-2006 Inside Debt and Total Bank Risk During the Crisis

Table 3 presents results of robust regression analysis of VaR, ES, CoVaR, and financial distress, all calculated from July 2007 to Mar. 2009 and regressed against CEO or CFO inside debt and control variables. VaR, ES, and CoVaR are defined as described in Section II.B. FINANCIAL_DISTRESS is a dummy variable equal to 1 if financial institutions have a survivorship-adjusted buy-and-hold return of −80% or worse, and 0 otherwise. All dependent variables are in percentages, and all independent variables are measured at the end of 2006 and defined in Table 1. *p*-values (2-tailed except for the variable of interest, in italics) are reported in parentheses and based on standard errors adjusted for heteroskedasticity. * and ** indicate significance at the 5% and 1% levels, respectively.

	VaR		ES		CoVaR		FINANCIAL_DISTRESS (0/1)	
Variables	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO
ln(INSIDE_DEBT_RATIO)	−0.216**	−0.192*	−0.293*	−0.319*	−0.191	−0.287	−0.191**	−0.145*
	(0.004)	(0.026)	(0.014)	(0.030)	(0.162)	(0.125)	(0.000)	(0.015)
EQUITY_VEGA	−0.018	0.086	−0.027	0.177	−0.077	0.335	−0.428	−0.055
	(0.851)	(0.553)	(0.858)	(0.495)	(0.669)	(0.398)	(0.358)	(0.549)
EQUITY_DELTA	−0.172**	−0.033	−0.266**	−0.074	−0.513**	−0.290	−0.126**	−0.124*
	(0.004)	(0.623)	(0.007)	(0.478)	(0.001)	(0.079)	(0.007)	(0.011)
ln(TOTAL_ANNUAL_COMPENSATION)	0.596*	0.647*	1.050*	0.977	0.953	0.778	0.380*	0.179
	(0.031)	(0.035)	(0.015)	(0.175)	(0.150)	(0.342)	(0.033)	(0.369)
ln(EQUITY_MARKET_VALUE)	−0.275	−0.188	−0.293	−0.042	0.978*	1.121*	−0.114	0.017
	(0.106)	(0.254)	(0.289)	(0.917)	(0.017)	(0.022)	(0.310)	(0.876)
MARKET-TO-BOOK_RATIO	0.115	0.240	0.124	0.274	0.031	0.368	−0.219	−0.248
	(0.573)	(0.294)	(0.704)	(0.460)	(0.954)	(0.551)	(0.211)	(0.168)
RETURN_ON_ASSETS	0.210	0.486	0.249	0.596	−0.345	−0.137	−0.030	0.042
	(0.420)	(0.058)	(0.540)	(0.155)	(0.493)	(0.801)	(0.849)	(0.818)
MARKET_LEVERAGE	0.137**	0.144**	0.262**	0.257**	0.156*	0.120	0.041	0.040
	(0.000)	(0.000)	(0.000)	(0.000)	(0.043)	(0.172)	(0.104)	(0.136)
DEPOSITORY_BANK (0/1)	−0.264	0.348	−0.284	0.594	1.664	2.644	0.157	−0.057
	(0.725)	(0.661)	(0.797)	(0.640)	(0.229)	(0.128)	(0.748)	(0.920)
Intercept	−10.487*	−13.981*	−22.925**	−25.331*	−16.406	−14.677	−7.919*	−5.653
	(0.020)	(0.012)	(0.001)	(0.014)	(0.092)	(0.252)	(0.015)	(0.120)
No. of obs.	286	228	286	228	286	228	286	228
Adj./Pseudo-R^2	0.166	0.132	0.186	0.157	0.228	0.188	0.201	0.160

could be subject to differences in estimation methodology), realized VaR is an ex post measure of a financial institution's willingness to absorb losses. Hence, the results on VaR suggest that inside debt encourages more conservative internal, external, and regulatory risk governance. This idea is further investigated in Section IV.

Columns 3 and 4 of Table 3 present results showing the impact of 2006 inside debt holdings on ES from 2007 to 2009. The results are roughly similar to those on VaR. Most importantly, coefficients on inside debt are negative and significant ($p < 0.03$). The results on ES complement those on VaR by suggesting that, given that an extremely negative shock materializes, the average exposure is lower for banks with higher levels of inside debt.

Columns 5 and 6 of Table 3 show the impact of inside debt on banks' vulnerability to the spreading of losses captured by CoVaR. The coefficients on natural log equity market value are significantly positive, suggesting that being "too-interconnected-to-fail" (e.g., Brunnermeier and Adrian (2009)) is a moral hazard problem related to larger banks. The results on inside debt are not as strong as in the columns on VaR or ES ($p < 0.13$ for CFOs). However, the Internet Appendix shows that coefficients on inside debt become significant once collinear variables are removed ($p < 0.05$ for CEOs, $p < 0.07$ for CFOs).

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The economic significance of inside debt is substantial, as before, with a 1-standard-deviation increase in the *k*-ratio for CEOs limiting VaR and ES during the crisis by $2.19 \times 0.216 = 0.5\%$ and $2.19 \times 0.293 = 0.6\%$, respectively. Similarly, a 1-standard-deviation increase in CFO inside debt limits VaR and ES by $2.08 \times 0.192 = 0.4\%$ and $2.08 \times 0.319 = 0.7\%$, respectively.

Aside from excluding systemically important banks or (non-)depository banks with similar but unreported results, I can also express bank risk in terms of *growth* in volatility, VaR, ES, and CoVaR from before the crisis to after the crisis, rather than in levels. These results (reported in the Internet Appendix) are more significant in a statistical sense, and quite similar: Higher inside debt is associated with lower growth in bank risk during the crisis. This result is interesting because, to the extent that negative shareholder returns *during* the crisis result mechanically from positive shareholder returns *before* the crisis, it suggests that inside debt moderates stock returns in both good times and bad times, as suggested by Figure 1.

2. Inside Debt and the Probability of Financial Distress

Bank tail risk is estimated at the $\alpha = 0.05$ risk threshold so that about 30 daily returns are used to calculate ES and CoVaR from July 2007 to Mar. 2009. Therefore, one may be concerned as to whether the lower tail is reliably described by VaR, ES, and CoVaR. For instance, because ES is an average, it can be distorted by a long lower tail, leading to overstated results. Another possible concern is that these statistics might not reflect risks far enough down the lower tail to be relevant for debtholders. Hence, it may not be immediately clear to what extent VaR, ES, and CoVaR actually relate to the total return on equity and debt and, consequently, whether inside debt is an important determinant of total bank risk.

To tackle these concerns, I use a probit model that captures the probability of financial distress that is relevant to shareholders as well as debtholders and other creditors, but does not require an estimate of the lower tail. The binary dependent variable equals 1 if financial institutions have a survivorship-adjusted buy-and-hold return of -80% or worse, and 0 otherwise. With returns adjusted for survivorship bias, the variable distinguishes surviving banks and banks delisted after a value-increasing takeover from distressed banks and banks delisted after a government-backed takeover or a bankruptcy. Results after reestimating equation (2) in a probit framework are presented in columns 7 and 8 of Table 3.

The coefficients on CEO and CFO inside debt are negative and significant, suggesting a negative impact on the probability of shareholder and debtholder distress. Unreported estimates after excluding systemically important banks or (non-)depository banks are very similar. This result confirms previous findings and alleviates concerns about the validity of the VaR, ES, and CoVaR measures, suggesting that banks with higher 2006 inside debt holdings are associated with lower bank risk exposures in 2007–2009.

IV. Inside Debt and Bank Risk-Taking Policies

The previous results are consistent with the theoretical predictions of Jensen and Meckling (1976) and Edmans and Liu (2011), who predict more conservative

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policy when inside debt holdings are larger. However, the positive impact of inside debt on bank risk says little about the specific policy mechanisms through which bank managers with large inside debt holdings manage their firms more conservatively. Hence, I consider several mechanisms that are specific to banks and are generally regarded important in the recent financial crisis. Table 1 provides the exact definitions of any new variables, and Table 4 presents results.

TABLE 4

End-of-2006 Inside Debt and Bank Risk-Taking Policies around the Crisis

Table 4 presents results of robust regression analysis of low-quality real estate, write-downs, repo growth, and noninterest income, regressed against CEO or CFO inside debt and control variables. Variables are defined as follows (Compustat item codes in square brackets): LOW-QUALITY_REAL_ESTATE is nonperforming assets on real estate [NPAORE] plus other real estate owned assets [OREO] in Dec. 2008, relative to total assets and the resulting variable multiplied by 100. WRITE-DOWNS is provisions for credit losses [PCL] and other provisions [PVON], pretax write-downs [WDP], losses on investment securities [INVSGL], and allowances or reserves for other losses [AROL], all summed over 2007 and 2008 and scaled by total assets. REPO_GROWTH is the proportional change in repurchase agreements [RPAGQ] from Dec. 2006 to July 2007. NONINTEREST_INCOME is total noninterest income [NIINT] divided by net operating income (noninterest income + interest income [TNII] − interest expense [XINT]), with the resulting variable natural log transformed. All dependent variables are in percentages, and all independent variables are measured at the end of 2006 and defined in Table 1. *p*-values (2-tailed except for the variable of interest, in italics) are reported in parentheses and based on standard errors adjusted for heteroskedasticity. * and ** indicate significance at the 5% and 1% levels, respectively.

	LOW-QUALITY_REAL_ESTATE		WRITE-DOWNS		REPO_GROWTH		NONINTEREST_INCOME	
Variables	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO
ln(INSIDE_DEBT_RATIO)	−0.119**	−0.110**	−0.357**	−0.262**	−8.403**	−7.367*	−6.589*	−5.850*
	(0.002)	(0.006)	(0.000)	(0.008)	(0.002)	(0.020)	(0.015)	(0.037)
EQUITY_VEGA	−0.230	0.095	−2.544**	−0.353	−15.679	−30.582	−6.253	32.769
	(0.306)	(0.530)	(0.001)	(0.626)	(0.541)	(0.247)	(0.819)	(0.160)
EQUITY_DELTA	−0.058*	−0.031	−0.206**	−0.144	4.577	1.413	3.675	0.408
	(0.025)	(0.262)	(0.004)	(0.063)	(0.338)	(0.672)	(0.153)	(0.883)
ln(TOTAL_ANNUAL_COMPENSATION)	0.224	0.001	0.773*	−0.252	17.336	−11.222	−2.844	−4.204
	(0.078)	(0.992)	(0.039)	(0.640)	(0.274)	(0.436)	(0.777)	(0.727)
ln(EQUITY_MARKET_VALUE)	−0.285**	−0.172*	−0.385	0.151	−19.452	1.357	15.854*	16.534*
	(0.008)	(0.043)	(0.127)	(0.596)	(0.149)	(0.886)	(0.020)	(0.011)
MARKET-TO-BOOK_RATIO	−0.038	−0.004	−0.630	−0.451	−6.080	2.805	5.407	15.290
	(0.815)	(0.979)	(0.102)	(0.256)	(0.535)	(0.731)	(0.587)	(0.166)
RETURN_ON_ASSETS	0.100	0.110	0.534	0.825*	47.690	18.156	−48.409**	−50.919**
	(0.302)	(0.297)	(0.119)	(0.024)	(0.052)	(0.247)	(0.000)	(0.000)
MARKET_LEVERAGE	−0.030	−0.042	0.036	0.077	−1.498	−1.389	3.308*	5.065**
	(0.174)	(0.187)	(0.443)	(0.132)	(0.461)	(0.191)	(0.044)	(0.001)
DEPOSITORY_BANK (0/1)	0.825**	0.750**	2.014**	2.845**			−23.943	88.420**
	(0.001)	(0.000)	(0.009)	(0.000)			(0.784)	(0.000)
Intercept	0.961	4.145	−8.792	−4.071	−106.288	210.799	−229.002	−489.853*
	(0.629)	(0.180)	(0.177)	(0.601)	(0.641)	(0.206)	(0.182)	(0.011)
No. of obs.	146	116	256	201	100	67	214	168
Adj. R^2	0.117	0.0524	0.156	0.0555	0.126	0.0421	0.312	0.348

A. Investment Policy: Real Estate Lending and Write-Downs

First, on the asset side of the bank's balance sheet, banks built substantial exposure to the subprime loans that set off the crisis. Subprime mortgages are risky assets because they continue to have a balance remaining after all the scheduled payments are paid and need refinancing at an appreciated home price to avoid a jump in the mortgage rate. Therefore, when house prices fall, subprime borrowers may no longer be able to refinance and risk foreclosure. This deteriorates the quality of a bank's real estate portfolio that increasingly consists of nonperforming assets, that is, nonaccrual loans in which payment of interest or principal is

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unlikely or the borrower has fallen behind in interest payments, as well as foreclosed and repossessed properties.

Hence, if inside debt induces bank managers to preserve firm value, I expect a significant relation between inside debt holdings and the quality of the bank's real estate portfolio during the crisis. The fraction of low-quality real estate is proxied by nonperforming assets on real estate (NPAORE), which represent nonaccrual loans that are considered impaired because the payment of interest or principal is doubtful, plus other real estate owned assets (OREO), which represent properties acquired through foreclosure and repossession that serve as a total or partial repayment of a loan.[13]

Columns 1 and 2 of Table 4 present regression results on the quality of banks' asset portfolios at the end of 2008. The estimation model is equivalent to equation (2), with the fraction of low-quality real estate in a bank's asset portfolio as the dependent variable. The inside debt coefficient is highly significant for CEOs and CFOs ($p < 0.01$).

An alternative way of examining investment policy is through the income statement, with write-downs proxying for the extent of risk taking, as in Chesney et al. (2012). Although banks have some discretion over write-downs, they are required to take write-downs on investments that could ex ante be considered risky even if the assets do not actually result in realized losses. Furthermore, write-downs summarize a wide range of investment policy decisions that go beyond real estate lending alone. Therefore, similar to Chesney et al. (2012), I measure write-downs by summing 2007 and 2008 provisions for credit losses and other provisions, pretax write-downs, losses on investment securities, and allowances or reserves for other losses, all scaled by total assets.

Columns 3 and 4 of Table 4 show that CEO and CFO inside debt holdings are negatively correlated to write-downs scaled by total assets ($p < 0.03$ for CEOs, $p < 0.01$ for CFOs). The statistical significance of inside debt further increases when write-downs are expressed in dollar terms (unreported to conserve space). Hence, the evidence on the fraction of low-quality real estate and write-downs is consistent with the assertion that inside debt encourages managers to invest more conservatively.

B. Financing Policy: Precrisis Borrowing

On the liability side of the bank's balance sheet, additional risk was taken by funding assets mostly by short-term market borrowing (Acharya, Philippon, Richardson, and Roubini (2009)). Because a bank's balance sheet is continuously marked to market, increases (decreases) in the value of the asset portfolio appear immediately as increases (decreases) in the net worth of the bank, allowing (requiring) financial intermediaries to increase (decrease) the dollar value of debt (Adrian and Shin (2010)). Several papers argue that the active management of banks' balance sheets increases aggregate volatility, the price of risk, and the probability of financial distress during the financial crisis (e.g., Brunnermeier and Pedersen (2008), Fostel and Geanakoplos (2008), Kashyap, Rajan, and Stein

[13] See, for instance, Northern Trust's 2010 annual report, p. 56 (https://www.northerntrust.com/documents/annual-reports/northern-trust-annual-report-2010.pdf).

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(2008), Brunnermeier (2009), He, Khang, and Krishnamurthy (2010), and Adrian and Shin (2010)).[14]

Hence, if higher leverage increases the probability of default and inside debt encourages managers to avoid default, I expect that a negative relation exists between inside debt holdings and growth in bank debt. A straightforward measure for growth in bank debt would be the increase in market leverage. However, because leverage appears in the denominator of the inside debt measures, any documented association between inside debt and financial leverage could be driven by a mechanical relationship. Therefore, I examine proportional growth in repurchase agreements (repos) to proxy for balance sheet expansion, which is arguably a more important channel for banks to raise debt (e.g., see Adrian and Shin (2010)). In a repurchase agreement, a bank sells a security in order to buy it back at a preagreed price on a fixed future date. Hence, a repo is equivalent to a collateralized loan with interest being the excess of the repurchase price over the sale price. I measure balance sheet expansion by the proportional change in repurchase agreements from Dec. 2006 to alleviate concerns about endogeneity between inside debt and leverage policy, and until July 2007 to isolate balance sheet expansion from changes in bank borrowing due to the crisis.

Columns 5 and 6 of Table 4 present coefficient estimates of equation (2) with precrisis growth in repurchase agreements as the dependent variable. Even though the sample contains 100 observations or less, larger holdings of 2006 inside debt are significantly associated with less growth in repos during the first half of 2007. Consistent with the negative association between inside debt holdings and bank risk during the crisis, CEOs and CFOs with larger inside debt holdings conduct balance sheet policy that is less risky. Notably, precrisis repo growth quantifies the impact of inside debt on firm policies *before* the start of the crisis.

Furthermore, it can be expected that the effect of inside debt is the strongest when the potential for risk shifting toward debtholders is the largest (i.e., when leverage is high). To examine this, I split the sample at the median leverage ratio and rerun the key regressions in Tables 2 and 3. In unreported results, the impact of CEO inside debt on stock market losses, volatility, VaR, ES, and CoVaR (CFO inside debt on volatility, VaR, ES, and CoVaR) is indeed larger for banks with above-median leverage.

C. Business Policy: Noninterest-Based Banking

Finally, in the years leading up to the crisis, banking companies have increasingly departed from the traditional, interest-based "originate-and-hold" banking model (in which banks use deposits to fund illiquid loans that are held on-balance sheet) toward fee-based investment banking, brokerage, insurance sales, and underwriting, as well as a fee-based "originate-to-distribute" lending model

[14] An important explanation is that when mortgage values eroded in 2007 and 2008, banks needed to de-leverage their positions by selling part of the assets. The sales occurred when the prices of these assets were low, and led to even lower prices. This raised concerns with other banks about the solvency and liquidity of the banking system, and margin and collateral requirements were increased. Due to these tightened lending standards, banks could no longer roll over their short-term debt, leading to further assets sales and deeper losses.

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(in which banks securitize their loans, sell them to various third-party investors, and use the proceeds to fund new loans).

Previous studies find that banks more involved in such fee-based, noninterest income are associated with increased operating leverage, revenue volatility, and earnings volatility (DeYoung and Roland (2001)). In addition, DeYoung et al. (2013) find that *equity*-based risk incentives have encouraged CEOs at U.S. commercial banks to generate *more* income from noninterest banking activities. Hence, it seems plausible that a negative relation exists between inside debt holdings and noninterest-based banking activities. To examine this, I follow DeYoung et al. (2013) and measure the fraction of total noninterest income as total noninterest income scaled by net operating income (noninterest income + interest income – interest expense). I natural log transform the resulting variable because it is strongly skewed. The Compustat items are taken at the first available date after 2006 inside debt, which is Dec. 2007.

Columns 7 and 8 of Table 4 present the regression estimates on total noninterest income. As expected, larger holdings of 2006 inside debt are significantly associated with a lower percentage of income from nontraditional banking activities, with each of the coefficients significant at better than the 5% level.[15] This evidence is consistent with the idea that CEOs and CFOs with larger inside debt holdings stick to traditional lines of business and are less involved in fee-based banking.

V. Endogenous Choice of Inside Debt Compensation

Any form of managerial compensation is likely to be influenced by a bank's business environment, its riskiness, and the nature of the agency problems that compensation is to address. For instance, banks could set inside debt remuneration while simultaneously having future bank risk in mind, which may result in a negative relation between inside debt and bank risk that is spurious rather than causal. Another alternative explanation for the negative relation between inside debt and bank risk is that more inside debt is awarded by banks that are less vulnerable to crises or operate in a more stable business environment. This seems especially valid in this cross-sectional study, which does not purge fixed effects as in a panel data setup.

Such concerns are partially addressed by measuring changes in share prices (i.e., returns), as in Table 2 and Figure 1. Similarly, results in the Internet Appendix show that 2006 inside debt also significantly affects *changes* in volatility, VaR, ES, and CoVaR from the start to the end of the financial crisis. This setup creates an appealing quasi-experimental setting because the crisis induced a discrete and exogenous increase in bank risk that was largely unanticipated by managers.[16] In addition, examining the impact of 2006 inside debt on 2007–2009 risk helps to

[15] This result remains significant when the dependent variable is ln(|NONINTEREST_INCOME|), where |.| stands for the absolute value, and an indicator variable for observations with negative noninterest income is added to equation (2). This setup allows for taking natural logs without discarding banks that have negative total noninterest income.

[16] For example, Fahlenbrach and Stulz (2011) find that bank CEOs did not reduce their stock holdings in anticipation of the crisis, and subsequently suffered large wealth losses.

ensure that the managers' inside debt holdings are predetermined. Furthermore, inside debt holdings are also negatively associated with *pre*crisis growth in repurchase agreements. Finally, accumulated pension benefits are a "stock" rather than "flow" quantity and are not easily manipulated from one year to another. These features reduce the endogeneity problem.

A. Instrumental Variables

To alleviate endogeneity concerns more directly, I reestimate the various instances of equation (2) using a 2-stage least squares (2SLS) regression model. One previously used instrument (see, e.g., Cassell et al. (2012)) that seems reasonably exogenous is executive age because pension value mechanically increases with age. In addition, for several reasons, it is relatively difficult to argue that the exclusion restriction is violated.

First, following the line of argument in Yim (2013), even though changes in personal characteristics that occur with age may also affect a bank executive's risk-taking propensity (Graham, Harvey, and Puri (2013), Berger, Kick, and Schaeck (2014)), this holds for *any* physiological, psychological, or mental characteristic. As a result, older bank CEOs and CFOs may either *increase* bank risk if they, for example, have lower energy levels to monitor risk or lack sufficient training in modern risk-management techniques, or *decrease* bank risk if they, for example, have more wisdom from experience or are more even-tempered and conservative. It is difficult to exhaustively distinguish among these stories.

Next, there exists considerable ambiguity over how personal characteristics change with age. For instance, whereas some management and psychology studies of nonexecutives suggest that older people are less overconfident (Taylor (1975), Kovalchik, Camerer, Grether, Plott, and Allman (2005), and Forbes (2005)), Yim (2013) finds that CEO age does not proxy for overconfidence. Furthermore, older CEOs and CFOs may actually be *more* overconfident due to survival and self-attribution bias (Doukas and Petmezas (2007), Billett and Qian (2008)). In an empirical study on bank executives, Fahlenbrach, Prilmeier, and Stulz (2012) argue that CEOs with experience of earlier crises do not manage more conservatively in (pre-)crisis years.

Finally, empirical findings that document a positive correlation between age and risk aversion are plagued by various identification problems because risk aversion is generally affected by time-specific developments such as current and past recessions. Ameriks and Zeldes (2004) identify these problems and find that the correlation between age and risk aversion disappears once these issues are addressed: Older individuals do not gradually allocate lower fractions of their wealth into (risky) equities.

The first-stage and second-stage results are presented in Table 5. Panel A shows that inside debt is significantly related to CEO and CFO age.[17] Panel B

[17]The coefficient on age is not significant in bank risk regressions that exclude inside debt, which could indicate a weak instrument problem (see also Angrist and Pischke (2008), p. 213). However, the results in Panel A suggest that age is a sufficiently strong instrument nonetheless (e.g., because age primarily affects bank risk through inside debt).

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TABLE 5

End-of-2006 Inside Debt and Bank Risk during the Crisis: 2SLS

Table 5 presents results of the 2SLS analysis of bank risk regressed against CEO or CFO inside debt and control variables. Inside debt is instrumented by the executive's age measured at the end of 2006. Panel A reports the results from first-stage regressions of CEO or CFO inside debt on age and the control variables included previously. The partial R^2 is the fraction of the variation in inside debt explained by age, net of its effect through the other explanatory variables. The Kleibergen–Paap (2006) *F*-statistic and Lagrange multiplier (LM)-statistic are heteroskedasticity-robust tests for weak identification and underidentification problems, respectively. Panel B reports the results from the second-stage regressions of stock market losses, total volatility, VaR, ES, and CoVaR, all calculated from July 2007 to Mar. 2009 and regressed against inside debt and the control variables from the main regressions, with inside debt as the endogenous variable. *p*-values (2-tailed except for the variable of interest, in italics) are reported in parentheses and based on standard errors adjusted for heteroskedasticity. * and ** indicate significance at the 5% and 1% levels, respectively.

Panel A. First-Stage Results

Variables	CEO	CFO
EXECUTIVE_AGE	0.082**	0.057**
	(0.000)	(0.001)
All variables from main regressions	Yes	Yes
No. of obs.	284	226
Adj. R^2	0.270	0.239
Partial R^2	0.079	0.045
Kleibergen–Paap *F*-statistic (H_0: weakly identified)	20.16	12.43
Kleibergen–Paap LM-statistic (H_0: underidentified)	19.46	11.08
	(0.000)	(0.000)

Panel B. Second-Stage Results

	STOCK_MARKET_LOSSES		TOTAL_VOLATILITY		VaR		ES		CoVaR	
Variables	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO	CEO	CFO
ln(INSIDE_DEBT_RATIO)	–4.047	–9.467*	0.058	–0.418	–0.058	–0.639	0.145	–0.867	–0.162	–0.628
	(0.078)	(0.033)	(0.393)	(0.133)	(0.407)	(0.090)	(0.368)	(0.134)	(0.405)	(0.272)
EQUITY_VEGA	1.345	3.127	–0.077	0.109	–0.026	0.243	–0.120	0.379	–0.068	0.341
	(0.242)	(0.148)	(0.410)	(0.434)	(0.830)	(0.188)	(0.559)	(0.239)	(0.809)	(0.434)
EQUITY_DELTA	–2.004**	–1.124	–0.136**	–0.054	–0.168**	–0.051	–0.264**	–0.095	–0.527**	–0.308
	(0.003)	(0.207)	(0.003)	(0.297)	(0.003)	(0.461)	(0.006)	(0.364)	(0.001)	(0.050)
ln(TOTAL_ANNUAL_COMPENSATION)	12.664**	5.725	0.487**	0.237	0.706**	0.658*	1.115**	0.994	1.036	0.638
	(0.000)	(0.244)	(0.009)	(0.481)	(0.004)	(0.040)	(0.007)	(0.170)	(0.094)	(0.427)
ln(EQUITY_MARKET_VALUE)	–6.259**	–2.986	–0.089	–0.052	–0.232	–0.304	–0.153	–0.240	0.998*	1.112*
	(0.001)	(0.303)	(0.537)	(0.818)	(0.206)	(0.186)	(0.617)	(0.598)	(0.018)	(0.043)
MARKET-TO-BOOK_RATIO	0.469	–0.109	0.090	0.173	0.148	0.260	0.148	0.316	0.138	0.381
	(0.860)	(0.976)	(0.546)	(0.408)	(0.467)	(0.296)	(0.656)	(0.419)	(0.786)	(0.550)
RETURN_ON_ASSETS	4.494*	7.598**	–0.014	0.152	0.312	0.536*	0.258	0.547	–0.390	–0.190
	(0.038)	(0.002)	(0.947)	(0.439)	(0.215)	(0.019)	(0.560)	(0.185)	(0.501)	(0.732)
MARKET_LEVERAGE	1.382**	0.512	0.137**	0.053	0.177**	0.075	0.342**	0.157	0.177	0.084
	(0.010)	(0.554)	(0.000)	(0.395)	(0.000)	(0.349)	(0.000)	(0.229)	(0.137)	(0.627)
DEPOSITORY_BANK (0/1)	17.120*	24.989*	–0.502	0.025	0.965	1.643*	0.146	1.325	2.048	1.905
	(0.031)	(0.017)	(0.542)	(0.976)	(0.243)	(0.025)	(0.929)	(0.398)	(0.477)	(0.487)
Intercept	–219.144**	–91.539	–11.487**	–3.062	–16.864**	–9.450	–31.370**	–17.186	–19.688	–9.169
	(0.000)	(0.308)	(0.003)	(0.660)	(0.001)	(0.250)	(0.000)	(0.234)	(0.061)	(0.616)
No. of obs.	284	226	284	226	284	226	284	226	284	226

shows that, despite the relatively small sample size, the impact of inside debt on volatility, VaR, and ES is predominantly significant around conventional levels for CFOs ($p < 0.14$), but not for CEOs ($p < 0.41$). This holds to a lesser extent for the impact of inside debt on buy-and-hold returns for CEOs ($p < 0.08$) and CFOs ($p < 0.03$). The Internet Appendix shows that once collinear variables are removed, the impact of inside debt on stock market losses, volatility, VaR, and ES is significant at conventional levels for CFOs ($p < 0.10$), but again not for CEOs ($p < 0.48$). This difference in coefficients between CEOs and CFOs is

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noteworthy: If some omitted variable is responsible for the results in Panel B even after instrumenting inside debt, then it must affect CEOs' and CFOs' incentives in different ways to produce these different results. Although it is difficult to rule out all omitted variables, the difference in coefficients alleviates concerns about many of them. For instance, a more stable business environment is unlikely to affect compensation to CFOs but not compensation to CEOs.

Although most coefficients in Panel B of Table 5 have the expected signs and significance levels, the 2SLS-estimated coefficients on CFO inside debt are insignificant for CoVaR ($p < 0.27$ in the main text and the Internet Appendix). For that reason, even though the high p-values may reflect the innately less precise 2SLS estimator rather than a spurious, endogenously driven effect of inside debt, I interpret the result on CoVaR with more care. Nevertheless, the evidence presented in Table 5 is in line with the evidence presented earlier and increases confidence in the validity of the main results.

B. CEOs and CFOs With and Without Inside Debt

Finally, one may be concerned that pension benefits and deferred compensation are not always awarded: Panel B of Table 1 indicates that within the 319 banks that have nonzero inside debt, around 20% and 40% of the CEOs and CFOs do not receive any accumulated pension benefits or NQDC, respectively.[18] These observations might introduce a sample selection bias in favor of the main hypotheses if the omissions are nonrandom in some way.

Simply replacing the missing values with zeros would censor the inside debt variable and generate new statistical bias in favor of the main hypotheses (e.g., Rigobon and Stoker (2009)). In addition, statistical procedures that address selection bias do so for selection in outcome variables rather than explanatory variables (e.g., Tobin (1958), Heckman (1979), or the partial identification methods in Manski (1990)). Therefore, to alleviate concerns about the observations that have no valid k-ratio, I create a between-groups "treatment" indicator variable that equals 1 if *any* inside debt is held by a CEO or CFO and 0 otherwise, and use this instead of the k-ratio to estimate equation (2) on the full sample of banks with and without inside debt. This substantially increases the sample size from 319 banks to 422 banks: 24% of the banks do not award any inside debt to the CEO or CFO. Because at least some of the inside debt that an executive builds up from NQDC is discretionary, it could be that the NQDC part of inside debt depends on the executive's view of future default risk. Therefore, I also create an indicator variable for whether CEOs and CFOs hold any pensions because there is less discretion for accumulating pensions than for annually awarding NQDC.

Table 6 presents results after rerunning the main regressions on the extended sample. Panels A–D present results that are in line with the main claim of the

[18] Closer inspection of these observations reveals that CEOs and CFOs without inside debt do not have equity holdings, debt holdings, or both, because they i) have joined the company within or around the 2006 fiscal year and had not been granted inside debt or equity yet; ii) have resigned or were about to resign within or around the 2006 fiscal year, and their equity was forfeited or accelerated in vesting; or iii) did not have outstanding inside debt or equity because the bank has not granted any in a long time or has never granted inside debt or equity.

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TABLE 6

Additional Evidence from CEOs and CFOs With and Without Inside Debt Holdings

Table 6 presents results of robust regression analysis of stock market losses, volatility, VaR, ES, and CoVaR, regressed against inside debt and all control variables from the main regressions. The previously used inside debt measure is replaced by indicator variables. In Panels A and C, the indicator is equal to 1 if positive inside debt holdings are reported in the proxy statements, and 0 otherwise. In Panels B and D, the indicator is equal to 1 if positive accumulated pensions are reported in the proxy statements, and 0 otherwise. All other variables are as defined previously. 1-tailed *p*-values are reported in parentheses and based on standard errors adjusted for heteroskedasticity. * and ** indicate significance at the 5% and 1% levels, respectively.

	STOCK_MARKET_LOSSES	VOLATILITY	VaR	ES	CoVaR
Panel A. CEOs With and Without Inside Debt					
CEO_WITH_INSIDE_DEBT (0/1)	−8.632**	−0.757**	−0.937**	−1.602**	−1.904**
	(0.007)	(0.003)	(0.004)	(0.002)	(0.004)
Variables from main regressions	Yes	Yes	Yes	Yes	Yes
No. of obs.	429	429	429	429	429
Adj. R^2	0.098	0.124	0.134	0.130	0.175
Panel B. CEOs With and Without Pensions					
CEO_WITH_PENSION (0/1)	−9.541**	−0.441*	−0.605*	−0.919*	−1.517*
	(0.001)	(0.028)	(0.023)	(0.028)	(0.011)
Variables from main regressions	Yes	Yes	Yes	Yes	Yes
No. of obs.	429	429	429	429	429
Adj. R^2	0.105	0.112	0.125	0.118	0.172
Panel C. CFOs With and Without Inside Debt					
CFO_WITH_INSIDE_DEBT (0/1)	−7.987**	−0.528**	−0.738**	−1.240**	−1.160*
	(0.006)	(0.009)	(0.005)	(0.004)	(0.038)
Variables from main regressions	Yes	Yes	Yes	Yes	Yes
No. of obs.	423	423	423	423	423
Adj. R^2	0.082	0.088	0.113	0.117	0.187
Panel D. CFOs With and Without Pensions					
CFO_WITH_PENSION (0/1)	−9.738**	−0.504**	−0.741**	−1.146**	−1.325*
	(0.001)	(0.010)	(0.004)	(0.006)	(0.022)
Variables from main regressions	Yes	Yes	Yes	Yes	Yes
No. of obs.	423	423	423	423	423
Adj. R^2	0.091	0.086	0.111	0.114	0.185

paper and relieve concerns about sample selection issues. Even though important information is lost by dichotomizing, holding any CEO or CFO inside debt is negatively and significantly associated with the various measures for bank risk. Results are similar for CEOs and CFOs with or without any accumulated pensions, which alleviates concerns that the inside debt measures reflect the CEO's, CFO's, or bank's view of default risk. Hence, the negative link between inside debt and bank risk extends to a sample of CEOs and CFOs with and without inside debt.

VI. Conclusion

In order to discourage risk-taking behavior fueled by executive compensation, legislators amended the Securities Exchange Act of 1934 to address moral hazard between managers and shareholders. This presumes that the monitoring of risk will be more effective once more power is assigned to shareholders.

This paper examines incentives that address the debtholder rather than the shareholder agency problem. It discusses how bank risk is affected by awarding

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executives with debt-based executive pay, which consists of defined benefit pensions and deferred compensation (inside debt). Using a sample of CEOs and CFOs in small and large U.S.-listed banks, the results in this paper demonstrate that higher inside debt holdings are associated with systematically less bank risk during the crisis. In addition, inside debt holdings are negatively correlated to several bank-specific risk-taking channels. This suggests that inside debt limits bank losses incurred in crisis times by encouraging more conservative decision making.

The results have clear implications for the evaluation of current regulatory reforms and the broader public policy issue of how to limit the risks surrounding financial institutions. For example, the documented link between inside debt and bank risk suggests that creditors are more inclined to monitor bank risk than shareholders. As a consequence, the strengthening of shareholder governance that is now implemented in many countries may not necessarily be the most effective tool for limiting risk.

Appendix. Sample Selection

Table A1 shows that of the 319 banks that enter the final sample in July 2007, only 264 still exist when the sample ends in Mar. 2009. Hence, survivorship bias is a potential problem in the sample.

TABLE A1

Attrition of Banks Included in Sample

The main sample includes 319 lending institutions in fiscal year 2006. "Merged or acquired" signifies that the institution left the sample due to an acquisition or merger during the sample period, and "Delisted by exchange" signifies a delisting of the institution due to a violation of listing requirements or bankruptcy. "Remaining in sample" signifies that the institution is still listed on a major U.S. exchange by Mar. 2009.

	With Inside Debt	
	Frequency	Percentage
Merged or acquired	23	7.21
Delisted by exchange	32	10.03
Remaining in sample	264	82.76
Total	319	100.00

References

Acharya, V.; T. Philippon; M. Richardson; and N. Roubini. "The Financial Crisis of 2007–2009: Causes and Remedies." In *Restoring Financial Stability: How to Repair a Failed System*, V. Acharya and M. Richardson, eds. Hoboken, NJ: John Wiley & Sons (2009).

Adrian, T., and H. Shin. "Liquidity and Leverage." *Journal of Financial Intermediation*, 19 (2010), 418–437.

Aggarwal, R., and A. Samwick. "Performance Incentives within Firms: The Effect of Managerial Responsibility." *Journal of Finance*, 58 (2003), 1613–1649.

Altman, E. "Predicting Financial Distress of Companies: Revisiting the Z-Score and ZETA Models." Working Paper, New York University (2000).

Ameriks, J., and S. P. Zeldes. "How Do Household Portfolio Shares Vary with Age?" Working Paper, Columbia University (2004).

Anantharaman, D.; V. Fang; and G. Gong. "Inside Debt and the Design of Corporate Debt Contracts." *Management Science*, 60 (2014), 1260–1280.

Anantharaman, D., and Y. G. Lee. "Managerial Risk Taking Incentives and Corporate Pension Policy." *Journal of Financial Economics*, 111 (2014), 328–351.

https://doi.org/10.1017/S0022109016000168 Published online by Cambridge University Press

Angrist, J. D., and J.-S. Pischke. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press (2008).
Artzner, P.; F. Delbaen; J. Eber; and D. Heath. "Coherent Measures of Risk." *Mathematical Finance*, 9 (1999), 203–228.
Balachandran, S.; B. Kogut; and H. Harnal. "The Probability of Default, Excessive Risk, and Executive Compensation: A Study of Financial Services Firms from 1995 to 2008." Working Paper, Columbia University (2010).
Bali, T.; K. Demirtas; and H. Levy. "Is There an Intertemporal Relation between Downside Risk and Expected Returns?" *Journal of Financial and Quantitative Analysis*, 44 (2009), 883–909.
Bebchuk, L.; J. Fried; and D. Walker. "Managerial Power and Rent Extraction in the Design of Executive Compensation." *University of Chicago Law Review*, 69 (2002), 751–846.
Bebchuk, L., and H. Spamann. "Regulating Bankers' Pay." *Georgetown Law Journal*, 98 (2010), 247–287.
Beltratti, A., and R. Stulz. "The Credit Crisis around the Globe: Why Did Some Banks Perform Better?" *Journal of Financial Economics*, 105 (2012), 1–17.
Bennett, R.; L. Güntay; and H. Unal. "Inside Debt, Bank Default Risk, and Performance during the Crisis." *Journal of Financial Intermediation*, 24 (2015), 487–513.
Berger, A. N.; T. Kick; and K. Schaeck. "Executive Board Composition and Bank Risk Taking." *Journal of Corporate Finance*, 28 (2014), 48–65.
Billett, M. T., and Y. Qian. "Are Overconfident CEOs Born or Made? Evidence of Self-Attribution Bias from Frequent Acquirers." *Management Science*, 54 (2008), 1037–1051.
Black, F., and M. Scholes. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy*, 81 (1973), 637–654.
Bolton, P.; H. Mehran; and J. Shapiro. "Executive Compensation and Risk Taking." *Review of Finance*, 19 (2015), 2139–2181.
Brunnermeier, M. "Deciphering the Liquidity and Credit Crunch 2007–2008." *Journal of Economic Perspectives*, 23 (2009), 77–100.
Brunnermeier, M., and T. Adrian. "CoVaR." Working Paper, Federal Reserve Bank of New York (2009).
Brunnermeier, M., and L. Pedersen. "Market Liquidity and Funding Liquidity." *Review of Financial Studies*, 22 (2008), 2201–2238.
Carpenter, J.; T. Cooley; and I. Walter. "Reforming Compensation and Corporate Governance." In *Regulating Wall Street: The New Architecture of Global Finance,* V. V. Acharya, T. F. Cooley, M. P. Richardson, and I. Walter, eds. Hoboken, NJ: John Wiley & Sons (2011).
Cassell, C.; S. Huang; J. Sanchez; and M. Stuart. "Seeking Safety: The Relation between CEO Inside Debt Holdings and the Riskiness of Firm Investment and Financial Policies." *Journal of Financial Economics*, 103 (2012), 588–610.
Chava, S.; P. Kumar; and A. Warga. "Managerial Agency and Bond Covenants." *Review of Financial Studies*, 23 (2010), 1120–1148.
Chava, S., and A. Purnanandam. "CEOs versus CFOs: Incentives and Corporate Policies." *Journal of Financial Economics*, 97 (2010), 263–278.
Chen, F.; Y. Dou; and X. Wang. "Executive Inside Debt Holdings and Creditors' Demand for Pricing and Non-Pricing Protections." Working Paper, Chinese University of Hong Kong (2010).
Cheng, I.; H. Hong; and J. Scheinkman. "Yesterday's Heroes: Compensation and Creative Risk-Taking." Working Paper, Princeton University (2012).
Chesney, M.; J. Stromberg; and A. F. Wagner. "Managerial Incentives to Take Asset Risk." Working Paper, Swiss Finance Institute–University of Zurich (2012).
Coles, J.; N. Daniel; and L. Naveen. "Managerial Incentives and Risk-Taking." *Journal of Financial Economics*, 79 (2006), 431–468.
DeYoung, R.; E. Y. Peng; and M. Yan. "Executive Compensation and Business Policy Choices at U.S. Commercial Banks." *Journal of Financial and Quantitative Analysis*, 48 (2013), 165–196.
DeYoung, R., and K. P. Roland. "Product Mix and Earnings Volatility at Commercial Banks: Evidence from a Degree of Total Leverage Model." *Journal of Financial Intermediation*, 10 (2001), 54–84.
Doukas, J. A., and D. Petmezas. "Acquisitions, Overconfident Managers and Self-Attribution Bias." *European Financial Management*, 13 (2007), 531–577.
Edmans, A., and X. Gabaix. "The Effect of Risk on the CEO Market." *Review of Financial Studies*, 24 (2011), 2822–2863.
Edmans, A., and Q. Liu. "Inside Debt." *Review of Finance*, 15 (2011), 75–102.
Fahlenbrach, R.; R. Prilmeier; and R. Stulz. "This Time Is the Same: Using Bank Performance in 1998 to Explain Bank Performance during the Recent Financial Crisis." *Journal of Finance*, 67 (2012), 2139–2185.
Fahlenbrach, R., and R. Stulz. "Bank CEO Incentives and the Credit Crisis." *Journal of Financial Economics*, 99 (2011), 11–26.

https://doi.org/10.1017/S0022109016000168 Published online by Cambridge University Press

Fama, E. F., and K. R. French. "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics*, 33 (1993), 3–56.
Forbes, D. P. "Are Some Entrepreneurs More Overconfident Than Others?" *Journal of Business Venturing*, 20 (2005), 623–640.
Fostel, A., and J. Geanakoplos. "Leverage Cycles and the Anxious Economy." *American Economic Review*, 98 (2008), 1211–1244.
Gabaix, X., and A. Landier. "Why Has CEO Pay Increased So Much?" *Quarterly Journal of Economics*, 123 (2008), 49–100.
Graham, J. R.; C. R. Harvey; and M. Puri. "Managerial Attitudes and Corporate Actions." *Journal of Financial Economics*, 109 (2013), 103–121.
Guay, W. "The Sensitivity of CEO Wealth to Equity Risk: An Analysis of the Magnitude and Determinants." *Journal of Financial Economics*, 53 (1999), 43–72.
Guldimann, T.; P. Zangari; J. Longerstaey; J. Matero; and S. Howard. *RiskMetrics Technical Document*. New York, NY: JP Morgan (1994).
He, Z.; I. Khang; and A. Krishnamurthy. "Balance Sheet Adjustments in the 2008 Crisis." Working Paper, University of Chicago (2010).
Heckman, J. "Sample Selection Bias as a Specification Error." *Econometrica*, 47 (1979), 153–161.
Jensen, M., and W. Meckling. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics*, 3 (1976), 305–360.
Jensen, M., and K. Murphy. "Performance Pay and Top-Management Incentives." *Journal of Political Economy*, 98 (1990), 225–264.
Jin, L. "CEO Compensation, Diversification, and Incentives." *Journal of Financial Economics*, 66 (2002), 29–63.
John, K.; A. Saunders; and L. Senbet. "A Theory of Bank Regulation and Management Compensation." *Review of Financial Studies*, 13 (2000), 95–125.
Kashyap, A.; R. Rajan; and J. Stein. "Rethinking Capital Regulation." In *Symposium on Maintaining Stability in a Changing Financial System,* Federal Reserve Bank of Kansas City (2008).
Kleibergen, F., and R. Paap. "Generalized Reduced Rank Tests Using the Singular Value Decomposition." *Journal of Econometrics*, 133 (2006), 97–126.
Kovalchik, S.; C. F. Camerer; D. M. Grether; C. R. Plott; and J. M. Allman. "Aging and Decision Making: A Comparison between Neurologically Healthy Elderly and Young Individuals." *Journal of Economic Behavior and Organization*, 58 (2005), 79–94.
Lambert, R. A., and D. F. Larcker. "An Analysis of the Use of Accounting and Market Measures of Performance in Executive Compensation Contracts." *Journal of Accounting Research*, 25 (1987), 85–125.
Liu, Y.; D. Mauer; and Y. Zhang. "Merger Decisions and Inside Debt." Working Paper, Texas A&M University (2012).
Manski, C. "Nonparametric Bounds on Treatment Effects." *American Economic Review*, 80 (1990), 319–323.
Prendergast, C. "The Tenuous Trade-Off between Risk and Incentives." *Journal of Political Economy*, 110 (2002), 1071–1102.
Rigobon, R., and T. Stoker. "Bias from Censored Regressors." *Journal of Business and Economic Statistics*, 27 (2009), 340–353.
Shleifer, A., and R. Vishny. "Liquidation Values and Debt Capacity: A Market Equilibrium Approach." *Journal of Finance*, 47 (1992), 1343–1366.
Sundaram, R. K., and D. Yermack. "Pay Me Later: Inside Debt and Its Role in Managerial Compensation." *Journal of Finance*, 62 (2007), 1551–1588.
Taylor, R. N. "Age and Experience as Determinants of Managerial Information Processing and Decision Making Performance." *Academy of Management Journal*, 18 (1975), 74–81.
Tobin, J. "Estimation of Relationships for Limited Dependent Variables." *Econometrica*, 26 (1958), 24–36.
Tung, F., and X. Wang. "Bank CEOs, Inside Debt Compensation, and the Global Financial Crisis." Working Paper, Boston University (2010).
Wang, C.; F. Xie; and X. Xin. "Managerial Ownership of Debt and Bank Loan Contracting." Working Paper, Chinese University of Hong Kong (2010).
Wei, C., and D. Yermack. "Investor Reactions to CEOs' Inside Debt Incentives." *Review of Financial Studies*, 24 (2011), 3813–3840.
Yim, S. "The Acquisitiveness of Youth: CEO Age and Acquisition Behavior." *Journal of Financial Economics*, 108 (2013), 250–273.

https://doi.org/10.1017/S0022109016000168 Published online by Cambridge University Press