CEO Option Compensation, Risk-taking Incentives, and Systemic Risk in the Banking Industry

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Li Li
University of International Business and Economics

Mary L. Z. Ma
Xiamen University

Frank M. Song
The University of Hong Kong

Author Information:

Li Li	Email:	lily.li1980@gmail.com	Telephone number: (86) 6449-3229
Mary L. Z. Ma	Email:	mlizhi@xmu.edu.cn	Telephone number: (86) 2182-551
Frank M. Song	Email:	fmsong@hku.hk	Telephone number: (852) 28578507

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Abstract

We find that CEO risk-taking incentives induced by option compensation increase a bank's contribution to systemic contraction and crash risks. The relation operates through three channels: non-interest income, financial innovations such as asset securitization, collateralized debt obligations, credit default swaps, and maturity mismatch, and is affected by information transparency, market liquidity, financial crisis, and bank size. The relation is found to be attributable to previous option grants, while CEO risk-taking incentives induced by new option grants decrease a bank's contribution to systemic risk, suggesting that restriction of cashing out on options constraints CEO risk-takings that increase systemic risk.

Keyword: Executive compensation; CEO risk-taking incentives; Systemic Risk; non-interest income; financial innovations; mismatch; Banking

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1. Introduction

This paper examines the role of CEO risk-taking incentives induced by option compensation in leading to financial crisis. Banking industry is vulnerable to shocks and is exposed to high systemic risk, and systemic risk in the banking industry is the precursor or predictor of economic-wide crisis or downturns (Acharya et al. 2012; Allen et al. 2012). Systemic risk in the banking industry is a major concern of bank regulators (Diamond and Dybvig, 1983; Dowd, 1992; Shleifer and Vishny, 2010). With the aim to curtail systemic risk, the newly enacted Dodd-Frank Wall Street Reform and Consumer Protection Act ("Dodd-Frank Act") has created a framework in its "Title I" to identify, measure, and regulate systemic risk, and has established a Financial Stability Oversight Council (FSOC) to focus on maintaining stability of the financial system as a whole. The 2008-2009 financial crisis also arose research interests in systemic risk in the banking industry. Recent studies report that risky non-interest-income, non-interest income, and credit derivatives contribute more to systemic risk (Brunnermeier et al. 2011; Eagle et al. 2012; Rodríguez-Moreno et al. 2012). The relation between CEO option compensation and systemic risk and financial crisis remains hot regulatory and academic debates. Bank option compensation induces CEO risk-taking incentives and have been blamed for "building-up" risks and leading up to the 2008-2009 financial crisis (OECD 2009; Binder 2009).[1] Bebchuck et al. (2010) and Dalls (2011) claim that equity compensation provides executives with incentives to seek short-term results and excessive risk-taking. In contrast, Murphy (2012) concludes that the popular outsized

[1]For instance, US Treasury Secretary Timothy Geithner in his testimony on the U.S. treasury budget on June 9, 2009 argued 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 … in this financial crisis". OECD (2009) argues that remuneration systems have contributed to the financial crisis via encouraging excessive short-term thinking and blindness to risk. The final report of the Financial Crisis Inquiry Commission (2011) blames that too often the compensation systems "encouraged the big bet—where the payoff on the upside could be huge and the downside limited". Alan Blinder, the former vice-Chairman of the Board of Governors of the Federal Reserve System, declares that poor incentives "built into the compensation plans of many financial firms", "incentives that encourage excessive risk-taking" are one of the most fundamental causes of the credit crisis (Binder, 2009).

bonuses of cash, stock, and options at Wall Street actually reduces risk-taking incentives prior to and during financial crisis.

Available studies presents mixed theory and evidence about CEO option compensation and bank-specific risk in general and during 2008-2009 financial crisis. For example, the seminal and influential paper of Fahlenbrach and Stulz (2011) finds no relation between CEO option compensation and bank performance during financial crisis.[2] In contrast, other study reveals that option compensation generates risk-taking incentives that increase bank-specific default risk, bank risk and excessive risk-takings (Balachandran et al. 2010; Bolton et al. 2010; Mehran and Rosenberg, 2011; Vallascas and Hagendorff, 2011; Inderst and Pfeil, 2011). In addition, Chesney et al. (2012) document that asset incentives rather than option incentives explain asset risk-taking of U.S. financial institutions before the 2007 to 2008 crisis. Thanassoulis (2012) and Acharya et al. (2012) suggest analytically that compensation arrangements (not only confined to option compensation) induce incentives for short-termism and excessive risk-taking and increase bank default risk because of competition for bankers and their mobility across banks.

Evidence that CEO risk-taking incentives induced by option compensation increase bank-specific risks, however, does not mean that option compensation leads to sector-wide financial crisis unless bank-specific risks are highly contagious. Contagions are at the heart of systemic risk (De Bandt and Hartmann, 2000), and Billio et al. (2012) document that institutions that declined the most during the 2008-2009 Crisis were the ones that greatly affected other institutions rather than the ones affected by others. Therefore this study separately examines the effects of CEO risk-taking incentives generated from option compensation on a bank's contribution to systemic risk. CEO risk-taking incentives usually induce them to be involved in risky business activities such as non-traditional non-interest income-generated activities, and heavy reliance on risky short-term debt in financing. Among others, recent asset securitization,

[2]However, this evidence cannot refute the charges against equity compensation because accounting- and market- performance deteriorates and makes any performance-based incentive plans lose power. Option values in many companies drop to zero and stock price drop sharply during financial crisis period, and thus neither can motivate risk-averse mangers to work harder or take more risk to maximize their own wealth or shareholders' wealth. Other special features of the financial crisis such as the aggravated market illiquidity may enhance the effects of CEO risk-taking incentives on systemic risk.

CDO and CDS, and the reliance on short-term debt in financing the real estate related new financial instruments have been blamed to be the main causes of the recent financial crisis (Brunnermeier, 2009; Diamond and Rajan, 2009). This motivate this study to separately examine whether CEO risk-taking incentives affect a bank's contribution to systemic risk through three mediating mechanisms: non-interest income generating activities, financial innovations such as asset securitization, CDO, and CDS, and maturity mismatch.

This study proposes that CEO option compensation induces excessive risk-taking incentives that increase bank-specific default and crash risks and their contagions to other banks, thus increasing a bank's contribution to systemic risk. In particular, CEO option compensation induce CEOs to conduct risky business activities, including but not confined to non-interest income-generated activities, financial innovations such as asset securitization (in particular CDO), and CDS, and maintaining high maturity mismatch by cutting cash holding and increasing short-term debt financing (Suntheim, 2011; Chava and Purnanandam, 2010). More significantly, the convexity of CEO's option compensation induces bank CEOs' herding in conducting these risky business activities because CEOs' stock options' value will be damaged if they fail to follow the fashion, whereas CEOs will not get punished if their herding damage banks' long-term performance. This option-compensation-induced *herding* in risk-taking increases asset commonality and interconnectedness that enhances contagion of bank-specific failure and generate excessive systemic risk (Allen et al. 2012; Billio et al. 2012). Especially herding in asset securitization and CDSs generates natural contagion channel by building interconnections among banks, increasing joint default risk and counterparty risk (Krahnen and Wilde, 2007; Hansel and Krahnen, 2007; Biais et al. 2010; and Liu, 2010). Herding in maintaining high maturity mismatch aggravates the interbank contagions via interbank market since banks with high maturity mismatch rely largely on interbank short-term financing liquidity provision during distress (Diamond and Rajan, 2005; Iyer and Peydró, 2011). The reasoning also suggest that CEO risk-taking incentives affects a bank's contribution to systemic risk through three channels--non-interest income-generating activities, recent financial innovations (asset securitization, collateralized debt obligations (CDO), and credit default swaps (CDS), and maturity mismatch.

This paper examines these propositions using a sample of publicly traded bank holding companies (BHCs) and commercial banks in the U. S. during 1992-2009. We focus on BHCs and commercial banks because they play a much more important role in transmitting shocks than other financial institutions such as investment banks, hedging funds etc. (Billo et al. 2012). We construct two measures for a bank's marginal contribution to systemic risk by the percentile regression method, extending Adrian and Brunnermeier (2010): a bank's contribution to systemic default risk--the possibility that the banking sector is in default give that a bank is default, and a bank's contribution to systemic crash risk--the possibility that the banking sector melts down give that a bank's stock price crashes. Following the literature, we use stock volatility sensitivity of CEO option compensation to proxy for CEO risk-taking incentives induced by CEO option compensation in general, and use that of CEO option new grants, options previously granted to proxy for CEO risk-taking incentives induced by each of these parts, respectively. Empirical analysis yields the following main findings consistent with predictions. CEO risk-taking incentives are positively associated with a bank's contribution to systemic contraction risk and systemic crash risk. Banks with higher CEO risk-taking incentives have larger portion of risky non-interest income, higher level of asset securitization, CDO, CDS, and larger maturity mismatch, all of which in turn are positively associated with a bank's contribution to systemic default and crash risks.

Whether different components of option compensation induce different risk-taking incentives and thus contribute differently to systemic risk, nonetheless, is still an unexplored research question, and relevant evidence has policy implications for advancing executive compensation reforms. but restricted stock options help to mitigate their excessive risk-takings and encourage long-term value-creating (Bebchuk, 2009; and Romano and Bhagat, 2009). Therefore, we propose that the positive relations of CEO risk-taking incentives induced from CEO's option compensation granted previously (from new option grants) and a bank's contribution to systemic risk are stronger (weaker). CEOs' freedom to cash out equity contributes substantially to CEO short-term excessive risk-takings We find consistent evidence in further analysis; specifically, CEO risk-taking incentives induced by options previously granted (new option grants) is significantly positively (negatively) associated with a bank's contribution to systemic contraction risk and systemic crash risk.

We further conjecture that several exogenous conditions impact the relations between CEO risk-taking incentives and a bank's contribution to systemic risk: liquidity, financial crisis, information transparency, and bank size. Consistent with predictions, further analysis reveals that information transparency and bank size weaken while financial crisis, market and bank-specific illiquidity enhance the positive relation between CEO risk-taking incentives and a bank's contribution to systemic risk. Moreover, crisis is found to lead CEO option compensation to lose power for both bank performance and bank risk during financial crisis, a finding supplementing and extending Fahlenbrach and Stulz (2011). The evidence suggests that financial crisis works as exogenous shocks that reduce CEO risk-taking incentives by rendering options out-of-money and reducing CEO equity wealth, and inferably enhances contagions of bank-specific effects. .

Our study contributes to the literatures on bank CEO compensation, bank risk and financial crisis, and has immediate policy implications. In particular, this paper extends CEO equity compensation by documenting original evidence that CEO risk-taking incentives induced by option compensation are positively associated with a bank's contribution to systemic contraction and crash risks in general, and with non-interest income, financial innovations, and maturity mismatch operating as some of the mediating channels. This study also contributes to the executive equity compensation literature by separately examining the different incentive effects provided by new option grants and previous option grants and by documenting different incentive effects of different components of option compensation, and suggests that the enhancing effects of CEO risk-taking incentives on systemic risk stems from exercisable previous option grants. The evidence is consistent with Bebchuck's (2009) argument that executive pay arrangements have produced incentives for excessive risk–taking and contributed to bringing about the current financial crisis. It also support Dittmann and Maug (2007)'s thesis that optimal compensation schemes should have at best miniscule holdings of stock options.

This study also contribute to the bank risk literature by providing original evidence that advances our understandings about the different effects of CEO risk-taking incentives on systemic risk in noncrisis period and in crisis period. In particular, CEO risk-taking incentives contribute to financial crisis by enhancing bank performance, bank-specific risks, and risk contagions during noncirisis period. However, during financial crisis period, CEO risk-taking incentives only enhance risk contagions but not the bank-specific risks per se. The evidence is consistent with findings in Fahlenbrach and Stulz's (2011) about no significant relation between CEO portfolio Vega and bank performance during financial crisis, and further extends it to noncrisis period and to bank risk. Overall, our study provides evidence suggesting that inappropriate CEO option compensation design may be one of the causes for the recent financial crisis by distorting CEO risk-taking incentives towards conducting risky business activities highly contagious to the whole banking system and of high systemic risk.

This study also sheds new light on the current controversy regarding the role of option compensation in financial crisis and carries direct policy implications. Our findings endorse the policy-makers' criticism that executive pay arrangements have produced incentives for excessive risk–taking and contributed to the financial crisis (Bebchuk and Spamann, 2010; OECD, 2009; Binder, 2009; the financial crisis inquiry commission, 2011). The evidence that CEO risk-taking incentives induced by exercisable previous option grants (new option grants) is positively (negatively) associated with a bank's contribution to systemic risk also provides guidance to reform the incentive plan and suggests that the reform should at least constrain the exercise of CEO stock options compensation and add stricter restrictions on new option grants.

The remainder of the paper is organized as follows. Section 2 conducts a review of the related literature and develops our hypotheses. Section 3 describes the data and the measurement of key variables. Section 4, 5 and 6 present results about empirical analysis, further analysis, and robustness check, respectively, and Section 6 concludes this paper.

2. Hypotheses development

CEO risk-taking incentives increase contagions of bank failure and crash risks as well as these risks per se, thus increase a bank's contribution to systemic risk. In particular, risk-taking incentives induce CEOs to herd in risky business operations such as taking on non-interest income-generating activities (including financial innovations, such as CDS and asset securitization in particular CDO) and maintaining high maturity mismatch, through which CEOs' risk-taking incentives affect bank-specific failure and crash risks, and more importantly, their contagions. CEO risk-taking incentives induced from CEOs' previously granted options (from new option grants) have stronger (weaker) positive relations with a bank's contribution to systemic risk. In addition, exogenous conditions—information transparency, bank size, market liquidity, and financial crisis—are expected to moderate associations between CEO risk-taking incentives and a bank's contribution to systemic risk. We elaborate these mechanisms in more details below.

2.1. CEO risk-taking incentives, risky business policies, and a bank's contribution to systemic risk

Bank systemic risk originates from failure and stock price crash in an individual financial institution.[3]Through motivating risky investments and high maturity mismatch that increase bank-specific default and crash risks, CEO risk-taking incentives contribute to the source of bank systemic risk. CEO's option compensation induces banks' risky investments such as conducting non-interest income-generating activities,[4] private mortgage-backed securities investments, or risky bank acquisitions, all of which increase bank-specific default and crash risks (Mehran and

[3]For example, the recent 2008-2009 financial crisis stems from the collapse or forced mergers/bailouts of Bear Stearns, AIG, Fannie Mae, Freddie Mac, Lehman Brothers, IndyMac Bank, Merrill Lynch, Wachovia, Washington Mutual, and many others.
[4]Non-interest income includes income from trading, securitization, investment banking and advisory fees, brokerage commissions, venture capital, fiduciary income, and gains on non-hedging derivatives.

Rosenberg, 2009; Hagendorff and Vallascas, 2011; DeYoung, Peng, and Yan, 2010).[5] For example, conducting more risky non-interest income-generating activities leads to higher total (operating and financial) leverage and earnings volatility (DeYoung and Roland, 2000), which increases default risk as well as other bank risks (Chen, Steiner, and Whyte, 2006; Mehran and Rosenberg, 2009). CEOs' equity-based incentives induce firms' suboptimal investment policies and their incentives to conceal bad news about future growth, which lead to severe overvaluation and stock price crash (Benmelech, Kandel, and Veronesi, 2010; Kim, Li, and Zhang, 2011).

CEO risk-taking incentives spurn firm risk management since managers are better-off if firms do not hedge and conversely take on more risks as the risk-taking incentives increases (Smith and Stulz, 1985; Knopf, Nam, and Thornton, 2002; Rogers, 2002; Rajgopal and Shevlin 2002), which implies that CEO risk-taking incentives induce CEOs to take liquidity risk and discourage liquidity risk management in particular. CEO risk-taking incentives further induce bank CEOs to cut down cash holdings and increase short-term debt financing to pursue high short-term return (Chava and Purnanandam, 2010). Therefore, CEO risk-taking incentives result in severe maturity mismatch and liquidity risk, which increases bank default risk (Campbell, Hilscher, and Szilagyi, 2008).

CEO risk-taking incentives further induce banks' *herding* in the above risky business operations, which enhance contagions of bank default and crash risks among correlated banks. Kirkpatrick (2009) suggests that bank herding increases with managerial performance-based compensations in commercial banks. In particular, as other banks with high short-term profits from the risky activities such as mortgage loan securitization, it is rational for CEOs with equity-based compensation to herd in the risky activities since no herding leads to lower profits

[5]In particular, Chen, Steiner, and Whyte (2006) report that CEO's exposure to stock options leads to greater risk-taking, across alternative market based risk measures. Mehran and Rosenberg (2009), Hagendorff and Vallascas (2011), and DeYoung, Peng, and Yan (2010) investigate the effects of executive compensation incentives on bank business policy choices; in particular, Mehran and Rosenberg (2009) show that higher vega leads to riskier investments, and higher levels of equity and asset volatilities, Hagendorff and Vallascas (2011) extend the evidence to the specific risky bank acquisition settings, and DeYoung, Peng, and Yan (2010) extend the conclusion to the specific non-interest income generated activities and private MBS investments.

and stock price in the short-run and injures the benefits of CEOs with equity-based compensation. Morevoer, the convex pay-off structure of options compensation do not punish CEOs if they herd in the risky activities that ultimately damage the long-term bank performance. Therefore option compensation could equip CEOs excessive suboptimal risk-taking incentives to herd in risky investments correlated with other banks. As modeled by Mondschean and Pecchenino (1995) and Pecchenino (1998), herd behaviors by banks induces and magnifies cyclical fluctuations, suggesting that this herding in undertaking investments or business activities enhances contagion and contributes to systemic risk.

In similar vein, equity-based incentives can also induce CEOs to herd in taking high liquidity risk and maintaining high maturity mismatch. Banks with high maturity mismatch heavily rely on interbank lending for liquidity provision during distress, so the interbank market could function as interbank contagion channel that spread liquidity risk and failure from an individual bank to other interconnected banks. Furthermore, the fear of interbank contagion may further reduce interbank lending, impair liquidity provision among banks and dry up liquidity on the interbank markets, force banks to firesale illiquid assets (Bleakley and Cowan, 2010), and other depositors and stakeholders to withdraw dealings with these banks (Iyer and Peydró, 2011; Gorton, 2009)). Diamond and Rajan (2005) analytically argue that bank failures shrink the common pool of liquidity, creating or exacerbating aggregate liquidity shortages and lead to a total meltdown in the system even without depositor panic. Iyer and Peydró (2011) document that interbank debt linkages propagate the failure shock. Therefore herding in maintaining high maturity mismatch induced by CEO equity-based incentives enhance contagions and result in the high systemic risk too.

2.2. CEO risk-taking incentives, contagions through asset securitization, CDO, CDS, and a bank's contribution to systemic risk

Among other risky investments, CEO risk-taking incentives particularly motivate herding in financial innovations-- asset securitization, derivatives and other financial innovations--since these activities yield high short-term benefits to CEOs with equity-based compensation. By nature, some of the innovative financial products increase bank profitability without incurring systemic risk, yet some financial innovations such as asset securitization (including CDO) and CDS enhance interconnection both on- and off- balance sheets among banks, and form the conduct that facilitates interbank contagion and generate domino effects (Adrian and Shin, 2008). Financial innovation is associated with higher idiosyncratic bank fragility as well as higher systemic banking distress, and leads to lower subsequent banks' profitability during the recent crisis (Beck, Chen, Lin and Song, 2011).

Asset securitization increases correlated defaults via enhanced debts or loans connections and construct a major source of systemic risk (Krahnen and Wilde, 2007; Hansel and Krahnen, 2007). The "originate-to-distribute" business model of CDOs and Collateralized Loan Obligations (CLOs) transfers individual default risk to others, increases the likelihood that banks incur losses jointly, and thus enhances joint default risk in the banking sector (Nijskens and Wagner, 2011). This model also increases the risk of systemic crisis by inducing securitization-active banks to lend more (Shivdasani and Wang, 2011), reducing the screening and monitoring efforts on their lending (Keys, Mukherjee, Seru, and Vig, 2010), and by packaging and distributing low-quality lending to others. Securitization further amplifies systemic risk in the whole financial system by allowing the senior tranches of CDOs or CLOs to be distributed to a broad universe of investors such as banks, insurance companies, pension funds, and certain asset managers that might not otherwise invest in high risk instruments (Shivdasani and Wang, 2011). As manifested in the 2008-2009 financial crisis, tranches of CDOs based on cash flows of portfolios of subprime home-equity loans were the major source of credit losses for many financial institutions. Longstaff (2010) confirms and provides evidence that financial contagions of subprime asset-backed CDOs spread to stock and loan markets primarily through liquidity shocks and risk-premium channels rather than informational channels.

CDS works as an insurance contract that a buyer pays a premium to the seller in return for protection against a credit default. Banks transfer credit risks by buying protection using CDS, and incur other credit risks by selling protection of CDS at the same time. Unlike traditional lending activities, the counterparties of CDS are financial firms, thus making banks more correlated with each other and increasing the pairwise default probabilities within the banking system.[6] CDS creates systemic risk upon bad information about the protection buyer, which undermines protection seller's incentives to manage its balance-sheet risk, hence increasing the counter-party risk of the protection buyer (Biais, Heider, and Hoerova, 2010). CDS also increases systemic risk through encouraging banks to originate more securitizations and to reduce ex ante screening and ex post monitoring on lending (Morrison, 2005). In addition, CDS contributes to systemic risk through sharing default risks (Liu, 2010). Allen and Carletti (2006)'s model suggests that the credit risk transfer using CDS increases the risk of financial crisis due to contagion between different financial sectors. The above analysis suggests that risk-taking incentives spur CEOs to invest in innovative financial products such as CDS and CDO which increase interconnections among banks and forms natural contagion channel to foster sector-wide systemic risk.

In sum, the above reasoning concludes that CEO equity-based risk-taking incentives motivate risky business such as non-interest income-generating activities, financial innovations, and maturity-mismatch, which increase a bank's contribution to systemic risk by enhancing contagions of bank-specific failure and crash as well as these risks as such.

H1: CEO risk-taking incentives increase a bank's contribution to systemic risk.

The above analysis also suggests that CEO's risk-taking incentives increase a bank's contribution to systemic risk through channels of non-interest income generated activities and maturity mismatch, as hypothesized below:

[6]For example, if Wells Fargo buys a CDS from Citigroup, the CDS will appear as conditional asset for Wells Fargo and conditional liability for Citigroup. Similarly, Citigroup may buy a CDS from Bank of America, and Bank of America may buy a CDS from JP Morgan Chase… thus the BHCs have intertwined balance sheets along with the claim chain. If Wells Fargo takes a hit and suffers from default or crash risk, its claim will make Citigroup suffer a loss, and if the loss is large enough to wipe out Citigroup's capital, then Citigroup defaults. Bank of America then takes a hit. In turn, if the loss is big enough, Bank of America defaults, and JP Morgan Chase takes a hit, etc.

H2a: CEO risk-taking incentives increase a bank's contribution to systemic risk through the non-interest-income channel.

H2b: CEO risk-taking incentives increase a bank's contribution to systemic risk through the maturity mismatch channel.

The above reasoning about financial innovations such as asset securitizations, CDO and CDS also leads to the following corollaries to hypothesis H2a:

C1a: asset securitizations (in particular CDO) and CDS increase a bank's contribution to systemic risk.

C1b: CEO risk-taking incentives increase a bank's contribution to systemic risk through asset securitizations (in particular CDO) and CDS channels.

2.4 Decomposition of CEO Risk-taking Incentives

CEO risk-taking incentives could be induced differently by new option grants, exercisable and unexercisable option granted previously. Bebchuk (2009) argue that managerial equity compensation including option motivates managers to engage in short-termist risk-taking behaviors to inflate current stock or option prices at the expense of long-term firm value, and that freedom to cash out equity contributes substantially to creating short-term incentive distortions. Many new option grants are restrictive in that they block managers from cashing in on them for a specified period after vesting, usually five to ten years, whereas exercisable CEO's option compensation granted previously allows broad freedom to cash out. Romano and Bhagat (2009) observe that restricted stock options helps to mitigate excessive risk-takings that lead to systemic risk and focus CEO incentives on creating and sustaining long-term firm value, and advice to restrict stock options for a period of at least two to four years after the executive's resignation or last day in office. We expect that suboptimal excessive risk-taking incentives generated from CEO's new option grants is lower than from CEO's option compensation granted previously. As a result, the positive relations of the CEO risk-taking incentives induced from exercisable CEO's option granted previously (from new option grants) and a bank's contribution to systemic risk are expected to be stronger (weaker). The reasoning gives rise to the following hypothesis:

H3: CEO risk-taking incentives induced by CEO's option granted previously (by new option *grants) have stronger (weaker) positive effects on a bank's contribution to systemic risk.*

2.5. Conjectures about moderating effects of conditioning variables

Several exogenous conditions moderate the relations between CEO risk-taking incentives and a bank's contribution to systemic risk: information transparency, bank size, market liquidity, and financial crisis. Banks are subject to strong information asymmetry and opaqueness (Morgan, 2002), which boost contagions of bank failure and crash risk, thus enhancing the positive relation between CEO risk-taking incentives and a bank's contribution to systemic risk. Therefore mechanisms that enhance information transparency such as analyst forecast accuracy and bank size, are expected to mitigate this positive relation. Lower analyst forecast dispersion implies more transparent information environment which reduces informational and pure contagions.

Large bank size attracts more analysts, institutional shareholders, media coverage, and other monitoring forces, leading to a more timely and comprehensive information discovery process (Cheng, Dhaliwal, and Neamtiu, 2011). In particular, analysts monitor a bank's suboptimal risk-taking behaviors that increase bank-specific failure and crash risks. However, bank size could also proxy for "too-big-to-fail".[7] This implicit bailout guarantee could curb the contagions if market participants believe in the guarantee, but at the same time bank creditors have little propensity to limit CEO's excessive risk-takings (John, Saunders, and Senbet, 2000; John, Mehran, and Qian, 2010), which could increase CEOs risk-taking incentives and lead to increased bank risks and contagion (Duchin and Sosyura, 2011; Bebchuk and Spamann, 2009). Thus this uncertain "too-big-to-fail" effect of bank size can result in the dominance of the information transparency effect of bank size on the relation between *Vega* and a bank's contribution to systemic risk.

Market illiquidity enhances the positive relations between CEO risk-taking incentives and banks' contribution to systemic risk through its effects on contagions. During periods of market

[7]Considering the vulnerability of banking industry to contagious bank runs and the importance of banking sector to the whole economy (Levine, 1997, 2005), governments provide implicit regulatory guarantee of "too-big-to-fail" (O'Hara and Shaw, 1990), to make banks more credible to depositors in financial crisis.

illiquidity, asset sales have greater impact on short-run price than during periods of liquidity (Amihud, 2002). Adrain and Shin (2010) and Longstaff (2010) document that market illiquidity during financial crisis operates as a contagion channel especially for subprime asset-backed collateralized debt obligations. This additional contagion induced by high market illiquidity could accentuate the effects of CEO risk-taking incentives on a bank's contribution to systemic risk.

Financial crisis impacts the proposed positive relation between CEO risk-taking incentives and a bank's contribution to systemic risk in a subtle way. The exogenous shocks of financial crisis significantly reduces risk-averse CEO's wealth (Fahlenbrach and Stulz, 2010), and thus and thus reduces their excess risk-taking incentives induced by Vega (Carpenter 2000; Ross, 2004). Nonetheless, financial crisis also renders most options out-of-money and thus directly reduce the incentive power of option compensation for risk-taking. Instead, financial crisis may still breed excessive CEO risk-taking because option devaluation reduces CEO's loss from a bet that turns out poorly, which induces CEOs to conduct negative NPV investment that brings more net private gains. Contagion effects also increase during financial crisis due to increased market illiquidity (Adrain and Shin, 2010; Longstaff, 2010). Therefore, the above considerations suggest that the moderating effects of financial crisis are open empirical questions.

3. Research Design

3.1. Data Description

This study covers publicly traded commercial banks and bank holding companies (BHCs) in the U. S., namely, banks with two-digit SIC codes 60, 61, and 6712 from year 1992 to 2009.[8] Banks with SIC code 6163 (Loan Brokers) are deleted since they are pure brokerage or investment banks. Non-banking firms within SIC code 6199 such as American Express are also deleted. Financial statement data is retrieved from Compustat, the Report of Condition and Income (“Call Report”), and FR Y-9C report filed by a commercial bank or BHC with the Federal Reserve. CEO compensation data is obtained from Execucomp, and stock price and return data

[8]In particular, the final sample includes SIC 6020, 6021,6022, 6025, 6029, 6030, 6035, 6036, 6060, 6090, 6141, 6153, 6162, 6712. Banks with SIC code 6020 are State Commercial Banks; 6022 are Savings Institutions, and 6035 are Federally Chartered.

are from CRSP. To be included in the final sample, all systemic risk and compensation variables used in the study should be available. We mainly use the linkage database available at the Federal Reserve Board of New York website to merge FR Y-9C report and Call Report data for BHCs with Compustat, CRSP and Execump data, and use hand-identified linkage database to merge data for commercial banks. We winsorize all variables to 1% and 99% of their empirical distributions to eliminate the effects of outliers. Our final sample contains an unbalanced panel of 119 unique banks and 2,223 bank-quarter observations.

3.2. Dependent variable: a bank's contribution to systemic risk

Recent systemic risk literature presents an increasing number of systemic risk measures but reaches no consensus regarding which one is the best. Bisias et al. (2012) provide a thorough review over these measures. Among others, Allen et al. (2012) develop an aggregate systemic risk measure, *CATFIN*, which uses the principal components of the 1% *VaR* and expected shortfall of a cross-section of financial firms to predict economic downturns almost one year in advance. Unfortunately, both *CATFIN* and the interconnectedness measure are not bank-specific measures. Billio et al. (2012) propose two network-based systemic risk measures that capture the interconnectedness among the monthly returns of hedge funds, banks, brokers, and insurance companies based on principal components analysis and Granger-causality tests. Acharya et al. (2010) adopt the marginal expected shortfall measure (*MES*) when the overall market declined substantially and Acharya et al. (2012) similarly develop a *SRISK* measure that gauge a bank's expected capital shortfall in a financial crisis. Both *MES* and *SRISK* focus on the magnitude of a bank's exposure to a systemic crisis. Huang et al. (2009) and Giglio (2010) develope CDS-based measures that gauge systemic contraction risk from CDS prices that content information about joint default risks of the bond issuer and the protection seller. These measures, however, are only applicable to large banks with CDS transactions.

The *CoVaR* based systemic risk measures proposed by Adrian and Brunnermeier (2010), explicitly accounts for a bank's contribution to the crisis which is different from a bank's loss associated with the loss in other banks. Billio et al. (2012) document that institutions that declined the most during the 2008-2009 Crisis were the ones that greatly affected other institutions and not the institutions affected by others. In addition the *CoVaR* measure admits market inefficiency and information asymmetry and allows CEO risk-taking incentives to affect a bank's contribution to systemic risk, so is thus fitted for our research settings. However, it is possible that many banks endure significant loss simultaneously due to common exposures in a crisis such that *MES* and *SRISK* also measure a bank's contribution to systemic risk. Therefore we use both measures in robustness check.

This study uses two *ΔCoVaR* measures for a bank's contribution to systemic risk: a bank's contribution to systemic contraction risk *ΔCoVaR5_at* and *ΔCoVaR_at* which are based on asset return following Adrian and Brunnermeier (2010), and a bank's contribution to systemic crash risk *ΔCoVaR_stk* and *ΔCoVaR5_stk* which are based on stock return extending Adrian and Brunnermeier (2010). Following Boyson et al. (2010) and Adrian and Brunnermeier (2010), we use quantile regression method to estimate a bank's contribution to systemic risk. Boyson et al. (2010) use quantile regressions to measure contagions in hedging funds, while Adrian and Brunnermeier (2010) employ quantile regressions to gauge a bank's contribution to systemic risk, the value at risk (VaR) of the financial sector conditional on each bank's VaR in its asset values.[9] Quantile regression estimates the conditional probability that a variable falls below a given threshold (quantile) when another random variable is also below this same quantile. It is a simple and efficient method to gauge contagion or systemic risk, as it requires no distributional assumptions, is estimable for a large range of possible quantiles, and allows for heteroskedasticity (Boyson et al. 2010).

A bank's contribution to systemic default risk: ΔCoVaR_at and ΔCoVaR5_at

We designate a bank's value-at-risk $VaR^{i}_{1\%}$ as the weekly asset return/loss that bank *i* might experience with 1% probability over a pre-set horizon *T*. We define a bank's value-at-risk $VaR^{i}_{5\%}$

[9] *VaR* refers to the worst expected loss under normal distribution over a specific time interval at a given confidence level.

in similar way:

$$Probability\ (R^i <= VaR^i_{1\%}) = 1\% \qquad (1)$$

$$Probability\ (R^i <= VaR^i_{5\%}) = 5\% \qquad (2)$$

We use $CoVaR^{system|i}_{1\%}$ to indicate the *VaR* of the financial system with 1% probability and conditional upon bank *i* in distress and with a $VaR^i_{1\%}$, and express it as

$$Probability\ (R^{system} <= VaR^{system|i}_{1\%}|R^i = VaR^i_{1\%}) = 1\% \qquad (3)$$

Similarly, $CoVaR^{system|i,medain}_{1\%}$ refers to the he financial system's *VaR* with 1% probability conditional on the asset return of bank *i* at its median level, is denoted as

$$Probability\ (R^{system} <= VaR^{system|i,median}_{1\%}|\ R^i = median^i) = 1\% \qquad (4)$$

Then asset return based contribution to systemic risk of bank *i* $\Delta CoVaR\_at^i$ can be defined as the difference between the financial system's *VaR* conditional on bank *i* in distress ($CoVaR^{system|i}_{1\%}$), and the financial system's *VaR* conditional on bank *i* functioning in its median state ($CoVaR^{system|i,medain}_{1\%}$), as shown below:

$$\Delta CoVaR\_at^i = CoVaR^{system|i,medain}_{1\%} - CoVaR^{system|i,medain}_{1\%} \qquad (5)$$

Appendix B provides estimation details for *ΔCoVaR_at*. We define *ΔCoVaR5_at* similarly.

A bank's contribution to systemic crash risk: ΔCoVaR_stk and ΔCoVaR5_stk

Extending Adrian and Brunnermeier (2010), this study constructs a corresponding stock return based measure Δ*CoVaR_stk* to gauge a bank's contribution to systemic crash risk. The estimation for *ΔCoVaR_stk* and *ΔCoVaR5_stk* parallel that for Δ*CoVaR_at* and Δ*CoVaR5_at* except that asset return is replaced by stock return. Appendix B provides estimation details.

Stock return based systemic risk measures are different from asset based measure in that they emphasize a bank's contribution to the risk that the banking industry has a large downside risk or crash in the stock price, while asset based measures emphasize the contagion of the drop in a bank's asset value to that of all other banks in the whole sector. In this sense, stock return based measure gauges a bank's contribution to systemic crash risk, while stock return based systemic risk gauges a bank's contribution to systemic default risk.

3.3. CEO risk-taking incentives and other compensation variables

Our variables of interest are CEO risk-taking incentives induced by CEO option compensation. It is well-established that the convexity of option compensations give managers incentives to take on risky projects because they share the gains but not the losses with shareholders (Jensen and Meckling, 1976; Haugen and Senbet, 1981; Smith and Stulz, 1985; Smith and Watts, 1992; Gaver and Gaver, 1993; Guay, 1999; and Core and Guay, 1999). We measure CEO risk-taking incentives by the stock volatility sensitivity of option compensation *Vega*, which is denoted as the natural logarithm of the dollar change in the value of CEO's option holdings resulting from a 1% increase in a firm's stock volatility. We further decompose *Vega* into two components: risk-taking incentives from CEO's new option grants, *Vega_awards;* from CEO's option granted previously, *Vega_old*. *Vega_awards* and *Vega_old* are specified as one plus the natural logarithm of the dollar change resulting from a 1% increase in a firm's stock volatility in the value of CEO's new option grants, and previously granted options, respectively.[10]

We use the sensitivity of CEO options and equity shareholdings to stock price *Delta* to proxy for CEO risk-averse incentives and calculate it as the natural logarithm of the dollar change in the value of CEO option and stock holdings resulting from a 1% increase in firm's stock price.[11] We define incentives from cash bonus *bonus* as the ratio of executive bonus to total salary. Both *Delta* and *bonus* are used as controlling variables.

3.4. Baseline model and its estimation

We use the following lead-lag model to investigate the associations between a bank's contribution to systemic risk and CEO risk-taking incentives, with other CEO compensation variables, and other controls acting as control variables:

$$\Delta CoVaR_{it} = \varphi_0 + \varphi_1 Vega_{it-1} + \varphi_2 COMP_{it-1} + Controls + \varepsilon_{it}, \quad (6)$$

where $\Delta CoVaR_{it}$ refers to a bank's contribution to systemic contraction risk $\Delta CoVaR\_at$,

[10] we use the log of one plus the raw value for both new option grants and previous option grants to ensure no missing observations when a bank-quarter has only new option grants or only previous option grants.

[11] *Delta*, is not used to measure risk-taking incentives as it induces managers to work harder or more effectively but exposes managers to more risk, enhancing their risk-averse propensity.

Δ*CoVaR5_at* or a bank's contribution to systemic crash risk Δ*CoVaR_stk*, Δ*CoVaR5_stk*, respectively. *Vega* gauge CEO risk-taking incentives, and *COMP* includes other CEO compensation variables *Delta* and *bonus*. When Δ*CoVaR_at* or Δ*CoVaR5_at* is used as dependent variable, *Controls* include market to book *Mb*, leverage ratio *Leverage*, equity return volatility *Sigma*, total asset *Size* and its square *Size_sqr*, return on asset *ROA*, loan to asset ratio *Loan*, and dummies for the fourth fiscal quarter. When Δ*CoVaR_stk* or Δ*CoVaR5_stk* is used as dependent variable, we add additional controls such as momentum *Mom*, down-to-up volatility *Duvol*, and relative kurtosis of stock return to the market *Cokurt*. H1 predicts that $\varphi_1 > 0$. We run OLS regressions with yearly and quarterly fixed effects and with *T*-statistics adjusted for bank-level clusters for Model (6).

3.5. Channel variables and channel tests

We use the following measures for the three channels examined: we use the ratio of difference between cash holdings and short-term debt to total assets *Mismatch* as measures for maturity mismatch, and the ratio of non-interest income to interest income *N2I* as proxy for non-interest income. For the financial innovative instruments channel, this study uses the natural logarithm of one plus the dollar amount of asset securitization volume in a fiscal quarter *Securitize*, the natural logarithm of one plus the dollar amount of CDO in a fiscal quarter *CDO*, and the natural logarithm of one plus the dollar amount of trading CDS in a fiscal quarter *CDS*.

Then we employ a model consisting of equations (7) and (9) below to examine how each channel affects relations between CEO risk-taking incentives and a bank's contribution to systemic risk. Specifically, Model (7) regresses a specific channel on CEO risk-taking incentives *Vega*, other CEO compensation variables *COMP*, and other control variable. Next one may want to use Model (8) that regresses a bank's contribution to systemic risk Δ*CoVaR* on *Channel* variable, *Vega*, *COMP*, and other controls *Controls2*. If $\beta_1 > 0$ and $\gamma_1 < 0$, it means that CEO risk-taking incentives *Vega* mitigates contributions to systemic risk via a channel. However, a model that consists of Model (7) and (8) could potentially yield spurious results. For example, if a channel is affected by CEO risk-taking incentives *Vega* but not vice versa and it de facto does not influence systemic risk, we could still observe $\gamma_1 < 0$, which is a spurious result. To address this issue, it is important to factor out the effects of *Vega* on a channel variable. We therefore use the residual estimated from Model (7), *Channel_R*, to replace its raw value in Model (9). Therefore Equations (7) and (9) construct a 2SLS model to test hypotheses H2a, H2b, C1a and C1b, which predict that $\beta_1 > 0$ and $\eta_1 < 0$.

$$Channel_{it} = \beta_0 + \beta_1 Vega_{it-1} + \beta_2 COMP_{it-1} + Controls1_{it-1} + \upsilon_{it} \qquad (7)$$

$$\Delta CoVaR_{it} = \gamma_0 + \gamma_1 Channel_{it-1} + \gamma_2 Vega_{it-1} + \gamma_3 COMP_{it-1} + Controls2_{it} + \varepsilon_{it} \qquad (8)$$

$$\Delta CoVaR_{it} = \eta_0 + \eta_1 Channel\_R_{it-1} + \eta_2 Vega_{it-1} + \eta_3 COMP_{it-1} + Controls2_{it} + \mu_{it} \qquad (9)$$

where $\Delta CoVaR_{it}$, *Vega*, *COMP*, and *Controls2* are the same as in Model (7). *Channel* refers to non-interest income to interest income *N2I*, the decompositions of *N2I*, financial innovations *securitize*, *CDO*, *CDS*, and maturity mismatch *Mismatch*, respectively. *Controls1* in Model (7) differs depending on the channel variable *channel* tested.[12]

4. Empirical analysis

4.1 Descriptive statistics

Table 1 presents the summary statistics for variables used in the main empirical tests. The mean (median) values of a bank's contribution to systemic default risk, *ΔCoVaR5_at* and *ΔCoVaR_at* are 22.2955 (19.1546) and 27.0738 (21.6506), respectively, which are comparable to the corresponding figures in Brunnermeier, Dong, and Palia (2011), and in Adrian and Brunnermeier (2010).[13] The mean (median) values of a bank's contribution to systemic crash risk,

[12] When maturity mismatch *Mismatch* is used as dependent variable, *Controls1* include total asset *Size* and its square *Size_sqr*, return on asset *ROA*, tier-one capital ratio *CAPR1Q*, loan to asset *Loan*, net interest margin *Nim*, bond market liquidity spread *Repo*, change in the three-month Treasury bill rate *3M*. When *N2I*, its components, or financial innovations are used as dependent variables, *Controls1* includes market to book *Mb*, financial leverage *Leverage*, ratio of loan loss allowance to total assets *LLA*, total asset *Size* and its square *Size_sqr*, return on asset *ROA*, tier-one capital ratio *CAPR1Q*, loan to asset *Loan*, and net interest margin *Nim*.

[13] The figures appear much higher in magnitude than the corresponding figures reported in Brunnermeier, Dong, and Palia (2011), and in Adrian and Brunnermeier (2010), which is around 1.00 to 1.20. The seeming inconsistency is mainly due to that they report the weekly percentage *ΔCoVaR*, however we report the quarterly *ΔCoVaR* which equals to the average of weekly *ΔCoVaR* in a quarter times 13. Therefore, our mean *ΔCoVaR* should be about 13 times of their measure. The inconsistency is partly due to the different industries and years covered in calculating *ΔCovar_at*: We use only the commercial banks and bank holding companies and do not cover 1989 crisis period and the period from 1986 to 1991, while Adrian and Brunnermeier (2010) additionally cover investment banks and real estate sectors, and sample periods extend to the 1989 crisis period and the period from 1986 to 1991. Besides, we use only those commercial banks and bank holding companies with CEO compensation data available, while

ΔCoVaR5_stk and *ΔCoVaR_stk* are 26.5301 (22.6778) and 39.9309 (34.0367), respectively. The mean (median) of CEO's *Vega*, *Vega_old* and *Vega_awards* are -2.6515 (-2.7943), 0.022 (0.001), and 0.219 (0.057), respectively.

Table 2 reports the Pearson correlation matrixes for the main testing variables in Panel A and for the contribution to systemic risk measures and various other bank risk measures in Panel B respectively. In Panel A, the two measures for contribution to systemic default risk, *ΔCoVaR5_at* and *ΔCoVaR_at*, are significantly correlated with each other with a Pearson correlation of 0.7955. The two measures for contribution to systemic crash risk, *ΔCoVaR5_stk* and *ΔCoVaR_stk*, are also significantly correlated with each other with a Pearson correlation of 0.8981. The two sets of contributions to systemic default and crash risk measures are significantly correlated with each other with correlations between 0.4858 and 0.7141, indicating their construct validity and convergent validity. CEO risk-taking incentives *Vega* are significantly positively associated with its mediating channels to affect banks' contribution to systemic risk-non-interest income *N2I* , financial innovations *Securitize*, *CDO*, *CDS*, and maturity mismatch *Mismatch*, and all of them are significantly positively associated with the four measures for banks' contribution to systemic risk. The results provide initial evidence supporting hypotheses H1 and H2a, b, and corollary C1a, C1b. However, these partial correlations can be spurious without controlling for the effects of other determinants of contributions to systemic risk, and further multivariate analyses about their relations are justified.

In Panel B, the four measures for banks' contribution to systemic risk are all significantly positively correlated with other bank risk measures—return volatility *Sigma*, stock market systematic risk measure *Beta*, bank-specific value at risk for asset return *VaR_at*, bank-specific value at risk for stock return *VaR_stk*, *MES*, except for *Z-Score* as higher Z-score implies higher bank stability and thus lower default risk. *Z-Score* is significantly negatively correlated with *ΔCoVaR5_stk* and *ΔCoVaR_stk*, and is insignificantly negatively associated with *ΔCoVaR5_at* and

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Brunnermeier *et. al.* (2011) include all the commercial banks and bank holding companies with available *ΔCoVaR_at* data.

ΔCoVaR_at. *MES* is also significantly positively associated with bank-specific risk measures *Sigma*, *Beta*, *VaR_at*, and *VaR_stk*, except for *Z-Score*. The evidence further manifests the construct validity and convergent validity of the measures for banks' contribution to systemic risk, and suggests that bank-level distress risk and crash risk are the source of systemic risk.

4.2 Associations between CEO risk-taking incentives and a bank's contribution to systemic risk

Table 3 presents OLS regression results for testing hypothesis H1 that predicts positive associations between CEO risk-taking incentives and a bank's contribution to systemic default risk. Models 1 and 5 show that *Vega* is significantly positively associated with *ΔCoVaR5_at* and *ΔCoVaR_at* at the 1% level, with coefficients (*T*-statistics) 1.162 (3.135) and 1.911 (3.558), respectively. This observed relation is also economically significant. In particular, the impact of a one-standard deviation increase in *Vega* (1.9999) equals 2.324, which is 10.42 percent of the mean value of the *ΔCoVaR5_at*; the impact of a one-standard deviation increase in *Vega* (1.9999) on *ΔCoVaR_at* equals 3.8218, which is 14.12 percent of the mean value of the *ΔCoVaR_at*. The evidence suggests that the CEO risk-taking incentives derived from higher *Vega* is associated with higher contribution of a bank to systemic default risk, thus lending support to hypothesis H1.

Models 2, 3, 6, and 7 test whether *Delta* and *Bonus* respectively are associated with a bank's contribution to systemic default risk. The results show that *Delta* and *Bonus* are insignificantly related with a bank's contribution to systemic default risk, consistent with previous divergent viewpoints about their effects on CEO risk-taking incentives.[14] Models 4 and 8 in Table 3 include *Delta* and *Bonus* simultaneously as further controls and consistently yield significantly positively relations between *Vega* and *ΔCoVaR5_at* and *ΔCoVaR_at*, consistent with and complementary to the evidence that higher *Vega* induces manager's risk-taking incentives and is related to higher firm-level default risk (Knopf, Nam, and Thornton, 2002; Coles, Daniel, and

[14]Prior studies suggest that *Delta* impacts managers' risk-taking, however, the direction is uncertain (Knopf, Nam, and Thornton, 2002; Brockman, Martin, and Unlu, 2010; Kim, Li, and Zhang, 2011). Knopf, Nam, and Thornton (2002) suggest that higher *Delta* reduces mangers' risk-taking incentive, which is evidenced by Brockman et al. (2010). However, Kim et al. (2011) provide evidence that higher *Delta* of top managers is positively related to the firm's future stock price crash risk. Balachandran, Kogut, and Harnal (2010) report that non-equity based incentives *Bonus* reduce financial firms' probability of default, however, policy makers and media criticize that cash bonuses encourage executives to focus on short-term gains at the expense of long-term performance (Bebchuk and Spamann, 2009).

Naveen, 2006; Brockman, Martin, and Unlu, 2010). The coefficients on *Delta* and *Bonus* are still insignificant, consistent with results for Models 2, 3, 6, and 7. The results in Table 3 collectively suggest that higher sensitivity of CEO's equity compensation portfolio to stock return volatility *Vega* is associated with larger contribution of a bank to systemic contraction risk and thus strongly support H1.

Results for control variables are generally consistent with Adrian and Brunnermeier (2010) and Brunnermeier et al. (2011). In particular, firm size *Size* significantly increases a bank's contribution to systemic default risk, consistent with the notion that when those banks larger and important to the industry approaches default, it will possibly lead to larger systemic contraction risk in the banking sector. Consistent with Brunnermeier et al. (2011), the effect of bank size is non-monotonic, with large banks (97.20%) inducing higher systemic default risk. Return volatility *Sigma* is significantly positively related to a bank's contribution to systemic default risk.

Table 4 reports OLS regression results for testing the part of hypothesis H1 that predicts a positive relation between CEO risk-taking incentives and a bank's contribution to systemic crash risk. Similar to the results in Table 3, Models 1, 4 and 5, 8 in Table 4 indicate that *Vega* is significantly positively associated with *ΔCoVaR5_stk* and *ΔCoVaR_stk* except in Model 5, suggesting that CEO risk-taking incentives induced from higher *Vega* is associated with higher contribution to systemic crash risk, consistent with and complementary to results in Table 3 that higher *Vega* induces managers' risk-taking incentives and increases a bank's contribution to systemic default risk. The effect of *Vega* on a bank's contribution to systemic crash risk is also economically significant. For example, Model 1 suggests that a one-standard deviation increase in *Vega* (1.9999) increases *ΔCoVaR5_stk* 1.7959 and by 6.77%. The results in Table 4 collectively suggest that higher *Vega* is associated with larger contribution to systemic crash risk and thus strongly support hypothesis H1.

Models 3, 4, 7, and 8 also exhibit a significantly negative relation between *Bonus* and a bank's contribution to systemic crash risk, consistent with Balachandran, Kogut, and Harnal (2010) that non-equity based incentives from cash bonus decrease financial firm's default risk. Results for control variables are generally consistent with Adrian and Brunnermeier (2010), Brunnermeier, Dong, and Palia (2011), and results in Table 3. In particular, firm size *Size*, return volatility *Sigma*, and daily return kurtosis *Cokurt* significantly increase while momentum *Mom* significantly reduces a bank's contribution to systemic crash risk. The coefficients on Market to book ratio *Mb* and profitability *ROA* are positive when significant.

4.3 Non-interest income, financial innovations, and maturity mismatch as channels for relations between CEO risk-taking incentives and a bank's contribution to systemic risk

Up to now, CEO's risk-taking incentives are manifested to increase a bank's contribution to systemic default and crash risks on average. This section reports results for testing hypotheses H2a and H2b and relevant corollaries C1a and C1b that *Vega* increases a bank's contribution to systemic risk through non-interest income-generating activities, some financial innovations, and maturity mismatch channels. The estimation methods involved include two paired OLS regressions consisting of Models (8) and (9) and 2SLS regressions consisting of Models (8) and (10), wherein the first regression (Model (8)) examines whether *Vega* increases a channel variable, and the second regression (Model (9) or Model (10)) examines whether a channel variable increases a bank's contribution to systemic default and crash risks or not. Tables 5 reports regression results for the non-interest income channel, Tables 6 and 7 present those for the financial innovation channel, and Tables 8 and 9 report findings for the maturity mismatch channel.

Tables 5 reports the OLS and 2SLS regression results for non-interest income generated activities channel *N2I* in Models 1 to 3 and Models 4 to 5, respectively. The OLS Model 1 indicates that *Vega* is significantly positively associated with *N2I*, supporting the notion that risk-taking incentives induce CEOs to engage more in the more risky non-traditional non-interest income-generated activities (Mehran and Rosenberg, 2007; DeYoung, Peng, and Yan, 2010; and Balachandran, Kogut, and Harnal, 2010). The OLS Models 2 and 3 demonstrate that *N2I* is significantly positively associated with both *ΔCoVaR5_at* and *ΔCoVaR5_stk*, suggesting that banks engaged more in *N2I* tend to contribute more to systemic default and crash risks, consistent with Brunnermeier, Dong, and Palia (2011) and complementary to Chen, Steiner, and Whyte (2006) and Mehran and Rosenberg (2007). The second-stage 2SLS regression results in Models 4 and 5 show that the residual of *N2I* estimated from the first stage, *N2I_R*, is significantly positively associated with both *ΔCoVaR5_at* and *ΔCoVaR5_stk* after netting the endogeneity between *N2I* and *Vega*, reconfirming the OLS estimation results in Models 2 and 3 that banks engaged more in *N2I* tend to contribute more to systemic default and crash risks. Overall, evidence in Table 5 provides strong support for H2a that non-traditional non-interest income-generated activities function as a channel for CEO risk-taking incentives to affect a bank's contribution to systemic contraction risk and to systemic crash risk.

Models 4 and 5 also indicate that *Vega* is still significantly positively associated with *ΔCoVaR5_at* and *ΔCoVaR5_stk* given the impacts of the channel variables, implying that besides *N2I*, other mediating mechanisms also work. Following Brunnermeier, Dong, and Palia (2011), we also decompose *N2I* into three components: trading income *T2I*, investment banking and venture capital income *V2I*, and other income *O2I*, to further examine the source of its mediating effects.[15] Untabulated 2SLS estimation indicate that *Vega* significantly increases *T2I*, *V2I*, and *O2I* in first-stage regressions, and the estimated residuals *T2I_R*, *V2I_R*, and *O2I_R* from first-stage regressions are positively associated with *ΔCoVaR5_at* and *ΔCoVaR5_stk* in the second-stage regressions. The results suggest that CEO incentives from *Vega* increase a bank's contribution to systemic risk through all types of non-interest income-generating activities, thus

[15]The definitions of each component $T2I_t$, $V2I_t$ and $O2I_t$ are as follows. $T2I_t$ proxy for proxy for trading income, one component of non-interest income, and is measured as the ratio of trading income to interest income calculated at the end of fiscal quarter *t*. Trading income includes trading revenue, net securitization income, gain (loss) of loan sales and real estate sales. $V2I_t$ proxy for investment banking and venture capital income, one component of non-interest income, and is measured as the ratio of investment banking and venture capital income to interest income calculated at the end of fiscal quarter *t*. investment banking and venture capital income includes investment banking and advisory fees, brokerage commissions, and venture capital revenue. $O2I_t$ proxy for other income, one component of non-interest income, and is measured as the ratio of other income to interest income calculated at the end of fiscal quarter *t*. Other income includes fiduciary income, deposits service charges, net servicing fees, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, etc.

further strongly supporting hypothesis H2a.

Tables 6 reports OLS regression results for testing corollary C1a and C1b that CEO risk-taking incentives increases financial innovations like asset securitizations, CDO and CDS, among other financial innovations, increase a bank's contribution to systemic risk. Results in Models 1 to 3 show that CEO risk-taking incentives are significantly positively associated with asset securitization *Securitize*, *CDO*, and *CDS* respectively. Table 6 consistently indicates significantly positive coefficients on asset securitizations, CDO and CDS in all OLS regressions of *ΔCoVaR5*_at and *ΔCoVaR5*_stk in Models 4 to 9. This finding strongly corroborates corollary C1a by showing that asset securitizations, CDO and CDS significantly increase banks' contribution to systemic contraction risk and to systemic crash risk. This evidence also supports the criticism that extensive use of innovative financial products such as CDO and CDS has contributed to the recent financial crisis through sharing default risks (Liu, 2010), and increasing counter-party risk and joint default risk (Biais, Heider, and Hoerova, 2010; Krahnen and Wilde, 2007; Hansel and Krahnen, 2007). The combination of evidence in Table 6 provide initial evidence that financial innovations works as channels for CEO incentives to affect a bank's contribution to systemic risk, thus supporting C1b.

Tables 7 report the second-stage 2SLS regression results for more refined tests for corollary C2a that financial innovations asset securitizations, CDO and CDS act as mediating channels for CEO risk-taking incentives to affect a bank's contribution to systemic risk. Models 1 to 6 show that estimated channel residuals from the first-stage regressions, *Securitise_R*, *CDO_R*, and *CDS_R*, are all positively associated with *ΔCoVaR5_at* and *ΔCoVaR5_stk*, with significant coefficients in all models except in Model 2 where the coefficient on *Securitise_R* is positive but insignificant. Thei evidence indicates that the effects of financial innovations as such on banks' contribution to systemic risk still hold after netting the influence of CEO incentives on financial innovations. Findings in Table 7 reconfirms OLS regression results in Table 6 and provide further support for corollary C1b that *Vega* increases a bank’s contribution to systemic risk through innovative financial product channels such as asset securitization, CDO and CDS, and also suggests that suboptimal CEO option compensation coupled with risky financial innovations is one cause that triggers the recent financial crisis.

Table 8 presents OLS and 2SLS regression results for testing hypothesis H2b that *Vega* impacts a bank's contribution to systemic default and crash risks through maturity mismatch *Mismatch*. The OLS regression Model 1 in Table 8 shows that *Vega* is significantly positively associated with maturity mismatch, suggesting that higher CEO risk-taking incentives motivate high maturity mismatch, consistent with Knopf, Nam, and Thornton (2002) and Chava and Purnanandam (2010). Table 8 indicates that *Mismatch* is significantly positively associated with *ΔCoVaR5_at* but is insignificantly positively associated with *ΔCoVaR5_stk* in the OLS Models 2 and 3, but the residuals of mismatch *Mismatch_R* is significantly positively associated with both *ΔCoVaR5_at* and *ΔCoVaR5_stk* in the second-stage 2SLS regressions in Model 4 and 5. The result suggests that higher maturity mismatch is related with higher bank contribution to systemic risk, which extends Campbell, Hilscher, and Szilagyi (2008)'s finding that liquidity reduces firm-level default risk, supporting Diamond and Rajan's (2009) argument that one of the causes of financial crisis is that banks largely finance the real estate-related new financial instruments with short-term debt, and is consistent with Bleakley and Cowan (2010) that short-term exposed firms pay higher financing costs and liquidate assets at "fire sale" prices during periods of capital outflows. Combined, the evidence in Table 8 justifies maturity mismatch as a mediating channel for CEO risk-taking incentives to affect contribution of a bank to systemic default and crash risks, thus strongly supports H2b.

4.4 Decomposition of Vega

Table 9 presents the OLS regression results for testing hypothesis H3 that predict the positive relations of the CEO risk-taking incentives induced from CEO's option compensation granted previously (from newly granted options) and a bank's contribution to systemic risk to be stronger (weaker). Table 10 indicates that in all models, *Vega_awards*, CEO risk-taking incentives from new option grants, is significantly negatively associated with *ΔCoVaR5_at* and *ΔCoVaR5_stk*. In contrast, *Vega_old*, CEO risk-taking incentives from the sum of exercisable and unexercisable previous option grants, is significantly positively associated with *ΔCoVaR5_at* and *ΔCoVaR5_stk* in all models. The results also imply that the impacts of *Vega* on a bank's contribution to systemic default and crash risks are mainly driven by CEO's previous option grants, and the newly granted options are generally restrictive in nature and thus mitigate the risk-taking incentives of CEO. The evidence is consistent with the arguments that the freedom of CEO to cash out equity contributes substantially to creating short-term incentive distortions (Bebchuk, 2009), whereas restricted stock options help to mitigate excessive risk-takings that lead to systemic risk (Romano and Bhagat, 2009).

We further decompose previous option grants *Vega_old* into excercisable and unexercisible option grants, and find that both components are significantly positively associated with a bank's contribution to systemic contraction risk and systemic crash risk. When we use the log transformation for new option grants and previous option grants definition instead, the results are qualitatively the same as reported, but the sample size shrink by about 40%. Overall, results in Table 9 strongly support hypothesis H3 and imply that granting CEOs with restrictive options may be a feasible way to optimally incentivize CEOs and curb CEOs' excessive risk-takings that increase systemic risk.

5. Further analysis

5.1 Moderating effects of bank size and information transparency

This section performs further analysis about the moderating effects of bank size, information transparency, market illiquidity and financial crisis on the associations between *Vega* and a bank's contribution to systemic default and crash risks. Table 10 reports results for the moderating effects of information transparency and "Too-big-to-fail" effects proxied by bank size *Size*, analyst forecast dispersion *Disp*, and bid-ask spread *HLspread*. The interaction term *Vega* Size* is significantly negatively associated with *ΔCoVaR5_at* and *ΔCoVaR5_stk*, suggesting the dominance of the information transparency effect over “too-big-to-fail” effects in the moderating role of bank size, consistent with predictions. Models 4 and 5 in Table 10 show a significantly positive coefficient on the interaction terms *Vega*Disp* and *Vega* HLspread*, suggesting that higher information asymmetry aggravates the relation between *Vega* and a bank’s contribution to systemic crash risk. Results in Table 10 collectively suggest that improved information transparency helps to mitigate the impacts of *Vega* on a bank’s contribution to systemic risk.

5.2 Moderating effects of market illiquidity and financial crisis

Table 11 reports estimation results for the moderating effects of market illiquidity proxied by *Repo* and *Mktilliq*, and financial crisis *Crisis*. The significantly positive coefficients on the interactions *Vega*Repo*, *Vega*Mktilliq* and on *Repo*, and *Mktilliq* as such in Models 7 and 8 suggest that higher market illiquidity accentuates relations between *Vega* and a bank’s contribution to systemic crash risk as expected, and also directly increase a bank’s contribution to systemic crash risk. The interpretation is that market illiquidity enhances the positive relations between CEO risk-taking incentives and banks' contribution to systemic risk through increased contagion effects (Amihud, 2002; Adrain and Shin, 2010; Longstaff, 2011).

As aforementioned, the direction of the impacts of financial crisis on the relation between Vega and a bank's contribution to systemic risk is undecided. However, models 1 and 5 in Table 11 indicate that the interaction term *Vega*Crisis* is positively associated with banks’ contribution to systemic contraction risk and to systemic crash risk, respectively. Using only the subsample during financial crisis period in OLS regressions, Models 2 and 6 show that risk-taking incentives are consistently positively associated with banks’ contribution to systemic risks, and the magnitude of coefficients on *Vega* is higher than the corresponding figures in Tables 3 and 4. The results imply that financial crisis accentuates the relation between *Vega* and a bank’s contribution to systemic risk. Two factors may be responsible for the findings. First, financial crisis enhances the effects of contagions induced by market illiquidity. Second, excessive risk-takings induced by option devaluation dominate the reduced risk-taking incentives from diminished CEO wealth during financial crisis and result in higher bank-risk.

5.3 *Reconcile with findings in Fahlenbrach and Stulz (2010)*

Our results that CEO risk-taking incentives mitigates a bank's contribution to systemic risk is in striking contrast to the findings in Fahlenbrach and Stulz (2010) that CEO risk-taking incentives before financial crisis at least do not worsen bank performance during financial crisis. The interpretation is that these two studies look at different relations that involve different mechanism--this study focuses on the association from CEO incentives to the sector-wide systemic risk, whereas Fahlenbrach and Stulz (2010) examine association from CEO incentives to bank-level performance. To reconcile with Fahlenbrach and Stulz (2010), this study examines associations between CEO risk-taking incentives *Vega* and bank-specific performance measure *ROA* and crash risk *VaR_stk* in the future four quarters, and reports the results in Table 12.

In Table 12, Models 1 to 4 report results for regressing bank performance *ROA* against *Vega* for the whole sample (Models 1 and 2), for only the crisis period (Model 3), and for only the noncrisis period (Model 4), and show that *Vega* is consistently positively associated with *ROA*, with significant coefficient except in Model 3, suggesting that during normal period, CEO risk-taking incentives increase bank performance, but lost its power during financial crisis period. The coefficient on the interaction *Vega*Crisis* is insignificantly positive in Models 2, reconfirming conclusions about the crisis period in Model 3. This evidence is both consistent with Fahlenbrach and Stulz (2010) and extends it to the noncrisis period.

Models 5 to 8 report results for regressing bank-specific risk *VaR_stk* against *Vega* for the whole sample (Models 5 and 6), for only the crisis period (Model 7), and for only the noncrisis period., and demonstrate that *Vega* is significantly positively associated with *VaR_stk* except in Model and 7, suggesting that during normal period, CEO risk-taking incentives increase bank-specific risk, but lost its power for bank risk during financial crisis period. The coefficient on the interaction *Vega*Crisis* is insignificantly positive in Models 6, reconfirming results in Model 7. The combination of Models 3 and 7 is consistent with Fahlenbrach and Stulz (2010), and also suggest that CEO option compensation loses incentive power for both bank performance and for bank risk when options are generally out-of-money and CEO risk-aversion increases with the shrinkage in CEO wealth during financial crisis.

When regressing bank-specific performance measure *ROA* and crash risk *VaR_stk* against previous one quarter CEO risk-taking incentives *Vega* the results are qualitatively the same. The findings in Tables 12 as well as in Table 11 collectively indicate that during normal period, CEO risk-taking incentives increase a bank's contribution to systemic risk through enhancing contagion and bank-specific risks. During financial crisis period, however, CEO risk-taking incentives lost power for increasing bank-specific risks, but still increase a bank's contribution to systemic risk inferably through enhancing contagions.

7. Conclusion

This study examines the relations between risk-taking incentives induced by CEO option compensation and a banks' contribution to systemic risk in the banking industry for a sample of U. S. bank holding companies and commercial banks from year 1992 to 2009. CEO risk-taking incentives are positively associated with a bank's contribution to systemic contraction risk and systemic crash risk, consistent with the argument that CEOs' risk-taking incentives induce them to engage in risky business activities, which amplify contagions of bank-specific failure and crash risks and increase these risks per se, thus ultimately leading to increased contribution to systemic default or crash risk. CEO risk-taking incentives induced from previous option compensation (new option grants) are significantly positively (negatively) associated with a bank's contribution to systemic risk, consistent with the notion that freedom (restriction) of cashing out on options encourages (confines) excessive CEO risk-takings that increase systemic risk. We also document evidence that with non-interest income-generating activities, financial innovations, and maturity mismatch act as two mediating channels and that information transparency, market illiquidity, financial crisis and bank size moderate the positive relations between CEO risk-taking incentives and banks' contribution to systemic risk.

This study contributes to the literature on managerial incentives and financial crisis by documenting the first evidence on CEO option compensation and banks' contributions to systemic risk. The findings extend previous studies on managerial incentives and bank-specific risks, and advance insights about the role of CEO compensation scheme in the contagions of financial crisis. This paper also has immediate policy implications for compensation reform in the post-crisis era and suggests the usage of more restrictive stock options compensation plans for CEOs.

Appendix A Variable Definitions

A bank's Contribution to Systemic Risk Measures

$\Delta CoVaR\_at_{it}$: a bank'sn *i*'s contribution to systemic contraction risk at the end of fiscal quarter *t* calculated based on percentage return of book equity. It is calculated as the difference between *CoVaR* when the bank is at its 1% *VaR* and *CoVaR* in the median state of the bank where *CoVaR* is the predicted value from running 1-% (or 50%) quantile regressions of book equity returns of the financial system on 1% (or 50%) VaR^i for bank *i* and the lagged value for a vector of state variables. Appendix B describes calculation details for $\Delta CoVaR\_at$.

$\Delta CoVaR5\_at_{it}$: an alternative to $\Delta CoVaR\_at$ calculated based on the 5-% quantile regressions.

$\Delta CoVaR\_stk_{it}$: a bank *i*'s contribution to systemic crash risk at the end of fiscal quarter *t* calculated based on percentage stock return. The calculation method is similar to that for $\Delta CoVaR\_at_{it}$ and Appendix B provides estimation details.

$\Delta CoVaR5\_stk_{it}$: an alternative to $\Delta CoVaR\_stk$ calculated from the 5-% quantile regressions.

Bank-level Risk Measures

VaR_at_{it}: the 1% percentile of the distribution of percentage weekly return of book equity over the previous 100 weeks. It is calculated for bank *i* at the end of fiscal quarter *t*.

VaR_stk_{it}: the 1% percentile of the distribution of percentage weekly return of book equity over the previous 100 weeks for bank *i* and is calculated at the end of fiscal quarter *t*. The weekly return is calculated as the natural logarithm of the sum of one plus the residual from the following expanded market model regression:

$$RET_{it}= \beta_{0i} + \beta_{1i}RET_{mt-2} + \beta_{2i}RET_{mt-1} + \beta_{3i}RET_{mt} + \beta_{4i}RET_{mt+1} + \beta_{5i}RET_{mt+2} + \varepsilon_{it}$$

$Beta_{it}$: the sensitivity of stock return for bank *i* at the end of fiscal quarter *t* to CRSP value-weighted market return calculated over a twelve-month rolling window.

$Sigma_{it}$: Standard deviation of daily stock returns (in percentage) for bank *i* at the end of fiscal quarter *t*.

Z_Score_{it}: the Altman (1968) *Z* Score that proxies for bankruptcy risk for bank *i* at the end of fiscal quarter *t*, and is calculated as 3.3**ROA* + 1.2*(net working capital/total assets) + 1.00*(sales/total assets) + 0.6*(Market Equity/Book debt) + 1.4*(accumulated retained earnings/total assets). The higher the Altman (1968) *Z Score* the lower the bankruptcy risk.

MES_{it}: the marginal expected shortfall of the stock of bank *i* given that the market return (in percentage) is below its 5%-percentile, calculated following Acharya, Philippon, and Richardson (2010).

Compensation Variables

$Vega_{it}$: the natural logarithm of the dollar change in the value of CEO's option holdings resulting from a 1% increase in bank *i*'s stock volatility at the end of fiscal quarter *t*.

$Vega\_old_{it}$: the natural logarithm of one plus the dollar change in the value of CEO's exercisable and unexcercisable option holdings previously granted resulting from a 1% increase in bank *i*'s stock volatility at the end of fiscal quarter *t*.

$Vega\_awards_{it}$: the natural logarithm of one plus the dollar change in the value of CEO's newly granted option holdings resulting from a 1% increase in bank *i*'s stock volatility at the end of fiscal quarter *t*.

$Delta_{it}$: the natural logarithm of the dollar change in the value of CEO's option holdings and stock holdings resulting from a 1% increase in bank *i*'s stock price at the end of fiscal quarter *t*.

$Bonus_{it}$: the percentage ratio of executive cash bonus to total salary for bank *i* at the end of fiscal quarter *t*.

Channel Variables

$Mismatch_{it}$: the percentage ratio of short-term debt minus cash holdings to total asset calculated

for bank *i* at the end of fiscal quarter t.
$N2I_{it}$: the percentage ratio of non-interest income to interest income ratio calculated for bank *i* at the end of fiscal quarter *t*.
$Securitize_{it}$: proxy for asset securitization, and is measured as the natural logarithm of one plus the dollar amount of total securitization for bank *i* at the fiscal quarter end *t*.
CDO_{it}: proxy for collateralized debt obligations and is measured as the natural logarithm of one plus the dollar amount of total collateralized debt obligations for bank *i* at the fiscal quarter end t.
CDS_{it}: proxy for credit default swap and is measured as the natural logarithm of one plus the dollar amount of total credit default swap for bank *i* at the fiscal quarter end *t*.

<u>Moderating Variables</u>

$Disp_{it}$: proxy for uncertainty in the information environment for bank *i* at the fiscal quarter end *t*. It is calculated as the mean standard deviation of analyst forecast at fiscal quarter *t-1*.
$Hlspread_{it}$: the average daily high and low spread for bank *i* at the fiscal quarter end *t*. and it is calculated over the previous fiscal quarter following Corwin and Schultz (2011).
$Repo_{it}$: proxy for bond market illiquidity for bank *i* at the fiscal quarter end *t* and it is measured by the difference between the three-month general collateral repo rate and the three-month bill rate short-term liquidity risk, calculated at fiscal quarter-end *t*.
$Mktilliq_{it}$: proxy for monthly stock market illiquidity for bank *i* at the fiscal quarter end *t*. It is negative one times the monthly raw market-wide liquidity adjusted for tick size change effects estimated following Boyson et al. (2010), where monthly value-weighted raw market-wide liquidity is calculated as value-weighted monthly average of a daily ratio of absolute return to dollar volume for each common stock on CRSP with listing on NYSE, after drop the top and bottom 1% observations in each month to remove outliers.
Crisis: Dummy for the 2008-2009 financial crisis period and it is equal to one for the period July 2007 to March 2009, and zero otherwise.

<u>Control Variables</u>

$Leverage_{it}$: proxy for leverage ratio and is measured as the ratio of long-term debt to total assets for bank *i* at the end of fiscal quarter *t*.
$Loan_{it}$: the ratio of total loan to total assets for bank *i* at the end of fiscal quarter t.
$Size_{it}$: the total assets ($ 0.1 millions) at the end of fiscal quarter t.
$Size\_sqr_{it}$: the square value of the total assets ($ 0.1 millions) for bank *i* at the end of fiscal quarter t.
ROA_{it}: the percentage ratio of income before extraordinary items to the book value of total assets for bank *i* at the end of fiscal quarter *t*.
Mb_{it}: market-to-book ratio for bank *i* at the end of fiscal quarter *t*.
$CAPR_{it}$: tier-one capital ratio for bank *i* at the end of fiscal quarter *t*.
LLA_{it}: the percentage ratio of loan loss allowance to total assets for bank *i* calculated at the end of fiscal quarter *t*.
Nim_{it}: proxy for net interest margin and is calculated as the ratio of net interest revenue to interest-bearing assets for bank *i* at the end of fiscal quarter *t*.
Mom_{it}: previous buy-and-hold stock return for bank *i* over the eleven-month period ending one-month prior to the fiscal quarter-end *t*.
$Cokurt_{it}$: kurtosis of daily returns relative to that of the market of bank *i* over the twelve-month period ending at fiscal quarter-end *t*.
$Duvol_{it}$: the natural logarithm of the ratio of the standard deviations of down-week to up-week firm-specific weekly return for bank *i* and is calculated at fiscal quarter-end *t*. The weekly return is calculated as the natural logarithm of one plus the residual from the following expanded market model regression:

$$RET_{it} = \beta_{0i} + \beta_{1i}RET_{mt-2} + \beta_{2i}RET_{mt-1} + \beta_{3i}RET_{mt} + \beta_{4i}RET_{mt+1} + \beta_{5i}RET_{mt+2} + \varepsilon_{it}$$

$3M_t$: The change in the three-month treasury bill rate at fiscal quarter-end *t*.

Appendix B Computation of A Bank's Contribution to Systemic Risk

To estimate the systemic contraction risk conditional on bank *i* in distress, we first run the following 1% quantile regressions for weekly return on book equity for bank *i* and for the whole financial system respectively to estimated the bank-specific coefficients:

$R^i_t = \alpha^i + \beta^i Z_{t-1} + \varepsilon^i$ (1)

$R^{system}_t = \alpha^{system|i} + \beta^{system|i} Z_{t-1} + \beta^{system|i} R^i_{t-1} + \varepsilon^{system|i}$ (2)

where R^i_t is the weekly growth rate of market value of total asset of bank *i* at time *t* expressed as $R^i_t = [(MV^i_t - Leverage^i_t)/(MV^i_{t-1} - Leverage^i_{t-1})]-1$, where MV^i_t is the market value of bank *i*'s book equity at time t, and $Leverage^i_t$ is the ratio of the book value of total asset $Asset^i_t$ to book equity. R^{system}_t is the weighted average of the weekly growth rate of the market-valued total assets of all banks in the financial system at time *t*, using the market-valued assets MV^i_t as weight, as shown below:

$$R^{system}_t = \sum_{i=1}^{N} \frac{MV^i_t * Leverage^i_{t-1} * R^i_t}{\sum_j^N MV^j_{t-1} * Leverage^j_{t-1}} \quad (3)$$

Z_{t-1} is the vector of macroeconomic and financial factors measured in the previous week, including stock market return, equity volatility, liquidity risk, interest rate risk, term structure, default risk and real-estate return. We use the weekly value weighted equity returns (excluding ADRs) with all distributions to proxy for the market return. Volatility is the standard deviation of the natural logarithm of stock returns three months prior to time *t*. Short-term liquidity risk is the difference between the three-month LIBOR rate and the three-month T-bill rate. Interest rate risk is the change in the three-month T-bill rate. We use the change in the slope of the yield curve, the yield spread between the ten-year T-bond rate and the three-month T-bill rate, to proxy for the term structure. Default risk is the change in the credit spread between the ten-year BAA corporate bonds and the ten-year T-bond rate. Real estate return is based on the FHFA house price index.

Then we input the estimated bank-specific coefficients from models (1) and (2) into models (4) and (5) respectively, calculate an individual bank *i*'s 1% *VaR* as the predicted value from model (4), and estimate systemic contraction risk conditional on bank *i* in distress, $CoVaR^{system|i}$, as the asset return of the banking system estimated from model (5). Model (5)uses VaR^i_t estimated from model (4) and lagged value of state variables as inputs:

$VaR^i_t = \hat{R}^i_t = \alpha^i + \beta^i Z_{t-1}$, (4)

$CoVaR^{system|i} = \hat{R}^{system}_t = \alpha^{system|i} + \beta^{system|i} Z_{t-1} + \beta^{system|i} VaR^i_t$ (5)

Similarly, we run 50% quantile (median) regressions for models (1) and (2), respectively, to get their coefficient estimates, as shown in models (6) and (7), and plug them into models (8) and (9):

$R^i_t = \alpha^{i,median} + \beta^{i,median} Z_{t-1} + \varepsilon^{i,median}$ (6)

$R^{system}_t = \alpha^{system|i,median} + \beta^{system|\,i,median} Z_{t-1} + \beta^{system|i,median} R^i_{t-1}$ (7)

Then we calculate the median asset return for bank *i*, and the systemic risk conditional on bank *i* functioning in its median state as

$R^{i,median}_t = \alpha^{i,median} + \beta^{i,median} Z_{t-1}$ (8)

$CoVaR^{system|median} = \hat{R}^{system}_t = \alpha^{system|i,median} + \beta^{system|i,median} Z_{t-1} + \beta^{system|i,median} R^{i,median}_{t-1}$ (9)

The bank *i*'s contribution to systemic contraction risk is estimated as the difference between the financial system's 1% VaR when bank *i* is at risk and when bank *i* is in its median state:

$\Delta CoVaR^{iw}_{1\%} = CoVaR^{system|\,i,medain}_{1\%} - CoVaR^{system|\,i,medain}_{1\%}$ (10) We use the average of the weekly $\Delta CoVaR^{iw}_{1\%}$ over a quarter as our measure for bank *i*'s contribution to systemic contraction risk$\Delta CoVaR^i_{1\%}$. Using the similar method, we could also calculate $\Delta CoVaR^i_{5\%}$ by running a 5% quantile regression for models (1) and (2), ceterus parabus. Likewise, we calculate bank *i*'s contribution to stock return based systemic risk $\Delta CoVaR\_stk^i_{1\%}$ and $\Delta CoVaR\_stk^i_{5\%}$ by replacing R^i_t and $R^{i,median}_t$ in all models into weekly stock return and weekly median stock return, and replace R^{system} by value-weighted market return.

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Table 1 Descriptive Statistics

This table reports summary statistics for the variables used in this study. Definition details are provided in Appendices A and B.

Variable Name	Mean	Median	STD	Q1	Q3
ΔCoVaR_at(%)	27.074	21.651	23.473	11.783	35.548
ΔCoVaR5_at(%)	22.296	19.155	16.096	11.671	28.594
ΔCoVaR_stk(%)	39.931	34.037	24.091	24.428	48.799
ΔCoVaR5_stk(%)	26.530	22.678	15.374	16.994	31.698
Delta	4.282	4.573	2.357	3.451	5.588
Vega	-2.652	-2.794	2.000	-3.913	-1.269
Bonus(%)	34.513	37.626	27.807	0.000	54.811
Vega_awards	0.022	0.001	0.177	0.000	0.004
Vega_old	0.219	0.057	0.456	0.019	0.234
Mismatch(%)	7.438	4.916	7.741	3.083	8.559
N2I	41.872	30.374	44.072	19.084	46.691
Securitize	3.470	0.000	6.452	0.000	0.000
CDO	0.120	0.000	1.264	0.000	0.000
CDS	0.709	0.000	3.306	0.000	0.000
var_st	0.126	0.101	0.078	0.076	0.150
MES	2.857	1.928	2.640	1.271	3.158
Sigma	36.483	26.695	28.571	20.152	40.250
Cokurt	3.499	2.709	3.461	2.039	3.746
CAPR(%)	9.162	9.535	4.014	7.960	11.360
ROA	0.279	0.313	0.281	0.228	0.386
LLA(%)	0.996	0.927	0.554	0.724	1.180
Leverage	0.099	0.080	0.086	0.034	0.143
Mb	2.113	1.972	1.044	1.444	2.638
Size	0.750	0.118	2.289	0.056	0.488
Size_sqr	5.800	0.014	36.580	0.003	0.238
Repo	0.332	0.279	0.323	0.075	0.529
3M	0.005	0.000	0.101	-0.019	0.055
Mom	0.043	0.048	0.223	-0.067	0.161
Duvol	-0.040	-0.037	0.350	-0.283	0.179
Nim	3.698	3.860	1.256	3.220	4.450
Disp	0.034	0.013	0.062	0.010	0.029
Hlspread(%)	0.783	0.597	0.587	0.414	0.892
Mktilliq	-0.238	-0.162	0.194	-0.349	-0.092

Table 2 Correlation Matrix for Main Testing Variables and Bank Risk Measures

This table reports the Pearson correlation matrixes for the main testing variables used in this study. for various bank risk measures in Panel A and Panel B respectively. * indicates that the correlation is statistically significant at the 1% confidence level. Definition details are provided in Appendices A and B.

Panel A: Correlation matrix for main testing variables

	ΔCoVaR5_ at	*ΔCoVaR_at*	*ΔCoVaR5_stk*	*ΔCoVaR_stk*	*Vega*	*Vega_old*	*Vega_ awards*	*N2I*	*Mismatch*	*Securitize*	*CDO*	*CDS*
ΔCoVaR5_at	1											
ΔCoVaR_at	0.796*	1										
ΔCoVaR5_stk	0.714*	0.498*	1									
ΔCoVaR_stk	0.658*	0.486*	0.898*	1								
Vega	0.114*	0.097*	0.150*	0.112*	1							
Vega_old	0.077*	0.045	0.067*	0.063*	0.717*	1						
Vega_awards	-0.009	-0.023	0.035	0.046	0.322*	0.642*	1					
N2I	0.189*	0.205*	0.109*	0.117*	0.334*	0.272*	0.110*	1				
Mismatch	0.196*	0.319*	0.089*	0.109*	0.193*	0.118*	0.025	0.459*	1			
Securitize	0.143*	0.055*	0.157*	0.129*	0.399*	0.353*	0.075*	0.364*	0.072*	1		
CDO	0.088*	0.016	0.226*	0.224*	0.052*	0.019	-0.004	0.002	0.046	0.166*	1	
CDS	0.053*	0.008	0.191*	0.206*	0.065*	0.033	-0.007	0.009	0.098*	0.217*	0.776*	1

Panel B: Correlation matrix among bank risk measures

	ΔCoVaR5_at	*ΔCoVaR_at*	*ΔCoVaR5_stk*	*ΔCoVaR_stk*	*MES*	*Sigma*	*Beta*	*VaR_at*	*VaR_stk*	*Z-Score*
ΔCoVaR5_at	1									
ΔCoVaR_at	0.796*	1								
ΔCoVaR5_stk	0.714*	0.498*	1							
ΔCoVaR_stk	0.658*	0.486*	0.898*	1						
MES	0.532*	0.418*	0.604*	0.563*	1					
Sigma	0.503*	0.386*	0.661*	0.613*	0.751*	1				
Beta	0.250*	0.195*	0.252*	0.238*	0.654*	0.406*	1			
VaR_at	0.368*	0.298*	0.321*	0.323*	0.806*	0.662*	0.531*	1		
VaR_stk	0.402*	0.339*	0.413*	0.409*	0.774*	0.611*	0.542*	0.977*	1	
Z-Score	-0.025	-0.016	-0.078*	-0.074*	-0.310*	-0.308*	-0.182*	-0.274*	-0.301*	1

Table 3 OLS Regression Results for Relations between CEO Incentives and a Bank's Contribution to Systemic Default Risk

This table presents OLS estimation results for regressing a bank's contribution to systemic contraction risk measure *ΔCoVaR5_at* or *ΔCoVaR_at* against CEO risk-taking incentives variable *Vega*, other CEO incentives variables *Delta* and *Bonus*, and other control variables, respectively. Models 1 to 4 use *ΔCoVaR5_at* as dependent variable, and Models 5 to 8 use *ΔCoVaR_at* as dependent variable. *T*-statistics are adjusted for bank-level clusters, model details are provided in Model (7) in the text, and variable definitions in Appendices A to B.

Variables	**Dependent Variable: ΔCoVaR5_at**				**Dependent Variable: ΔCoVaR_at**			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
$Vega_{t-1}$	1.162***			0.995**	1.911***			1.718***
	(3.135)			(2.552)	(3.558)			(2.744)
$Delta_{t-1}$		0.427		0.144		0.636		0.176
		(1.218)		(0.392)		(1.216)		(0.315)
$Bonus_{t-1}$			0.003	-0.010			0.032	0.009
			(0.105)	(-0.344)			(0.606)	(0.174)
$Leverage_{t-1}$	2.751	4.981	5.885	2.913	8.208	12.059	13.741	8.800
	(0.246)	(0.430)	(0.516)	(0.253)	(0.513)	(0.732)	(0.856)	(0.548)
$Size_{t-1}$	2.137*	2.944**	3.083**	2.239*	-1.030	0.338	0.330	-1.084
	(1.658)	(2.128)	(2.273)	(1.721)	(-0.727)	(0.218)	(0.207)	(-0.719)
$Size\_sqr_{t-1}$	-0.164**	-0.210**	-0.212**	-0.168**	-0.035	-0.112	-0.106	-0.031
	(-2.082)	(-2.402)	(-2.459)	(-2.113)	(-0.403)	(-1.116)	(-1.021)	(-0.338)
ROA_{t-1}	1.239	1.733	1.576	1.102	-4.453	-3.607	-3.970	-4.760
	(0.531)	(0.723)	(0.646)	(0.469)	(-1.265)	(-0.987)	(-1.066)	(-1.311)
Mb_{t-1}	1.279	1.502	1.734*	1.425	2.616*	3.004*	3.165*	2.655*
	(1.369)	(1.589)	(1.808)	(1.497)	(1.713)	(1.933)	(1.960)	(1.713)
$Loan_{t-1}$	-4.227	-4.248	-4.263	-4.068	-32.141*	-32.209	-32.226	-31.922
	(-0.607)	(-0.584)	(-0.579)	(-0.572)	(-1.670)	(-1.632)	(-1.629)	(-1.646)
$Sigma_{t-1}$	0.351***	0.354***	0.341***	0.342***	0.371***	0.375***	0.366***	0.368***
	(8.442)	(8.487)	(8.322)	(8.715)	(6.347)	(6.396)	(6.170)	(6.469)
Intercept	15.438***	9.030*	10.145**	14.643***	37.371***	27.022**	27.637**	35.594***
	(3.114)	(1.701)	(1.982)	(2.725)	(3.178)	(2.253)	(2.265)	(2.837)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Bank-specific Cluster	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	2,034	2,034	2,019	2,019	2,034	2,034	2,019	2,019
R-squared	0.439	0.428	0.419	0.432	0.342	0.325	0.319	0.338

Table 4 OLS Regression Results for Relations between CEO Risk-taking Incentives and a Bank's Contribution to Systemic Crash Risk

This table presents OLS estimation results for regressing a bank's contribution to systemic crash risk measure *ΔCoVaR5_stk* or *ΔCoVaR_stk* against CEO risk-taking incentives variable *Vega*, other CEO incentives variables *Delta* and *Bonus*, and other control variables, respectively. Models 1 to 4 use *ΔCoVaR5_stk* as dependent variable, and Models 5 to 8 use *ΔCoVaR_stk* as dependent variable, *T*-statistics are adjusted for firm-level clusters, model details are provided in Model (7) in the text, and variable definitions in Appendices A to B.

Variables	Dependent Variable: ΔCoVaR5_stk				Dependent Variable: ΔCoVaR_stk			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
$Vega_{t-1}$	0.898***			1.050***	0.503			0.894*
	(3.575)			(3.573)	(1.108)			(1.822)
$Delta_{t-1}$		0.125		-0.092		0.102		-0.028
		(0.530)		(-0.361)		(0.301)		(-0.077)
$Bonus_{t-1}$			-0.055**	-0.067***			-0.127***	-0.138***
			(-2.566)	(-3.252)			(-2.801)	(-3.033)
$Leverage_{t-1}$	12.647*	14.607**	14.820*	12.895*	18.280	19.300	24.713*	22.951
	(1.829)	(2.187)	(1.959)	(1.712)	(1.231)	(1.316)	(1.718)	(1.614)
$Size_{t-1}$	4.028***	4.816***	5.569***	4.772***	6.862***	7.283***	8.970***	8.264***
	(4.066)	(4.637)	(5.078)	(4.563)	(5.232)	(5.384)	(6.515)	(6.379)
$Size\_sqr_{t-1}$	-0.205***	-0.249***	-0.289***	-0.245***	-0.298***	-0.321***	-0.415***	-0.377***
	(-2.764)	(-3.141)	(-3.514)	(-3.234)	(-3.142)	(-3.242)	(-4.111)	(-4.042)
ROA_{t-1}	5.258**	5.814**	6.114**	5.676**	5.324	5.628	7.298**	6.921*
	(2.171)	(2.338)	(2.390)	(2.284)	(1.432)	(1.501)	(1.992)	(1.908)
Mb_{t-1}	0.491	0.801	1.168	0.860	2.101*	2.264**	3.297***	3.018**
	(0.671)	(1.114)	(1.439)	(1.073)	(1.886)	(2.027)	(2.680)	(2.475)
$Sigma_{t-1}$	0.249***	0.247***	0.245***	0.250***	0.373***	0.372***	0.390***	0.394***
	(5.923)	(5.750)	(5.528)	(5.719)	(5.303)	(5.266)	(5.495)	(5.537)
$Duvol_{t-1}$	0.365	0.031	-0.020	0.382	1.326	1.151	1.165	1.525
	(0.471)	(0.039)	(-0.025)	(0.478)	(0.877)	(0.765)	(0.792)	(1.009)
Mom_{t-1}	-6.701***	-7.182***	-7.215***	-6.575***	-6.317**	-6.577**	-6.007*	-5.446*
	(-4.122)	(-4.305)	(-4.327)	(-4.061)	(-2.189)	(-2.244)	(-1.976)	(-1.803)
$Cokurt_{t-1}$	0.503***	0.557***	0.585***	0.526***	0.551*	0.579*	0.655**	0.601**
	(2.792)	(2.855)	(3.122)	(2.974)	(1.901)	(1.931)	(2.263)	(2.128)
Intercept	7.265**	2.059	3.253	9.384***	6.241	3.297	4.232	9.414*
	(2.223)	(0.666)	(1.085)	(2.986)	(1.267)	(0.723)	(0.940)	(1.890)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Firm-specific Clusters	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	2,223	2,223	2,191	2,191	2,223	2,223	2,191	2,191
R-squared	0.643	0.636	0.635	0.644	0.566	0.565	0.577	0.579

Table 5 OLS and 2SLS Estimation Results for Non-interest Income as a Channel for Relations between CEO Risk-taking Incentives and a Bank's Contribution to Systemic contraction risk and to Systemic Crash Risk

This table presents the OLS and the 2SLS estimation results for non-interest income *N2I* as a channel for relations between CEO risk-taking incentives and a bank's contribution to systemic contraction risk and crash risk*ΔCoVaR5_at* or *ΔCoVaR5_stk*, respectively. Models 1 to 3 present the OLS estimation results for regressing *N2I* against *Vega*, regressing *ΔCoVaR5_at* and *ΔCoVaR5_stk* against *N2I*, and other controls respectively. Models 4 and 5 present the second-stage results for 2SLS estimation that regress *ΔCoVaR5_at* and *ΔCoVaR5_stk* against *N2I_R*, the estimated residuals from Model 1. *T*-statistics are adjusted for bank-level clusters, model details are provided in Models (8) to (10) in the text, and variable definitions in Appendices A to B.

Independent Variable	OLS Regression			2nd Stage 2SLS Regression	
	N2I	**ΔCoVaR5_at**	**ΔCoVaR5_stk**	**ΔCoVaR5_at**	**ΔCoVaR5_stk**
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
$Vega_{t-1}$	3.421***			0.967**	1.079***
	(2.705)			(2.562)	(3.579)
$N2I_{i,t-1}$		0.060**	0.032***	0.048**	0.027**
		(2.366)	(2.727)	(2.089)	(2.449)
$N2I\_R_{i,t-1}$				0.967**	1.079***
				(2.562)	(3.579)
$Delta_{t-1}$	1.026			0.134	-0.017
	(1.441)			(0.344)	(-0.057)
$Bonus_{t-1}$	0.158			-0.012	-0.054***
	(1.382)			(-0.409)	(-2.737)
$Leverage_{t-1}$	66.324	0.163	13.773*	4.288	17.899**
	(1.103)	(0.015)	(1.757)	(0.370)	(2.126)
$Size_{t-1}$	-0.185	2.800**	4.780***	2.223*	4.510***
	(-0.044)	(2.085)	(4.833)	(1.772)	(4.266)
$Size\_sqr_{t-1}$	-0.190	-0.189**	-0.240***	-0.167**	-0.229***
	(-0.863)	(-2.259)	(-3.195)	(-2.224)	(-2.929)
ROA_{t-1}	42.187*	-0.014	3.079	-0.816	2.004
	(1.807)	(-0.005)	(1.177)	(-0.326)	(0.818)
Mb_{t-1}	8.467***	1.023	0.778	1.477	1.026
	(2.640)	(1.047)	(0.923)	(1.514)	(1.132)
$Loan_{t-1}$	-129.266**	3.741	6.914	-4.317	1.598
	(-2.443)	(0.515)	(1.268)	(-0.627)	(0.303)
$Sigma_{t-1}$		0.335***	0.294***	0.309***	0.209***
		(7.798)	(8.239)	(6.182)	(5.170)
$CAPR_{t-1}$	-4.902**				
	(-2.186)				
Nim_{t-1}	4.628				
	(1.068)				
LLA_{t-1}	-0.256				
	(-0.328)				
$Duvol_{t-1}$	-4.902**		0.349		1.057
	(-2.186)		(0.398)		(1.208)
Mom_{t-1}	-4.902**		-6.444***		-4.482**
	(-2.186)		(-3.743)		(-2.581)
$Cokurt_{t-1}$	4.628		0.442***		0.325**
	(1.068)		(2.973)		(2.424)
Intercept	80.973**	5.403	-1.688	14.319***	12.132***
	(2.431)	(1.035)	(-0.363)	(2.649)	(2.683)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Bank-specific Cluster	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	2,000	2,034	2,086	1,739	1,731
R-squared	0.452	0.444	0.656	0.492	0.700

Table 6 OLS Regression Results for Financial innovations as Channels for Relations between CEO Incentives and a Bank's Contribution to Systemic contraction risk and to Systemic Crash Risk

This table presents OLS estimation results for financial innovations as a channel for relations between CEO risk-taking incentives *Vega* and a bank's contribution to systemic contraction risk and to systemic crash risk. Models 1 to 3 regress financial innovation measures asset securitization *Securitize*, *CDO*, *CDS*, against *Vega* and other control variables, respectively. Models 4 to 9 regress a bank's contribution to systemic default and crash risk measures *ΔCoVaR5_at* (in Models 4 to 6) and *ΔCoVaR5_stk* (in Models 7 to 9) against financial innovation measures such as asset securitization *Securitize*, *CDO*, *CDS*, and other control variables, respectively. *T*-statistics are adjusted for bank-level clusters, model details are provided in Models (8) to (10) in the text, and variable definitions are provided in Appendices A to B.

Independent Variables	**Securitize**	**CDO**	**CDS**	**ΔCoVaR5_at**			**ΔCoVaR5_stk**		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
	0.499***	0.076***	0.199***						
	(2.832)	(2.678)	(3.134)						
Securitize$_{t-1}$				0.494***			0.236**		
				(3.468)			(2.261)		
CDO$_{-1}$					1.799**			2.673***	
					(2.515)			(7.035)	
CDS$_{t-1}$						0.846**			1.351***
						(2.539)			(7.122)
Delta$_{t-1}$	0.155	-0.011	-0.006						
	(1.412)	(-1.158)	(-0.253)						
Bonus$_{t-1}$	0.021	-0.005*	-0.012**						
	(1.653)	(-1.908)	(-2.222)						
Leverage$_{t-1}$	10.222**	1.485**	2.659*	-1.055	4.604	4.754	13.459	14.549*	14.638**
	(2.137)	(2.349)	(1.838)	(-0.098)	(0.431)	(0.444)	(1.638)	(1.975)	(2.033)
Size$_{t-1}$	1.719***	-0.296	0.101	1.945	3.867***	3.253***	4.385***	5.946***	5.041***
	(2.756)	(-1.492)	(0.237)	(1.554)	(2.913)	(2.848)	(4.668)	(8.165)	(7.885)
Size_sqr$_{t-1}$	-0.059	0.044***	0.038	-0.170**	-0.309***	-0.258***	-0.232***	-0.385***	-0.314***
	(-1.480)	(2.634)	(1.288)	(-2.286)	(-3.235)	(-3.409)	(-3.295)	(-7.629)	(-6.494)
ROA$_{t-1}$	1.689	0.102	0.190	0.795	1.218	1.254	3.593	2.998	2.984
	(1.465)	(0.826)	(0.449)	(0.313)	(0.515)	(0.505)	(1.423)	(1.288)	(1.282)
Mb$_{t-1}$	-1.025***	-0.038	-0.047	2.019**	1.754*	1.681*	1.318	1.290	1.184
	(-3.793)	(-0.769)	(-0.389)	(2.284)	(1.913)	(1.857)	(1.597)	(1.616)	(1.520)
Loan$_{t-1}$	0.551	-0.497	-1.304	-4.420	-4.327	-3.856	2.553	2.770	3.531
	(0.175)	(-1.360)	(-1.357)	(-0.661)	(-0.608)	(-0.570)	(0.480)	(0.501)	(0.720)
Sigma$_{t-1}$				0.349***	0.333***	0.328***	0.299***	0.272***	0.262***
				(8.252)	(7.912)	(7.710)	(8.511)	(8.425)	(8.152)
CAPR$_{t-1}$	-0.009	0.001	0.005						
	(-0.113)	(0.050)	(0.232)						
Nim$_{t-1}$	-0.102	0.081	0.055						
	(-0.395)	(1.508)	(0.493)						
LLA$_{t-1}$	-0.280	0.165*	0.110						
	(-0.459)	(1.781)	(0.599)						
Duvol$_{t-1}$							0.412	0.335	0.408
							(0.481)	(0.389)	(0.456)
Mom$_{t-1}$							-7.181***	-6.939***	-6.848***
							(-4.186)	(-4.091)	(-4.224)
Cokurt$_{t-1}$							0.461***	0.483***	0.469***
							(3.054)	(3.135)	(3.143)
Intercept	1.147	0.630**	1.836**	10.484**	10.365**	10.739**	0.753	0.291	1.184
	(0.427)	(2.054)	(2.119)	(2.219)	(2.097)	(2.223)	(0.164)	(0.064)	(0.279)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Bank -specific	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Clusters									
Observations	2,013	2,013	2,013	2,034	2,034	2,034	2,022	2,022	2,022
R-squared	0.531	0.398	0.398	0.446	0.436	0.437	0.654	0.674	0.681

Table 7 2SLS Regression Results for Financial Innovations as Channels for Relations between CEO Incentives and a Bank's Contribution to Systemic Default and to Systemic Crash Risks

This table presents the second-stage 2SLS estimation results for financial innovations such as asset securitization *Securitize*, CDO, and CDS as channels for relations between CEO risk-taking incentives *Vega* and a bank's contribution to systemic contraction risk and crash risk*ΔCoVaR5_at* and *ΔCoVaR5_stk*, with Models 1 and 2, 3 and 4, 5 and 6 examining *Securitize*, *CDO*, and *CDS*, respectively. Models 1, 3, 5 use *ΔCoVaR5_at* as dependent variable, whereas Models 2, 4, 6 use *ΔCoVaR5_stk* as dependent variable. channel measures *Securitize_R*, CDO*_R*, and CDS*_R* refer to the estimated residual from the first-stage OLS regressions employing Models 1 to 3 in Table 7, respectively. *T*-statistics are adjusted for bank-level clusters, model details are provided in Models (8) to (10) in the text, and variable definitions in Appendices A to B.

Independent Variable	ΔCoVaR5_at	ΔCoVaR5_stk	ΔCoVaR5_at	ΔCoVaR5_stk	ΔCoVaR5_at	ΔCoVaR5_stk
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$Vega_{t-1}$	0.983**	1.085***	0.989**	1.074***	0.988**	1.078***
	(2.592)	(3.592)	(2.605)	(3.788)	(2.605)	(3.876)
$Securitize\_R_{i,t-1}$	0.385***	0.172				
	(2.850)	(1.628)				
CDO_R_{t-1}			1.898**	2.854***		
			(2.370)	(4.853)		
CDS_R_{t-1}					0.900**	1.478***
					(2.401)	(6.830)
$Delta_{t-1}$	0.117	-0.026	0.124	-0.030	0.120	-0.036
	(0.317)	(-0.092)	(0.322)	(-0.109)	(0.310)	(-0.129)
$Bonus_{t-1}$	-0.012	-0.054**	-0.009	-0.052**	-0.003	-0.042**
	(-0.394)	(-2.608)	(-0.277)	(-2.597)	(-0.089)	(-2.170)
$Leverage_{t-1}$	3.978	17.746**	4.706	18.599**	5.113	19.335**
	(0.346)	(2.123)	(0.416)	(2.404)	(0.453)	(2.596)
$Size_{t-1}$	2.222*	4.496***	2.218**	4.566***	2.228**	4.591***
	(1.977)	(4.424)	(1.983)	(5.548)	(2.120)	(6.287)
$Size\_sqr_{t-1}$	-0.167**	-0.228***	-0.167**	-0.233***	-0.164***	-0.227***
	(-2.491)	(-3.015)	(-2.447)	(-4.194)	(-2.654)	(-4.495)
ROA_{t-1}	-0.435	2.277	-0.659	1.365	-0.718	1.178
	(-0.182)	(0.966)	(-0.298)	(0.644)	(-0.298)	(0.532)
Mb_{t-1}	1.521	1.052	1.492	1.127	1.444	1.057
	(1.638)	(1.219)	(1.605)	(1.393)	(1.562)	(1.323)
$Loan_{t-1}$	-4.487	1.508	-4.563	1.464	-4.891	0.908
	(-0.688)	(0.282)	(-0.680)	(0.274)	(-0.755)	(0.190)
$Sigma_{t-1}$	0.320***	0.214***	0.296***	0.174***	0.287***	0.157***
	(6.441)	(5.337)	(5.939)	(4.749)	(5.827)	(4.298)
$Duvol_{t-1}$		1.038		0.814		0.977
		(1.214)		(0.951)		(1.153)
Mom_{t-1}		-4.865***		-4.803***		-4.680***
		(-2.810)		(-2.849)		(-3.024)
$Cokurt_{t-1}$		0.349**		0.372***		0.345**
		(2.555)		(2.707)		(2.531)
Intercept	14.207***	11.702**	14.717***	12.154***	14.926***	13.037***
	(2.842)	(2.587)	(2.846)	(2.816)	(2.950)	(3.186)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Bank-specific Cluster	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	1,752	1,743	1,752	1,743	1,752	1,743
R-squared	0.476	0.699	0.476	0.722	0.477	0.729

Table 8 OLS and 2SLS Estimation Results for Maturity Mismatch as a Channel for Relations between CEO Incentives and a Bank's Contribution to Systemic contraction risk and to Systemic Crash Risk

This table presents the OLS and 2SLS estimation results for maturity mismatch *Mismatch* as a channel for relations between CEO incentives *Vega* and a bank's contribution to systemic contraction risk and crash risk*ΔCoVaR5_at* and *ΔCoVaR5_stk* respectively. Models 1 to 3 present the OLS estimation results for regressing *Mismatch* against *Vega,* regressing *ΔCoVaR5_at* and *ΔCoVaR5_stk* against *Mismatch*, and other controls respectively. Models 4 and 5 present the second-stage 2SLS results that regress *ΔCoVaR5_at* and *ΔCoVaR5_stk* against *Mismatch_R*, the estimated residuals from Model 1 in this table. *T*-statistics are adjusted for bank-level clusters, model details are in Models (8) to (10) in the text, and variable definitions in Appendices A to B.

Independent Variable	OLS Regression			2nd Stage 2SLS Regression	
	Mismatch	**ΔCoVaR5_at**	**ΔCoVaR5_stk**	**ΔCoVaR5_at**	**ΔCoVaR5_stk**
	Model 1	**Model2**	**Model 3**	**Model 4**	**Model 5**
$Mismatch_{i,t-1}$		0.488***	0.061		
		(4.160)	(0.617)		
$Mismatch\_R_{i,t-1}$				0.448***	0.176*
				(3.738)	(1.723)
$Vega_{t-1}$	0.376**			0.981***	1.080***
	(2.294)			(2.651)	(3.578)
$Delta_{t-1}$	0.084			0.115	-0.023
	(0.526)			(0.291)	(-0.080)
$Bonus_{t-1}$	0.053***			-0.015	-0.055***
	(3.122)			(-0.460)	(-2.705)
$Leverage_{t-1}$	-0.506	7.247	19.840***	7.039	19.477**
	(-0.931)	(0.648)	(3.376)	(0.596)	(2.274)
$Size_{t-1}$	0.019	2.842**	4.751***	2.139*	4.414***
	(0.753)	(2.164)	(4.580)	(1.755)	(4.196)
$Size\_sqr_{t-1}$	-1.499	-0.197**	-0.247***	-0.161**	-0.224***
	(-1.144)	(-2.361)	(-3.171)	(-2.167)	(-2.837)
ROA_{t-1}		2.696	3.277	0.928	2.892
		(1.181)	(1.505)	(0.437)	(1.251)
Mb_{t-1}		1.234	0.937	1.156	0.890
		(1.457)	(1.252)	(1.307)	(1.050)
$Sigma_{t-1}$		0.336***	0.289***	0.306***	0.206***
		(7.994)	(8.853)	(6.331)	(5.066)
$Loan_{t-1}$	-31.680***	11.944*		-5.089	
	(-3.687)	(1.725)		(-1.010)	
$Duvol_{t-1}$			0.026		0.964
			(0.029)		(1.081)
Mom_{t-1}			-7.596***		-5.466***
			(-4.433)		(-2.942)
$Cokurt_{t-1}$			0.423***		0.335**
			(2.694)		(2.398)
$CAPR_{t-1}$	0.068				
	(0.435)				
Nim_{t-1}	-0.610				
	(-1.066)				
$3M_{t-1}$	-2.038***				
	(-3.661)				
$Repo_{t-1}$	-7.610				
	(-0.151)				
Intercept	28.512***	-3.805	3.647	15.107***	13.015***
	(5.013)	(-0.632)	(1.313)	(3.261)	(4.592)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Bank -specific Cluster	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	2,000	2,020	2,086	1,739	1,731
R-squared	0.452	0.459	0.656	0.492	0.700

Table 9 Decomposition of Vega

This table presents OLS estimation results for regressing a bank's contribution to systemic contraction risk *ΔCoVaR5_at*, *ΔCoVaR_at* or systemic crash risk *ΔCoVaR5_stk*, *ΔCoVaR_stk* against the components of CEO risk-taking incentives variables *Vega_old* and *Vega_awards*, and other control variables, respectively. Models 1 to 4 use *ΔCoVaR5_at*, *ΔCoVaR5_at*, *ΔCoVaR5_stk* and *ΔCoVaR_stk* as dependent variable respectively. *T*-statistics are adjusted for bank-level clusters, model details are provided in Model (7) in the text, and variable definitions in Appendices A to B.

Dependent Variable	**ΔCoVaR5_at Model 1**	**ΔCoVaR_at Model 2**	**ΔCoVaR5_stk Model 3**	**ΔCoVaR_stk Model 4**
Vega_old$_{t-1}$	4.688***	7.899***	2.882***	4.087**
	(3.787)	(4.248)	(3.034)	(2.214)
Vega_awards$_{t-1}$	-13.891***	-21.259***	-11.209***	-14.934***
	(-5.592)	(-5.026)	(-5.325)	(-3.469)
Bonus$_{t-1}$	-0.006	0.019	-0.059***	-0.132***
	(-0.184)	(0.354)	(-2.714)	(-2.756)
Delta$_{t-1}$	0.324	0.470	0.119	0.142
	(0.930)	(0.934)	(0.507)	(0.417)
Leverage$_{t-1}$	3.913	13.331	14.905**	23.874*
	(0.332)	(0.845)	(1.992)	(1.675)
Size$_{t-1}$	2.537*	-0.590	5.200***	8.164***
	(1.851)	(-0.366)	(4.547)	(5.784)
Size_sqr$_{t-1}$	-0.179**	-0.046	-0.267***	-0.366***
	(-2.138)	(-0.453)	(-3.231)	(-3.630)
ROA$_{t-1}$	2.434	-1.526	6.905***	8.061**
	(1.012)	(-0.444)	(2.764)	(2.198)
Mb$_{t-1}$	1.197	1.743	0.786	2.867**
	(1.258)	(1.231)	(1.028)	(2.387)
Sigma$_{t-1}$	0.341***	0.364***	0.244***	0.387***
	(8.499)	(6.318)	(5.451)	(5.397)
Loan$_{t-1}$	-0.728	-20.559		
	(-0.110)	(-1.470)		
Duvol$_{t-1}$			0.032	1.377
			(0.037)	(0.900)
Mom$_{t-1}$			-7.776***	-6.263**
			(-4.557)	(-2.017)
Cokurt$_{t-1}$			0.549***	0.609**
			(2.978)	(2.137)
Intercept	7.910	21.065**	4.211	5.559
	(1.549)	(2.190)	(1.458)	(1.269)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*
Bank -specific Cluster	*Yes*	*Yes*	*Yes*	*Yes*
Observations	1,947	1,947	2,133	2,133
R-squared	0.432	0.317	0.642	0.582

Table 10 Moderating Effects of Exogenous Conditions: Information Transparency and Bank Size

This table presents OLS estimation results for regressing a bank's contribution to systemic contraction risk measure *ΔCoVaR_at* or a bank's contribution to systemic crash risk measure *ΔCoVaR_stk* against CEO risk-taking incentives measure *Vega*, interactions of *Vega* with bank bail-out proxy *Size*, bank information environment measure *Dispa*, *Hlspread* and other control variables, respectively. Models 1 to 3 use *ΔCoVaR_at* as dependent variable, and use *Vega*, its interactions with *Size* and *Disp*, *Hlspread* and other control variables as independent variables, respectively. Models 4 to 6 use *ΔCoVaR_stk* as dependent variable, and *Vega*, its interactions with *Size* and *Disp*, *Hlspread* and other control variables as independent variables, respectively. *T*-statistics are adjusted for bank-level clusters, model details are provided in Model (7) in the text, and variable definitions in Appendices A to B.

Dependent Variable	**ΔCoVaR5_at**			**ΔCoVaR5_stk**		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
$Vega_{t-1}*Size_{t-1}$	-0.344***			-0.421***		
	(-2.801)			(-3.388)		
$Vega_{t-1}*Disp_{t-1}$		3.229			22.156*	
		(0.292)			(1.904)	
$Vega_{t-1}*Hlspread_{t-1}$			0.763			1.861***
			(1.263)			(4.318)
$Disp_{t-1}$		34.514			67.456**	
		(1.168)			(2.507)	
$Hlspread_{t-1}$			-2.632			7.803***
			(-0.798)			(2.759)
$Vega_{t-1}$	1.280***	1.231***	0.509	1.034***	0.407	-0.366
	(3.308)	(2.797)	(1.040)	(3.902)	(1.220)	(-1.135)
$Leverage_{t-1}$	1.882	4.687	1.243	12.280*	15.182**	15.379**
	(0.170)	(0.337)	(0.112)	(1.783)	(2.168)	(2.597)
$Size_{t-1}$	2.325*	0.030	2.226*	4.243***	4.221***	4.139***
	(1.721)	(0.053)	(1.783)	(4.012)	(4.271)	(4.636)
$Size\_sqr_{t-1}$	-0.190**		-0.175**	-0.235***	-0.208***	-0.219***
	(-2.213)		(-2.292)	(-2.956)	(-3.312)	(-3.354)
ROA_{t-1}	1.049	0.865	0.673	5.004**	3.952*	2.329
	(0.452)	(0.389)	(0.305)	(2.117)	(1.763)	(1.173)
Mb_{t-1}	1.376	1.468	1.379	0.562	1.070	0.583
	(1.480)	(1.485)	(1.463)	(0.776)	(1.418)	(0.738)
$Sigma_{t-1}$	0.345***	0.366***	0.433***	0.245***	0.262***	0.266***
	(8.437)	(8.956)	(10.001)	(5.926)	(7.333)	(7.253)
$Loan_{t-1}$	-3.953	-4.019	-3.483			
	(-0.585)	(-0.503)	(-0.515)			
$Dturn_{t-1}$				0.253	0.267	0.432
				(0.323)	(0.296)	(0.501)
Mom_{t-1}				-6.259***	-7.836***	-6.118***
				(-3.870)	(-4.496)	(-3.762)
$Cokurt_{t-1}$				0.465***	0.588**	0.379***
				(2.678)	(2.534)	(2.619)
Constant	15.309***	10.485*	13.744***	7.839**	1.067	4.694
	(3.174)	(1.905)	(2.819)	(2.441)	(0.249)	(1.396)
Year and Quarter Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Bank-specific Cluster	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,034	1,762	2,020	2,223	1,923	2,086
R-squared	0.445	0.447	0.452	0.650	0.663	0.678

Table 11 Moderating Effects of Exogenous Conditions: Financial Crisis and Market Illiquidity

This table presents OLS estimation results for regressing a bank's contribution to systemic contraction risk measure *ΔCoVaR_at* or to systemic crash risk measure *ΔCoVaR_stk* against CEO risk-taking incentives measure *Vega*, the interactions of *Vega* with market meltdown proxy *Crisis*, bond and stock market liquidity measures *Repo* and *Mktilliq*, and other control variables, respectively. Models 1 to 3 use *ΔCoVaR_at* as dependent variable, and use *Vega*, its interactions with *Crisis*, *Repo*, and *Mktilliq*, and other control variables as independent variables, respectively. Models 4 to 6 use *ΔCoVaR_stk* as dependent variable, and use *Vega*, its interactions with *Crisis*, *Repo*, and *Mktilliq*, and other control variables as independent variables, respectively. *T*-statistics are adjusted for bank-level clusters, model details are provided in Model (7) in the text, and variable definitions in Appendices A to B.

	ΔCoVaR5_at				**ΔCoVaR5_stk**			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
$Vega_{t-1}$*Crisis	2.774**				4.489***			
	(2.445)				(5.459)			
$Vega_{t-1}$*$Repo_{t-1}$			98.656				174.609***	
			(1.495)				(3.831)	
$Vega_{t-1}$* $Mktilliq_{t-1}$				1.446				2.672***
				(0.827)				(2.693)
Crisis	12.961**				25.117***			
	(2.095)				(5.627)			
$Repo_{t-1}$			1,454.078***				751.356***	
			(5.391)				(4.262)	
$Mktilliq_{t-1}$				0.737				11.179***
				(0.165)				(4.059)
$Vega_{t-1}$	0.916**	1.420	0.730**	1.520***	0.483**	2.340***	0.161	1.530***
	(2.580)	(1.146)	(2.103)	(2.968)	(2.129)	(2.801)	(0.676)	(4.423)
$Leverage_{t-1}$	2.677	34.162	3.288	2.428	15.410***	30.609**	14.681**	16.006***
	(0.240)	(1.138)	(0.294)	(0.216)	(2.628)	(2.479)	(2.432)	(2.680)
$Size_{t-1}$	2.236*	9.525***	2.116*	2.125*	4.109***	11.846***	4.057***	3.978***
	(1.937)	(3.780)	(1.662)	(1.663)	(5.598)	(4.853)	(4.292)	(4.258)
$Size\_sqr_{t-1}$	-0.179**	-0.557***	-0.163**	-0.165**	-0.224***	-0.593***	-0.209***	-0.206***
	(-2.519)	(-3.833)	(-2.092)	(-2.117)	(-4.148)	(-4.581)	(-3.034)	(-2.957)
ROA_{t-1}	0.944	2.516	0.530	1.083	2.368	1.797	2.555	2.214
	(0.439)	(1.045)	(0.248)	(0.470)	(1.198)	(1.219)	(1.171)	(1.041)
Mb_{t-1}	1.390	0.905	1.126	1.308	0.802	0.488	0.579	0.836
	(1.479)	(0.236)	(1.204)	(1.379)	(1.074)	(0.241)	(0.754)	(1.090)
$Sigma_{t-1}$	0.342***	0.250***	0.274***	0.350***	0.284***	0.184***	0.285***	0.290***
	(8.654)	(2.673)	(6.011)	(8.364)	(10.061)	(3.239)	(8.656)	(9.293)
$Loan_{t-1}$	-4.095	-12.580	-5.013	-4.303		30.609**		
	(-0.606)	(-0.930)	(-0.711)	(-0.619)		(2.479)		
$Duvol_{t-1}$					0.544	-7.145**	0.616	0.572
					(0.630)	(-2.279)	(0.729)	(0.672)
Mom_{t-1}					-6.319***	-17.137***	-6.135***	-6.712***
					(-3.895)	(-3.134)	(-3.723)	(-4.061)
$Cokurt_{t-1}$					0.372***	-0.095	0.307**	0.419***
					(2.619)	(-0.127)	(2.272)	(2.754)
Intercept	14.540***	37.146*	18.121***	13.328***	7.631**	38.175***	8.534***	11.490***
	(3.021)	(1.880)	(3.649)	(2.694)	(2.583)	(3.365)	(2.679)	(4.149)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Bank -specific Cluster	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	2,020	249	2,020	2,020	2,086	265	2,086	2,086
R-squared	0.449	0.573	0.469	0.440	0.687	0.750	0.672	0.666

Table 12 Reconcile with Fahlenbrach and Stulz (2011): Bank-specific performance and Risk Measures

This table presents OLS estimation results for regressing bank performance variable *ROA* and bank-specific crash risk measure *VaR_stk* against CEO risk-taking incentives variables *Vega*, the interaction *Vega**Crisis*, *Crisis*, and other control variables in Models 1 to 4 and Models 5 to 8, respectively. Models 1 and 5 report the OLS regression results for the whole sample period without considering the effects of financial crisis, Models 2 and 6 incorporate the effects of financial crisis by adding *Crisis* and the interaction *Vega**Crisis* as further controls. Models 3 and 7 report OLS regression results for the subsample of financial crisis period, and Models 4 and 8 report OLS regression results for the subsample of non-financial crisis period. *T*-statistics are adjusted for bank-level clusters, and variable definitions are provided in Appendices A to B.

Independent Variable	**Dependent Variables: ROA**				**Dependent Variables: VaR_stk**			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
$Vega_{t-1}$*Crisis*		0.019				0.007		
		(0.940)				(1.396)		
$Vega_{t-1}$	0.008*	0.006*	0.036	0.006*	0.003**	0.002*	0.007	0.002**
	(1.943)	(1.865)	(1.433)	(1.922)	(2.318)	(1.795)	(1.296)	(2.157)
Crisis		-0.184**				0.099***		
		(-1.994)				(3.435)		
$Leverage_{t-1}$					0.057	0.055	0.005	0.022
					(1.492)	(1.382)	(0.049)	(0.779)
$Size_{t-1}$					-0.006*	-0.006*	0.010	-0.004*
					(-1.877)	(-1.936)	(0.692)	(-1.664)
$Size\_sqr_{t-1}$					0.001**	0.001**	-0.000	0.000*
					(2.500)	(2.503)	(-0.254)	(1.680)
ROA_{t-1}	0.313***	0.313***	0.214***	0.439***	-0.017*	-0.018*	-0.021*	-0.008
	(4.702)	(4.813)	(3.035)	(4.422)	(-1.715)	(-1.710)	(-1.725)	(-0.792)
Mb_{t-1}	0.069***	0.069***	0.224***	0.043***	0.001	0.001	-0.025*	0.001
	(7.072)	(7.046)	(6.944)	(5.059)	(0.258)	(0.278)	(-1.873)	(0.249)
$Sigma_{t-1}$					0.062***	0.062***	0.047***	0.040***
					(23.421)	(23.024)	(11.015)	(9.284)
$Duvol_{t-1}$					(9.363)	(8.669)	(2.469)	(10.674)
					0.036***	0.036***	0.044	0.037***
Mom_{t-1}					(6.055)	(6.128)	(1.620)	(6.814)
					0.007	0.009	-0.038	0.039***
$Cokurt_{t-1}$					(0.552)	(0.692)	(-0.986)	(3.438)
					-0.002***	-0.002***	-0.007	-0.000*
$Bonus_{t-1}$	-0.000	0.000	0.000	-0.000				
	(-0.150)	(0.203)	(0.082)	(-0.163)				
$Sizelogmv_{t-1}$	0.005	0.003	-0.008	0.004				
	(0.917)	(0.547)	(-0.339)	(0.811)				
$CAPR1Q_{t-1}$	-0.000	-0.000	0.016	-0.002				
	(-0.058)	(-0.103)	(1.230)	(-0.880)				
Intercept	0.145***	0.146***	-0.310	0.154***	0.115***	0.112***	0.304***	0.048***
	(2.651)	(2.665)	(-0.991)	(2.950)	(8.851)	(8.507)	(7.038)	(4.148)
Year and Quarter Dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Bank-specific Cluster	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	1,491	1,491	250	1,241	1,507	1,507	254	1,253
R-squared	0.489	0.491	0.356	0.423	0.738	0.741	0.461	0.491