A Quantitative Model of Executive Compensation Regulations in US Banking Sector*

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Abstract

Using a novel dataset on U.S. bank executives, reduced-form analysis finds that pre-crisis CEO cash bonus incentive ratio and unexercisable stock options contributed to poor performance and failures during the Global Financial Crisis (GFC), with cash bonuses having a greater impact. Through an estimated dynamic financing model of heterogeneous banks and managers, I explain why cash bonuses, though smaller than shareholdings, provide strong incentives for systemic risk-taking. Counterfactual simulations suggest that capping cash bonuses significantly curtails risk-taking and loan supply, while deferring compensation or banning stock options yields only modest effects.

Keywords: Bonus Cap; Deferred Compensation, Bank Executives, Structural Estimation
JEL Classification: G21, G32, J33, M12

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Criticism intensified following the 2007–2009 Global Financial Crisis (GFC), alleging that Chief Executive Officer (CEO) compensation encourages excessive risk-taking in the U.S. banking industry.[1] More recently, the 2023 bank failures underscore the importance of senior management incentives. According to Bank for International Settlements (2023), Silicon Valley Bank's management focused on short-term profits, incentivized by remuneration policies that overlooked sound risk management. In response to these events, U.S. policymakers revise policy proposals, including the Dodd-Frank Wall Street Reform Act (July 2010), which suggests clawbacks of executive compensation.[2] The direct control of CEO incentives via such measures remains unadopted in the United States. Conversely, the European Union (EU) introduced bonus caps in 2014, limiting bankers' cash bonuses to either their base pay or twice that amount; this regulation remains effective as of 2024. Nevertheless, evidence supporting the entrenchment perspective is limited, casting doubt on the efficacy of these compensation regulations. The U.K., for instance, implemented a bonus cap in 2014 but discontinued the decade-old restriction in 2024.

I investigate the extent to which bank CEO compensation regulations—such as imposing bonus caps, switching to deferrals of cash bonuses, incorporating equity- and debt-based compensation, banning options, and adding contingent pays—alter bank risk-taking and lending, as well as the quantitative significance of these effects. The novelty of this paper's approach is twofold. First, I construct a comprehensive dataset on CEO compensation contracts and financial performance in the U.S. banking sector. Unlike prior studies that focus on large banks included in the S&P 1500, my dataset encompasses a broader range of U.S. banks, including small and medium-sized banks (SMBs). Second, I structurally estimate a dynamic financing model of heterogeneous banks and managers.

The counterfactual analysis of bank CEO compensation yields the result: capping bonuses at salary level and deferring bonuses could have reduced annual failure rates by 28 basis points during the GFC, while curbing lending by 60 basis points. To reach this conclusion, I employ two complementary approaches. The first is a reduced-form analysis, which offers transparency through its linear specification and closed-form representation, though it is limited in extending policy implications to counterfactuals and struggles with endogenous relationships, particularly regarding systemic risk-taking and inter-temporal financing decisions. The second approach employs a structurally estimated dynamic financing model, enabling the testing of a larger set of counterfactuals, such as adopting deferred compensation, bonus caps, and stock option bans. A quantitative model is essential because counterfactual policies, like capped cash bonuses below base salary, depend on the endogenous salary, increasing in bank size. Even though reduced-form analysis is often described as a flexible approach, certain assumptions are crucial for drawing policy implications. For example, the literature frequently uses Vega in option pricing to quantify risk-taking incentives

[1] Key opinions from policymakers are provided in the Appendix A.1.

[2] The Dodd-Frank Act is a comprehensive package of financial regulations aimed at preventing a recurrence of the financial crisis. Three proposals for incentive-based compensation arrangements were published in 2010, 2016, and 2024. The 2024 proposal, currently under review, reintroduces and seeks feedback on the regulatory text previously proposed in 2016, with certain modifications. After revisions of this proposal, the new compensation regulations are aimed to reduce excessive compensation for preventing material financial loss.

(e.g., Fahlenbrach and Stulz (2011)). However, Vega—the option's sensitivity to changes in the underlying stock's volatility—is derived under the assumptions of the Black–Scholes option-pricing model. First, the option pricing model does not explicitly address systemic risk-taking. Second, the model assumes fixed investment, which does not align with the theoretical understanding that bank size is heterogeneous and evolves dynamically. A dynamic financing model with heterogeneous banks and managers addresses these issues.

In my paper, both the reduced-form analysis and the dynamic financing model demonstrate that cash bonuses generate substantial incentives for systemic risk-taking—an outcome that may appear counterintuitive in light of certain empirical facts. Why, then, does the academic literature largely overlook restrictions on flow pay, such as cash bonuses?[3] Cash bonuses are an order of magnitude smaller than salaries and shareholdings. On average, the cash bonus-to-salary ratio is 0.4, while the share value-to-total compensation (salary plus cash bonuses) ratio is 8. Four critical points are missing in previous arguments. (i) Cash bonuses vary substantially across banks along both the extensive and intensive margins: roughly one-fifth of banks did not pay bonuses in 2006, while 8% of CEOs at small and medium-sized banks and 39% of CEOs at large banks (e.g., those listed in the S&P 1500) received cash bonuses exceeding their base salaries. (ii) Pay level and pay sensitivity are distinct concepts. Cash bonus incentive ratio—the degree to which cash bonuses are tied to bank revenue—varies widely among banks that do pay bonuses. (iii) Cash bonuses are paid on a per-period basis, whereas share values reflect multi-period discounted cash flows, making direct comparisons inappropriate. (iv) The estimated coefficient on the one-year lag of cash bonus incentive ratio in a fixed-effects dynamic panel regression is 0.6, indicating strong persistence. This persistence suggests that high risk-taking incentives remain elevated over time. I build a dynamic model replicates these real-data relationships and provide an economic rationale for the significance of cash bonuses. Together, these points highlight the model's focus on both heterogeneity and inter-temporal decisions affecting CEO payouts. Before discussing the model's mechanism, I summarize empirical evidence from reduced-form regressions.

Unlike prior studies that found no effect of cash bonuses, this paper provides the first evidence using a broad sample that cash bonuses can foster systemic risk-taking. Initially, I apply cross-sectional regressions to examine the relationship between bank CEO compensation structure and bank performance. Contrary to widespread beliefs among policymakers that managerial entrenchment leads to excessive risk-taking, empirical research (Bebchuk and Spamann (2009); Fahlenbrach and Stulz (2011)) finds a little or no evidence linking poor bank performance during the financial crisis to CEO compensation. My paper constructs a comprehensive dataset consisting exclusively of commercial banks, in contrast to Fahlenbrach and Stulz (2011) (hereafter, FS (2011)), who pool various types of financial institutions. This focus allows me to control for institutional heterogeneity across the financial sector and draw sharper inferences about commercial bank behavior. Moreover, expanding the dataset provides informative variations into the intensive margin of cash bonus. The main specification is a cross-sectional regression of Return On Assets (ROA) during the crisis on the structure of bank CEO compensation in the pre-crisis period. I argue that cash

[3] A similar question arises in the context of managerial conflicts in non-financial firms, as discussed in Edmans et al. (2023).

bonuses and unexercisable stock options contribute to excessive risk-taking by banks, reflected in low ROA during the GFC. Consistently, I observe higher likelihood of bank failure for higher cash bonus incentive ratio and unexercisable stock options. My findings remain robust even after addressing potential endogeneity bias. This bias, as Cheng et al. (2015) suggests, implies that riskier firms might offer higher total pay to compensate for additional equity risk. With recognizing that compensation structures and bank performance may be jointly determined, I employ a modified control function regression method (Klein and Vella (2010); Armstrong et al. (2022)). In this method, the presence of heteroskedasticity achieves identification. While correcting endogenous biases, the results are unchanged both qualitatively and quantitatively. Since cash bonuses and unexercised stock options are shown to contribute to poor bank performance, restricting these compensation forms could naturally enhance stability.

While the reduced-form analysis provides empirical evidence of a relationship between CEO compensation and risk-taking, it cannot assess how compensation regulations affect bank stability in the crises and lending in the long-run. For example, Armstrong et al. (2022) does not study regulatory counterfactuals or compare the magnitude with other types of regulations, which are the central contributions of my paper. Put differently, the question is how much lending policymakers are willing to forego to mitigate the risk of bank failures, which occur rarely but can have severe consequences during banking crises. I document several banking facts that interact with managerial compensation and bank financial decisions. The data reveal that salary, the largest average flow of pay, exhibits decreasing returns to scale relative to bank size.[4] Effective risk aversion arises from banks' exposure to volatile insured deposit flows, coupled with the high cost of raising equity and the need to comply with capital regulations. These constraints make deposits and equity imperfect substitutes. Bank CEO builds up equity as a buffer against volatile deposit flows. The model treats volatile insured deposit flows as exogenous Markov process and endogenously generates the bank equity distribution. There are several assumptions I made in the dynamic model. First, the manager, who is the bank's CEO, exercises primary control over financial decision-making. Second, the manager faces a trade-off between short-term gains from higher risk-taking and long-term costs associated with a greater probability of failure. Third, the manager's compensation is suboptimal due to exogenous factors.

I develop a fully dynamic quantitative model of bank financing that incorporates capital requirements, deposit insurance, endogenous systemic risk-taking and leverage, and a bank CEO's incentive contract—providing a framework suitable for evaluating compensation regulations. Most importantly, standard quantitative dynamic financing models in banking sector (e.g., Van den Heuvel (2008); Begenau (2020); Bolton et al. (2020); Corbae and D'Erasmo (2021); Elenev et al. (2021); Begenau and Landvoigt (2022); Wang et al. (2022)) overlook the monetary incentives of bank CEOs, assuming instead that self-interested managers are compensated exclusively through shareholdings. However, this assumption is inconsistent with the real-data. The quantitative dynamic financing model proposed in this paper in-

[4]The cross-sectional relationship between salary and non-financial firm size, known as "Roberts's law," is well established. I identify a distinct pattern in the banking industry that is crucial for explaining why bank CEOs tend to be risk-averse, effectively. Unlike in non-financial firms, the data supports the fact that temporary variations in salary changes are explained by bank size.

tegrates CEOs' pecuniary interests and validates key patterns in the cross-sectional and time-series variations observed in the U.S. banking sector. The simulated data based on the structurally estimated dynamic financing model aligns well with real-world data on both compensation structures and bank financials. Specifically, the dynamic model simulated-(real-) data an average bonus-to-salary ratio of 0.41 (0.40), a mean share value-to-salary ratio of 8.22 (8.04), and the mean of equity payout-to-salary and bonus is 0.36 (0.30). After validating the model's performance in depth, I conduct a counterfactual analysis by adjusting compensation contracts to evaluate their impact on risk-taking and lending.

The results from the dynamic model indicate that higher managerial shareholdings increase systemic risk-taking, leading to more bank failures during crises and a reduction in long-run lending. This mechanism arises in a dynamic setting without relying on the traditional risk-shifting channel characterized by convex equity payoffs and mean-preserving spreads. As shareholdings increase, managers optimally reduce retained earnings, thereby limiting the bank's equity capacity to support lending. Lower equity reduces the marginal continuation value while heightening the incentive to take risks. Moreover, the relative value of salary declines compared to the CEO's equity stake, weakening its role as a counterbalance to risk-taking incentives. Consequently, larger shareholdings strengthen managers' incentives to increase dividend payouts, encouraging riskier strategies that yield higher short-term returns.

Afterward, I evaluate several counterfactual policy scenarios, including: (i) deferred bonuses under Section 956 of the Dodd-Frank Act, modeling both full (100%) and partial (50%) deferral schemes; (ii) the EU bonus cap, which imposes a cap on bonuses and incorporates a 50% deferral requirement; (iii) debt-based compensation (Bebchuk and Spamann (2009)), and (iv) an option ban. Each scenario is assessed relative to the existing compensation plan as a benchmark.[5,6] These compensation regulations could affect financial stability and intermediation. The dynamic financing model shows that deferred bonuses, bonus caps, contingent debt, and option bans reduce bank failures, although the magnitude of the effect varies by regulatory type. Capping bonuses significantly reduces bank failure rates but also curtails lending and lowers bank value.

Roadmap. The remainder of the paper is organized as follows. Section 1 provides literature overview. Section 2 explains sample construction. In Section 3, I provide reduced-form evidence. Section 4 introduces the estimated model and provides counterfactual experiments. Section 5 concludes.

[5]There is a wider variety of debt-based compensation proposed in the literature, including subordinated debt compensation (Tung (2011)) and convertible equity compensation (Gordon (2010)) However, these forms of compensation are not examined in this paper.

[6]Relating to the option ban, Hayes et al. (2012); Shue and Townsend (2017) find a causal relationship between option-based compensation and risk-taking using the exogenous change of the revised accounting standard as an instrument.

1 Literature Overview

My paper builds on the empirical literature examining bank risk-taking and CEO compensation components. The closest related paper in reduced-form analysis is FS (2011). FS (2011) use a dataset in which only 20 S&P banks paid CEO bonuses in 2006, and only four banks filed for bankruptcy between July 2006 and December 2010, limiting variation in both compensation structures and bank failures. The small sample size constrains estimates of both intensive margin effects (changes in cash bonus size) and extensive margin effects (the presence or absence of cash bonuses), both of which are crucial during crises. My study addresses this limitation by incorporating a broader dataset that includes both cash bonus-paying and non-cash-bonus-paying banks. As a result—perhaps unexpectedly—the banking literature provides little to no evidence linking cash bonuses to risk-taking, contrary to prevailing policy discussions. Nevertheless, the corporate finance literature suggests that such a link should not be dismissed. Guay et al. (2019) argue that cash bonus plans in non-financial firms exhibit performance sensitivity to earnings-based metrics that is approximately ten times larger than previously estimated using equity-based sensitivity measures. Building on their insights, I adopt a simple measure of cash bonus incentive ratio—the ratio of cash bonuses to revenue—for reduced-form analysis and apply the same measure to a structurally estimated dynamic financing model, allowing sensitivity to change over time with persistence. Besides cash bonuses, a substantial body of research in banking examines a positive relationship between risk-taking and ownership structure (Saunders et al. (1990); Laeven and Levine (2009); Berger et al. (2016)), Vega of option value (Bai and Elyasiani (2013); DeYoung et al. (2013); Armstrong et al. (2022)), and inside-debt (Bennett et al. (2015); Van Bekkum (2016)).

To the best of my knowledge, no existing research structurally estimates a dynamic financing model in banking that incorporates a detailed compensation structure. Therefore, my paper contributes to the methodological literature. One of the closest models in corporate finance is Glover and Levine (2017), but my framework departs from theirs in several key ways. First, I relax the assumption of constant returns-to-scale technology in revenue generation, allowing bank size to be endogenously determined. Empirically, I find a tight relationship in between bank size and CEO's salary. I model a trade-off of in between sizing up the bank at the expense of distributing dividends to shareholders. This is a novel channel that would not being modeled explicitly in the literature. Second, I recast the model to be fully dynamic, rather than assuming that the CEO retires annually and a new CEO takes over. The implied 100% turnover rate in their model is inconsistent with real-world data, where the average CEO tenure is approximately 10 years, corresponding to an annual turnover rate of 10%. Third, firms in my model face financial constraints and banking-specific frictions, such as capital requirements and insured deposits. Despite the importance of short-termism in shaping risk-taking incentives, structurally estimated dynamic models addressing this relationship remain largely unexplored in the banking literature.[7]

[7]Practitioners have highlighted the importance of short-termism in financial stability, yet only a few academic studies have examined this issue. The most closely related reduced-form study is Kolasinski and Yang (2018), which develops an equity-duration-based measure of short-termism and argues that short-termism was a root cause of the subprime crisis.

In terms of policy implications, John et al. (2000); Edmans and Liu (2011); Bolton et al. (2015) propose that interventions in bank executive compensation structures can influence financial stability. However, the effectiveness of such regulatory measures remains uncertain. My paper provides both theoretical and empirical evidence on the impact of compensation regulations.

2 Data

Both Sections 3 and 4, which present the reduced-form analysis and the dynamic model, rely on the same primary dataset on bank CEO compensation and bank financials, sourced from S&P Capital IQ. Because the full dataset is not available in a structured format on Wharton Research Data Services (WRDS), it was collected manually, including web-scrapping. Technical details on data construction using S&P Capital IQ are provided in Internet Appendix A.2. S&P Capital IQ compiles data from multiple sources. For publicly listed bank holding companies and stand-alone commercial banks, balance sheet and income statement information is extracted from annual reports (SEC Form 10-K), while CEO compensation data is obtained from proxy statements (SEC Form DEF 14A). Prices of bank equity listed on major U.S. exchanges—NYSE, NYSE Arca, NYSE American, and the NASDAQ markets—are obtained from S&P Capital IQ. For shares traded on over-the-counter (OTC) markets, including the Pink Sheets and the OTC Bulletin Board, S&P Capital IQ sources data from the Intercontinental Exchange (ICE). Board.[8]

I collect data for all companies classified under the Standard Industrial Classification (SIC) code 6020 (commercial banks) from S&P Capital IQ. The sample includes national, regional, and community banks, encompassing those traded on major U.S. stock exchanges as well as those traded on over-the-counter (OTC) markets. I narrow down the sample to a specific geographic region within the U.S. and exclude banks that do not report total assets or CEO salaries. The final sample includes 717 commercial banks as of year-end 2006. Summary statistics are presented in detail in Section 3.2. While many studies on bank CEO compensation rely on Execucomp, which is limited to banks listed on the S&P 1500, my novel dataset includes an additional 648 commercial banks, significantly increasing the sample size. To facilitate comparability, FS (2011) examine 95 financial institutions—including bank holding companies and investment banks (SIC codes 6000–6300)—for the year 2006. Because their sample includes non-bank financial firms, I construct a matched subsample consisting of the S&P 1500 commercial banks from my dataset that correspond to the firms listed in the appendix of FS (2011). I manually reconcile discrepancies in bank names to ensure an exact match. This process identifies 69 banks in my sample, which I refer to as S&P 1500 banks. The remaining 648 banks are categorized as small and medium-sized banks (SMBs), with their size distribution in 2006 measured by total assets, as shown in Appendix Figure A1. The size distribution reveals significant heterogeneity among banks not listed in the S&P 1500. For example, not every SMBs are smaller than S&P 1500 banks. This choice of including SMBs is motivated by two facts. Firstly, a comprehensive

[8]The OTC Bulletin Board and Pink Sheets require U.S. banks with non-SEC-registered securities to follow the disclosure guidelines outlined in the OTCQX Rules for U.S. Banks.

sample including both SMBs and S&P 1500 banks provides valuable insights for scholars and policymakers by illustrating the quantitative impact of executive compensation structures, as the conflicts between bank managers and shareholders are common across banks of all sizes. Secondly, SMBs encountered even greater challenges during the financial crisis than S&P 1500 banks. One piece of evidence shows that 113 SMBs still owed Troubled Asset Relief Program (TARP) money five years after the financial crisis, while most large banks had repaid TARP funds (Coles et al. (2006)).

3 Reduced-form Analysis

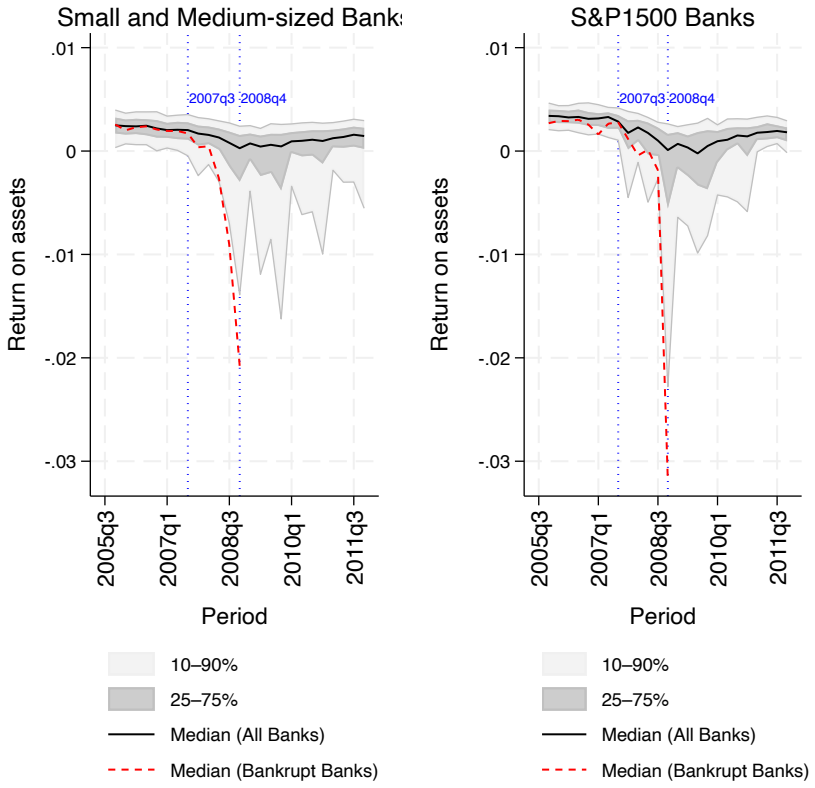
In Section 3.1, I present descriptive time-series plots of bank performance around the GFC, focusing on four risk-taking measures: bankruptcy, Return on Assets (ROA), Return on Equity (ROE), and buy-and-hold returns. Section 3.2 reports summary statistics on banks' financial characteristics and CEO compensation. These four measures serve as the dependent variables in the reduced-form analysis presented in Section 3.3.

3.1 Evolution of Bankruptcy and Accounting and Market Returns in the GFC

The years 2009 and 2010 mark the first and second peaks of bankruptcy in the aftermath of the GFC and around half of bankruptcies eventually resulted in Chapter 11 reorganization. Appendix Figure A5 illustrates the evolution of the numbers of bankruptcies in my final sample from 2000 to 2019. I construct a bankruptcy indicator equal to one for banks that filed for bankruptcy between July 2007 and December 2010, and zero otherwise, to capture the outcome of risk-taking. This variable is used in the cross-sectional regression analysis in Section 3.3.2.

Sharp declines in accounting returns such as ROA often precede bankruptcy, as deteriorating performance serves as a leading indicator while the bankruptcy process unfolds over time. I document the evolution of ROA before and after the GFC in Figure 1. The figure presents the median and selected percentiles of ROA across two bank size categories: SMBs and banks included in the S&P 1500 index. S&P 1500 banks generally consist of larger institutions than those in the SMB sample. The evolution of ROA is similar across bank size categories. In both size categories, the median ROA (solid black line) begins to decline in 2007, reaches a trough at the end of 2008, and then gradually recovers across both groups. Return on Equity (ROE) follows a nearly identical pattern (available upon request). Examining the cross-sectional variation, there is substantial heterogeneity in ROA, which increases notably during the GFC—particularly in the lower tail of the distribution. When restricting the sample to banks that eventually filed for bankruptcy, the dash-dotted red line shows a sharp decline in the fourth quarter of 2008, aligning with the 90th percentile of the ROA distribution. This pattern supports a basic empirical regularity: banks with poorer performance in accounting returns are more likely to file for bankruptcy.

Figure 1: Return on Assets for All and Failed Banks, by Size, 2005Q4–2011Q4.



The figure presents cross-sectional and time-series variation in Return on Assets (ROA), defined as net income divided by total assets, for U.S. commercial banks over 24 quarters from 2005:Q4 to 2011:Q4. The sample includes two size groups: small and medium-sized banks (SMBs, left panel) and S&P 1500 banks (right panel). The S&P 1500 group consists of publicly listed banks on the NYSE, NYSE Arca, NYSE MKT, NASDAQ Global Select Market, NASDAQ Select Market, and NASDAQ Capital Market. Within each group, the solid black line plots the median ROA, while shaded areas represent the interquartile range: dark shading spans the 25th to 75th percentiles, and light shading spans the 10th to 90th percentiles. The red dashed line shows the median ROA for banks that failed in 2009 or 2010, based on data through 2008. Vertical lines indicate the onset (2007:Q3) and intensification (2008:Q4) of the financial crisis.

3.2 Summary Statistics: Pre-Crisis Bank Financials and CEO Compensation, and Crisis-Era Performance

Table 1 presents pre-crisis bank financials from 2006 and post-crisis performance measures during the financial crisis, some of which are later used as outcome variables in the regression analysis. Table 2 summarizes crisis-era bankruptcy counts. Table 3 focuses exclusively on pre-crisis CEO compensation in 2006, which serves as explanatory variables in the regressions. The right-most column in each table reports p-values from two-sided t-tests that compare the means of SMBs with those of S&P 1500 banks.

The upper panel of Table 1 shows that the average total assets (market capitalization) of

SMBs is $2.3 billion ($0.5 billion) in 2006, while the average size of S&P 1500 banks is $37.6 billion ($7.5 billion)—more than ten times larger than that of SMBs. For bank performance measures, the lower panel reports cumulative returns over the crisis period, spanning July 2007, to December 2008, by size category. These periods exclude the time in 2009 when shareholder uncertainty about potential bank nationalizations is rising. This window follows FS (2011), and thus allows readers to compare our results directly with theirs. The average ROA of SMBs (S&P 1500 banks) is 0.86 % (1.28 %) in 2006, and it fell to −0.03% (0.07%) over the crisis window of 2007:Q3–2008:Q4. Because the crisis figure aggregates net income over six quarters while the 2006 value is annual, the two numbers are not strictly comparable, but they still highlight the sharp decline in performance. The buy-and-hold returns are a performance measure that calculates the income and capital gains a stock investor earns over a given period. The buy-and-hold returns of SMBs during the crisis average -42%. Turning to forward-looking risk measures, the short-run marginal expected shortfall (MES) equals 55 basis points for SMBs and 144 basis points for S&P 1500 banks. The average SRISK-to-market-capitalization ratio—defined by Brownlees and Engle (2017)—is roughly 1 % for both groups. The modest ratio reflects the fact that only 3–5 % of banks in the 2006 sample exhibit a strictly positive SRISK. I include systemic risk measures as a control variable in the regressions that predict subsequent under-performance at the individual-bank level, consistent with Brownlees et al. (2020); Acharya et al. (2025).

Table 1: Summary Statistics for Pre-Crisis Bank Financials and Crisis-Era Performance, by Size Group.

	Small and medium-sized banks				S&P1500 banks				Difference
	Obs.	Mean	Median	Std.Dev.	Obs.	Mean	Median	Std.Dev.	Mean
Pre-Crisis (2006)									
Total assets ($ millions)	648	2331.66	648.59	10443.15	69	37602.72	10571.82	48773.90	-35271.06***
Market capitalization ($ millions)	648	482.71	104.03	2372.28	69	7493.40	2055.08	9836.25	-7010.69***
ROA (%)	648	0.86	0.90	0.57	69	1.28	1.26	0.41	-0.42***
ROE (%)	648	9.43	9.95	5.67	69	13.27	12.92	4.74	-3.84***
Short-run MES in 2006 (%)	633	0.55	0.22	0.96	69	1.44	1.35	0.51	-0.88***
ln(1+SRISK)	648	0.14	0.00	0.65	69	0.10	0.00	0.61	0.04
SRISK-to-market cap ratio (%)	648	1.05	0.00	5.67	69	0.26	0.00	1.53	0.79**
Fraction of SRISK>0 (%)	648	5.40	0.00	22.62	69	2.90	0.00	16.90	2.50
Book-to-market ratio	648	0.61	0.60	0.19	69	0.52	0.50	0.16	0.09***
Tier 1 capital ratio (%)	648	12.81	11.84	4.84	69	10.14	9.80	2.69	2.67***
Wholesale funding-to-total assets (%)	648	4.48	1.66	6.00	69	6.74	6.46	5.82	-2.26**
Crisis Window (2007:Q3–2008:Q4)									
ROA (%)	622	-0.03	0.61	2.21	69	0.07	0.82	2.18	-0.11
ROE (%)	619	0.02	6.52	23.27	67	0.49	6.44	21.29	-0.47
Buy-and-hold returns (%)	599	-42.20	-44.36	32.34	62	-41.61	-42.87	31.62	-0.59

This table presents summary statistics for pre-crisis balance-sheet variables and accounting returns (upper panel) and crisis-window accounting and market returns (lower panel). In both panels, absolute variables are reported in millions of dollars. Ratios are expressed as percentages, except for the book-to-market ratio. In the upper (pre-crisis) panel, the accounting returns—ROA and ROE—are computed as net income summed over four quarters divided by the book value of total assets and shareholders' equity, respectively. In the upper panel, SRMES (Short-run MES) is the conditional expectation of one-day losses, where a positive value indicates a decline in bank value, expressed as a percentage of market value. The conditional expectation is averaged over all days when market returns fall within the worst 5% of observations. SRISK is computed as: SRISK=$\max\{0, \text{market cap} \times (k \times \text{leverage} + (1-k) \times \text{LRMES} - 1)\}$ where k is the prudential capital ratio, set at 8%, and leverage is defined as the ratio of the book value of liabilities to the sum of the book value of liabilities and market capitalization. LRMES (long-run MES) is defined as $\sqrt{h} \times$ SRMES, where h is set to 252 trading days per year. Wholesale funding corresponds to "OTHER BORROWED MONEY" in Capital IQ. In the lower panel, ROA and ROE are calculated as net income from 2007:Q3 to 2008:Q4, divided by total assets and equity as of the end of 2007:Q2. Market return—buy-and-hold returns—reflects total returns, including dividends and capital gains, from July 1, 2007, to December 31, 2008, relative to the share price on July 1, 2007. The "Difference" column reports results from two-sided t-tests comparing each statistic between SMBs and S&P 1500 banks. Asterisks (*, **, and ***) denote p-values from t-tests of statistical significance at the 0.1, 0.05, and 0.01 levels, respectively (two-sided).

Accounting and market returns reflect systemic risk-taking only indirectly. A more direct manifestation is the number of bank bankruptcies recorded during the GFC. Between July 2007 and December 2010, a total of 30 banks filed for bankruptcy (Table 2). Of these, 26 are SMBs. Therefore, the vast majority of crisis-era bankruptcies occurred among SMBs.

Table 2: Bank Bankruptcy Filings, July 2007–December 2010.

	Small and medium-sized banks		S&P1500 banks	
	# of events	Frequency	# of events	Frequency
Filed for bankruptcy	26	0.040	4	0.058

This table summarizes bank bankruptcy events from July 2007 to December 2010. "Filed for bankruptcy" includes banks that entered Chapter 11, transitioned from Chapter 11 to Chapter 7, or filed directly under Chapter 7.

Table 3 reports the pre-crisis (2006) CEO compensation structure, detailing cash pay, ownership, and stock options holdings. I characterize the compensation structure using three parameters—cash bonus incentive ratio (θ_B), shareholdings (θ_S), and unexercisable options (θ_O)—are used in both the reduced-form analysis in Section 3.3 and the dynamic model in Section 4.

Average cash compensation in 2006 is \$0.52 million for SMB CEOs and \$2.14 million for CEOs of S&P 1500 banks, so large-bank CEOs earned roughly four times as much cash pay as their SMB counterparts. Salary and cash bonuses constitute the two largest components of cash compensation. Cash bonuses are roughly half as large as salaries for SMB CEOs, whereas they exceed salaries for S&P 1500 CEOs on average. In 2006, 81% of SMB CEOs and 83% of S&P 1500 bank CEOs received non-zero cash bonuses. Throughout this paper, I define cash bonuses as the sum of discretionary and formulaic bonuses paid out.

Appendix Figure A2 shows the time-series evolution of the share of cash bonuses—defined as discretionary plus formulaic awards—paid to bank CEOs (black solid line) from 2000 to 2019. The red dashed line plots the share of CEOs who received only discretionary bonuses. In 2006, when the SEC revised its executive-compensation disclosure rules, banks were required to report discretionary and formulaic components separately, and roughly half of CEOs received discretionary bonuses. Discretionary bonuses are awarded without a pre-set performance formula. By contrast, formulaic bonuses are paid under a formal incentive plan with performance goals established ex ante. At the height of the GFC in 2009, fewer than half of CEOs received any cash bonus, but bonus prevalence returned to its pre-crisis level by 2013[9]. In the final sample year, 2019, about two-thirds of CEOs received formulaic bonuses and one-third received discretionary bonuses. Overall, the crisis produced only a modest and transitory change in cash-bonus practices.

[9]Under TARP, recipients of exceptional assistance—namely Bank of America and Citigroup in my sample—face an outright ban on paying cash bonuses to senior executives. In contrast, the majority of TARP recipients, classified as receiving less extensive assistance, are not subject to a cash bonus ban. Instead, they are required to impose limits on incentive compensation structures, including a mandate that the board of directors' compensation committee review and certify that compensation plans do not encourage unnecessary or excessive risk-taking.

In Table 3, the bonus-to-revenue ratio (θ_B) is 0.29% on average for SMBs with a standard deviation of 0.36% in 2006. I proxy the cash-bonus incentive with the bonus-to-revenue ratio. This measure rests on a key assumption: revenue constitutes a relevant performance metric for determining cash bonuses. While direct evidence from the banking sector is limited, this assumption aligns with findings from the broader literature on executive compensation in non-financial firms. Guay et al. (2019) document that 93% of firms in the ISS Incentive Lab database link CEO bonus contracts to earnings-based performance measures, while 35% use sales as the second most common metric. These figures provide evidence that bonus contracts are predominantly tied to per-period earnings performance rather than to stock price movements.[10] Moreover, compared with profit, revenue—defined as net interest income plus non-interest income—is a more tractable performance metric: because net interest income is generally positive and typically exceeds non-interest income, revenue is seldom zero or negative.

The average percentage ownership of shares (θ_S) is 2.7% in the SMB sample, which is larger compared to the S&P 1500 banks, where the average is 0.5% (Table 3). Although the ownership percentage is lower in S&P 1500 banks, their average market capitalization is more than ten times larger than that of SMBs (Table 1). This size difference accounts for the substantially higher dollar value of CEO shareholdings in S&P 1500 banks, which averages $21 million, compared to $6 million in SMBs. The value of CEO shareholdings is roughly ten times larger than the corresponding cash compensation in both size categories.

The average unexercisable option-to-total share ratio (θ_O)—defined as the number of unexercisable options divided by the total number of shares outstanding—is 0.3% in both the SMB and S&P 1500 bank samples, which is lower than the corresponding ratio for exercisable options. This discrepancy arises because unexercisable options are typically more recent grants, whereas exercisable options were issued in prior years. In the SMB sample, the number of unexercisable options is roughly one-tenth the size of shareholdings, while in the S&P 1500 sample, this gap is nearly zero.

[10] Banks may employ a range of performance measures in their annual incentive plans. The 1996–1997 Annual Incentive Plan Design Survey conducted by Towers Perrin reports that 19 out of 21 U.S. finance and insurance firms use earnings-based metrics, including net income, pre-tax income, and returns on assets, equity, and capital.

Table 3: Summary Statistics of Pre-Crisis CEO Compensation in 2006, by Size Group.

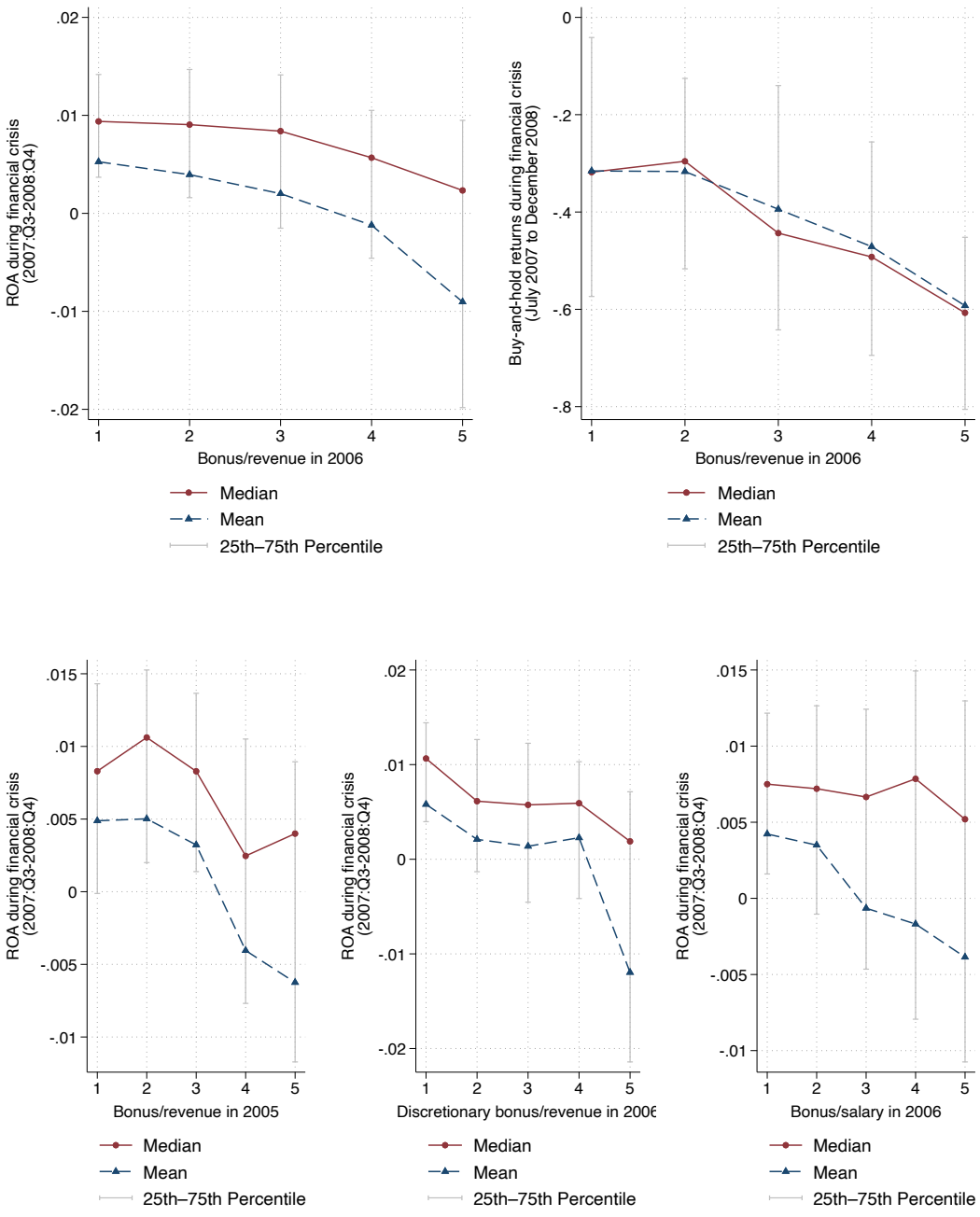
	Small and medium-sized banks				S&P1500 banks				Difference
	Obs.	Mean	Median	Std.Dev.	Obs.	Mean	Median	Std.Dev.	Mean
Cash Compensation in 2006									
Cash compensation ($ thousands)	648	523.50	348.00	740.61	69	2144.24	1495.68	1985.54	-1620.74***
Salary and others	648	346.61	277.11	225.54	69	927.21	867.81	388.42	-580.60***
Salary	648	287.27	240.00	153.98	69	716.80	737.50	235.85	-429.53***
Cash bonuses	648	152.84	52.81	421.88	69	1116.40	545.20	1476.26	-963.56***
Bonus/revenue (%, θ_B)	647	0.29	0.18	0.36	69	0.10	0.07	0.10	0.19***
Fraction bonus is paid (%)	648	80.56	100.00	39.61	69	82.61	100.00	38.18	-2.05
Bonus/salary ratio above 100%	648	0.08	0.00	0.27	69	0.39	0.00	0.49	-0.31***
Ownership in 2006									
Percentage ownership from shares (%, θ_S)	545	2.66	0.89	5.35	61	0.54	0.30	0.70	2.11***
Share value	545	6421.75	1113.86	19831.32	61	21445.77	8922.40	33157.97	-15024.02***
Fraction share value is non-zero (%)	545	100.00	100.00	0.00	61	100.00	100.00	0.00	0.00
Annual stock grant	648	76.00	0.00	534.04	69	1098.67	306.23	1852.84	-1022.67***
Share value-to-salary and bonus ratio	544	9.60	2.88	22.65	61	10.64	5.64	12.97	-1.04
Stock Options in 2006									
Unexercisable options/shares (%, θ_O)	648	0.29	0.00	0.75	69	0.32	0.12	0.84	-0.03
Fraction unexercisable options are granted (%)	648	73.15	100.00	44.35	69	94.20	100.00	23.54	-21.05***
Exercisable options/shares (%)	648	1.32	0.41	3.64	69	0.99	0.43	1.84	0.33
Annual option grant	648	69.70	0.00	345.00	69	966.20	389.91	1321.52	-896.50***

The table presents summary statistics of pre-crisis bank CEO compensation in 2006. Absolute values are reported in thousands of dollars; ratios are expressed as percentages. Compensation is categorized into three components: cash compensation, shareholdings, and stock options. "Cash compensation" includes salary, cash bonuses, and other forms of cash-based pay. Cash bonuses are defined as the sum of discretionary bonuses and non-equity incentive plan compensation. "Fraction of bonus is paid" reports the share of CEOs who received a non-zero cash bonus in 2006. "Percentage ownership from shares" is calculated as the ratio of shares held by the CEO to the total number of shares outstanding. Stock options are separated into unexercisable and exercisable components. The "Difference" column reports the difference in means between SMBs and S&P 1500 banks. p-values from two-sided t-tests are denoted by asterisks: $*$, $**$, and $***$ indicate significance at the 10%, 5%, and 1% levels, respectively.

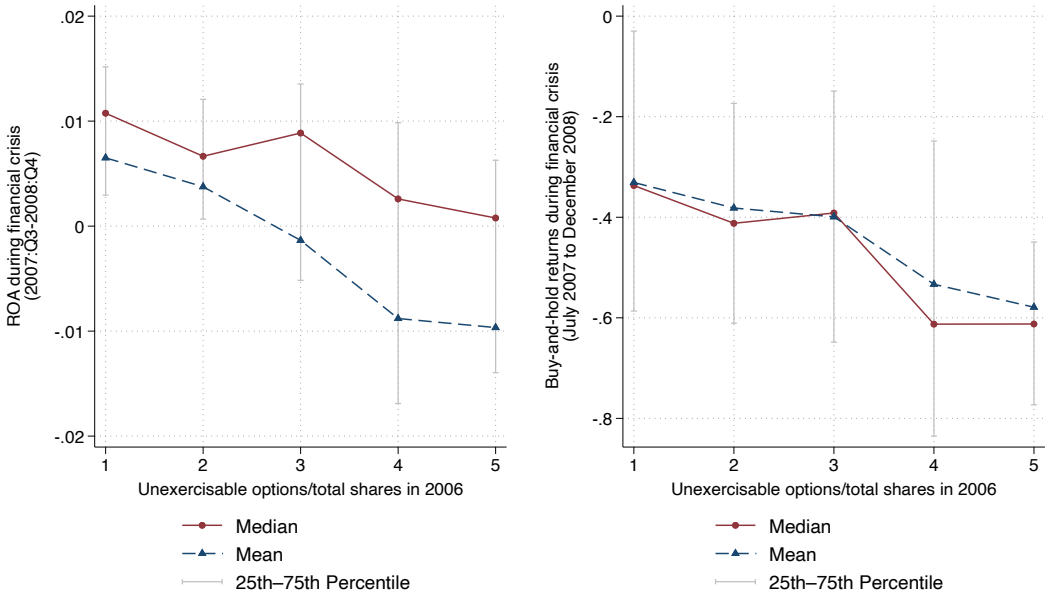
To motivate my focus on bank performance and CEO compensation structure, Figure 2 presents unconditional relationships between performance during the GFC—measured by ROA and buy-and-hold returns—and pre-crisis incentive measures. The horizontal axis categorizes pre-crisis incentive measures into five bins, and the vertical axis represents either ROA or buy-and-hold returns. Panel A shows that ROA and buy-and-hold returns are strongly negatively associated with the 2006 cash bonus incentive ratio, defined as the ratio of cash bonuses to revenue. Panel B shows a similarly negative association with the value of unexercisable options in 2006. The negative relationship between ROA and cash bonuses remains robust under alternative specifications: when shifting the timing to the 2005 bonus incentive ratio, using a narrower definition that excludes formulaic components, or replacing the denominator with salary to construct the 2006 bonus-to-salary ratio (lower Panel A). While Figure 2 highlights a strong association, it reflects only an unconditional correlation, as it does not control for other CEO compensation components or bank characteristics. In next Section 3.3, I show that the relationship persists after conditioning on these factors. The result also remains robust after addressing potential endogeneity in CEO compensation structure.

Figure 2: ROA and Buy-and-Hold Returns During the Financial Crisis, by Bank CEO Bonus Incentive Measures and Unexercisable Options.

Panel A: Cash Bonus Incentive Coefficients



Panel B: Unexercisable Options



All variables are winsorized at the 1st and 99th percentiles. The figure presents line plots of ROA and buy-and-hold returns during the Global Financial Crisis, categorized by quintile of various CEO bonus incentive measures and unexercisable options, including the 2005 and 2006 bonus-to-revenue ratios, discretionary bonus-to revenue ratio, bonus-to-salary ratio, and unexercisable option-to-share ratio in 2006. ROA during the crisis is calculated as net income from the third quarter of 2007 to the fourth quarter of 2008, divided by the book value of total assets as of the end of the second quarter of 2007, capturing the early phase of the financial crisis. Buy-and-hold returns are measured from July 2007 to December 2008. Each panel plots median (red) and mean (blue) outcomes, along with the interquartile range (25th to 75th percentile, shaded).

3.3 Empirical Results

3.3.1 Main Specification: Cross-Sectional Ordinary Least Squares Regression of Bank Returns

In this section, I argue that the pre-crisis bonus-to-revenue ratio and the unexercisable option-to-total-share ratio are strong predictors of poor bank performance and a higher incidence of bankruptcy during the crisis. In contrast, other compensation variables have quantitatively smaller or statistically insignificant effects. I use this evidence to motivate the dynamic model developed in Section 4.

I estimate variants of the following cross-sectional model:

$$
\begin{aligned}
\text{Risk-taking}_{i,\text{crisis}} &= \beta_0 + \beta_1\Big(\text{Bonus}_{i,\text{pre-crisis}}/\text{revenue}_{i,\text{pre-crisis}} \\
&+ \beta_2/\beta_1 \mathbb{1}_{\text{Bonus}_{i,\text{pre-crisis}}>0}\Big) \\
&+ \beta_3 \text{Ownership from shares}_{i,\text{pre-crisis}} \\
&+ \beta_4\Big(\text{Unexercisable options/total shares}_{i,\text{pre-crisis}} \\
&+ \beta_5/\beta_4 \mathbb{1}_{\text{Unexercisable options}_{i,\text{pre-crisis}}>0}\Big) \\
&+ \beta_6 \text{Salary and others}_{i,\text{pre-crisis}}/\text{total assets}_{i,\text{pre-crisis}} \\
&+ \beta_7 \text{Exercisable options}_{i,\text{pre-crisis}}/\text{total shares}_{i,\text{pre-crisis}} \\
&+ \gamma' \text{Controls}_{i,\text{pre-crisis}} + \varepsilon_i. \qquad (1)
\end{aligned}
$$

Here, i indexes either the bank (for financial variables) or the matched CEO (for compensation variables). In Equation (1), the left-hand side dependent variable, $\text{Risk-taking}_{i,\text{crisis}}$, denotes the ex-post realized and expected gains or losses at the bank level for bank i during the crisis. I run regressions for three bank performance indices: ROA, ROE, and buy-and-hold returns. ROA and ROE are calculated as the ratio of net income from July 2007 to December 2008 divided by total assets and book value of equity as of the end of June 2007. Buy-and-hold returns are measured as the total returns of banks, including dividends and capital gains, from July 1, 2007, to December 31, 2008, relative to the share price on July 1, 2007.

The right-hand side variables capture ex-ante measures of bank CEOs' risk-taking incentives and bank-level control variables, all observed in the pre-crisis period, as of 2006. The coefficients β_j where $j \in \{1, 3, 4, 6, 7\}$ indicate the sensitivity of each compensation component to risk-taking, β_0 is the constant term, γ' is a vector of coefficients for control variables with a prime to indicate the transpose of a vector, and ε_i represents the error term. I choose compensation ratios instead of the levels of compensation to address issues related to scaling. Since cash bonuses are tied to bank performance, the bonus-to-revenue ratio θ_B reflects the strength of bonus incentives, analogous to the bonus beta in Guay et al. (2019). Stock and option holdings are scaled by the total number of shares (θ_S and θ_O), and salary and other cash pay are scaled by total assets. This scaling approach for stock and options aligns with the dynamic model in Section 4.

Not all CEOs receive cash bonuses or stock options (Table 3). To disentangle the intensive and extensive margin effects of CEO incentives, β_1 and β_3 capture the intensive margin—that is, the sensitivity of risk-taking to the magnitude of cash bonuses and unexercisable options, conditional on their presence. In parallel, β_2 and β_4 capture the extensive margin—that is, the effect of receiving any strictly positive cash bonuses or stock options—through the indicator variables $\mathbb{1}_{\text{Bonus}_{i,\text{pre-crisis}}>0}$ and $\mathbb{1}_{\text{Unexercisable options}_{i,\text{pre-crisis}}>0}$. The indicator function $\mathbb{1}_{x>0}$ equals one if x is strictly positive and zero otherwise. When $\beta_1 < 0$ and $\beta_2 > 0$, the bonus-performance relationship exhibits an inflection point at $-\beta_2/\beta_1 > 0$. For banks with a bonus-to-revenue ratio below this threshold, the total contribution of bonuses, given by $\beta_1\Big(\text{Bonus}_{i,\text{pre-crisis}}/\text{revenue}_{i,\text{pre-crisis}} + \beta_2/\beta_1\Big)$, is positive; for those above the threshold, the total contribution of bonuses is negative. This pattern supports the view that capping cash

bonuses may reduce risk-taking that leads to poor outcomes during the GFC. Specifically, banks and CEOs with moderate bonus sensitivity exhibit better performance during the crisis, suggesting that limiting excessive bonus incentives can mitigate risk-taking that proves detrimental in periods of financial stress.

I control for bank characteristics, including the price-to-book ratio, the logarithm of market capitalization, the Tier 1 capital ratio, and the wholesale funding-to-total asset ratio, all measured at the end of 2006. Correia et al. (2024) find that two key dimensions of a bank's fundamentals—solvency and funding vulnerability—strongly predict bank failures. I use the Tier 1 capital ratio as a proxy for solvency and the wholesale funding ratio as a proxy for funding vulnerability, following their findings that failing banks tend to exhibit deteriorating capitalization and an increasing reliance on expensive, risk-sensitive funding. Although market price, bank size, solvency, and funding vulnerability are jointly determined, I include these variables as controls to examine the conditional relationship between compensation structure and systemic risk-taking. I begin by presenting results for return on assets (ROA), followed by robustness checks using ROE, market returns, and bank failures in Section 3.3.2. In addition, I address potential endogeneity concerns in the same section.

ROA. Table 4 presents the cross-sectional Ordinary Least Squares (OLS) estimates where accounting returns are the dependent variable. The average ROA declined during the crisis (Figure 1). Greater risk-taking incentives embedded in CEO compensation are associated with a higher likelihood of experiencing a larger decline in ROA relative to peer banks during the crisis. I test whether poor performance is predicted by CEO incentives, as measured by compensation. The first five specifications in Panel A of Table 4 use five key compensation ratios as the sole independent variables: cash bonus incentive ratio, shareholdings, unexercisable options, salary, and exercisable options, respectively. Cash bonus incentive ratio and unexercisable options remain statistically significant and robust across specifications. Column (6) presents the benchmark specification, which controls for bank characteristics and accounts for lagged return dependence. A one standard deviation increase in the bonus-to-revenue (unexercisable option-to-total share) ratio—0.36% (0.75%)—is associated with a 0.72% (0.23%) reduction in ROA, calculated as $-2.00. \times 0.36\%$ ($-0.30 \times 0.75\%$). The inflection point for the bonus-to-revenue ratio is 0.45% (calculated as $-\beta_2/\beta_1$), while the mean bonus-to-revenue ratio is 0.29% with a standard deviation of 0.36%. Given the sizable dispersion in bonus sensitivity, a number of banks has bonus sensitivity exceeding the inflection point estimated from the reduced-form model. Moreover, the variation in ROA implied by compensation ratios is economically meaningful, relative to the observed crisis-period ROA standard deviation of 1.51% (Table 1). Column (7) pools SMBs and S&P 1500 banks; the resulting estimates are nearly identical to those based on the SMB sample alone.

Table 4: Regression Results for Return on Assets During the Financial Crisis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bonus/revenue (θ_B)	-1.250***					-1.996***	-1.987***
	(-3.32)					(-3.94)	(-3.99)
$\mathbb{1}_{\text{Bonus}>0}$	0.00798***					0.00891***	0.00723***
	(3.18)					(3.27)	(2.88)
Ownership from shares (θ_S)		-0.0136				-0.00640	-0.0111
		(-0.65)				(-0.25)	(-0.45)
Unexercisable options (θ_O)			-0.372***			-0.472**	-0.554***
			(-2.63)			(-2.28)	(-2.93)
$\mathbb{1}_{\text{Unexercisable option}>0}$			-0.000983			-0.00224	-0.00182
			(-0.49)			(-0.98)	(-0.81)
Salary and others/total assets				-4.293		-0.450	1.145
				(-1.63)		(-0.09)	(0.25)
Exercisable options					-0.0425*	0.0149	0.0167
					(-1.82)	(0.36)	(0.41)
SMB Sample Only	Yes	Yes	Yes	Yes	Yes	Yes	No
Lagged Returns	No	No	No	No	No	Yes	Yes
Control of Bank Characteristics	No	No	No	No	No	Yes	Yes
Adjusted R-squared	0.035	-0.001	0.014	0.006	0.003	0.124	0.123
Total Obs.	622	534	622	622	622	524	585

The table reports results from cross-sectional regressions of ROA for a sample of bank holding companies and stand-alone banks. ROA is measured as the ratio of net income from July 2007 to December 2008, divided by total assets as of the end of June 2007. The "bonus-to-revenue ratio" is defined as the 2006 annual cash bonus divided by annual revenue. "Ownership from shares" refers to the CEO's shareholdings as a percentage of total shares outstanding. "Salary and others/total assets" is calculated as the annual salary plus other cash compensation (excluding cash bonuses) divided by total assets in 2006. "Exercisable options" and "Unexercisable options" are expressed as the number of options granted divided by total shares outstanding. Specifications (1), (3), and (6-7) include indicator variables. $\mathbb{1}_{\text{Bonus}>0}$ ($\mathbb{1}_{\text{Unexercisable option}>0}$) is an indicator equal to one if cash bonuses are paid (granted unexercisable option is non-zero) in 2006, and zero otherwise. $\mathbb{1}_{\text{FS}}$ equals one if the bank is included in the S&P 1500 sample, following FS (2011), zero otherwise. Columns (1-6) include only SMBs; Column (7) pools SMBs and S&P 1500 banks. "Lagged returns" refers to 2006 stock returns. Control variables include the price-to-book ratio, log market capitalization, and Tier 1 capital ratio as of 2006. Standard errors are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

3.3.2 Robustness

In this section, I assess and confirm the robustness of the predictive power of the pre-crisis cash bonus incentive ratio and unexercisable options for bank performance during the crisis.

Cross-Sectional Regressions with Alternative Specifications. Appendix Table A1 confirms that the baseline results remain robust when alternative definitions of risk-taking are used. Panel A replaces ROA with return on equity (ROE), and Panel B uses buy-and-hold stock returns. In both cases, the direction and magnitude of the estimated effects are consistent with the baseline.

Appendix Table A2 replaces the denominator of the cash bonus incentive ratio with market capitalization instead of revenue. The bonus coefficient remains negative and statistically significant, reinforcing the result that stronger bonus incentives are associated with weaker bank performance during the GFC.

Appendix Table A3 includes systemic risk measures—SRMES, ln(1+SRISK), and SRISK-to-market capitalization —as additional controls. Neither variable is statistically significant, and the inclusion of these controls does not materially alter the estimated effects of bonus incentives and option holdings.

Lastly, I replicate the results of FS (2011) by applying their specification to the S&P 1500 bank sample, consistent with the scope of their study. This alignment enables a direct comparison and helps isolate whether differences in results arise from the empirical specification or from the underlying sample composition.

Logit Regressions of Bank Bankruptcy. The preceding sections focus on the intensive margin of ex-post performance—measured by ROA, ROE, and market returns—based on a sample restricted to banks that survived through 2008, since institutions that filed for bankruptcy are largely excluded from post-failure return data. This approach, however, omits banks that are severely impaired or exited the market during the GFC due to excessive risk-taking. To address this limitation, I estimate logit models of bank failure for both Bank Holding Companies (BHCs) and stand-alone commercial banks. These regressions use CEO compensation structure as the main explanatory variables, mirroring the cross-sectional OLS specification for ROA in Table 4. Columns (1)–(3) report univariate logit regressions, where each specification includes a single CEO compensation ratio as the sole explanatory variable, without controlling for bank characteristics. As shown in Table 5, the bonus-to-revenue ratio, shareholdings, and the unexercisable-option-to-share ratio are all positively associated with the likelihood of failure, indicating that stronger pre-crisis incentives are linked to greater bankruptcy risk during the crisis. The Area Under the ROC Curve (AUC) for the benchmark specification in column (4) is 0.8, suggesting that the model exhibits strong discriminatory power in distinguishing banks that filed for bankruptcy from those that remained solvent during the crisis.

Table 5: Logit Estimates of Bank Failure During the Financial Crisis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bonus/revenue (θ_B)	100.3***			182.3***	183.4***	167.3***	181.6***
	(3.22)			(3.17)	(3.22)	(2.90)	(3.17)
Ownership from shares (θ_S)		4.653**		6.843**	6.789**	6.847**	6.862**
		(2.01)		(2.25)	(2.25)	(2.24)	(2.27)
Unexercisable options (θ_O)			35.51***	77.11***	76.84***	79.64***	77.43***
			(2.85)	(3.81)	(3.76)	(3.88)	(3.83)
Salary and others/total assets				-408.2	-350.8	-170.0	-398.6
				(-0.32)	(-0.28)	(-0.15)	(-0.31)
Exercisable options				-13.59***	-13.67***	-13.63***	-13.66***
				(-2.67)	(-2.62)	(-2.66)	(-2.69)
Short-run MES in 2006					11.37		
					(0.43)		
ln(1+SRISK)						0.419*	
						(1.77)	
SRISK-to-market cap ratio							0.459
							(0.24)
Control of Bank Characteristics	No	No	No	Yes	Yes	Yes	Yes
AUC	0.660	0.579	0.696	0.810	0.815	0.829	0.811
Log-Likelihood	-121.503	-115.043	-122.361	-98.261	-98.165	-96.624	-98.249
Total Obs.	716	606	717	596	596	596	596

This table reports coefficient estimates from logit regressions of bank failure during the period July 2007 to December 2010. The dependent variable equals one if the bank filed for bankruptcy and zero otherwise. Control variables include the price-to-book ratio, the log of market capitalization, and the Tier 1 capital ratio, all measured as of year-end 2006.

Modified Control Function Regressions of the System Equation. The previous arguments assume the endogeneity problem to be of secondary importance. In this section, I relax that assumption. The endogeneity problem in estimating the parameters β_i, where $i \in \{1, 3, 4, 6, 7\}$ in Equation (1), arises if risk-taking and the CEO's compensation structure are jointly determined by the bank manager and the board of directors representing shareholders. For example, reverse causality may occur if higher levels of risk-taking are rewarded with greater performance sensitivity through cash bonuses. In this case, the error terms ε_i in Equation (1) and cash bonus incentive ratio are correlated, violating the OLS assumption and potentially leading to biased estimates. This section employs modified control function regressions to address endogeneity, leveraging heteroskedasticity for identification. The main finding from these regressions is that cash bonuses and unexercisable options causally contribute to increased risk-taking during the contraction period of the GFC, ultimately resulting in a significant decrease in returns and lending activities.

I use two independent sets of system equations: one for cash bonuses and one for options. Below, I explain the system of equations for cash bonuses using the modified control function regression as follows:

$$\text{Bonus/Revenue}_{i,t} = \alpha_{0,i} + \lambda_1 \text{Bonus/Revenue}_{i,t-1} + \alpha' X_{i,t-1} + \xi_{i,t} \quad (2)$$

$$\triangle \text{ROA}_{i,t} = \beta_0 + \beta_1 \text{Bonus/Revenue}_{i,t-1} + \Gamma' X_{i,t-1-s} + \text{year}_t + \eta_{i,t}. \quad (3)$$

Equation (2) captures the determination of the bonus-to-revenue ratio based on one-period lagged bonus-to-revenue ratio and bank characteristics: (i) price-to-book ratio, (ii) the logarithm of market capitalization, and (iii) Tier 1 capital ratio, with $X_{i,t}$ representing a 3-by-1 vector of bank characteristics. The dynamic specification of cash bonus incentive ratio reflects the persistence of cash bonus incentive ratio observed in the data. Subsequently, the dynamic model in Section 4 specifies cash bonus incentive ratio as an AR(1) process, similar to the specification in Equation (3). The subscripts i and t of each variables denote the bank and matched CEO index and time, respectively. Equation (3) models ex-post realized losses as a function of the bonus-to-revenue ratio. α' and Γ' are 1-by-3 transposed vectors of coefficients, with a prime to indicate the transpose of a vector. $\triangle\text{ROA}_{i,t}$ is the first-order difference of ROA. year_t represents year fixed effects to control common factors affecting all banks. $\alpha_{0.i}$ is individual-level fixed effect and β_0 is a constant term. $\xi_{i,t}$ and $\eta_{i,t}$ are error terms.

The parameter of interest is β_1, which measures the magnitude of how much the change in returns is caused by the compensation structure. Endogeneity arises when $\text{Bonus/Revenue}_{i,t-1}$ and $\eta_{i,t}$ are correlated. To address potential endogeneity, a linear projection of the error term $\eta_{i,t}$ is taken, defined as: $\eta_{i,t} = \rho\left(\frac{\sigma_{\eta,m}}{\sigma_{\xi,m}}\right)\xi_{i,t-1} + \omega_{i,t}$ where ρ is the correlation between the error terms $\xi_{i,t}$ and $\eta_{i,t}$. Here, parameters $\sigma_{\xi,m}$ and $\sigma_{\eta,m}$ represent the standard deviation of shocks $\xi_{i,t-1}$ and $\eta_{i,t}$ in "market" $m \in \{1,\ldots,M\}$ where M denotes the total number of "markets". "Market" m refers to a segmentation based on heteroskedasticity in the US banking sector. Each bank matched with CEO labeled as i is grouped into a specific market m, which represents a combination of the year and one of the four geographic regions aligned with the Office of the Comptroller of the Currency (OCC) supervision structure. This identification strategy follows Armstrong et al. (2022) and employs geographic and time variations in error term heteroskedasticity. To simplify the problem, I consider no more than two endogenous variables at a time.

Substitute the expression for $\eta_{i,t}$ into Equation (3), I get

$$\triangle\text{ROA}_{i,t} = \beta_0 + \beta_1\text{Bonus/Revenue}_{i,t-1} + \Gamma' X_{i,t-1} + \text{year}_t + \rho\left(\frac{\sigma_{\eta,m}}{\sigma_{\xi,m}}\right)\xi_{i,t-1} + \omega_{i,t}. \quad (4)$$

Crucially, $\text{Bonus/Revenue}_{i,t-1}$ and $\omega_{i,t}$ are constructed to be uncorrelated. I employ an iterative approach to estimate β_1, the coefficient of interest. In the first stage, I use the Arellano-Bond dynamic panel estimator for Equation (3) to estimate the error terms $\xi_{i,t}$. In the second stage, estimating β_1 involves calculating the ratio of standard deviations $\frac{\sigma_{\eta,m}}{\sigma_{\xi,m}}$ for all four regions of OCC supervision and time, then estimating β_1 given the ratio of standard deviations fixed. The process continues by updating $\sigma_{\eta,m}$ based on the estimated parameter β_1 at the first stage, and iterating this process until error terms $\xi_{i,t-1}$ in Equation (2) converges.

Table 6 summarizes the statistics of dependent and independent variables. The data is available at annual frequency from 2000 to 2019. All variables are winsorized at 1% and 99% to mitigate the effect of outliers. Growth rates for loans and deposits are adjusted for inflation, and level values are reported in real terms, indexed to 2006. e

Table 6: Summary Statistics of Risk-taking Measures, Compensation, and Bank Characteristics in Panel Data from 2000 to 2019.

	Full sample				Contraction periods				Difference
	Number	Mean	Median	Std. Dev.	Number	Mean	Median	Std. Dev.	Mean
Risk-taking measures									
ΔROA (%)	7,860	-0.051	-0.001	0.793	1,486	-0.488	-0.186	1.128	0.54***
Total loan growth (%)	7,942	7.080	5.013	13.839	1,489	4.176	2.366	13.558	3.57***
Commercial loan growth (%)	7,907	5.817	5.023	23.094	1,480	1.879	1.610	25.837	4.84***
Consumer loan growth (%)	7,811	1.450	-1.156	27.949	1,465	1.284	-2.323	32.056	0.20
Commercial mortgage growth (%)	7,364	9.426	6.674	19.935	1,352	9.931	7.385	22.261	-0.62
Residential mortgage growth (%)	6,895	4.697	2.481	23.393	1,241	2.603	0.346	26.654	2.55**
Deposit growth (%)	8,469	7.382	4.659	13.189	1,507	7.759	5.666	13.552	-0.46
Annual compensation									
Bonus/revenue (%)	8,567	0.199	0.114	0.273	1,525	0.144	0.019	0.262	0.07***
Unexercisable options (%)	8,533	0.200	0.000	0.472	1,522	0.234	0.014	0.504	-0.04**
Bank characteristics									
Book to market ratio	8,567	1.011	0.757	0.900	1,525	1.494	1.038	1.261	-0.59***
ln(market capitalization)	8,567	5.171	4.861	1.853	1,525	4.603	4.243	1.831	0.69***
Tier 1 capital ratio (%)	8,567	12.397	12.020	4.011	1,525	11.694	11.500	3.912	0.86***
Wholesale funding-to-total assets ratio (%)	8,567	5.293	3.586	5.822	1,525	6.174	4.797	6.232	-1.07***

The sample period spans from 2000 to 2019, with contraction periods identified in 2001, 2008, and 2009, corresponding to the Dot-com Bubble and the Global Financial Crisis (GFC). The sample includes both SMBs and S&P 1500 banks. Growth rates are adjusted for inflation and level values are reported in real terms, indexed to 2006. "Unexercisable options" represent the ratio of the number of unexercisable options to total shares, expressed as a percentage.

Table 7 presents the regression coefficients along with their 10% and 90% confidence intervals, derived using the modified control function methods. I estimate bootstrapped standard errors using 1,000 resamples to address concerns that certain influential observations—data points with a disproportionate impact on parameter estimates—could distort the accuracy of standard errors. The baseline return measure is ROA, with the right-hand-side variables including one-period lagged compensation ratios and the control function $\Gamma' X_{i,t-1} + \rho \left(\frac{\sigma_\eta}{\sigma_\xi}\right) \xi_{i,t-1}$. Panel A of the table displays the estimates of ROA on the bonus-to-revenue ratio. The main specification in Panel A is shown in Column (2), which highlights a significant negative interaction between the bonus-to-revenue ratio and the contraction period indicators for 2001, 2008, and 2009, encompassing both the Dot-Com bubble burst and the GFC. A one standard deviation increase in the bonus-to-revenue ratio results in a $-0.09\%(= -0.33 \times 0.27\%)$ decrease in ROA during contraction periods—a substantial effect considering the average (one standard deviation) ROA change of -0.49% (1.13%) during these periods, as shown in Table 6. The estimated negative coefficient for this interaction term is statistically significant at the 10% level. To examine the effect of endogeneity, I run an alternative regression without the endogeneity correction reported in Column (3) by dropping the linear projected error terms $\xi_{i,t-1}$ in Equation (4). The estimated parameters for cash bonus incentive ratio remain quantitatively unchanged, suggesting that the endogeneity of the compensation structure in cash bonuses is of lesser concern. Moreover, the estimated correlation parameters ρ in column (1-2) are statistically indistinguishable from zero, providing no evidence of endogeneity in the data.

Incentives for non-CEO bank executives may influence decision-making in the boardroom. However, the results remain robust even when the right-hand-side variables in Equations (2-3) are adjusted from CEO compensation to the average compensation of the top five executives, including non-CEO executives, as shown in specification (4) of Table 7. This robustness check addresses another concern that the CEO has limited control over the bank's decision-making, and the heterogeneity of compensation between CEOs and non-CEOs is substantial.

Panel B in Table 7 examines the causal effect of unexercised options on risk-taking. The point estimate of the cross-term of cash bonus incentive ratio and the contraction period indicators is negative and statistically significant at the level of 10%. In summary, cash bonus incentive ratio and options remain robust after accounting for endogeneity.

Table 7: The Sensitivity of Return on Asset on Cash Bonus and Options during the Contraction Periods.

Panel A: Cash Bonus Incentive Coefficient θ_B

	Top executive			Top 5 executives
	(1)	(2)	(3)	(4)
Bonus/revenue$_{i,t-1}$	-0.139 [-0.245,-0.033]	-0.114 [-0.213,-0.016]	-0.0686 [-0.133,-0.004]	-0.143 [-0.335,0.048]
Bonus/revenue$_{i,t-1} \times \mathbb{1}_{[t=01,08,09]}$		-0.327 [-0.650,-0.004]	-0.279 [-0.617,0.059]	-0.639 [-1.242,-0.036]
ρ	0.0149 [-0.039,0.069]	0.0288 [-0.026,0.084]		0.0257 [-0.033,0.084]
Endogeneity Correction	Yes	Yes	No	Yes
R-squared	0.132	0.133	0.132	0.132
Total Obs.	7,170	7,170	7,170	7,170

Panel B: Unexercisable Options θ_0

	Top executive			Top 5 executives
	(1)	(2)	(3)	(4)
Unexer. options$_{i,t-1}$	0.0182 [-0.039,0.075]	0.0412 [-0.016,0.099]	0.0461 [-0.015,0.107]	0.0135 [-0.024,0.051]
Unexer. options$_{i,t-1} \times \mathbb{1}_{[t=01,08,09]}$		-0.391 [-0.608,-0.173]	-0.383 [-0.586,-0.180]	-0.133 [-0.335,0.069]
ρ	-0.0282 [-0.081,0.025]	0.00629 [-0.050,0.063]		-0.0453 [-0.126,0.035]
Endogeneity Correction	Yes	Yes	No	Yes
R-squared	0.132	0.137	0.137	0.137
Total Obs.	7,151	7,151	7,154	7,151

The dependent variable is ΔROA_t in period t, with regressors including compensation and bank characteristics from period $t-1$, except for the indicator variables. Panel A (B) uses cash bonus incentive ratio θ_B (unexercisable options θ_0) as the compensation variable. Top executive is identified based on salary. "Cash bonus incentive ratio θ_B" is defined as the ratio of bonus to revenue. "Unexercisable options θ_0" represents the ratio of the number of unexercisable options to the total number of shares of common stock outstanding. The sample period spans from 2000 to 2019. I present 10% and 90% confidence intervals in parentheses below the coefficient estimates. Bootstrapped standard errors are estimated using 1,000 resamples to address concerns regarding certain influential observations. The sample includes both large firms and SMBs. Columns (1–2) and (4) include an endogeneity correction and column (3) does not correct endogeneity. ρ represents the correlation between the error terms $\xi_{i,t}$ and $\eta_{i,t}$. Column (4) uses the same specification as Column (2) but alters the sample to include the top 5 executives, with their average compensation used as a right-hand-side variable.

Performance-sensitive cash bonuses might incentivize the supply of more loans. In particular, I ask: what are the effects of cash bonuses on lending and deposit-taking activities before and during the crisis? Table 8 applies control function methods to analyze balance sheet growth relative to compensation during contraction periods. The specifications are similar to those in Equations (2-3), except interchanging left-hand-side variables to loan, mortgage, deposit growths. The analysis uncovers two key findings. Firstly, higher bonus-to-revenue ratios lead banks to increase lending in the long term. All models (1-6) exhibit positive and statistically significant coefficients, as reported in the first row of Table 8. Secondly, elevated cash bonuses result in a more pronounced contraction in total loans, commercial mortgages,

and deposits during the crisis periods of 2001, 2008, and 2009. Models (1), (4), and (6) estimate negative coefficients for the interaction term between cash bonus incentive ratio and the crisis period indicator, indicating that these negative coefficients contribute to a larger decline in commercial lending and deposit-taking activities during crises. In summary, capping cash bonuses might present trade-offs: while lowering cash bonus incentive ratio reduces the adverse impact on loans during crises, it may also diminish CEOs' incentives to increase lending in the long-run. Motivated by the empirical evidence, I introduce a dynamic model in Section 4, which allows testing how much lending changes in response to capping cash bonuses at the level of salary.

Table 8: The Sensitivity of Balance Sheet Growths on Cash Bonus During the Contraction Periods.

	(1) Total Loan Growth	(2) Commercial Loan Growth	(3) Consumer Loan Growth	(4) Commercial Mortgage Growth	(5) Residential Mortgage Growth	(6) Deposit Growth
$\text{Bonus/revenue}_{i,t-1}$	10.93	7.931	7.226	9.676	11.71	10.72
	[8.857,13.008]	[4.061,11.802]	[2.444,12.007]	[6.141,13.210]	[7.067,16.347]	[8.707,12.731]
$\text{Bonus/revenue}_{i,t-1} \times \mathbb{1}_{[t=01,08,09]}$	-8.895	-6.431	-4.614	-9.616	1.086	-6.673
	[-12.234,-5.556]	[-12.230,-0.632]	[-14.704,5.476]	[-15.442,-3.790]	[-7.075,9.247]	[-10.074,-3.271]
ρ	0.00243	0.0107	-0.00625	0.0114	-0.0216	-0.0229
	[-0.043,0.048]	[-0.038,0.060]	[-0.059,0.047]	[-0.036,0.059]	[-0.077,0.034]	[-0.072,0.027]
R-squared	0.201	0.079	0.032	0.082	0.044	0.105
Total Obs.	7,078	7,051	6,957	6,613	6,239	7,148

The dependent variables are balance sheet growth rates. The sample period spans from 2000 to 2019. I present 10% and 90% confidence intervals in parentheses below the coefficient estimates. Bootstrapped standard errors are estimated using 1,000 resamples to address concerns regarding certain influential observations. The sample includes both large firms and SMBs. ρ represents a correlation between the error terms in Equations (2) and (3).

4 Dynamic Model

The reduced-form analysis in Section 3 establishes a link between systemic risk-taking and bank CEOs' incentives. This section presents a structural estimation of a dynamic model using the Simulated Method of Moments (SMM) estimator. The dynamic model utilizes a novel database of bank CEO compensation for structural estimation, as I explain in Section 4.2. The primary purpose of introducing the dynamic model is to conduct counterfactual experiments on compensation regulations to quantify the impact of bank CEOs' incentives on risk-taking and lending. As of 2024, the United States lacks formal regulations on bank CEO compensation. Assessing the impact of proposed regulations, such as deferred compensation, capping cash bonuses at the level of salary, and adding contingent pay, goes beyond the reduced-form specifications used in Section 3.

The theoretical objective is to construct a dynamic model that aligns with observed bank financials while assuming that CEOs act in their self-interest. The model accounts for the fact that bank CEOs derive utility not only from shareholding but also from salary, cash bonuses, options, and pension benefits. A stylized fact is established, showing that salary exhibits decreasing returns to scale relative to bank size. The model endogenously determines the bank size distribution, meaning that size and compensation are jointly determined in equilibrium. Salary introduces concave payoffs, while bank CEOs face uncertainty arising from insured deposit inflows and outflows. Combining these features, the model's key economic mechanism is precautionary savings.

In the policy debate, most proposed policies are argued to address issues of short-termism. Short-termism in the dynamic model arises through multiple channels. First, it is modeled by incorporating CEO turnover, which shifts CEOs' focus toward short-term gains at the expense of long-term stability. Second, managerial conflicts arise from the compensation structure. Performance-sensitive cash bonuses create incentives to prioritize short-term gains. Moreover, shareholdings exert pressure to prioritize short-term gains relative to salaries contingent on survival.

The model section begins by introducing the loan production technology, the preferences of managers and shareholders, the population, and the definition of the competitive industrial equilibrium.

4.1 Population, Preference, Technology, and Equilibrium

The model casts in discrete time with an infinite horizon ($t = 1, 2, \ldots$). The frequency is annual. To ease notation, the variable x (x') represents the current period t (the next period $t + 1$).

There are two agents in the economy: the bank manager and a representative household. The bank manager (also referred to as the CEO) takes a control of bank's financial decisions. The representative household constitutes the majority of the shareholders and delegates decision-making to the bank manager. Assuming an atomistic bank manager simplifies the problem by treating share prices as exogenous and approximating that bank-level equity

payouts are unaffected by individual CEO compensation. In the model, any shares granted to the CEO, including those from exercised stock options, are immediately repurchased by the bank to maintain a constant number of shares over time. Both the bank manager and the representative household are risk-neutral and discount their utility at the same rate, β. Consequently, no agency conflict arises at the level of preferences. Risk neutrality of the household abstracts from aggregate fluctuations in asset prices.

Table 9 summarizes the economy-wide states and loan production technology. I describe the states of the economy c, their associated probabilities, loan revenues, and bank failure rates. The second column of Table 9 shows the probability of each state's realization. The model focuses on inter-temporal trade-offs in systemic (or correlated) risk-taking. The likelihood of failure depends on the economy-wide state, c. Nature selects the binary state $c \in \{0, 1\}$, representing either a normal state ($c = 0$) or a systemic banking crisis state ($c = 1$), motivated by the clustering of bank failures during periods of systemic banking crises (Internet Appendix A.7). The parameters of Π and $1 - \Pi$ are the probabilities of normal and banking crisis states, respectively. Systemic banking crises are treated as transitory events to avoid introducing additional state variables into the model and aggregate fluctuations.

Bank Manager. Banks have access to a loan production and risk-taking technology. These technologies yield higher returns in the current period at the expense of an increased likelihood of bank failure in the future period. A static version of this technology is first introduced by Allen and Gale (2000); Boyd and De Nicolo (2005). The bank failure rate is correlated with the state of the economy c.

I first explain systemic risk-taking in the normal state ($c = 0$). Extending the static environment in Allen and Gale (2000); Boyd and De Nicolo (2005), the probability of success in loan production in the normal state ($c = 0$) is modeled as $p(S) = 1 - \eta_0 S^{\eta_1}$, where $S \in \left[0, (1/\eta_0)^{1/\eta_1}\right]$ represents the level of risk-taking, with η_0 as the scaling factor and η_1 as the returns-to-scale parameter. The parameter η_0 governs a scaling factor of returns on risk-taking, and $\eta_1 \in [0, \infty)$ is the elasticity of returns on risk-taking. I parameterize $\eta_0 = 1 - \bar{p}$ with the long-run average rate of success of $\bar{p}$. These parameterizations lead to $p(S = 1) = \bar{p}$, indicating that a risk-taking level of one ($S = 1$) matches the average success rate. To see the dependency of risk-taking S on the success probability in normal state p, I can express risk-taking as $S(p) = \{(1 - p)/(1 - \bar{p})\}^{1/\eta_1}$, which satisfies the following relationships: $S' < 0$, indicating that returns decrease with a higher success rate, and $S'' \leq 0$, reflecting decreasing marginal returns on risk-taking, for all $p \in [0, 1]$. Decreasing marginal returns ensure an interior solution for the optimal choice of risk-taking.

ASl^{α_l} gives loan revenue, where A is a scaling factor of loan returns, l represents the outstanding of loans, $\alpha_l \in (0, 1)$ denotes the returns to scale (Table 9). The scaling factor of loan revenue is set as $A = \beta^{-1} - 1$, where β is the shareholders' discount rate. Loan production and risk-taking incur variable costs, δ_l, which include not only loan losses but also operating costs proportional to the bank's size, l.

The model captures systemic risk-taking by setting the probability of failure higher during banking crisis periods ($c = 1$) than during non-crisis periods ($c = 0$). Define $\Lambda(p)$ as the

unconditional success probability: $\Lambda(p) = \Pi p + (1 - \Pi)\{1 - \lambda_p(1 - p)\}$. The interpretation is as follows. In a crisis state, failure rate $1 - p$ increases by a fixed proportion $\lambda_p > 1$ (Table 9). Therefore, $\lambda_p(1 - p)$ gives the failure rate in banking crisis states. How do loan production and risk-taking technology, along with correlated bank failures, correspond to reality? The clustering of bank failures may arise from the concentration of loan portfolios. For instance, Cole and White (2012) find that banks with high exposure to commercial real estate loans experienced high failure rates following the crisis. Another example is that high systemic risk-taking manifests as a concentration in highly rated tranches, leading to poor performance in stressed economic conditions (Erel et al. (2014)). Following those discussions, risk-taking S can also be interpreted as the loan portfolio weights assigned to specific sectors, such as commercial real estate, though this is not an exhaustive explanation.

Table 9: States of Non-Crisis and Systemic Banking Crises and the Loan Production/Risk-Taking Technology.

State	Prob. of State Realization	Loan Revenue	Bank Failure Rate
Non-crisis ($c = 0$)	Π	ASl^{α_l}	$1 - p$
Banking Crisis ($c = 1$)	$1 - \Pi$		$\lambda_p(1 - p)$

This table describes two aggregate states in the economy: the non-crisis state ($c = 0$) and the systemic banking crisis state ($c = 1$). More detailed definitions are provided in the text.

What are the economic costs associated with a bank failure? In the event of a bank failure, both the manager and shareholders incur substantial costs. The bank's share price plummets to zero, leading to significant losses for both parties. Empirical evidence indicates that the FDIC's average loss from selling a failed bank is approximately 28% of the bank's assets (Granja et al. (2017)), an amount that often exceeds the typical book value of equity. Consequently, the share value of a failed bank is likely negligible.[11]

To solve for the stationary equilibrium, failed banks are replaced by new ones. When the bank fails, the only costs borne exclusively by shareholders are the initial equity injections for newly established banks.

Bank CEO turnover is a key driver of short-termism. Turnover is relatively common in the banking industry, with the average CEO tenure being approximately 10 years (Internet Appendix A.6). In the model, CEOs leave office for two reasons. The first is random resignation, referred to as exogenous turnover, which occurs with a constant probability α_v in each period. The second reason is bank failure, in which case a new CEO assumes control—this is referred to as endogenous turnover. Notably, higher exogenous turnover exacerbates agency

[11]The manager's problem is normalized to the value associated with a failed bank's manager. Regardless of the CEO's employment status, the bank's manager receives a constant cash flow of c_0, in addition to CEO compensation, while employed. Here, c_0 represents guaranteed income or a constant withdrawal from personal wealth. The value of a failed bank's manager is defined as $v_0 = c_0 + \beta v_0$ (excluding gains from selling shares and exercising stock options). Since the manager's utility is risk-neutral, c_0 can be set to zero without loss of generality, implying $v_0 = 0$.

conflicts by shortening the manager's decision-making horizon while leaving shareholder incentives unaffected.

Once CEOs leave their position—either due to exogenous turnover resulting from an unlucky draw or endogenous turnover caused by a bank failure—they no longer receive salaries or cash bonuses and proceed to sell shares and exercise options. Considering the strong signaling effect of selling shares and exercising options during their tenure, I prohibit managers from selling shares or exercising options while in office.[12]

The bank manager operates over an infinite time horizon and chooses (i) the level of risk-taking, S (or equivalently, the probability of success, p), and (ii) next period's equity, e', given the current state vector, z, and current equity, e. These decisions simultaneously determine the levels of loans and dividends. The state variables are z and e. z follows an exogenous process, while e and e' are endogenously determined in equilibrium. The state variable, a duplet $z \equiv (\widetilde{\theta}_B, \ln \delta_d)$, includes the latent cash bonus incentive ratio, $\widetilde{\theta}_B \in \mathbb{R}$, and the logarithm of deposit capacity, $\ln \delta_d$. In the model, banks set cash bonuses as performance-based pay, tied to revenue as a metric. Cash bonuses are then paid in proportion to revenue and are non-negative. Choosing revenue as a performance measure is consistent with the specifications used in the reduced-form analysis in Section 3, and follows the same reasoning for that choice. In turn, the second element of the state vector z is the logarithm of deposit capacity $\ln \delta_d$. Each bank has its own upper bound on the amount of deposits it can undertake, and these capacities vary over time. To incorporate the persistence observed in the data, I model the dynamics of the state vector z using a one-period lagged Vector Auto Regression (VAR) process (details are in Internet Appendix A.9). Given the negligible correlation between cash bonus incentive ratio and the logarithm of deposits, the correlation between these shocks is set to zero in the VAR model. Cash bonus incentive ratio follows the exogenous process. This exogeneity reflects corporate governance practices where the bank CEO has limited influence over the compensation committee in the short run, which determines cash bonus incentive ratio.

Banks finance their loans, l, through deposits, d, and equity, e, with deposits being a relatively inexpensive source of funding compared to equity. Loans and deposits are central to banking, but the model can also interpret loans as total assets and deposits as liabilities more broadly. For simplicity, I refer to them as loans and deposits, as they are typically the largest components of a bank's assets and liabilities. Deposit rates are denoted as r_d, which is equal to $\beta_d r_f$, where β_d is the deposit rate pass-through, and $r_f = \beta^{-1} - 1$ is the risk-free rate. Since the majority of retail deposits are insured by the FDIC, cross-sectional difference in individual banks' default risks are not priced into deposit rates r_d. Matching the deposit spread $r_f - r_d$ is particularly important since Egan et al. (2022) estimates that deposit productivity accounts for two-thirds of the median bank's value. The bank does not have access to external equity financing due to information frictions between the managers and shareholders. Therefore, net equity payouts are subject to a non-negativity constraint. This external equity financing constraint reflects the fact that seasoned equity offerings (SEOs) both rare and typically small in scale (Wang et al. (2022)).

[12] In practice, banks require CEOs and other executive officers to maintain a minimum level of stock ownership to align incentives, typically set as a fixed multiple of their salary.

Finally, I note that compensation pay is endogenous, whereas the compensation contract is exogenous.[13] Compensation pay refers to the monetary amount received by CEOs, while the compensation contract defines the structure of this payment, including elements such as pay-for-performance sensitivity and the number of option contracts. Since both bank performance and share price are endogenously determined, compensation pay is also endogenously determined. Salary and cash bonuses are awarded on a per-period basis, while the other components—shareholdings, stock options, and pension benefits—are treated as one-time allocations. I model salary F as $\theta_F l^{\alpha_F}$ where $\theta_F \geq 0$ and $\alpha_F \in (0,1)$ are fixed parameters across banks and time, capturing scaling factors. Since bank size l is endogenous, salary pay is also endogenous. Shareholdings θ_S and stock option ratios θ_O are also fixed across banks and time. θ_P denotes a common parameter, consistent across banks and time, representing the ratio of the present value of pension benefits to salary. Later, the three parameters, θ_S, θ_O, and θ_P, are calibrated to match the averages observed in the data.

Manager's Optimization Problem. The bank manager maximizes their lifetime utility $w(z,e)$ given the equilibrium share price $v(z,e)$. The recursive problem is

$$\begin{aligned} w(z,e) &= \max_{\Phi=(S,e')} F + \theta_B \max\left\{ASl^{\alpha_l} - r_d d, 0\right\} \\ &+ \theta_S D(e,S,e') + (1-\alpha_w)\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[w(z',e')\right] \\ &+ \alpha_w\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[\theta_S v(z',e') + \theta_O \max\{v(z',e') - \text{ATM}, 0\} + \theta_P F\right], \end{aligned} \tag{5}$$

subject to auxiliary equations and financial constraints:

$$F = \theta_F l^{\alpha_F} \quad \text{(Fixed salary)}, \tag{6}$$

$$l = d + e, \tag{7}$$

$$\theta_B = \max\left\{\tilde{\theta}_B, 0\right\}, \tag{8}$$

$$D(e,S,e') = (1-\tau_{\text{eff}})\left[(1-\tau_{\text{c}})\left\{ASl^{\alpha_l} - r_d d - \delta_l l\right\} + \tau_{\text{c}}\delta_l l - (e'-e)\right], \tag{9}$$

$$D \geq 0 \quad \text{(External equity issuance constraint)}, \tag{10}$$

$$\text{ATM} = v(z,e|\Phi) - D \quad \text{(At the money strike price)}, \tag{11}$$

$$d = \min\left\{\delta_d, \bar{d}\right\} \quad \text{(Deposit capacity)}, \tag{12}$$

$$\frac{e}{\bar{d}+e} = \bar{\chi} \quad \text{(Capital requirement)}. \tag{13}$$

Eq. (5) provides the manager's per-period utility, continuation values, and terminal values. Φ is a set of policy functions with respect to control variables: risk-taking S and next period equity e'. The first term on the right hand-side of Eq. (5) represents the fixed salary F, which is defined in Eq. (6). The second term in Eq. (5) is the bonus, a revenue-based

[13] Unlike in optimal contract theory, I do not treat the compensation contract as endogenous for two reasons. First, the focus of this paper is to provide quantitative insights into how bank CEOs respond to changes under the suboptimal compensation contracts. Second, the data poses challenges in constructing a quantitative model with optimal contracting. For instance, the cost of CEO compensation in the shareholders' objective function appears disproportionately small in the data compared to theoretical predictions, as noted by Edmans et al. (2023). For these two reasons, I develop a model with a suboptimal compensation contract.

payment calculated as the actual cash bonus incentive ratio, $\max\left\{\tilde{\theta}_B, 0\right\}$, multiplied by revenue $ASl^{\alpha_l} - r_d d$. The latent bonus incentive coefficient, $\tilde{\theta}_B$, follows an AR(1) process, which allows $\tilde{\theta}_B$ to take negative values. However, the realized bonus payment must remain positive; otherwise, it is set to zero. In the third term in Eq. (5), the bank manager receives a fraction θ_S of the bank-level dividends D. The fourth term represents the continuation value if the bank succeeds in loan production with probability $\Lambda(p(S))$ and avoids forced turnover with probability $1 - \alpha_w$. The fifth term of Eq. (7) in the third line represents the terminal payoffs from selling shareholdings, stock options, and the present value of pension benefits for a resigned CEO. The parameter θ_O is the number of stock options normalized by the total number of shareholdings. The strike price is set at-the-money, one period ahead, following the modeling assumption in Glover and Levine (2017). Typically, the stock option is not dividend-protected; therefore, the at the money strike price (ATM) is set to the the ex-dividend price.

Eqs. (6-13) show the variable definitions and the key financial constraints that managers face. Eq. (7) represents the balance sheet identity. The after-tax equity payout D is equal to after-tax profit, plus tax deduction, minus the change in internal equity, $e' - e$. τ_c denotes the corporate tax rate (Eq. (9)). The before-tax profit $ASl^{\alpha_l} - r_d d - \delta_d l$ is equal to loan revenue minus the costs of deposits, and loan depreciation. τ_{eff} is the effective dividend costs, which includes regulatory compliance costs, signaling costs, and other costs associated with dividends that are not micro-founded. The after-tax equity payout, D, is constrained to be positive, and the bank manager cannot not issue external equity to meet financing needs (Eq. (10)). Eq. (11) defines the ex-dividend price of the stock, which is the cum-dividend price v minus the equity payout D. Deposit capacity δ_d captures bank's exposure to the quantity risks of in- and out-flowing deposits. The majority of deposits are demand deposits, which depositors can withdraw at any time. Deposit needs to meet deposit capacity constraint in E.q. (12). Eq. (13) imposes a capital requirement on banks, which contributes to the manager's risk aversion. Banks accept deposits up to their deposit capacity δ_d unless the deposit size exceeds the binding capital requirement given the size of equity.[14] $\bar{d}$ in Eqs. (12-13) represents the maximum amount of deposits under the capital requirement ratio $\bar{\chi}$ given the size of equity e.

Equilibrium. To close the model, I define the equilibrium. The stationary competitive industrial equilibrium is a collection of (i) managers maximizes their utility as in Equation (5) subject to Eqs. (6-13) given the equilibrium share price v, (ii) given manager's policy functions $\Phi = (S(z,e), e'(z,e))$, the representative household optimizes her portfolio. The representative household has no direct power to prevent the bank manager from deviating from the shareholders' interests, except through the market price for shareholding. The Internet Appendix A.11.1 shows the household's optimization problem. With market clearing condition of fixed supply of total share, share price v follows

[14]The model does not solve the optimization problem with respect to deposits (d), thereby reducing the number of control variables. Instead, it assumes that the manager is willing to accept as many deposits as possible, given their low cost compared to other financing options.

$$
\begin{aligned}
v(z,e|\Phi) &= D(e,S,e') + \underbrace{\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[v(z',e'|\Phi)\right]}_{\text{discounted expected value of survived banks}} \\
&+ \underbrace{\beta\left(1-\Lambda(p_{i,t})\right)\mathbb{E}_{z'|z}\left[-\underline{e}+v(z',\underline{e}|\Phi)\right]}_{\text{net discounted expected value of failed/new banks}} . \qquad (14)
\end{aligned}
$$

In Equation (14), the representative household prices shares as the sum of expected discounted cash flows minus the equity injection for newly chartered banks. $\underline{e}$ is a parameter that specifies the size of the equity injection required to start a new bank.

I solve Eqs. (5-14) numerically by discretizing the value function into a finite number of grid points. The numerical algorithm follows the procedure documented in Internet Appendix A.11.2.

4.2 Calibration, Estimation, Identification, and Model-Fit

There are 23 model parameters. 17 of calibrated and externally estimated parameters are reported in Table 10. 6 of internally estimated parameters are summarized in Table 11.

Benchmark Parameters. Discount factor β of 0.96 targets annual real interest rates of $r_f = 4\%$. The bank executive turnover rate α_w is set as 10% in the model, closely aligning with 9% annual turnover rate observed in data from 2000 to 2018. The turnover rate in the data is presented in Internet Appendix A.6. Next, I use large cross-country data and long historical US data to set parameters for systemic banking crises (Internet Appendix A.7). The probability of a banking crisis $1-\Pi$ is 5.5%, based on cross-country evidence from periods between 1800 and 2016 in the Global Crises Data. Krishnamurthy and Li (2020) target an unconditional annual frequency of financial crises of 4%, a value similar to that used in my calibration. The number of failure in banking crisis increases by $\lambda_p \simeq 11$ according to US historical events, using data compiled by the FDIC. The deposit rate pass-through is set to 0.3, a close estimate based on Drechsler et al. (2017, 2021). Assuming real interest rates are equal to the Federal Funds Rate, the deposit rate is $r_d = 1.2\%(= 0.3 \times 4\%)$ in the long-run. The persistence of deposit capacity κ_{δ_d} is estimated from a dynamic panel regression using the Arellano-Bond estimator. Normalization of real values in the model is achieved by setting the average deposit capacity $\bar{\delta}_d$ to 1. The capital requirement ratio $\bar{\chi}$ is set to 6% in the model, which is the midpoint of the minimum capital ratios of Tier 1 to Risk-Weighted Assets (RWA) of 4% and 8% of total capital to RWA in Basel I and II since 1988. The decreasing returns to scale parameter α_l is estimated outside the model using fixed-effects panel regression of revenue on total assets in the data. The estimate gives a 1% increase in total assets increases revenue by 0.84%. Lastly, corporate tax rate τ_c is set to 35%.

Panel B in Table 10 explains parameters regarding with compensation structure selected outside the model. Salary and bank size exhibits a strong log-linear correlation (Appendix Figure A6) A fixed-effects model estimates the elasticity of salary at 0.3, indicating that a 1% increase in bank size leads to a 0.3% increase in salary (Internet Appendix A.8). In

non-financial firms, cross-sectional differences in salary are primarily explained by firm size, but this relationship has weaker or no explanatory power for temporal changes within a firm—a phenomenon often referred to as the cross-sectional "Roberts's law." In contrast, in the banking sector, the log-linear relationship between firm size and CEO salaries remains consistent for temporal variations. Consequently, the decreasing sensitivity of salary to bank size ensures an interior solution for the optimal bank size. In turn, from the second to the fifth rows in Table 10 Panel B report model parameters for shareholdings, unexercisable options, and the present value of pension benefits. On average, the number of CEO's shareholding (unexercisable stock option) to total shares is $\theta_S \simeq 2\%$ ($\theta_O \simeq 0.3\%$) in the data. The average present value of the pension benefit-to-salary ratio in the data is 5. However, the data on pension benefits are limited; additional details are provided in A.10. The model sets a parameter θ_P to 5.[15] The estimated persistency of cash bonus incentive ratio κ_{θ_B} is 0.8 from dynamic panel regression (Internet Appendix A.8). Finally, the mean of the ergodic distribution of latent cash bonus incentive ratio $\bar{\theta}_B$, is set to zero in the benchmark. Since the actual cash bonus incentive ratio, θ_B, only takes positive values, half of the managers do not receive cash bonuses. This model prediction aligns with data observations from 2000 to 2019.

Table 11 reports the SMM estimated parameters inside model. Details of estimation and computation are provided in Internet Appendix A.11.2. The SMM estimator minimizes the objective function in Equation (21) by adjusting model parameters to align model-implied moments with the real-data. I combine a particle swarm algorithm for the global search and the Nelder-Mead algorithm for the local search. To identify six model parameters—θ_F, η_1, σ_{θ_B}, σ_{δ_d}, δ_l, and τ_{eff}—I use six moments. Six moments are the average bonus-to-salary ratio; failure rate; variance of bonus-to-revenue ratio; variance of deposit growth; the average leverage; the average market-to-book ratio. A couple of parameters are interpretable. The estimated elasticity of risky investment suggests that an increase of 1 percentage point in failure probability during normal periods p leads to approximately a 36 basis point increase in the revenue-to-asset ratio.[16] The estimated variable costs of loans, δ_l, are 28 basis points, while the effective dividend costs, τ_{eff}, are 71%. Without these expenses, the model produces a leverage ratio and a price-to-book ratio unusually higher than those observed in the data.

Identification. Figure 3 examines the sensitivity of moments to changes in model parameters. Each row represents a parameter, and each column represents a moment. Steep and monotonic relationships between the six parameters and six moments provide strong identification. The invertibility of the moment matrix ensures that each parameter contributes distinct information, further supporting identification, as evident from the standard errors of the estimated parameters (shown in parentheses in Table 11 Panel B). This invertibility is explained as follows. Horizontally, three moments—the variance of the bonus-to-salary ratio, the variance of deposit growth, and the price-to-book ratio—correspond to three parameters:

[15] The average ratio of CEO's inside-debt to salary ratio across 285 banks is calculated as 5.89 in Van Bekkum (2016).

[16] This result is derived from the following calculation: the marginal contribution to the revenue-to-asset ratio is given by $\frac{\partial}{\partial(1-p)}\left(ASl^{\alpha_l}/l\right) = r_f l^{\alpha_l - 1}\left(\frac{1}{\eta_1}\right)\left(\frac{1-p}{1-\bar{p}}\right)^{1/\eta_1 - 1}$. In equilibrium, with the benchmark parameterization where $\alpha_l \simeq 1$ and $p \simeq \bar{p}$, this simplifies to $\frac{\partial}{\partial(1-p)}\left(ASl^{\alpha_l}\right) \simeq \frac{r_f}{\eta_1}$.

σ_B, σ_{δ_d}, and τ_{eff}, respectively. Each of these parameters is the dominant and sole factor in the model that explains its corresponding moment through a one-to-one relationship with the data. The identification of the remaining three parameters, θ_F, η_1, and δ_l, is explained sequentially. Since σ_B is matched to the variance in deposit growth, the bonus-to-salary ratio informs the size of θ_F. τ_{eff}, determined by the price-to-book ratio, also influences leverage. The two cost parameters, δ_l and τ_{eff}, are identified separately due to the different timing of cost realization. Floating loan costs (δ_l) are incurred before the bank distributes cash flows as dividends or retained earnings (equity), affecting both the market and book value of equity. This results in a neutral or weak negative response on the price-to-book ratio. In contrast, effective dividend costs (τ_{eff}) are paid after the distribution of cash flows as retained earnings. Higher effective dividend costs reduce τ_{eff} dividends while keeping the book value of equity constant, leading to a negative relationship between effective dividend costs and the price-to-book ratio. Finally, floating loan costs (δ_l) are adjusted to ensure that the simulated leverage aligns with real data. The elasticity of risky investment (η_1) is identified by its impact on the failure rate, as changes in η_1 affect only the failure rate while leaving other moments unchanged. Panel A in Table 12 reports the targeted moments used in the SMM estimation. Six model moments are statistically indistinguishable from the real-data moments, confirming a good fit.

Validation. Panel B in Table 12 checks that the fraction of deposits is equal to capacity (i.e., the fraction of banks facing $d \simeq \delta_d$) is 98%, and only 2% of banks have a binding capital ratio constraint. The average deposits in the simulated (real) data is 1.034 (14.030 in log-million-dollars and 1239.5 in million-dollars).[17] Given that deposits are nearly equal to deposit capacity, one unit in the model corresponds to 1.2 billion dollars in 2006, adjusted by inflation.

[17]The average deposits may exceed one, while the mean of the logarithm of deposit capacity, $\ln(\delta_d)$, is zero. Since deposit capacity δ_d follows a log-normal distribution, the mean of δ_d is given by $\exp\left((1-\kappa_{\delta_d})\ln\bar{\delta}_d + \frac{1}{2}\sigma^2_{\delta_d}/(1-\kappa_{\delta_d})^2\right)$. Given that $\bar{\delta}_d = 1$, estimated variance $\sigma^2_{\delta_d} > 0$, and the mean-reversion parameter $0 < \kappa_{\delta_d} < 1$, this parameterization implies that the mean of δ_d is strictly greater than 1.

Table 10: Calibrated and Externally-Estimated Model Parameters.

	Value	Description	Source
Panel A: Preference, Technology, Financial Frictions, Regulations, Taxes Selected Outside Model			
β	0.9600	Manager's and Shareholder's Discount Factor	Standard Parameter
α_w	0.1000	Exogenous Turnover Rate	9% Per Annum
Π	0.9448	One minus Probability of Banking Crisis	Long-Run Cross-Country Average
λ_p	10.9835	Crisis Failure Rate/Non-crisis Failure Rate	Ratios of US Historical Average
$\bar{p}$	0.9985	Long-Run Average Returns on Loan Production	Long-Run Success Rate
β_d	0.3000	Deposit Rate Pass-through	DSS (2017)
κ_{δ_d}	0.8948	Persistency of Deposit Capacity	Panel Regression
$\bar{\delta}_d$	1.0000	Long-Run Average of Deposit Capacity	Normalization
$\bar{\chi}$	0.0600	Capital Requirement Ratio	Regulation
α_l	0.8355	Decreasing Returns to Scale of Loan Production	Panel Regression
τ_c	0.3500	Corporate Tax Rate	Standard Parameter
Panel B: Compensation Structure Selected Outside Model			
α_F	0.2851	Elasticity of Salary	Panel Regression
θ_S	0.0210	Avg. Manager's Total Stock Holding to Total Shares	S&P Capital IQ
θ_O	0.0020	Avg. Manager's Unexercisable Stock Option to Shares	S&P Capital IQ
θ_P	5.0000	Avg. Manager's Present Value of Pension to Salary	S&P Capital IQ
κ_{θ_B}	0.6352	Persistency of Bonus-to-Revenue Ratio	Panel Regression
$\bar{\theta}_B$	0.0024	Long-Run Bonus-to-Revenue Ratio	Frequency of Bonus Payment

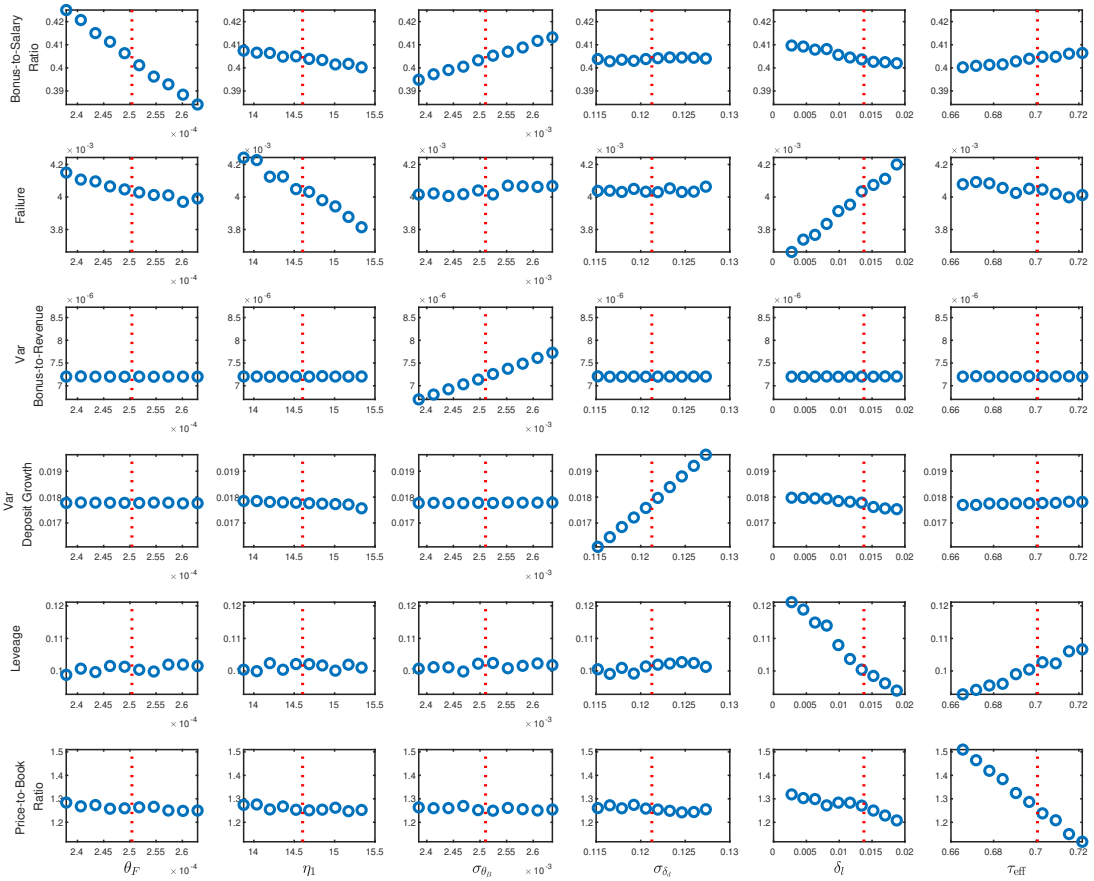
The tables report calibrated in Panel A and externally estimated model parameters in Panel B.

Table 11: Internally-Estimated Model Parameters.

	Description	Estimate
θ_F	Scaling Factor of Salary	0.00025
		(0.00002)
η_1	Elasticity of Risky Investment	14.6040
		(0.5395)
σ_{θ_B}	Volatility of Bonus Sensitivity	0.0025
		(0.0001)
σ_{δ_d}	Volatility of Deposit Capacity	0.1212
		(0.0120)
δ_l	Variable Costs of Loans	0.0138
		(0.0019)
τ_{eff}	Effective Dividend Costs	0.7006
		(0.0803)

Parameters are estimated using the simulated method of moments (SMM). The standard errors of the estimated parameters are reported in parentheses.

Figure 3: Comparative Statics of Moments For A Change in Model Parameters.



The number of simulated samples is $S = 50$. The time period is $T = 1000$, with a burn-in period of $T = 40$ and a sample size of $N = 500$ banks. The solid lines represent the relationship between the model parameters on the x-axes and simulated moments on the y-axes, while the vertical dotted lines correspond to the estimated parameters in each figures. The vertical axis lists the targeted moments, which include the Bonus-to-Salary Ratio, failure rate, variance of the Bonus-to-Revenue Ratio, variance of deposit growth, leverage, and the P/B ratio. The P/B ratio is the ratio of market capitalization to the book value of equity. The horizontal axis lists the estimated parameters being analyzed, denoted as $\theta_F, \eta_1, \sigma_{\theta_B}, \sigma_{\delta_d}, \delta_l$, and τ_{eff}. θ_F is the scaling factor for salary. η_1 measures the elasticity of risky investment. σ_{θ_B} and σ_{δ_d} govern the volatility of cash bonus incentive ratio and deposit capacity processes, respectively. δ_l represents the variable costs of loans, and τ_{eff} captures the effective dividend costs. Each cell in the grid represents the relationship between a specific targeted moment and an estimated parameter.

Table 12: Targeted Moments and Validation of Deposits.

Panel A: Targeted Moments in Simulated Method of Moments

Description	Model	Data	t-test of difference
Average of Bonus-to-Salary Ratio	0.403	0.406	0.004
Failure Rate (bps)	40	43	0.002
Variance of Bonus-to-Revenue Ratio $\times 1000$	0.007	0.007	-0.000
Variance of Deposit Growth	0.018	0.017	-0.003
Average of Leverage	0.100	0.096	-0.144
Average of P/B Ratio	1.269	1.402	0.171

Panel B: Model Simulated Deposit Capacity δ_d and Deposit d

Description	Model
Fraction of Deposits is Equal to the Capacity	0.979
Average Deposits	1.034

Panel A in this table reports the simulated versus real-data moments, along with t-statistics for the pairwise differences. The real-data sample includes bank financials and compensation data from 2000 to 2019. Failure rate includes both sample of normal and banking crises periods. The variance of real-data is calculated using within-bank variation after the removal of fixed effects. Panel B simulates the benchmark model and calculates the distribution and evolution of unobserved deposit capacity, δ_d, and observed deposits, d, across banks and time. In Panel B, "Fraction of Deposits Equal to Capacity" computes the fraction of banks whose deposits exactly match their deposit capacity.

Model Fit. Table 13 evaluates the model performance by comparing simulated moments with the real-data. Unlike with Table 12, moments in Table 13 are not targeted in the SMM estimation. Consequently, this comparison assesses the validity of the modeling assumptions and the parameter calibration. The logarithms of loans and deposits exhibit high persistence, as evidenced by their autocorrelations in both simulated- and real-data. The standard deviation of loan growth is approximately 12% in the model and 16% in the data. Due to the high volatility of the exogenous deposit capacity growth rate, loan growth also becomes highly volatile. The model understates the volatility of equity growth observed in the data, with a volatility of 16% compared to 22% in the data. The model-generated standard deviation of capital ratio is 3.6%, compared to 2.7% in the data. The motives for saving in equity arise from three channels. The first channel is the precautionary motive, driven by capital constraints, the costly nature of external equity financing, and decreasing returns to scale in salary. For instance, if a bank experiences a positive deposit capacity shock and its capital requirement is binding due to insufficient internal equity, it may miss profitable lending opportunities because external equity issuance is prohibited. Additionally, holding more equity reduces salary variability due to decreasing returns to scale. The third channel is the presence of effective dividend costs τ_{eff}. The marginal benefit of saving in equity increases relative to paying dividends when effective dividend costs are higher. This effect is pronounced, as evidenced by the sharp response of leverage to changes in effective dividend costs shown in Figure 3. The model generates an average revenue-to-asset ratio of 3% and an equity payout-to-asset ratio of 0.7%, both aligning with real-world data. Since cash bonuses are tied to the revenue-to-asset ratio, the model must ensure consistency be-

tween managerial compensation and bank financials across both flow and stock variables. Next, I check the distributional characteristics of the compensation structure.

Panel B in Table 13 presents statistics on cash bonuses, cash compensation, share value, and equity payouts. Half of the banks paid cash bonuses to their CEOs, and the model successfully replicates the observed pattern where only around 10% of banks paid cash bonuses exceeding the CEO's salary in both the simulated and real data. This feature is crucial for evaluating the impact of introducing a bonus cap, which is set relative to salary. Over- or underestimating the bonus-to-salary ratio leads to inconsistent results.

In the third row of Panel B in Table 13, the value of shareholdings is eight times larger than the sum of salary and bonuses in both the model-simulated and real-data. Given that the bonus-to-salary ratio is 0.4 (Table 12), the size of bonuses is an order of magnitude smaller than the value of shareholdings. Additionally, histograms of cash bonus incentive ratio θ_B and bonus-to-salary ratio are provided in Figure 4. These histograms show simulated and real–data exhibit similar distributional characteristics.

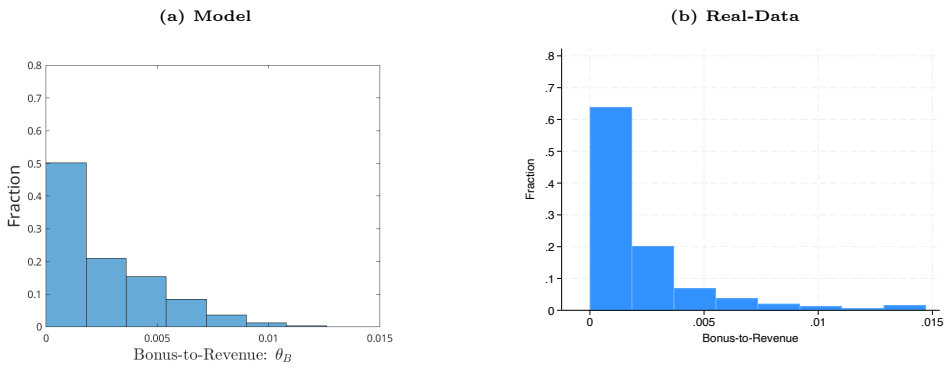
Table 13: Validation of Model Simulated-Data Against Real-Data of Bank Financials and Compensation.

Moments	Model	Data
Panel A: Balance Sheets and Profits and Losses		
Auto Corr. of ln Loans	0.8867	0.9341
Auto Corr. of ln Deposits	0.8833	0.9341
Std. Dev. of Loan Growth	0.1222	0.1619
Corr(ln Loans, ln Deposits)	0.9904	0.9837
Std. Dev. of Equity Growth	0.1622	0.2240
Std. Dev. of Leverage	0.0361	0.0270
Mean of Revenue per Assets	0.0310	0.0397
Mean of Equity Payout per Assets	0.0053	0.0047
Std. Dev. of Equity Payout per Assets	0.0066	0.0039
Panel B: Compensation		
Fraction of Banks Paying CEO Bonuses	0.7059	0.7391
Fraction of Banks Paying CEO Bonuses Equal to or Greater than Salary	0.0871	0.0985
Mean of Share Value-to-Salary and Bonus	8.2191	8.0380
Mean of Equity Payout-to-Salary and Bonus	0.3593	0.2935

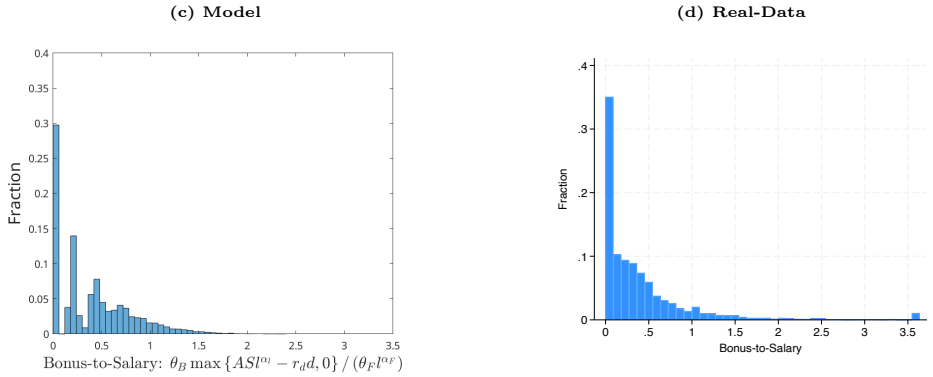
The table compares moments from the model with real data not used in the Simulated Method of Moments estimation. All real-data variables are expressed in inflation-adjusted terms, with the sample period spanning from 2000 to 2019. The autocorrelation of logarithms and the cross-correlation of loans and deposits are calculated using demeaned logarithms at the bank level to account for unobserved heterogeneity. Leverage is defined as the equity-to-total assets ratio. In the real-data, equity payouts in the model are matched with cash dividends. The "Fraction of Banks Paying CEO Bonuses" is calculated as the ratio of banks paying non-zero bonuses to the total number of banks in each period. In the model, the "Fraction of Banks Paying CEO Bonuses Equal to or Greater than Salary" is defined as the ratio of banks where bonuses $\max\left\{\tilde{\theta}_B, 0\right\} \max\left\{ASl^{\alpha_l} - r_d d, 0\right\}$ are equal to or greater than the salary $\theta_F l^{\alpha_F}$. Mean of share value-to-salary and bonus ratio is $\theta_S v / \left[\max\left\{\tilde{\theta}_B, 0\right\} \max\left\{ASl^{\alpha_l} - r_d d, 0\right\}\right]$.

Figure 4: Model Validation of Cash Bonus Incentive Coefficient and Bonus-to-Salary Ratio.

Variations in the Cash Bonus Incentive Ratio θ_B



Variations in the Bonus-to-Salary Ratio



These histograms compare cash bonus incentive ratio and the bonus-to-salary ratios in the model and real-data. In the model, observed cash bonus incentive ratio (the bonus-to-salary ratio) is calculated as $\theta_B = \max\left\{\tilde{\theta}_B, 0\right\}$ ($\theta_B \max\{ASl^{\alpha_l} - r_d d, 0\} / (\theta_F l^{\alpha_F})$). The number of simulated samples is $S = 50$. The histograms in Panel (a) and (c) are based on model simulated-data. The time period is $T = 1000$, with a burn-in period of $T = 40$ and a sample size of $N = 500$ banks. The histograms in Panel (b) and (d) are based on real-data from 2000 to 2019.

Policy and Value Functions. Panel A (Panel B) of Figure 5 depicts two policy (value) functions. These functions are computed at equilibrium and averaged over the model's ergodic distribution, conditional on the latent cash bonus incentive ratio, $\tilde{\theta}_B$, and deposit capacity, δ_d.

In the left-hand figure of Panel A, higher latent cash bonus sensitivity ($\tilde{\theta}_B$) increases the probability of failure during normal periods ($1-p$, top-left panel) while also raising the level of equity in the next period (e', top-right panel). The economic mechanism behind the elevated failure probability is that cash bonuses—being short-term in nature—increase the marginal incentive for risk-taking, as managers seek to maximize immediate payouts. In Section 4.4, I quantify the impact of a bonus cap and compare it with alternative compensation regulations proposed by policymakers. On the one hand, the capital constraint on next-period equity

(e') binds at low levels of bonus sensitivity, particularly in the northwest region of the state space. On the other hand, when bonus sensitivity is high (southeast region), the constraint becomes slack, and a precautionary saving motive dominates: the bank manager optimally chooses to hold a buffer of equity to mitigate future risks.

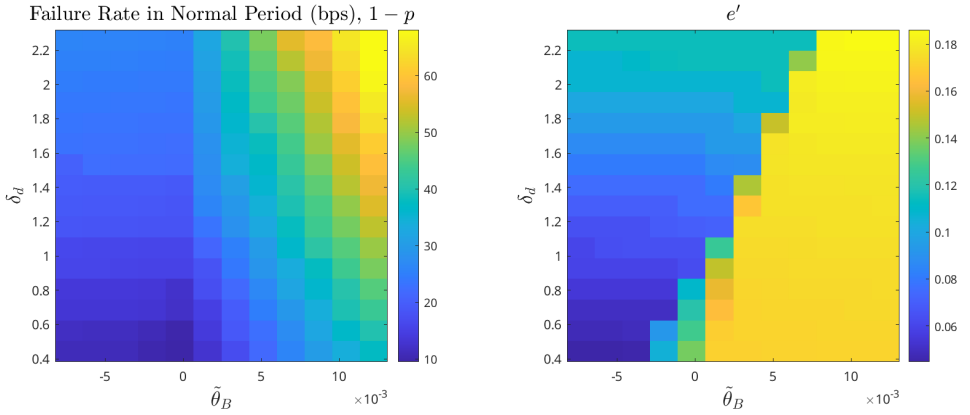
Panel B presents the model-implied value functions for the manager (w, left) and the shareholder (v, right). These characterize expected continuation values at equilibrium, conditional on $\tilde{\theta}_B$ and δ_d. The contrast in their patterns reflects the degree of incentive misalignment between the two parties. The manager's value function is more sensitive to changes in $\tilde{\theta}_B$, exhibiting greater variation along the horizontal axis. In contrast, the shareholder's value increases more uniformly with δ_d, and is less responsive to $\tilde{\theta}_B$. This asymmetry highlights that the effect of cash bonus incentives on shareholder value is largely indirect—operating through the manager's decisions. Theoretically, this can be understood via the envelope condition of the manager's recursive problem in Equation 5, which implies:

$$
\begin{aligned}
\frac{\partial}{\partial \tilde{\theta}_B}\left(\frac{\partial w}{\partial \delta_d}\right) \;=\; & \underbrace{\mathbb{1}_{\tilde{\theta}_B>0}\frac{\partial}{\partial \delta_d}\left(ASl^{\alpha_l}-r_d d\right)}_{\text{Marginal Revenue of Deposit Capacity (MRDC)}} \\
- \;& \mathbb{1}_{D\geq 0}\theta_S(1-\tau_{\text{eff}})\frac{\partial}{\partial \tilde{\theta}_B}\left(\frac{\partial}{\partial \delta_d}e'(z,e)\right) \\
+ \;& \frac{\partial}{\partial \tilde{\theta}_B}\Bigg\{\frac{\partial}{\partial \delta_d}\Bigg((1-\alpha_w)\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[w(z',e')\right]\alpha_w\beta\Lambda(p(S)) \\
+ \;& \alpha_w\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[\theta_S v(z',e')+\theta_O\max\{v(z',e')-\text{ATM},0\}\right]\Bigg)\Bigg\}. \quad (15)
\end{aligned}
$$

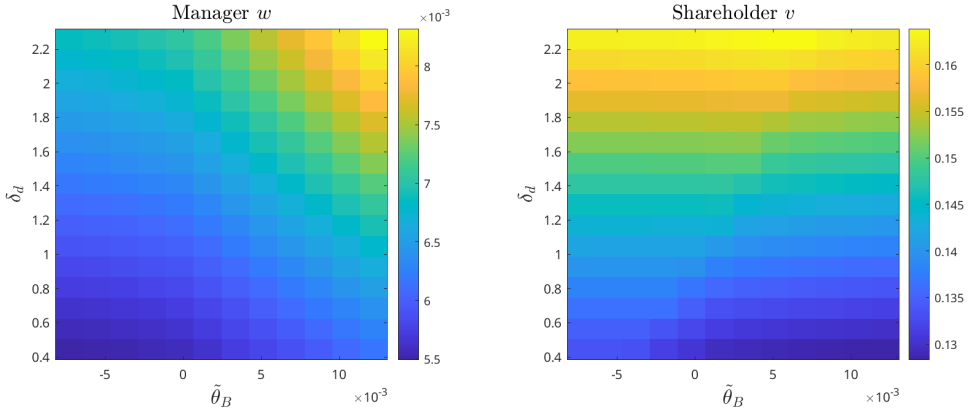
The cross-partial derivative $\frac{\partial}{\partial \tilde{\theta}_B}\left(\frac{\partial w}{\partial \delta_d}\right)$ captures how the marginal value of additional deposit capacity δ_d changes with respect to the latent cash bonus incentive ratio $\tilde{\theta}_B$. Economically, a positive cross-partial implies that stronger bonus incentives amplify the marginal benefit of increased deposit capacity for the manager's continuation value. Numerical simulations indicate that $\frac{\partial}{\partial \tilde{\theta}_B}\left(\frac{\partial w}{\partial \delta_d}\right) > 0$, and I provide an analytical explanation for this result. The first term in parentheses on the right-hand side of Equation 15 represents the marginal revenue of deposit capacity (MRDC), which is primarily positive due to a favorable interest rate margin—driven by the significant mark-down on deposit rates. As a result, an additional unit of deposit capacity is profitable and materially affects cash bonus payouts. The second term captures a direct negative effect on dividends due to increased retention of earnings. However, numerical results suggest this effect is comparatively small. The third and fourth terms in Equation 15, which involve discounted expected future values, reflect the persistence of the latent state variables $\tilde{\theta}_B$ and δ_d.

Figure 5: Equilibrium Policy and Value Functions as a Function of Bonus Sensitivity and Deposit Capacity.

Panel A: Policy Functions



Panel B: Value Functions



These figures show the optimal policy functions Φ (bottom panels) from Equation 5 at equilibrium, and the value functions w (top-left panel) and v (top-right panel). In the top-left and top-right panels, the probability of failure in normal periods $(1-p)$ and the optimal next-period equity (e'), respectively, are plotted as functions of the latent cash bonus incentive ratio $\tilde{\theta}_B$ and deposit capacity δ_d. These functions are computed at equilibrium and averaged over the model's ergodic distribution. In each figure, the colors represent the magnitude of the corresponding choice variable: failure rates, next-period equity, and manager and shareholder value functions, respectively.

4.3 Designs of Counterfactual Policies

In this section, I present counterfactual experiments, focusing on two sets of simulations. The first set aims to measure the impact of short-termism and managerial conflicts on failure rates, loans, and market capitalization. Firstly, I set the turnover rates α_v, from 10% in the benchmark scenario to 5% in the counterfactual. Additionally, I explore the effects of increasing managers' shareholdings, a commonly discussed remedy among policymakers to address agency conflicts. Finally, I entirely eliminate misalignments in managerial incentives arising from compensation schemes and turnover. In turn, the second set of counterfactual simulations compares policy proposals for regulating compensation schemes. The counterfactual policy scenarios include (i) the Dodd-Frank Act Section 956l, (ii) the EU bonus cap,

(iii) unsecured and secured contingent debt, and (iv) an option ban.

Dodd-Frank Act Section 956. Section 956 of the Dodd-Frank Act proposes deferring a portion of bonuses. In my model, I assume that 50% ($\tau = 50\%$, τ represents the weight of deferred compensation for bonuses and dividends) of bonuses are subject to a one-year deferral. This simplifies the proposed rule, which requires 40–60% of bonuses to be deferred, by using the midpoint. The deferred compensation accrues at the risk-free rate r_f and is discounted by the factor β. The manager's problem in Equation (5) is replaced with a new recursive formulation under the Dodd-Frank proposal:

$$\begin{aligned} w(z,e) &= \max_{\Phi=(S,e')} F + \underbrace{\{(1-\tau)+\tau\beta(1+r_f)\Lambda(p(S))\}\,\theta_B \max\{ASl^{\alpha_l} - r_d d, 0\}}_{\text{deferred bonuses}} \\ &+ \theta_S D(e,S,e') + (1-\alpha_w)\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[w(z',e')\right] \\ &+ \alpha_w\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[\theta_S v(z',e') + \theta_O \max\{v(z',e') - \text{ATM}, 0\} + \theta_P F\right]. \end{aligned} \tag{16}$$

Deferred bonuses repay a fraction of an expected failure rate $1-\Lambda(p(S))$ of the bonuses to shareholders in the 2nd term of Equation (16). Compared to the benchmark model in Equation (5), the bank CEO faces reduced incentives to pursue riskier strategies, as the expected payouts from bonuses are lower. Depending on the model parameters, the bank manager may adjust loan issuance either upward or downward.

EU Bonus Cap. The EU bonus cap combines capping and deferring bonuses. After the implementation of EU bonus cap-like compensation regulation in the US banking industry, the manager's problem becomes:

$$\begin{aligned} w(z,e) &= \max_{\Phi=(S,e')} F + \underbrace{\{(1-\tau)+\tau\beta(1+r_f)\Lambda(p(S))\}\min\{\theta_B \max\{ASl^{\alpha_l} - r_d d, 0\}, F\}}_{\text{bonus cap and deferred bonuses}} \\ &+ \theta_S D(e,S,e') + (1-\alpha_w)\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[w(z',e')\right] \\ &+ \alpha_w\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[\theta_S v(z',e') + \theta_O \max\{v(z',e') - \text{ATM}, 0\} + \theta_P F\right]. \end{aligned} \tag{17}$$

The fixed salary, F, is set as the bonus cap in the 2nd term of Equation (17). Additionally, the EU introduces a parameter τ that governs the proportion of bonuses that are deferred. I impose a deferred bonus weight τ of 50%, which is in the middle of the 40-60% range that the EU, and the rule in the UK before 2024 use to restrict the fraction of variable pay that must be deferred. Although the term "EU Bonus Cap" suggests only capping bonuses, the implemented regulation combines the bonus cap with deferred bonuses. As additional counterfactuals, I examine the effects of (i) deferred bonuses and (ii) bonus caps, respectively.

Unsecured and Secured Contingent Debts. This policy adds pension benefit-like pay as unsecured contingent debt.[18] Standard pension benefit practices, which are typically unsecured, calculate pension benefits as a percentage of the CEO's final salary or an average of salaries over recent years (Sundaram and Yermack (2007)). In the model, unsecured

[18] A broader concept of debt-like compensation, referred to as "inside debt," includes both deferred compensation and pension benefits.

contingent debt is payable upon both retirement and contingent on the bank's survival. The manager's problem with additional unsecured contingent debt is formulated as follows:

$$\begin{aligned} w(z,e) &= \max_{\Phi=(S,e')} F + \theta_B \max\{ASl^{\alpha_l} - r_d d, 0\} \\ &+ \theta_S D(e,S,e') + (1-\alpha_w)\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[w(z',e')\right] \\ &+ \alpha_w\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[\theta_S v(z',e') + \theta_O \max\{v(z',e') - \text{ATM}, 0\} + \theta_P F\right] \\ &+ \underbrace{\alpha_w\beta\Lambda(p(S))F}_{\text{unsecured contingent debt}}, \end{aligned} \tag{18}$$

where the parameter τ adds payouts of salary multiplied by the factor τ. I add contingent payments of the same size as the salary by setting the parameter τ to one. Incorporating contingent debt in a counterfactual experiment provides valuable insights into how changes in compensation structure influence risk-taking and lending behavior.

Similar to unsecured contingent debt, secured debt is payable upon retirement but is not contingent on the bank's survival. The manager's problem with additional secured contingent debt is formulated as follows:

$$\begin{aligned} w(z,e) &= \max_{\Phi=(S,e')} F + \theta_B \max\{ASl^{\alpha_l} - r_d d, 0\} \\ &+ \theta_S D(e,S,e') + (1-\alpha_w)\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[w(z',e')\right] \\ &+ \alpha_w\beta\Lambda(p(S))\mathbb{E}_{z'|z}\left[\theta_S v(z',e') + \theta_O \max\{v(z',e') - \text{ATM}, 0\} + \theta_P F\right] \\ &+ \underbrace{\alpha_w\beta F}_{\text{unsecured contingent debt}}. \end{aligned} \tag{19}$$

Qualitatively, unsecured contingent debt provides weaker risk-taking incentives than secured contingent debt, as its expected payout declines more sharply with increasing failure rates.

Option Ban. The option ban sets θ_O to zero in the benchmark model of Equation (5). The effect of options on risk-taking is ambiguous. Options may increase risk-taking by incentivizing dividends above the strike price. However, this effect might be mitigated or even reversed, as the risk-taking decision could be priced into the shareholder value, thereby raising the strike price in equilibrium. A higher strike price reduces option payoffs, assuming all else remains equal. Therefore, only the dynamic model can quantify the overall impact of banning stock options on risk-taking.

4.4 Results

4.4.1 Quantifying Agency Conflicts and Measuring the Effects of Counterfactual Compensation Regulations

Table 14 presents the results from the benchmark (Panel A) and counterfactual experiments (Panels B and C), based on the model specifications described in Section 4.3. The table

reports the effects on failure rates during crises, loans, book value of equity, and market capitalization in the long-run. I compare the benchmark model, which reflects the real-world, to counterfactuals. The simulated sample consists of $S = 50$, with $T = 1000$ time periods, a burn-in period of $T = 40$, and $N = 500$ hypothetical banks.[19] The longer time horizon compared to simulations in estimation allows me to ensure finite sample performance and accurately compute the average failure rate during a crisis.

In Panel B, I analyze the impact of incentive misalignment between managers and shareholders arising from exogenous turnover and compensation structures. First, I explain the effects of turnover (model (b)). To evaluate these effects, the counterfactual model lowers exogenous turnover by setting its rate, α_w, from 10% to 5%. The findings indicate that lower turnover (i) reduces risk-taking and (ii) increases lending. Turnover-induced short-termism intensifies pressure for immediate returns, thereby increasing risk-taking (S). Halving turnover reduces failure rates during crises by 48 basis points. Moreover, mitigating short-termism encourages managers to retain more earnings, as reflected in a reduction in the equity payout-to-equity ratio from 4.6% to 4.1%. The net effect on market capitalization in a low-turnover economy is near-zero.

Next, I describe the implications for shareholdings and examine the near elimination of agency conflicts (model (c-d)). Specifically, I test the prevailing hypothesis that increased equity ownership enhances bank governance. The results contradict this view. Model (c), which incorporates shareholdings one standard deviation above the benchmark, shows that higher shareholdings strengthen risk-taking incentives and reduce internal savings. To understand the incentive differences between salary and shareholdings, it is important to note that size-dependent salaries are relatively insensitive to short-term returns, whereas shareholdings are more sensitive. Even though an inter-temporal effect is present, where increased risk-taking raises revenue and subsequently boosts future equity and cash bonuses, is quantitatively insignificant. In model (c), with higher shareholdings, the relative size of salary decreases, giving the manager stronger incentives to take risks and weaker incentives to save as equity. This shift from retained earnings to dividends occurs because the manager's marginal continuation value declines with higher risk-taking. As a result, the simulation shows a 38-basis-point increase in failure rates during crises and a 3.1% decrease in loans compared to the benchmark, primarily driven by a drop in equity levels. This analysis, framed through the model, helps to explain the reduced-form findings in Section 3.3 and the empirical results in FS (2011) and Beltratti and Stulz (2012), all of which indicate that greater managerial shareholdings are associated with higher failure rates or poorer performance during the GFC.

Finally, model (d) examines the combined effects of eliminating exogenous turnover and implementing compensation structures that exclude shareholdings. This scenario leads to substantially higher failure rates, even under minimal agency conflict, as equity-based compensation typically incentivizes risk-taking. Loan volumes also decline relative to the benchmark. Despite these adverse effects, aggregate shareholder value increases by 1% in the zero-agency-conflict setting. This result underscores the tension between aligning manage-

[19] Michaelides and Ng (2000) suggests that $S = 10$ provides a reasonable size for finite sample performance. However, I adopt a more conservative sample size. A longer sample is necessary to calculate failure rates during crises, as both bank failure and banking crises occur infrequently in both the model and real-world data.

rial incentives and mitigating risk-taking.

In Panel C, I conduct additional seven counterfactual policy experiments (models (e)–(k)) as detailed in Table 14. These policies reflect proposals frequently discussed by scholars and policymakers. The Dodd-Frank Act Section 956 proposes (model (e)) deferred bonuses to address short-termism. Models (f) tests deferred bonuses, respectively. While these policies (models (e)–(f)) reduce risk-taking and increase lending, their impact on bank value is modest. Model (g) explores bonus caps at 100% of salary, respectively. This cap reduces long-term lending by 53 basis points and lower crisis failure rates by 25 basis points. Bank value in model (g) decreases by 1 percentage. In summary, policies involving deferred bonuses and bonus caps reduce bank value, rendering them unattractive to shareholders. Model (h) examines the EU bonus cap, which combines a deferred bonus structure with a cap on bonuses. The result is similar to model (g), which implements only a bonus cap. In summary, I find that bonus caps have higher impact on risk-taking compared to deferred bonuses.

Model (i) and (j) evaluates the introduction of additional unsecured and secured contingent debt equivalent to 100% of the previous year's salary, respectively. Both secured and unsecured debt yield nearly identical results, decreasing failure rates by 8-9 basis points. I conclude that contingent debt in the model primarily addresses short-termism arising from turnover risk. Lastly, the reduced-form evidence presented in Section 3.3 to consider the effects of banning stock options (model (k)). However, this policy has negligible impact, reducing failure rates by only 1 basis points.

To conclude, a bonus cap has the greatest impact on reducing failures during a crisis. However, it also significantly reduces market capitalization. This reduction is due to low risk-taking.

Table 14: Quantifying Agency Conflicts and Measuring the Effects of Counterfactual Compensation Regulations.

Policy	Failure in Crisis (bps)	Change (bps)	Change (%)	Loans	Change (%)	Equity	Change (%)	Market Cap	Change (%)	Def. Bonuses	Bonus Cap
Panel A: US Banking Sector											
(a) Benchmark	286	n.a.	1.1445	n.a.	0.1102	n.a.	0.1297	n.a.			
Panel B: Understanding Short-termism and Agency Conflicts											
(b) Exogenous Turnover 5%	238	-48	-17	1.1589	1.26	0.1241	12.67	0.1296	-0.02		
(c) $+1\sigma$ Shareholdings	324	38	13	1.1092	-3.09	0.0793	-28.07	0.1289	-0.59		
(d) Zero Agency Conflict	425	139	49	1.0949	-4.34	0.0738	-33.02	0.1309	0.98		
Panel C: Proposed Compensation Regulations											
(e) Dodd-Frank Act Section 956	283	-3	-1	1.1453	0.06	0.1112	0.92	0.1299	0.16	50%	
(f) Deferred Bonuses	278	-8	-3	1.1466	0.18	0.1123	1.92	0.1302	0.40	100%	
(g) Bonus Cap (100% of Salary)	261	-25	-9	1.1385	-0.53	0.1034	-6.18	0.1284	-0.98		100%
(h) EU Bonus Cap	258	-28	-10	1.1374	-0.62	0.1027	-6.80	0.1280	-1.25	50%	50%
(i) Unsecured Cont. Debt (100% of Salary)	277	-9	-3	1.1503	0.51	0.1155	4.84	0.1302	0.45		
(j) Secured Cont. Debt (100% of Salary)	278	-8	-3	1.1485	0.35	0.1142	3.66	0.1299	0.21		
(k) Banned Option	285	-1	-0	1.1443	-0.02	0.1097	-0.43	0.1296	-0.06		

The footnote is located at the bottom of the last table.

Policy	Equity Payout	Change	Leverage	Change
Panel A: US Banking Sector				
(a) Benchmark	0.0466	0.0000	0.0999	0.0000
Panel B: Understanding Short-termism and Agency Conflicts				
(b) Exogenous Turnover 5%	0.0411	-0.0055	0.1118	0.0119
(c) $+1\sigma$ Shareholdings	0.0654	0.0189	0.0726	-0.0272
(d) Zero Agency Conflict	0.0722	0.0257	0.0680	-0.0318
Panel C: Proposed Compensation Regulations				
(e) Dodd-Frank Act Section 956	0.0464	-0.0002	0.1008	0.0009
(f) Deferred Bonuses	0.0459	-0.0007	0.1016	0.0017
(g) Bonus Cap (100% of Salary)	0.0492	0.0027	0.0949	-0.0050
(h) EU Bonus Cap	0.0496	0.0030	0.0943	-0.0055
(i) Unsecured Cont. Debt (100% of Salary)	0.0447	-0.0019	0.1044	0.0045
(j) Secured Cont. Debt (100% of Salary)	0.0452	-0.0014	0.1031	0.0032
(k) Banned Option	0.0468	0.0002	0.0996	-0.0003

The tables in Panels A, B, and C calculate the failure rates during crises, long-run outcome of loans, book value of equity, market capitalization, equity payout, and leverage. The simulated sample consists of $S = 50$, with $T = 1000$ time periods, a burn-in period of $T = 40$, and $N = 500$ hypothetical banks. "Failure in crisis" in the first column represent the average across banks and time, using failures observed during periods of banking crisis ($c = 1$). Loans, equity, market capitalization, and equity payout are computed as the time average of the aggregate sum of individual financials, with the total measure across all banks normalized to one. Leverage is reported as the average across banks and over time. In Panel B, the first row (b) of the low turnover model reduces the turnover rate α_v from 10% (the benchmark) to 5% (the counterfactual). The second row (c) conducts an experiment by raising the shareholding ratio θ_S by one standard deviation (with one standard deviation equal to 0.043). In the zero agency conflict model (row (d)), turnover rates (α_v) are set to zero, and compensation is limited to shareholdings only. Agency conflict is not entirely eliminated because the equity injection for newly chartered banks is borne by shareholders rather than failed CEOs. Panel C reports on simulations of counterfactual CEO compensation policy proposals. The "Dodd-Frank Proposal" model (row (e)) implements deferred bonuses (Equation (16)). Row (f) analyzes the impact of deferring all cash bonuses. The "Bonus Cap 100%" model (row (g)) limits cash bonuses to 100% of salary. The "EU Bonus Cap" model (row (h)) introduces bonus cap on 100% of salary, with those bonuses deferred (Equation (17)). The "Secured Cont. Debt" model in row (i) includes a secured pension benefit equivalent to the annual salary paid in the previous year, which is disbursed upon retirement (Equation (19)). The "Unsecured Cont. Debt" model in row (j) features an unsecured pension benefit similar to secured contingent debt, except that it is paid only if the bank survives (Equation (18)). An option ban model (row (k)) sets unexercised options to zero (i.e., $\theta_O = 0$), effectively prohibiting option-based compensation.

5 Conclusion

This paper makes a twofold contribution to the literature. First, it provides new evidence linking bank performance to shortcomings in CEO compensation structures. I construct a novel dataset encompassing both SMBs and S&P 1500 banks. The reduced-form analysis identifies an economically significant positive relationship between systemic risk-taking and compensation, particularly cash bonuses and unexercisable stock options. These regression results remain robust across various bank performance measures, including ROA, ROE, buy-and-hold returns, and bank failure. To address potential endogeneity concerns, I employ the modified control function method, which allows me to establish a causal link between CEO compensation structures—especially cash bonus incentive ratio and unexercisable stock options—and risk-taking. Overall, the results are consistent across different specifications and estimation methods.

Second, I develop a quantitative banking model with dynamic financing choices to evaluate the effects of salary, bonuses shareholdings, stock options, and pension benefits on systemic risk-taking. The model incorporates bank managers facing decreasing returns to scale in salary, idiosyncratic and persistent risky deposit inflows and outflows, external equity financing costs, and capital requirements. Using U.S. data, I estimate the model and demonstrate its alignment with empirical findings from the reduced-form analysis. Furthermore, I compare the effects of proposed but unimplemented regulations discussed by policymakers. In a counterfactual analysis, I find that a bonus cap reduces both bank failures and loan volumes, leading to a decline in bank value relative to the benchmark. While these proposed policies effectively lower bank failure rates, they also introduce adverse effects on financial intermediation.

Future research could investigate how other banking regulations, such as capital requirements, and frictions, such as imperfect competition in the deposit market, interact with CEO compensation incentives. Moreover, extending dynamic banking models to incorporate incentive misalignments, including salaries, cash bonuses, shareholdings, stock options, and pension benefits, within a general equilibrium framework could yield valuable insights into the welfare implications of CEO compensation regulations and other micro- and macroprudential policies.

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A Internet Appendices

A.1 Post-GFC Policy Debates on Bank CEO Compensation

Ben Bernanke, Chairman of the Federal Reserve, commented, "*Compensation practices at some banking organizations have led to misaligned incentives and excessive risk-taking, contributing to bank losses and financial instability*" (Press Release, Board of Governors of the Federal Reserve System, October 22, 2009).

The Financial Stability Forum (2009) report notes that *"High short-term profits led to generous bonus payments to employees without adequate regard to the longer-term risks they imposed on their firms,"* raising concerns in short-termism in banking sector.

Timothy Geithner, United States Secretary of the Treasury, highlighted the role of compensation structures in the financial crisis, noting in his testimony to Congress on June 6, 2009, that *"although many things caused this crisis, what happened to compensation and the incentives in creative risk-taking did contribute in some institutions to the vulnerability that we saw in this financial crisis."*

William Dudley, President and CEO of the Federal Reserve Bank of New York, emphasized the importance of focusing on the incentives facing banks and their employees, stating that *"an effective regulatory regime and comprehensive supervision are not sufficient"* (U.S. Chamber of Commerce, Washington DC, March 26, 2018). Dudley suggests that bank CEO compensation *"needs to be a shift in the mix of deferred compensation away from equity and towards debt"* to improve financial stability and rebuild public trust (Dudley (2014)).

A.2 Data Construction from S&P Capital IQ

Since the only information available in the current and former job titles for each executive officer is reported in DEF 14A, I identify the bank CEO by choosing the executive officer with the highest salary. I presume that the highest salary officer is the bank CEO. Although this individual may hold a title such as president or chairman instead of CEO, any of these roles should represent the bank's top management, responsible for making major corporate decisions.

Most variables used in the reduced-form analysis and the dynamic model are accessible through the Excel plug-in in S&P Capital IQ. However, the key variables, "Percentage Ownership from Shares" and "Present Value of Accumulated Benefits," are not available through the plug-in. Consequently, I employ a combination of manual data collection and web scraping techniques to construct the database. Specifically, I manually download the "Capital IQ Person Screening Report" as an HTML-formatted file from S&P Capital IQ for each bank executive on the name list. The screening criteria are as follows: (i) the executive must work at a commercial bank; (ii) the bank's total assets in 2006 must be non-zero; and (iii) the executive's salary must be reported as non-zero for at least one period between 2000 and 2019. Second, I use Python, along with the Beautiful Soup library, to extract these two variables from the rows labeled "% Of CSO" and "Present Value of Accumulated Benefits"

in the HTML-formatted file.

The market capitalization is calculated from the product of outstanding shares and the stock price of the bank. Outstanding shares are as of the end of the year. Since the initial filing date of the balance sheet period end is not available in S&P Capital IQ, I use the end of the year stock price to compute the market capitalization.

A closely related dataset is constructed by Berger et al. (2016), who study a sample of 341 commercial banks from 2006:Q1 to 2010:Q3, with particular attention to hand-collected data from failed institutions. In contrast, my dataset includes nearly twice as many banks.

A.3 Robustness of Cross-Sectional Analysis

This section assesses the robustness of the reduced-form analyses in Section 3.3. Table A1 tests whether the results hold when the dependent variables are replaced with ROE and buy-and-hold returns. Table A2 employs an alternative measure for cash bonus incentive ratio.

A.3.1 Alternative Measure for Returns and Cash Bonus Incentive Coefficient

Table A1: Explaining Return on Equity and Buy-And-Hold Returns during the Financial Crisis.

Panel A: Return on Equity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bonus/revenue (θ_B)	-12.07***					-21.09***	-21.23***
	(-3.28)					(-3.99)	(-4.09)
$\mathbb{1}_{\text{Bonus}>0}$	0.0768***					0.0839***	0.0698**
	(3.04)					(2.84)	(2.57)
Ownership from shares (θ_S)		-0.251				-0.223	-0.237
		(-1.05)				(-0.81)	(-0.88)
Unexercisable options (θ_O)			-4.375**			-5.447**	-5.818***
			(-2.58)			(-2.17)	(-2.67)
$\mathbb{1}_{\text{Unexercisable option}>0}$			-0.00880			-0.0175	-0.0149
			(-0.43)			(-0.69)	(-0.60)
Salary and others/total assets				-22.60		10.94	21.45
				(-1.14)		(0.25)	(0.52)
Exercisable options					-0.481*	0.167	0.186
					(-1.89)	(0.35)	(0.39)
SMB Sample Only	Yes	Yes	Yes	Yes	Yes	Yes	No
Lagged Returns	No	No	No	No	No	Yes	Yes
Control of Bank Characteristics	No	No	No	No	No	Yes	Yes
Adjusted R-squared	0.029	0.001	0.017	0.000	0.004	0.118	0.124
Total Obs.	619	530	619	619	619	520	579

The footnote is located at the bottom of the last table.

Panel B: Buy-And-Hold Returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bonus/revenue (θ_B)	-28.07***					-35.37***	-35.49***
	(-6.58)					(-6.34)	(-6.20)
$\mathbb{1}_{\text{Bonus}>0}$	0.123***					0.109**	0.0930**
	(3.37)					(2.58)	(2.32)
Ownership from shares (θ_S)		-0.133				-0.112	0.0199
		(-0.42)				(-0.33)	(0.06)
Unexercisable options (θ_O)			-7.457***			-6.022***	-6.449***
			(-5.33)			(-2.61)	(-3.15)
$\mathbb{1}_{\text{Unexercisable option}>0}$			-0.0341			-0.0627*	-0.0544
			(-1.18)			(-1.70)	(-1.53)
Salary and others/total assets				-83.00***		68.37	17.76
				(-3.14)		(1.43)	(0.35)
Exercisable options					-1.296***	-0.274	-0.150
					(-4.27)	(-0.63)	(-0.33)
SMB Sample Only	Yes	Yes	Yes	Yes	Yes	Yes	No
Lagged Returns	No	No	No	No	No	Yes	Yes
Control of Bank Characteristics	No	No	No	No	No	Yes	Yes
Adjusted R-squared	0.081	-0.001	0.034	0.014	0.021	0.171	0.150
Total Obs.	598	504	599	599	599	495	550

The tables present results from cross-sectional regressions of ROA in Panel A and buy-and-hold returns in Panel B for a sample of bank holding companies and stand-alone banks. ROA is calculated as the ratio of net income from July 2007 to August 2008 divided by total assets as of the end of June 2007. The "bonus-to-revenue ratio" is calculated as the annual bonus for 2006 divided by the annual revenue for that year. "Ownership from shares" refers to the shareholdings of a bank CEO divided by the total number of shares issued. "Salary and others/total assets" is defined as the annual salary plus other cash compensation, excluding cash bonuses, for 2006, divided by total assets at the end of 2006. "Exercisable options" and "Unexercisable options" represent the ratios of the number of options to the total number of shares of common stock outstanding. Specifications (6) and (7) include indicator functions as dependent variables. $\mathbb{1}_{\text{Bonus}>0}$ ($\mathbb{1}_{\text{FS}}$) is an indicator function that takes the value of 1 if bank i's bonus payment is strictly positive (or if bank i is in the S&P 1500 group, as in the corresponding sample in FS (2011)). Columns (1) to (4) use a sample of SMBs, while Column (5) includes a sample of both SMBs and S&P 1500 banks. "Lagged returns" refers to the stock returns in 2006. Control variables for bank characteristics include the price-to-book ratio, the logarithm of market capitalization, and the Tier 1 capital ratio at the end of 2006. Standard errors are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table A2: Returns During the Financial Crisis: Market-Based Cash Bonus Incentive Ratios for SMBs.

	(1) ROA	(2) ROE	(3) Buy-and-Hold Returns
Bonus/market cap	-7.088***	-80.10***	-136.4***
	(-3.79)	(-3.83)	(-6.48)
$\mathbb{1}_{\text{Bonus}>0}$	0.00861***	0.0850***	0.113***
	(3.18)	(2.91)	(2.67)
Ownership from shares (θ_S)	-0.00459	-0.198	-0.0558
	(-0.19)	(-0.74)	(-0.17)
Unexercisable options (θ_O)	-0.503**	-5.788**	-6.502***
	(-2.42)	(-2.28)	(-2.83)
$\mathbb{1}_{\text{Unexercisable option}>0}$	-0.00203	-0.0143	-0.0573
	(-0.90)	(-0.57)	(-1.56)
Salary and others/total assets	-1.388	1.965	54.40
	(-0.29)	(0.05)	(1.14)
Exercisable options	0.0148	0.177	-0.256
	(0.36)	(0.37)	(-0.60)
SMB Sample Only	Yes	Yes	Yes
Lagged Returns	Yes	Yes	Yes
Control of Bank Characteristics	Yes	Yes	Yes
Adjusted R-squared	0.108	0.108	0.161
Total Obs.	524	520	495

This table replicates the baseline specification in Table 4 and A1, replacing the cash bonus incentive ratio (bonus-to-revenue) with a market-based measure (bonus-to-market capitalization). All other specifications, variables, and controls remain the same. Statistical significance is denoted by *, **, and *** for the 10%, 5%, and 1% levels, respectively. Standard errors are reported in parentheses.

Table A3: Returns during the Financial Crisis Controlling Systemic Risk Measures of 2006 for SMB.

	ROA			ROE			Buy-and-Hold Returns		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bonus/revenue (θ_B)	-2.011***	-2.010***	-2.024***	-21.09***	-21.20***	-21.39***	-34.10***	-35.32***	-35.76***
	(-3.97)	(-3.92)	(-3.99)	(-4.00)	(-3.99)	(-4.04)	(-6.04)	(-6.29)	(-6.35)
$\mathbb{1}_{\text{Bonus}>0}$	0.00891***	0.00888***	0.00881***	0.0839***	0.0837***	0.0829***	0.110***	0.109**	0.107**
	(3.26)	(3.27)	(3.26)	(2.84)	(2.85)	(2.83)	(2.64)	(2.58)	(2.54)
Ownership from shares (θ_S)	-0.00656	-0.00662	-0.00852	-0.223	-0.224	-0.240	-0.0851	-0.112	-0.135
	(-0.26)	(-0.26)	(-0.34)	(-0.81)	(-0.82)	(-0.89)	(-0.26)	(-0.33)	(-0.42)
Unexercisable options (θ_O)	-0.472**	-0.470**	-0.440**	-5.447**	-5.427**	-5.117**	-5.985**	-6.030***	-5.592**
	(-2.27)	(-2.25)	(-2.12)	(-2.17)	(-2.15)	(-2.03)	(-2.56)	(-2.61)	(-2.44)
$\mathbb{1}_{\text{Unexercisable option}>0}$	-0.00219	-0.00220	-0.00205	-0.0175	-0.0171	-0.0154	-0.0657*	-0.0629*	-0.0607
	(-0.96)	(-0.96)	(-0.90)	(-0.69)	(-0.68)	(-0.61)	(-1.80)	(-1.69)	(-1.64)
Salary and others/total assets	-0.355	-0.339	-0.656	10.96	11.84	8.676	54.85	68.03	65.59
	(-0.07)	(-0.07)	(-0.13)	(0.25)	(0.27)	(0.19)	(1.10)	(1.42)	(1.29)
Exercisable options	0.0150	0.0145	0.00853	0.167	0.164	0.103	-0.280	-0.273	-0.355
	(0.36)	(0.36)	(0.21)	(0.35)	(0.34)	(0.22)	(-0.65)	(-0.63)	(-0.85)
Short-run MES in 2006	-0.0589			-0.0113			5.084***		
	(-0.51)			(-0.01)			(2.67)		
ln(1+SRISK)		0.000696			0.00576			-0.00233	
		(0.40)			(0.29)			(-0.09)	
SRISK-to-market cap ratio			0.0278***			0.285**			0.367*
			(2.93)			(2.51)			(1.88)
SMB Sample Only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Returns	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control of Bank Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.123	0.123	0.131	0.116	0.117	0.124	0.184	0.170	0.177
Total Obs.	524	524	524	520	520	520	495	495	495

This table augments the baseline specification in Table 4 and A1 by controlling for systemic risk exposure. Columns (1)–(3), (4)–(6), and (7)–(9) report results for ROA, ROE, and buy-and-hold returns, respectively, with systemic risk controls. Systemic risk is proxied by the short-run marginal expected shortfall (SRMES), the log of one plus SRISK, and the SRISK-to-market capitalization ratio, all measured in 2006. SRMES captures the expected percentage decline in firm value on days when market returns fall within the worst 5%, while SRISK represents the expected capital shortfall in a crisis, computed from long-run MES (LRMES) and leverage. All other specifications, explanatory variables, and controls remain unchanged.

A.3.2 Replicating and Extending FS (2011)

This section replicates and extends FS (2011) for S&P 1500 banks. In particular, I run regressions using the same dataset described in Section 3.3, while keeping the specifications and sample as close as possible to those in FS (2011). The response variable is the buy-and-hold return, a measure employed as the primary specification in FS (2011). The key differences between Section 3.3 in my paper and FS (2011) are as follows: (i) I use the bonus-to-revenue ratio instead of the bonus-to-salary ratio, (ii) I employ the ownership ratio in levels rather than its logarithmic transformation, incorporating not only shareholdings but also exercisable and unexercisable options, (iii) I include small and medium-sized banks (SMBs) in my sample instead of restricting the analysis to large financial institutions listed in the S&P 1500, and (iv) I focus exclusively on commercial banks, whereas FS (2011) encompasses a broader range of financial firms. I incorporate all four changes in Table A4.

Here are the three main takeaways. First, the results in FS (2011) are replicable for the book-to-market ratio, though statistical significance differs for other variables. Second, excluding non-commercial banks increases statistical power. Third, the results for the SMB sample align with Section 3.3 but diverge from those in FS (2011). Column (1) in Panel A of Table A4 closely replicates Column (9) in Table 4 of FS (2011).[20] For ease of comparison, Panel B copies the results from FS (2011). The patterns are consistent; however, the model fit is stronger for the sample of commercial banks listed in the S&P 1500, with an R^2 of 37%, compared to 23% in FS (2011). In turn, Column (2) in Panel A estimates the model using a sample of SMBs. The cash bonus-to-salary ratio is negatively associated with bank performance and statistically significant.

[20] Due to data limitations, I exclude the explanatory variable "Equity risk (%)"—defined as the percentage change in the equity portfolio value for a 1% increase in stock volatility—from the regression. Notably, this variable was not statistically significant in FS (2011).

Table A4: Comparison Between Full Sample and Large Bank Sample Using a Closely Related Specification in Fahlenbrach and Stulz (2011).

Panel A: Sample from S&P Capital IQ

	(1) S&P 1500	(2) SMBs
Cash bonus/salary	0.0474***	-0.178***
	(0.0106)	(0.0338)
ln(Ownership)	-0.110***	-0.0403***
	(0.0361)	(0.00908)
Stock return in 2006	-0.487	-0.00180
	(0.331)	(0.0921)
Book-to-market ratio	-1.239***	-0.139
	(0.243)	(0.0986)
ln(market capitalization)	-0.140***	0.0832***
	(0.0266)	(0.0173)
Tier 1 capital ratio (%)	0.00812	0.00884**
	(0.00864)	(0.00365)
Adjusted R-squared	0.351	0.145
Total Obs.	55	494

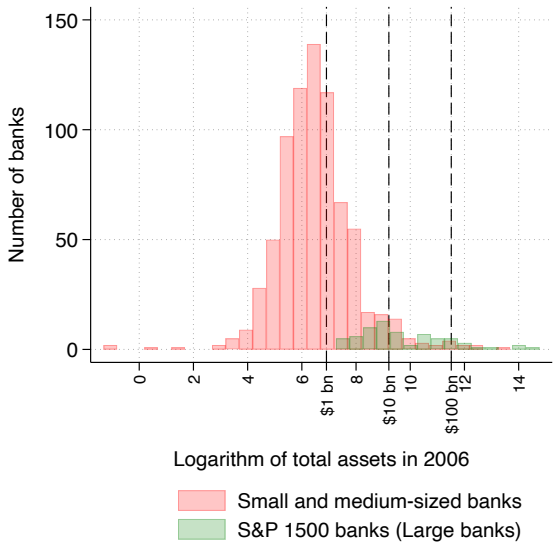
Panel B: Sample from ExecuComp

	FS (2011)
Cash bonus/salary	0.015
	(0.025)
ln(Ownership)	-0.049
	(0.032)
Stock return in 2006	-0.310
	(0.304)
Book-to-market ratio	-0.577***
	(0.240)
ln(Market capitalization)	-0.035
	(0.036)
Tier 1 capital ratio (%)	0.039**
	(0.018)
Adjusted R-squared	0.230
Total Obs.	77

The tables present regressions of buy-and-hold returns on compensation and control variables for two distinct samples. Column (1) in Panel A (left-hand table) uses data from S&P Capital IQ, while Column (2) in Panel A and Panel B (right-hand table) rely on ExecuComp. Column (2) in Panel A uses the close specification used in Table 4 of FS (2011) found on page 19. Panel B copies results from FS (2011). The sample size for S&P 1500 banks in Column (1) of Panel A is smaller than that of the ExecuComp sample in Panel B, as Panel A excludes brokerage firms to control for industry differences. Independent variables: "Cash bonus/salary" is defined as cash bonuses divided by salary. "ln(Ownership)" is calculated as the natural logarithm of the sum of shareholdings, exercisable options, and unexercisable options, divided by total shares outstanding. Standard errors are reported in parentheses. p-values from t-tests indicated by asterisks. $*$, $**$, and $***$ denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

A.4 Size Distribution of Banks

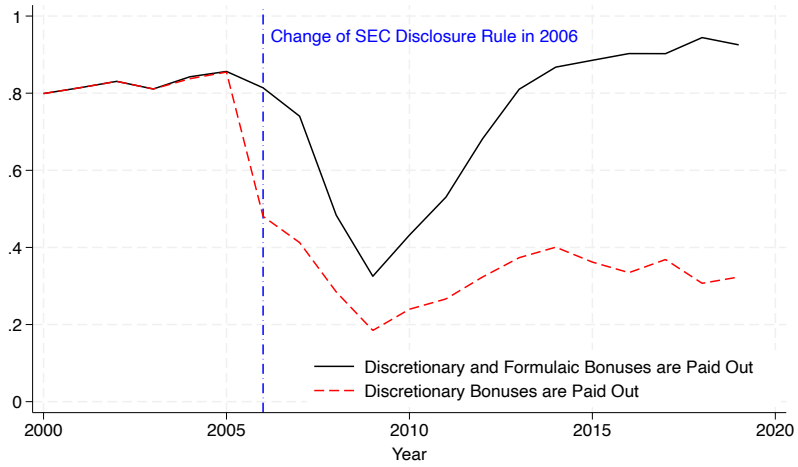
Figure A1: Size Distribution of Small and Medium-sized and S&P 1500 Banks.



This figure presents a histogram illustrating the size distribution of small and medium-sized banks and S&P 1500 banks. The horizontal axis displays the logarithm of total assets as of 2006. The three vertical dotted lines mark thresholds at $1 billion, $10 billion, and $100 billion in total assets. According to the Federal Reserve, banks with assets below $10 billion are categorized as community banks, those banks with assets between $10 billion and $100 billion as regional banks, and those banks exceeding $100 billion as national banks. The $1 billion threshold highlights banks targeted for regulation under the Dodd-Frank Act. The sample of S&P 1500 banks is based on the list of bank names provided in the appendix of FS (2011). The sample of small and medium-sized banks is drawn from the list of banks in S&P Capital IQ, excluding those banks included in the S&P 1500 index.

A.5 Bank Executive Bonuses

Figure A2: Share of Cash Bonuses Paid Out to the CEO.



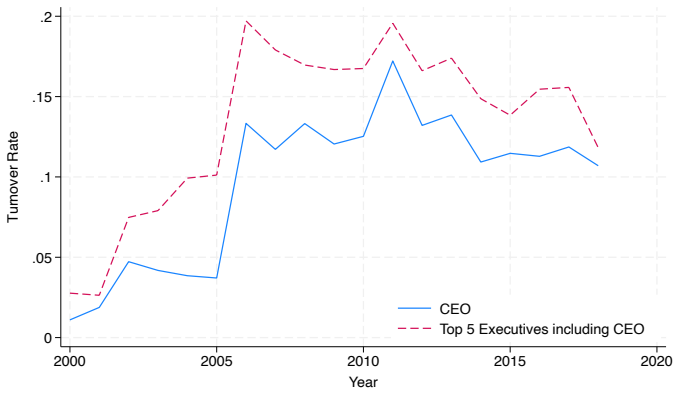
The figure plots the fraction of CEOs who receive cash bonuses. The solid black line shows the share receiving any cash bonus (discretionary+formulaic), whereas the dashed red line isolates CEOs paid only discretionary bonuses. "Formulaic" bonuses correspond to non-equity incentive-plan compensation that is awarded under a pre-set performance formula. The SEC's 2006 revision to executive-compensation disclosure rules, indicated by the vertical dashed line, required firms to report discretionary and formulaic components separately; before 2006, firms disclosed formulaic bonuses voluntarily.

A.6 Bank Executive Turnover Rate from 2000 to 2018

This section describes the bank executive turnover rate in a sample from Capital IQ. The turnover rate is calculated as the ratio of the number of CEOs who resigned from their positions to the total number of CEOs. CEO resignation is not directly observed in the data, so I use the highest salary among bank executives as a proxy for identifying the CEO, following the same approach in Section A.2. If a person's salary becomes zero or their salary ranking falls below the top two, I assume that the person has resigned from the CEO position. Additionally, I compute the average turnover rate of the top five executives, for comparison. The turnover rate for the top five executives is measured differently: if the salary of any one of the top five executives becomes zero or is unavailable in a given year, it is recorded that at least one executive left their position in the previous year.

Figure A3 reports the turnover rates of CEOs and non-CEO executives. The average turnover rate of CEOs from 2000 to 2018 is 0.096. This rate increases to 0.126 in the post-2006 sample. Although the definition of leaving the position differs between the measures of CEO and top-five executive turnover rates, the levels and dynamics are consistent across the two metrics.

Figure A3: Turnover Rates of Executives of CEOs and Non-CEOs.



The turnover rate (solid line) is defined as the ratio of the number of CEOs who resigned from their positions to the total number of CEOs. CEO resignation is not directly observed in S&P Capital IQ data. Instead, I use the highest salary among bank executives as a proxy for identifying the CEO. Whenever the reported salary drops to zero or the salary ranking is no longer the highest, I count this as the CEO having resigned. The turnover rate for the top five executives (dotted line) is measured differently: if the salary of any one of the top five executives becomes zero or is unavailable in a given year, it is recorded that at least one executive left their position in the previous year. This measure includes executives who leave the bank as well as those whose salaries fall outside the top five earners. For non-top five earners, compensation, including salary, is not required to be disclosed, so some banks report compensation for fewer than five executives. The turnover rate sample ends in 2018, as the final year of the original sample does not provide sufficient information to determine whether executives left their positions.

A.7 Banking Crises, Bankruptcies, and Failure Rates

This section presents the data used to calibrate the parameters of the dynamic model, focusing on banking crisis arrivals and systemic risk-taking. The primary data sources are (i) Global Crises Data by Country collected by Reinhart, Rogoff, Trebesch, and Reinhart (hereafter RRTR) and (ii) Failed Bank List compiled by FDIC. Global Crises Data covers more than 70 countries from 1800 to 2016. In the US, the recent banking crisis is from 2007 to 2010. First, I use the Global Crises Data to calculate the frequency of banking crises across countries, as the number of crisis events in the RRTR database is among the largest. The probability of banking crises is 5.5% in the full sample, and the GFC does not affect this estimate (Table A5). When the post-GFC period is excluded from the sample, the probability decreases slightly to 4.9%, which is lower than the full-sample estimate.

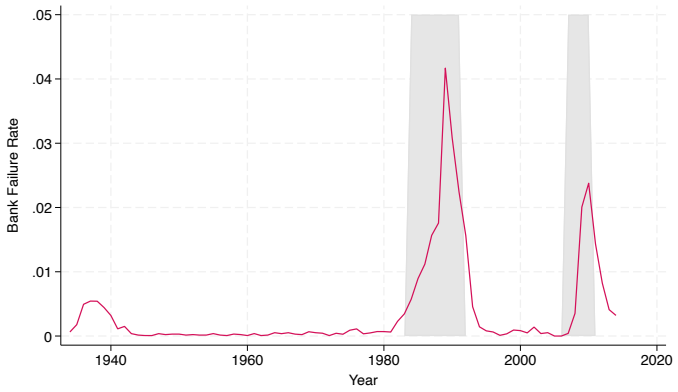
Table A5: Banking Crises of 70 Countries from 1800 to 2016.

	Periods of Banking Crisis/Total Periods
Post-GFC	0.206
Pre-GFC	0.0494
Full Sample	0.0552

The statistics reported in the table is calculated from Global Crises Data by Country collected by Reinhart, Rogoff, Trebesch, and Reinhart.

Next, I measure bank failures in periods of banking crises and normal periods in the U.S., respectively. Data source of bank failure and the number of banks is FDIC. The definition of bank failure is the closing of a bank by a federal or state banking regulatory agency. A bank is typically forced to close when it cannot meet its obligations to depositors and other creditors. The bank failure rate in crisis (normal) periods is 168bps (15bps).

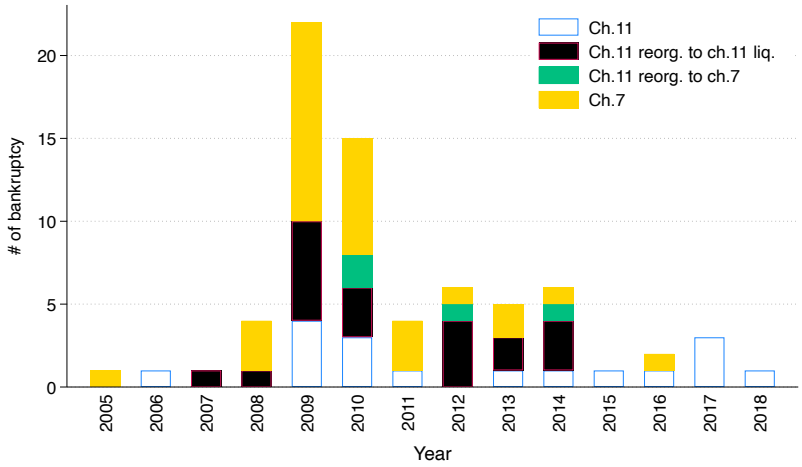
Figure A4: Bank Failure Rates in the U.S.



The shaded areas represent US banking crises defined in Global Crises Data by Country collected by Reinhart, Rogoff, Trebesch, and Reinhart. The red solid line is the number of US bank failure rate compiled by FDIC. The sample period is from 1934 to 2014.

Table A5 depicts the number of bankruptcy filings from 2000 to 2019.

Figure A5: Number of Bankruptcy Filings Before and After the Global Financial Crisis.

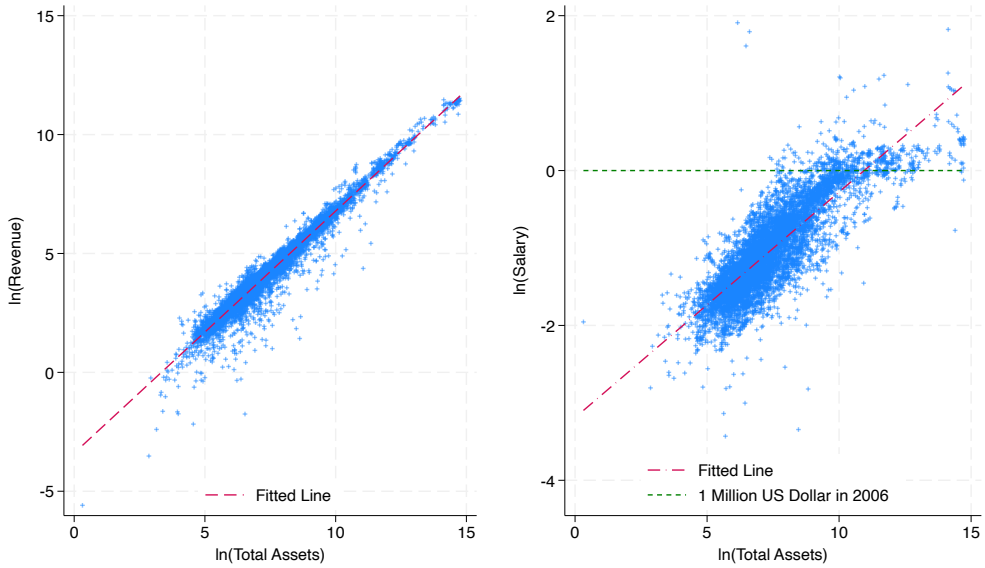


The figure shows the evolution of bankrupt financial firms from 2000 to 2019. No bankruptcies were reported between 2000 and 2004, or in 2019. The horizontal axis represents the total number of banks that filed for Chapter 11 or Chapter 7 bankruptcy during this period, based on the voluntary petition filing date. The sample includes both S&P 1500 banks and small and medium-sized banks (SMBs).

A.8 Size-Dependent Bank Revenue and CEO Salary

This section estimates the size dependencies of bank revenue and CEO's salary. Figure A6 plots the logarithm of revenue and bank CEO's salary comparing to total assets. Revenue and salary are highly correlated with total assets.[21]

Figure A6: Bank Size Dependency of Revenue and Salary Sensitivities.



Revenue, salary, and total assets are deflated using the Consumer Price Index (CPI). The sample period covers 2000 to 2019. The dotted lines represent fitted trends, while the solid horizontal line on the right-hand side of the figure marks the log-level equivalent of $1 million in 2006 U.S. dollars.

I estimate model parameters of α_l and α_F from fixed-effect panel model. Estimation results are reported in Table A6. The first (third) regressions show regression coefficients of the logarithm of revenue (salary) on logarithm of total assets. The slope of logarithm of bank revenue is around 0.8 and CEO's salary is around 0.3. This slope coefficient implies 1% of increase in total assets predicts 0.8% (0.3%) increase in revenue (salary). The bank(CEO)-level fixed-effects panel model explains 96% (73%) of the variation in the data, indicating a strong positive relationship between revenue (salary) and bank size. I assess the robustness of the results by incorporating year fixed effects, as reported in the second and fourth columns, to account for time trends. The estimated coefficients remain consistent with the baseline findings.

Table A6 proves temporal "Roberts's law" in banking holds for cash salary for banks. Gabaix and Landier (2008) document cross-sectional "Roberts's law"— CEO compensation

[21]The right-hand side of Figure A6 shows mild bunching around the $1 million threshold. Some large banks are subject to a $1 million cap on executive compensation due to tax incentives. A tax deduction for compensation above $1 million was introduced in 1994 under Section 162(m) of the U.S. Tax Code (Rose and Wolfram (2000)) and remained in effect until its repeal in 2017. Consequently, CEOs had an incentive to keep their salaries below the threshold to benefit from the tax deduction.

is proportional to (own firm size)$^{\kappa}$—for executive compensation for non-financial firms. They estimate κ to be approximately 0.3 based on pooled regressions. However, temporal prediction does not supported in non-financial firms. Therefore, the dynamic financing model of non-financial firms abstracts from managers' incentives derived from salaries under uncertainty because concavity is not supported by within-firm variation in the data.

Table A6: Fixed-effect Panel and Pooled Regression Models of Revenue and Salary.

	ln(Revenue)	ln(Revenue)	ln(Salary)	ln(Salary)	ln(Salary)
ln(Total Assets)	0.835***	0.890***	0.285***	0.302***	0.309***
	(101.30)	(86.06)	(53.55)	(40.28)	(40.54)
Year Fixed-Effects	No	Yes	No	Yes	Yes
Salary<1 million USD (subsample)	No	No	No	No	Yes
Number of Obs.	8475	8475	8567	8567	8273
R-squared	0.955	0.962	0.726	0.728	0.699

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

All model includes bank(CEO)-level fixed-effects. Models in 2nd and 4th columns add year fixed-effects. Revenue, salary, and total assets are deflated using the CPI. Revenue, salary, and total assets are winsorized at the 1% and 99% levels. The sample period is from 2000 to 2019.

A.9 Estimating Dynamic Process of Latent Cash Bonus Incentive Coefficient and Deposit Capacity

This section estimates persistence parameters of latent cash bonus incentive ratio and deposit capacity. I write down VAR(1) process of latent cash bonus incentive ratio θ_B and deposit capacity δ_d. The stochastic process of exogenous state $z = (\theta_B, \ln \delta_d)'$ is

$$z_{i,t} = \begin{pmatrix} (1-\kappa_{\theta_B})\bar{\theta}_B \\ (1-\kappa_{\delta_d}) \ln \bar{\delta}_d \end{pmatrix} + \begin{pmatrix} \kappa_{\theta_B} & 0 \\ 0 & \kappa_{\delta_d} \end{pmatrix} z_{i,t-1} + \varepsilon_{i,t} \tag{20}$$

where $\varepsilon_{i,t}$ is a vector of idiosyncratic shocks of bank i at time period t, assumed to follow a bivariate normal distribution: $\varepsilon_{i,t} \sim \mathcal{N}(0, \Sigma)$ with variance-covariance matrix

$$\Sigma = \begin{pmatrix} \sigma^2_{\theta_B} & 0 \\ 0 & \sigma^2_{\delta_d} \end{pmatrix}.$$

The persistence parameters are estimated in this section outside the dynamic financing model, while the volatility parameters σ_{θ_B} and σ_{δ_d} are estimated in Section 4.2 within the dynamic financing model. To reduce the number of parameters, I impose that the diagonal components of Σ are zero and that there is no correlation in idiosyncratic shocks $\varepsilon_{i,t}$.

Given the stochastic process in Eq. (20), the standard deviation of the latent cash bonus incentive ratio (deposit capacity) is $\sigma_{\theta_B}/\sqrt{1-\kappa_{\theta_B}}$ ($\sigma_{\delta_d}/\sqrt{1-\kappa_{\delta_d}}$). The long-run state is $\bar{z} = (\bar{\theta}_B, \ln \bar{\delta}_d)'$. The model allows latent cash bonus incentive ratio to take both positive and negative values. When cash bonus incentive ratio is negative, bank CEOs receive no bonus payments regardless of revenue size, which may often be related to an anti-bonus culture.

The estimated persistence parameters κ_{θ_B} and κ_{δ_d} are reported in Table A7. Panel A uses the S&P Capital IQ sample from 2000 to 2019. I exclude observations with zero bonuses from the sample in Column (1). This sample selection enables me to estimate the model without censoring in Eq. (20). The persistence parameter κ_{θ_B} is 0.83 from the Arellano-Bond (AB) estimator with fixed effects. Since the sample selection is non-random, the estimated coefficient in Column (1) may be biased. To address this concern, I apply a maximum likelihood estimator using a random-effects Tobit model, with the results presented in Column (2). The Tobit model treats cash bonus incentive ratio, $\bar{\theta}_B$, as a latent variable that is left-censored at zero, such that the observed value is $\max\{\bar{\theta}_B, 0\}$. The persistence parameter for cash bonus incentive ratio κ_{θ_B} is 0.88, which is 5 percentage points higher than the estimate from the AB estimator. I conclude that cash bonus incentive ratio is highly persistent and that sample selection bias is negligible. In turn, the persistence parameter for deposit capacity, κ_{δ_d}, is estimated at 0.90 reported in Column (3) using the AB estimator.

The persistence parameter estimates for deposit capacity, κ_{δ_d}, remain consistent across different sample lengths and bank coverage. Panel B uses the Call Reports sample from 1976 to 2020, which covers a broader set of individual banks while excluding BHCs, to assess the robustness of the estimates. This sample allows for a comparison with the S&P 1500 sample, which includes both BHCs and standalone banks. The estimated parameter κ_{δ_d} ranges from 0.83 to 0.86. In Panel B, Column (1) reports estimates using the AB difference-Generalized Method of Moments (GMM) estimator for the post-1994 sample. Column (2) extends the sample period from 1976 to 2020. Starting the sample in 1976—approximately doubling the sample period compared to the regression in Column (1) of Panel B in A7—I find that the persistence parameter decreases when earlier periods are included. This decline in persistency is caused by including samples pre-Riegle-Neal Act of 1994, when the banking system was more dispersed and competitive. Still the choice of sample banks and periods does not significantly alter the estimate of κ_{δ_d}, I choose the specification in Panel A, the third column as my baseline case for exogenous deposit capacity process.

Table A7: Dynamic Panel Model of Cash Bonus Incentive Coefficient and Deposits with Fixed and Random Effects.

Panel A: A Sample of S&P Capital IQ from 2000 to 2019

	(1) Bonus-to-Revenue	(2) Bonus-to-Revenue	(3) ln(Deposit)
Lagged Bonus-to-Revenue	0.635***	0.775***	
	(8.43)	(63.95)	
Lagged ln(Deposit)			0.895***
			(74.18)
N	5106	7860	7829
Arellano-Bond with Fixed Effects	Yes	No	Yes
Tobit with Random Effects	No	Yes	No

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Panel B: A Sample of Call Reports from 1976 to 2020

	(1) ln(Deposit)	(2) ln(Deposit)
Lagged ln(Deposit)	0.861***	0.827***
	(168.64)	(182.26)
N	194560	426132
Arellano-Bond with Fixed Effects	Yes	Yes
Post 1994	Yes	No

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

The tables in Panels A and B present estimated coefficients using two different estimators. The Arellano-Bond estimator with fixed effects is employed in Panel A (Columns (1) and (3)) and Panel B (Columns (1) and (2)). The maximum likelihood estimator of a Tobit model with random effects is used in Panel A (Column (2)) for robustness. For the Arellano-Bond estimator the instruments are second-order or higher lagged variables of the logarithm of deposits, and I employ a difference-GMM estimation. All variables are winsorized at the 1st and 99th percentiles and deflated using the Consumer Price Index (CPI). Panel A reports dynamic panel regressions of cash bonus incentive ratio and deposit logarithms using S&P Capital IQ data from 2000 to 2019. The regression in the first column of Panel A excludes observations where cash bonus incentive ratio equals zero. In Panel B, the data source of bank financials is the Call Reports, with the dependent variable being the logarithm of deposits. The sample for Columns (1) begins after the Riegle-Neal Act of 1994 and ends in 2020.

A.10 Present Value of Pension Benefits

Table A8 presents summary statistics on the present value of bank CEOs' pension benefits from 2006 to 2019. The sample of banks reporting pension benefits is approximately 38% of those reporting salary data (Table A8). Given this limitation and the lack of meaningful cross-sectional variation, I exclude the pension benefit variable from the reduced-form anal-

ysis. However, I include pension benefits in the dynamic model to properly account for the magnitude of short-termism. On average, the present value of pension benefits is five times the CEO's salary.

Table A8: Present Value of Pension Benefits.

	Number	Mean	Median	Std. Dev.
PV of Pension Benefits to Salary Ratio	2,022	4.938	2.836	6.347
Frac. of Non-missing Pension Benefits	5,360	0.377	0.000	0.485

The table presents summary statistics for the present value of the pension benefit-to-salary ratio for bank CEOs from 2006 to 2019. The data are sourced from S&P Capital IQ, specifically by web-scraping the reporting row labeled "Present Value of Accumulated Benefits." The reporting of the present value of the pension benefit begins in 2006, following the Securities and Exchange Commission's (SEC) adoption of enhanced disclosure rules on July 26, 2006, which mandated detailed reporting of executive compensation. The actuarial present value of each named executive officer's accumulated pension benefits is calculated in accordance with generally accepted accounting principles. The fraction of non-missing pension benefit-to-salary values represents the ratio of observations with non-missing pension benefit values to those with salary values. While all bank CEOs report salary data, only a subset are required to disclose pension benefit information under SEC regulations.

A.11 Model Details

A.11.1 Representative Household Problem

This section outlines the representative household's problem to derive the pricing equation for bank equity. The representative household "owns" banks and maximizes its lifetime utility:

$$\max_{\{C_t, x_{i,t}\}_{t=0}^{\infty}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t u(C_t) \right],$$

subject to

$$\begin{aligned} & C_t + \int d_{i,t+1} d\Gamma_{i,t} + \int (v_{i,t} - D_{i,t}) x_{i,t+1} d\Gamma_{i,t} \\ = & \int (1 + r_d)^{-1} d_{i,t} d\Gamma_{i,t} + \int \Lambda(p_{i,t}) v_{i,t} x_{i,t} d\Gamma_{i,t} \\ + & \int (1 - \Lambda(p_{i,t})) \left(-\underline{e} + \underline{v}_{i,t} \right) x_{i,t} d\Gamma_{i,t}, \end{aligned}$$

where $u(\cdot)$ is the utility function, C_t is consumption, β is the discount factor, $d_{i,t}$ represents deposits, $v_{i,t}$ is the cum-dividend share price, $D_{i,t}$ denotes equity payouts, $x_{i,t}$ is the size of shareholdings, $\Lambda(p_{i,t})$ is the survival rate, $\underline{e}$ is the newly chartered bank equity, and r_d is the deposit rates. In the simulation, $\underline{e}$ is set to the lower bound of the equity grid points: $e^{\min}$. The term $\int (\cdot)\, d\Gamma_{i,t}$ represents the population mean, normalized such that $\int (\cdot)\, d\Gamma_{i,t} = 1$, where $\Gamma_{i,t} = \Gamma(z_{i,t}, e_{i,t})$ denotes the bank distribution. This bank distribution follows a process described in Appendix Section A.11.3, given the equilibrium policy functions of

bank. Here, $v_{i,t}$ serves as a shorthand for $v(z_{i,t}, e_{i,t})$ and $\underline{v}_{i,t} = v(z_{i,t,}, \underline{e})$ represents the share price of entrants starting from the minimum capital $\underline{e}$. Although the household owns banks, its control over bank decision-making is limited. In particular, the compensation structure and turnover are both suboptimal.

The equilibrium is the household maximizes utility by choosing the sequence of consumption and shareholdings. Deposit in- and out-flows are exogenous. The market clearing condition of shareholding is $x_{i,t} = 1$, given a fixed supply of shares. The first-order condition (FOC) with respect to shareholding x_t:

$$\begin{aligned}(v_{i,t} - D_{i,t})u'(C_t) &= \Lambda(p_{i,t})\mathbb{E}_t\left[\beta u'(C_{t+1})v_{i,t+1}\right] \\ &+ \left(1 - \Lambda(p_{i,t})\right)\mathbb{E}_t\left[\beta u'(C_{t+1})\left(-\underline{e} + v_{i,t+1}(z_{i,t+1}, \underline{e})\right)\right].\end{aligned}$$

I assume the household's utility is linear (e.g., risk-neutrality), the stochastic discount factor simplifies to the discount factor β. It follows that the discounted value of equity payouts equals the share price observed in the market. The absence of aggregate uncertainty implies stationary consumption $C_t = C_{t+1}$. Then, the FOC leads to the price of shareholding in Equation (14).

A.11.2 Computational Algorithm

The dynamic model is solved exclusively through numerical methods. Algorithm to solve fixed point problem: start from guessing stock value v,

1. Given stock value v, solve the manager's problem and update the policy functions Φ.
2. Update stock value v by iterating on the shareholder's problem. Repeat step 1 until convergence.

The dynamic model is solved when the stock value and the manager's policy function converge. The exogenous states follow a VAR(1) of latent cash bonus incentive ratio $\bar{\theta}_B$ and deposit capacity δ_d, as described in Section A.9. I discretize the continuous-state Markov chains using the Tauchen method. The number of grid points for $\bar{\theta}_B$ and δ_d is 12 and 16, respectively.

To enhance computational efficiency, I rewrite the control variable S of the manager's optimization problem in Equation (5) to success rate p. Redefining the control variable reduces the number of grid points needed for the simulation while maintaining the precision of the value function iteration. I set the number of grid points for success rate p to 50. I discretize the state space of equity e into 40 piecewise log-linear grid points. The minimum of e on the grid is derived from the minimum value of deposit capacity in the model. Suppose the minimum value of deposit capacity is $\delta_d^{\min}$; the minimum value of equity is $e^{\min} = \{\bar{\chi}/(1-\bar{\chi})\}\delta_d^{\min}$. $e^{\min}$ represents the minimum level of equity required to prevent the capital constraint from binding when the bank faces the lowest deposit capacity. The upper bound

of equity depends on model parameters. I choose $e^{\max} = 0.40$ as most banks choose equity below this upper bound.

The minimum capitalization of entrants is set to 0.0275, or $\underline{e} = 0.0275$.[22] This value of $\underline{e}$ is not an exact match to the typical size of entrants but is of the same order of magnitude. The fact that entrants are small is consistent with this calibration. Adams and Gramlich (2014) finds that the average asset (deposit) size of new banks is \$34 million (\$23 million). This implies an average equity of \$11 million. As discussed in Section 4.2, $\underline{e}$ corresponds to \$33 million US dollars, calculated as \$1.2 billion US dollars $\times$ 0.0275, three times as big as the average equity observed in the data.

To accelerate the speed of value function iteration, the McQueen-Porteus error bounds have an advantage over the standard approach. I estimate the model using a desktop computer with a General-Purpose Graphics Processing Unit (GPGPU) of Nvidia RTX 3090. The value function iteration, one of the most computationally intensive calculations, is implemented in C/C++ using OpenACC, a simple API for multi-threaded GPGPU computing.

A.11.3 Stationary Bank Distribution

Industry-wide statistics in the simulation are computed by summing over the density of heterogeneous banks. This section explains the computation of the stationary bank distribution. The bank distribution evolves as follows:

$$\begin{aligned}\Gamma(z', e') &= \underbrace{\int \mathbb{1}_{e'=\Phi_e(z,e)} \left(1 - \Lambda(p(S = \Phi_S(z,e)))\right) g_{z'|z} d\Gamma(z,e)}_{\text{incumbent banks}} \\ &+ \underbrace{\int \mathbb{1}_{e'=\underline{e}} \Lambda(p(S = \Phi_S(z,e))) g_{z'|z} d\Gamma(z,e)}_{\text{newly established banks}},\end{aligned}$$

Φ_S and Φ_e are the equilibrium policy functions of risk-taking S and the next-period equity e', obtained by solving the fixed-point problem in Appendix Section A.11.2.

A.11.4 Simulated Method of Moments Estimator

In the Simulated Method of Moments (SMM) estimator, the estimated parameters $\hat{\Theta}$ is obtained by minimizing the cost function:

$$\hat{\Theta} = \arg\min_{\Theta} g_N(x, \Theta)' \hat{W}_N g_N(x, \Theta). \tag{21}$$

Here Θ represents a vector of model parameters. The cost function measures the discrepancy between the observed and simulated data. This discrepancy, $g_N(x, \Theta)$, is defined as:

[22] Given the number of grid points for δ_d, the minimum size of equity in the discretized model is $e^{\min} = 0.0275$. Thus, minimum equity size is equal to the minimum capitalization of entrants (i.e., $e^{\min} = \underline{e}$).

$$g_N(x,\Theta) \equiv (NT)^{-1}\sum_{n=1}^{N}\sum_{t=1}^{T}\left[h(x_{n,t}) - S^{-1}\sum_{s=1}^{S}h(y_{n,t,s}(\Theta))\right].$$

where x is a vector of real-data and $y_{n,t,s}$ is a simulated-data depends on model parameters Θ. Here, the moment from real-data $x_{n,t}$ is:

$$(NT)^{-1}\sum_{n=1}^{N}\sum_{t=1}^{T}h(x_{n,t}).$$

And the moment from simulate-data $y_{n,t,s}$ is:

$$(NTS)^{-1}\sum_{n=1}^{N}\sum_{t=1}^{T}\sum_{s=1}^{S}h(y_{is}(\Theta)).$$

where N, T, and S represents the number of cross-sectional units, time periods, and simulations. The weight matrix $\hat{W}_N$ is a positive definite matrix that coverages in probability to a deterministic definite matrix W. The inverse of the weight matrix $\hat{W}_N$ is estimated as the sample variance-covariance matrix of the real-data moments. The calculation follows the influence-function approach proposed by Erickson and Whited (2000). The asymptotic distribution of SMM estimator is $\sqrt{NT}(\hat{\Theta}-\Theta) \xrightarrow{d} \mathcal{N}(0, \text{avar}(\hat{\Theta}))$ where the asymptotic variance is: $\text{avar}(\hat{\Theta}) = \left(1+\frac{1}{S}\right)(J'WJ)^{-1}$. Here, $J \equiv \frac{\partial g_N}{\partial \Theta}$ is the Jacobian matrix of $g_N(\Theta)$. The Richardson extrapolation is a numerical method used to approximate the first-order derivative, which has lower numerical errors compared to Newton's method.

A.11.5 Policy Designs of Compensation Regulations

This section provides an overview of two key policies analyzed as counterfactual scenarios using the dynamic model in Section 4: the Dodd-Frank Proposal and the EU Bonus Cap.

Dodd-Frank Act of Section 956. In 2024, four federal regulators—the Federal Deposit Insurance Corporation (FDIC), Office of the Comptroller of the Currency (OCC), Federal Housing Finance Agency (FHFA), and National Credit Union Administration (NCUA)—jointly proposed new regulations on incentive-based compensation in response to the financial crisis. Notably, the Federal Reserve Board (FRB) and the Securities and Exchange Commission (SEC) did not participate in the proposal. The regulations apply to financial firms with total assets of $1 billion or more, categorizing them into three levels:

- Level 1: Firms with total consolidated assets of $250 billion or more.
- Level 2: Firms with total consolidated assets between $50 billion and $250 billion.
- Level 3: Firms with total consolidated assets between $1 billion and $50 billion.

Level 1 and Level 2 institutions must adhere to specific incentive compensation requirements for senior executive officers (e.g., the president, CEO, and chief operating officer) and significant risk-takers (top-paid non-senior employees). The proposal mandates that financial

firms defer at least 50% of executive bonuses for four years, exceeding the industry average of three years. It also introduces a minimum clawback period of seven years, allowing firms to recover bonuses if an executive's actions are found to have harmed the institution or if financial results require restatement. However, as of 2025, progress on finalizing the rule remains stalled due to regulatory disagreements over CEO pay restrictions.

EU Bonus Cap. Since January 2014, this cap has applied to all banks in the European Union (EU) following its adoption under the Capital Requirements Directive IV (CRD IV). The regulation targets senior managers and material risk-takers, excluding internal supervisors. Under this rule, bonuses are capped at 100% of fixed compensation (i.e., salary), though explicit shareholder approval can raise the limit to 200%. The cap applies to all banks operating within the EU, regardless of their size or whether they are headquartered inside or outside the EU. The regulation also mandates bonus deferral requirements. Typically, at least 40% of bonuses must be deferred, and for particularly large bonuses, at least 60% must be deferred. The deferral period generally spans three to five years, during which the deferred portion remains subject to performance-based adjustments. This structure ensures that bonuses are fully paid out only if the bank maintains strong long-term performance. The EU Bonus Cap was influenced by the Financial Stability Board's (FSB) Principles for Sound Compensation Practices, published in September 2009. These principles shaped the Capital Requirements Directive III (CRD III), published in July 2010, which led to national regulations such as Germany's Institutsvergütungsverordnung and the UK's Remuneration Code. The stricter EU-wide framework under CRD IV became binding in January 2014.