Stronger Risk Controls, Lower Risk: Evidence from U.S. Bank Holding Companies*

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Abstract

In this paper, we investigate whether U.S. bank holding companies (BHCs) with strong and independent risk management functions had lower enterprise-wide risk. We hand-collect information on the organizational structure of the risk management function at the 74 largest publicly-listed BHCs, and use this information to construct a Risk Management Index (RMI) that measures the strength of organizational risk controls at these institutions. We find that BHCs with a high RMI in the year 2006 (i.e., before the onset of the financial crisis) had lower exposure to private-label mortgage-backed securities, were less active in trading off-balance sheet derivatives, had a smaller fraction of non-performing loans, and had lower downside risk during the crisis years (2007 and 2008). In a panel spanning the 9 year period 2000–2008, we find that BHCs with higher RMIs had lower enterprise-wide risk, after controlling for size, profitability, a variety of risk characteristics, corporate governance, executive compensation, and BHC fixed effects. This result holds even after controlling for any dynamic endogeneity between risk and RMI. Overall, these results suggest that strong internal risk controls are effective in restraining risk-taking behavior at banking institutions.

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"The failure to appreciate risk exposures at a firmwide level can be costly. For example, during the recent episode, the senior managers of some firms did not fully appreciate the extent of their firm's exposure to U.S. subprime mortgages. They did not realize that, in addition to the subprime mortgages on their books, they had exposures through the mortgage holdings of off-balance-sheet vehicles, through claims on counterparties exposed to subprime, and through certain complex securities..."

- Chairman of the Federal Reserve, Ben Bernanke[1]

Introduction

There is wide-spread agreement on the proximate causes of the current financial crisis: banks had substantial exposure to subprime risk on their balance sheets, and these risky assets were funded mostly by short-term market borrowing (Kashyap et al. (2008), Acharya et al. (2009)). As a result, what began as a housing crisis in the United States soon turned into a full-blown global financial crisis. Among the explanations for why banks exposed themselves to such risks, a prominent explanation that has been advanced by policymakers, bank supervisors and academics is that there was a failure of risk management at banks.[2] The argument seems to be that traders and other bank executives with high-powered pay-for-performance schemes were exploiting deficiencies in the internal control systems, and risk managers were unable or powerless to restrain them (Senior Supervisors Group (2008), Kashyap et al. (2008)).

In this paper, we focus on the organizational structure of the risk management function at bank holding companies (BHCs) in the United States. The key question we examine is whether BHCs that had strong internal risk controls in place had lower enterprise-wide risk, after controlling for the underlying risk of the BHCs' business activities. To this end, we construct an innovative risk management index that measures the importance attached to the risk management function within the organization, and how well information on risk from the different business segments is conveyed to the BHC's board of directors. We gauge the importance attached to the risk management function by examining if the BHC has a designated Chief Risk Officer (CRO) and how powerful the CRO is within the organization; specifically, whether the CRO is among the top five highly paid executives, and how the CRO's pay compares with that of the Chief Executive Officer (CEO). Similarly,

[1] Comments from his special address delivered at the 44^{th} annual Conference on Bank Structure and Competition, held at the Federal Reserve of Chicago in May 2008.

[2] Stulz (2008) characterizes a failure of risk management as one of the following: failure to identify or correctly measure risks, failure to communicate risk exposures to the top management, and failure to monitor or manage risks adequately.

to gauge how well quantitative and qualitative information on risk is shared between the top management and business segments, we examine whether the directors serving on the BHC's designated board committee to oversee risk have prior banking experience, the frequency of the meetings held by the BHC's designated board risk committee, and the banking and financial industry experience of the directors serving on the board of directors.

Our research question is motivated by the idea that a strong and independent risk management function is necessary to effectively manage risk in modern-day banking institutions. This is because deposit insurance protection and implicit too-big-to-fail guarantees weaken the incentives of debtholders to impose market discipline, while the ever increasing complexity of modern-day banking institutions and the ease with which their risk profiles can be altered by traders and security desks makes it difficult for supervisors to regulate risks (Acharya et al. (2009)). The increasing complexity of modern-day banking institutions also makes it difficult to measure risk and to communicate risk objectives to business segments in easily quantifiable terms. As Stulz (2008) notes, once risk management moves away from established quantitative models, it becomes easily embroiled in intra-firm politics; e.g., traders whose bonuses depend on the risks they take, may be at cross-purposes with the risk officer. Therefore, the outcome for the institution depends on how strong and independent the risk management function is.

Policymakers and supervisors seem to echo this view. Based on its discussions with the largest financial institutions, the Senior Supervisors Group (2008) has concluded that what distinguished well-managed institutions that fared well during the crisis was that they had strong and independent risk management functions, and that there was a robust dialogue between their senior management team and business segments regarding organization-wide risk preferences.[3] In particular, the SSG report highlights specific weaknesses in risk management practices that contributed to heavy losses at institutions that performed poorly during the crisis: excessive reliance on external credit rating agencies and backward-looking measures of risk, and failure to conduct forward-looking stress tests;[4] failure to identify correlation risk;[5] and underestimation of liquidity risk.

Our specific focus on BHCs is motivated by three important considerations. First, a typical BHC is comprised of several independent subsidiaries, each with its own management and board of directors, involved in a wide variety of financial activities. This kind of an

[3]The Senior Supervisors Group (SSG) is a group of supervisory agencies from France, Germany, Switzerland, the United Kingdom, and the United States.

[4]Some institutions tended to assume that they could apply the low historical return volatility of corporate credits rated 'Aaa' to super-senior tranches of CDOs, a more novel instrument that rating agencies had likewise rated 'Aaa'.

[5]For example, several institutions assigned zero net risk to negative basis trades, where they held long position in a corporate bond combined with a protection in the form of a credit default swap (CDS), under the assumption that correlation between bond prices and CDS prices would follow historical relationships.

organizational structure enhances the importance of an enterprise-wide risk management mechanism that can identify and manage risks on a consolidated basis. Second, most BHCs are publicly listed on stock exchanges and file periodic reports (such as 10-K statements, proxy statements) with the Securities and Exchange Commission (SEC), from which we are able to collect information on their risk management structure. Third, because they are regulated by the Federal Reserve and the FDIC, BHCs are required to report detailed financial information on a quarterly basis. Apart from information on the balance sheet and income statement items, we are also able to obtain detailed information on usage of derivatives and off-balance sheet activities.

We obtain our data from several sources. We hand-collect data on the organization structure of risk management of BHCs from their 10-K statements, proxy statements, and annual reports. Given the effort involved in hand-collection and validation of information, we restrict ourselves to the 74 largest publicly-listed BHCs, in terms of the book value of their assets, at the end of 2007 (which accounted for 78% of the total assets of the banking system). We hand-collect this information for the nine year period, 1999–2007. Financial information on BHCs is obtained from the FR Y-9C reports that they file with the Federal Reserve System. We use three different measures of enterprise-wide risk: aggregate risk, downside risk and tail risk. We use the standard deviation of a BHC's excess weekly return (i.e., weekly return on the BHC's stock less the weekly return on the S&P500) over the calendar year as a proxy for its aggregate risk during the year (see Demsetz et al. (1997) and Laeven and Levine (2009)).[6] We proxy for downside risk using the mean implied volatility estimated using put options written on the BHC's stock (Bali and Hovakimian (2009), Cremers and Weinbaum (2008) and Xing et al. (2008)). We proxy for tail risk using the marginal expected shortfall (MES) measure proposed by Acharya et al. (2009), which is defined as the negative of the average return on the BHC's stock over the 5% worst days for the S&P500 during the year. We obtain data on stock returns from CRSP, and data on option prices and implied volatilities from the OptionMetrics database.

As a preamble to our analysis, and in keeping with the motivation of our paper, we begin by examining whether BHCs that had strong internal risk controls in place before the onset of the financial crisis fared better during the crisis years, 2007 and 2008. To answer this question, we estimate cross-sectional regressions in which the main independent variable is the BHC's RMI in 2006, and the outcome variables are performance measures in 2007 and 2008. The reason we choose RMI in 2006 as the independent variable is because the SSG report specifically highlights that institutions with strong risk management functions identified risks and started taking corrective actions as early as in 2006, when it was easier

[6] Our results hold even if we use the standard deviation of weekly raw returns as a measure of aggregate risk.

to offload holdings of mortgage-backed securities and CDOs, and was relatively cheaper to hedge risks. Consistent with the idea that BHCs with stronger internal risk controls were more judicious in their risk taking behavior, we find that BHCs with a high 2006 RMI had lower exposure to private-label mortgage-backed securities and risky trading assets, were less active in trading off-balance sheet derivative securities, and had a smaller fraction of non-performing loans during the crisis years. Moreover, BHCs with a high 2006 RMI fared (weakly) better in terms of stock return performance, and had lower implied volatilities during the crisis years.

Next, we examine a panel spanning the 9 year period from 2000–2008 to investigate whether BHCs with stronger risk controls had lower enterprise-wide risk, after controlling for the underlying risk profile of the BHC's business activities. In these panel regressions, we are better able to control for unobserved BHC characteristics by including BHC fixed effects. After controlling for various BHC characteristics like size, profitability, asset and liability composition including capital ratios, other risk characteristics, executive compensation and corporate governance, we find that BHCs with stronger risk controls (i.e., higher values of RMI) in the previous year had lower downside risk, lower tail risk, and lower aggregate risk in the current year. In terms of economic significance, a one standard deviation increase in RMI is associated with 0.43 standard deviation decrease in downside risk, a 0.62 standard deviation decrease in tail risk, and a 0.6 standard deviation decrease in aggregate risk. We must emphasize that our panel regression includes year fixed effects as well as BHC fixed effects. Thus, we are controlling for time-invariant unobserved heterogeneity across BHCs. Our results reflect a within-BHC decrease in enterprise-wide risk from a strengthening of the risk management function.

One concern with the fixed effects panel regression model is that the negative association between risk and RMI may be driven by some unobserved time-varying omitted variable that jointly determines both risk and the choice of risk controls, or by the dynamic endogeneity between risk and RMI; i.e., causation between risk and RMI could run both ways such that past risk determines both current risk and choice of internal risk controls. This can bias our inferences depending on how causation affects the choice of RMI. It is possible that BHCs exposed to greater risk choose stronger risk management systems, which should bias against us finding a negative association between BHC Risk and RMI.[7] Alternatively, it is possible that the underlying risk culture of the BHC determines both the choice of the risk and the strength of the risk management system; i.e., conservative BHCs take lower risks and put in place stronger risk management systems, while aggressive BHCs take higher risks and

[7]The hypothesis follows from theories which suggest that firms that are more likely to experience financial distress should also be more aggressive in managing their risks (Smith and Stulz (1985), Froot et al. (1993)). For empirical evidence on this in the banking sector, see Purnanandam (2007), who shows that banks with higher probability of financial distress manage their interest rate risk more aggressively.

also have weaker internal risk controls. If the risk-culture hypothesis is correct, it will tend to exaggerate the positive association between BHC risk and RMI.

To deal with the dynamic endogeneity problem and the omitted variable bias, we use a dynamic panel GMM estimator developed by Arellano and Bond (1991), that enables us to use the information from the BHC's history, in the form of lags of risk and other BHC characteristics, to provide instruments for identifying the relationship between RMI and risk. We choose a specification in which historical risk measures and other BHC characteristics that are lagged three periods or more are available for use as exogenous instruments for the current RMI. Our estimation results confirm the validity of instruments. More importantly, they show that BHCs with strong internal risk controls have lower enterprise-wide risk, even after controlling for the dynamic endogeneity between risk and RMI.

Finally, we also examine if the stock market rewards or penalizes BHCs that have strong internal risk controls. If strong internal risk controls cause the BHC to forgo profitable but risky activities like asset management or derivatives trading, then it is possible that the stock returns are lower for BHCs with high RMI. On the other hand, if strong risk controls can help a BHC avoid taking on excessive idiosyncratic risk, then the stock market should reward BHCs with high RMI. To test these hypotheses, we estimate our panel regressions with the annual return on the BHC's stock as the dependent variable. Our analysis indicates that, all else equal, stock returns are higher for BHCs with high RMI; i.e., the stock market rewards BHCs with strong internal risk controls. This result continues to hold even after we correct for any dynamic endogeneity between return and RMI, using the dynamic panel GMM estimator.

To summarize, our results support the idea that strong and independent risk controls lower enterprise-wide risk in banking institutions. BHCs with strong risk management functions in place before the onset of the financial crisis were more judicious in their exposure to risky financial instruments, and generally fared better during the crisis period. In a panel spanning 9 years, we find that BHCs with stronger internal risk controls had lower downside risk, lower tail risk, and lower aggregate risk, after controlling for size, profitability, asset and liability composition, governance, executive compensation, and unobserved heterogeneity using BHC fixed effects. This result is robust to controlling for any dynamic endogeneity between risk and strength of internal risk controls.

Our paper makes three important contributions. First, it highlights that weakening risk management at financial institutions may have contributed to the excessive risk-taking behavior that brought about the financial crisis. To the best of our knowledge, we are the first to show that banks with strong internal risk controls in place before the onset of the financial crisis were more judicious in exposing themselves to private-label mortgage-backed

securities, risky trading assets and off-balance sheet derivative trading activity. Moreover, they also generally fared better during the crisis years. Another prominent argument that has been advanced to explain the risk-taking behavior of banks leading up to the financial crisis is that executives at banks had poor incentives. However, Fahlenbrach and Stulz (2009) find no evidence in support of this argument. In fact, they find that banks with CEOs whose incentives were better aligned with the interests of their shareholders actually performed worse during the credit crisis. Further, option compensation did not have an adverse impact on bank performance during the crisis.

Second, our paper contributes to the large literature that examines risk-taking by banks. Past research has examined the impact of deposit insurance and competition (Keeley (1990), Hellmann et al. (2000), Demirgüç-Kunt and Detragiache (2002)), ownership structure and banking regulations (Laeven and Levine (2009)), size (Demsetz and Strahan (1997)), and franchise value (Demsetz et al. (1997)) on risk-taking by banks. Our paper contributes to this literature by examining how the strength and independence of the risk management function affects risk-taking.

Finally, our paper also contributes to the small but growing literature on the corporate governance of financial institutions. Macey and O'Hara (2003) argue that the fiduciary duties of bank officers and directors should be expanded beyond shareholders to include creditors. Adams and Mehran (2003) highlight key differences in internal governance structures and ownership structure between bank holding companies and non-financial firms. Examining 306 global financial institutions that were at the center of the financial crisis, Erkens et al. (2009) find that CEO turnover is more sensitive to shareholder losses among firms with greater board independence, larger institutional ownership, and smaller insider ownership. In contrast to papers on corporate governance that mainly focus on the bank's ability to take corrective action (e.g., firing the CEO) following poor performance, our focus is on internal risk controls that can restrain risk-taking behavior ex ante.

The rest of the paper is organized as follows. We outline our key hypotheses in Section 1. We describe our data sources and construction of variables in Section 2, and provide descriptive statistics and preliminary results in Section 3. Our main empirical results are presented in Section 4. Section 5 concludes the paper.

1 Hypotheses

The key hypothesis which we aim to test is that banking institutions with strong and independent risk management functions have lower enterprise-wide risk, all else equal. Our hypothesis recognizes that strong internal risk controls are necessary to rein in the risk-

taking tendencies of bank executives. The following paragraph from Acharya et al. (2009) summarizes the risk-taking tendencies that arise within modern-day financial institutions, and why these cannot be checked through traditional monitoring by their debtholders, supervisory action of regulators, or external market discipline:

> "Large, complex financial institutions are highly levered entities with over 90 percent leverage, many with access to explicit deposit insurance protection and most with implicit too big to fail guarantees. Together, these features have created several important problems. First, they have induced excessive leverage- and risk-taking tendencies. Second, the presence of implicit or explicit government guarantees – often underpriced and at best mispriced – has blunted the instrument of debt monitoring that would otherwise impose market discipline on risk taking by these firms. Third, the size of these institutions has shielded them from the disciplinary forces of the otherwise vibrant market for takeovers and shareholder activism. Finally, their ever-increasing complexity has diminished the power of governance from existing shareholders and non-executive board members. Unlike in industrial firms, it has become increasingly difficult for infrequently meeting boards to fully grasp the swiftness and forms by which risk profiles of these institutions can be altered by traders and security desks. "

One mechanism that can check the risk-taking tendencies of bank executives and traders is the presence of a strong and independent risk management function (see Kashyap et al. (2008), Landier et al. (2008)). Note that for risks to be successfully managed, they must first be identified and measured. This is particularly challenging for banking institutions given the multitude of risks that they are exposed to. Apart from credit risk, banks are also exposed to interest rate risk and liquidity risk given that they finance illiquid assets with liquid liabilities such as deposits (Diamond (1984), Diamond and Rajan (2001)). Trading and underwriting activities of their subsidiaries not only increase the risk exposures of individual banks, but also increase the risk of broad systemic failure, because the failure of one segment of a large institution (e.g., the derivatives desk at AIG) can trigger a broader systemic failure through depositor panics, counter-party failures, and systemic liquidity shortages (Diamond and Rajan (2005)).

Past research has highlighted that organizational structure influences the effectiveness of information sharing between business segments and the top management (Stein (2002), Liberti (2005)). Therefore, the organizational structure of the risk management function is likely to be important in determining how effectively qualitative and quantitative information on risk is shared between the top management and the individual business segments. Accordingly, we collect information on how the risk management function is organized at each bank holding company in our sample. However, measuring risk by itself may not be enough to restrain bank executives and traders, whose bonuses depend on the risks that

they take. As Kashyap et al. (2008) note (also see Stulz (2008)),

> "...high powered pay-for-performance schemes create an incentive to exploit deficiencies in internal measurement systems...this is not to say that risk managers in a bank are unaware of such incentives. However, they may be unable to fully control them. "

Therefore, it is important that the risk management function be strong and independent. Accordingly, we collect information on not just whether a BHC has a designated officer tasked with managing enterprise-wide risk, but also how important such an official is within the organization.

In our empirical analysis, we test our hypothesis against the *null hypothesis* that internal risk controls do not have any meaningful effect on enterprise-wide risk. This could be because even the most sophisticated organizational structure may not be able to grasp the swiftness with which traders and security desks can alter the risk profile of the BHC. Importantly, the compensation packages of traders may be so convex that they cannot be restrained by internal risk controls (Landier et al. (2008)).

We also recognize that the causation between the strength of the risk management function and enterprise-wide risk can run in both directions; i.e., BHC risk characteristics might determine the choice of the risk management function, and the risk management function in turn affects risk. There are two possible ways in which risk characteristics may affect the organizational structure of the risk management function.

It is possible that BHCs exposed to greater risk choose stronger risk management systems. We refer to this as the *endogenous choice hypothesis*. This hypothesis follows from theories of hedging, which suggest that firms that are more likely to experience financial distress should also be more aggressive in managing their risks (Smith and Stulz (1985), Froot et al. (1993)). Consistent with hedging theories, Purnanandam (2007) shows that banks that face a higher probability of financial distress manage their interest rate risk more aggressively, both by using derivatives and by adopting conservative asset-liability management policies.

Alternatively, it is possible that the underlying risk culture of the BHC determines both the choice of the risk and the strength of the risk management system; i.e., conservative BHCs take lower risks and put in place stronger risk management systems, while aggressive BHCs take higher risks and also have weaker internal risk controls. We refer to this as the *risk culture* hypothesis.

The above discussion highlights the need for an empirical methodology that can account for the dynamically endogenous relationship between a BHC's risk and its risk management

function.

2 Sample collection and construction of variables

2.1 Data Sources

Our data comes from several sources. From the Edgar system, we hand-collect data on the organization structure of the risk management function at BHCs from the annual 10-K statements and proxy statements filed by the BHCs with the Securities and Exchange Commission (SEC). Whenever the data is not available from these documents we use the BHCs' annual reports. We use this information to create a unique Risk Management Index (RMI) that measures the organizational strength and independence of the risk management function at the given BHC in each year. Given the effort involved in hand-collecting and validating the information for each BHC, we restrict ourselves to the time period 1999–2007, and to the 100 largest BHCs, in terms of the book value of their total assets at the end of 2007. Although there were over 5,000 BHCs at the end of 2007, the top 100 BHCs account for close to 92% of the total assets of the banking system. Because only publicly listed BHCs file 10-K statements with the SEC, our sample reduces to 74 BHCs, that accounted for 78% of the total assets of the banking system in 2007. Overall, we are able to construct the RMI for 74 BHCs over the time period 1999–2007. We list the names of these BHCs in Appendix A.

We obtain consolidated financial information of BHCs from the FR Y-9C reports that they file with the Federal Reserve System. Apart from information on the consolidated balance sheet and income statement, the FR Y-9C reports also provide us a detailed break-up of the BHC's loan portfolio, security holdings, regulatory risk capital, and off-balance sheet activities such as usage of derivatives. The financial information is presented on a calendar year basis.

We obtain data on stock returns from CRSP, and use these to compute our measure of a BHC's *Aggregate Risk*, which is defined as the standard deviation of the BHC's weekly excess return (i.e., weekly return on the BHC's stock less the weekly return on the S&P500) over the calendar year. We also use the CRSP data to compute a measure of *Tail Risk* proposed by Acharya et al. (2009), which they refer to as the marginal expected shortfall (MES). In a given year, the MES is defined as the negative of the average return on the BHC's stock during the 5% worst days for the S&P500. We obtain implied volatilities estimated from option prices from the OptionMetrics database, and use these to compute our measure of a BHC's *Downside Risk*, which is defined as the mean implied volatility estimated using put options written on the BHC's stock.

We obtain data on CEO compensation from the Execucomp database, and use these to compute the sensitivity of the CEO's compensation to stock price (*CEO's Delta*) and stock return volatility (*CEO's Vega*). We obtain data on institutional ownership from the 13-F forms filed by each institutional investor with the SEC, and the Gompers et al. (2003) G-Index from the IRRC database.

2.2 The Risk Management Index

We hand-collect information on various aspects of the organization structure of the risk management function at each BHC, and use this information to create a Risk Management Index to measure the strength and independence of the organizational strength of the risk management function. We obtain the RMI for each BHC and each year in our sample. In total we have 673 BHC-year observations for the RMI over the period 1999-2007.

Our first set of variables are aimed at capturing whether the BHC has a designated officer charged exclusively with managing enterprise-wide risk across all business segments, and how important this official is within the organization. Specifically, we create the following variables: *CRO Present*, which is a dummy variable that identifies if the BHC has a designated Chief Risk Officer (CRO) or not; *CRO Executive*, a dummy variable that identifies if the CRO is an executive officer of the BHC or not; *CRO-Top5*, a dummy variable that identifies if the CRO is among the five highest paid executives at the BHC or not; and *CRO Centrality*, defined as the ratio of the CRO's total compensation to the CEO's total compensation.[8]

We must point out that reporting issues may cause the *CRO Present* variable to be biased downwards. In some of the smaller BHCs that are mainly oriented towards retail banking, the Chief Lending Officer or the Chief Credit Officer may be the official in charge of risk management. To ensure that we are not missing out on these alternative designations, we treat them on par with Chief Risk Officer while coding the *CRO Present* variable, although this may introduce noise into our definition. More seriously, however, it is possible that a BHC has a Chief Risk Officer (or a Chief Lending Officer or a Chief Credit Officer) but simply fails to report this in its 10-K statement, proxy statement and annual report, because it is not required to report this information. This will clearly introduce a downward bias in the *CRO Present* variable. Indeed, as we discuss below, we find that a Chief Risk Officer (or an equivalent designation) is present only in a little over 60% of all the BHC-year observations. Given that this variable may be noisy because of reporting issues, we do not include *CRO Present* in our RMI measure. However, to test the robustness of our results,

[8]Keys, Mukherjee, Seru, and Vig (2009) use a similar measure to capture the relative power of the CFO within the bank.

we create an alternative RMI measure that also includes *CRO Present*.

Note that the *CRO Executive* variable is likely to be less noisy than *CRO Present* because firms are more likely to report the names and designations of their executive officers in their proxy statements or annual reports. Also, the *CRO-Top5* variable does not suffer from reporting issues because all firms are required to reveal the names and designations of their five highest paid executives in their 10-k statements.

Reporting issues also complicate the definition of the *CRO Centrality* variable, because publicly-listed firms are only required to disclose the compensation packages of their five highest paid executives. Thus, we have information on the CRO's compensation only when he/ she is among the five highest paid executives. We overcome this difficulty as follows: When the BHC has a CRO (or an equivalent designation) who does not figure among the five highest paid executives, we calculate *CRO Centrality* based on the compensation of the fifth highest-paid executive, and subtract a percentage point from the resultant ratio; i.e., we implicitly set the CRO's compensation just below that of the fifth-highest paid executive. In case of BHCs that do not report having a CRO, we define *CRO Centrality* based on the total compensation of the Chief Financial Officer if that is available (which happens only if the CFO is among the five highest paid executives);[9] if CFO compensation is not available, then we compute *CRO Centrality* based on the compensation of the fifth highest-paid executive, and subtract a percentage point from the resultant ratio. To the extent that the CRO's true compensation is much lower, these methods only bias against us, and should make it more difficult for us to find a negative relationship between RMI and risk. Another alternative is to code *CRO Centrality*=0 when the BHC does not have or does not report to have a designated CRO. Not surprisingly, in unreported tests, we find that our results become stronger when we use this more stringent definition of *CRO Centrality*.

Our next set of variables are intended to capture the quality of risk oversight provided by the BHC's board of directors. In this regard, we examine the characteristics of the board committee designated with overseeing and managing risk, which is usually either the Risk Management Committee or the Audit and Risk Management Committee. We do not distinguish between whether the board risk committee exclusively deals with risk management or combines it with another function such as auditing. *Risk Committee Experience* is a dummy variable that identifies whether at least one of the grey or independent directors serving on the board's risk committee has banking experience.[10] We also measure the banking and financial industry experience of all the grey and independent directors serving on the BHC's

[9]The reasoning behind using the CFO's compensation is that, in BHCs that either do not have or do not report having a CRO, the CFO is most likely in charge of risk management.

[10]As is standard in the Corporate Governance literature, we use the term "grey" directors for directors who are not insiders but are also not independent, because they have connections to the firm.

board of directors. We define the dummy variable *Experienced Board* to take the value of 1 if the BHC's board has a larger proportion of its independent and grey directors with banking or financial industry experience compared to the average board across all BHCs each year. We measure the activity of the board risk committee in terms of the frequency with which it meets during the year. The dummy variable *Active Risk Committee* then identifies if the BHC's board risk committee met more frequently during the year compared to the average board risk committee across all BHCs.

To capture how well risk information is shared between business units and the board, we define the dummy variable *Reports to Board* to identify whether the key management-level risk committee (usually called the "Asset and Liability Committee") reports directly to the BHC's board of directors, instead of to the CEO. Here again, we want to point out that the variable *Reports to Board* may suffer from reporting biases, because in slightly over 25% of the BHC-year observations, we find no information on the reporting channel of the management-level risk committee. In such cases, we set *Reports to Board* equal to zero; i.e., we assume that the key management-level risk committee reports to the CEO instead of to the Board. Due to these possible reporting biases, we do not include the *Reports to Board* variable our RMI. However, it is included in our alternative RMI measure, *Alt. RMI*, which we create to test the robustness of our results.

We obtain the *RMI* by taking the first principal component of the following five risk management variables: *CRO Executive*, *CRO-Top5*, *CRO Centrality*, *Risk Committee Experience*, and *Active Board Risk Committee* over the time period 1999-2007. As mentioned above, we create an alternative measure, *Alt. RMI*, to test the robustness of our results. We obtain *Alt. RMI* by taking the first principal component of the following seven risk management variables: *CRO Present, CRO Executive*, *CRO-Top5*, *CRO Centrality*, *Risk Committee Experience*, *Reports to Board* and *Active Board Risk Committee*.[11]

Principal component analysis effectively performs a singular value decomposition of the correlation matrix of risk management categories measured over time. The single factor selected in this study is the eigenvector in the decomposition with the highest eigenvalue. The main advantage of using principal component analysis is that we do not have to subjectively eliminate any categories, or make subjective judgements regarding the relative importance of these categories. In each of the three RMI specifications, we find that the most important component is the *CRO Centrality*.[12]

[11] In unreported tests, we verify that our results are also robust to a third measure, *Alt. RMI 2*, which we obtain by taking the first principal component of the following six risk management variables: *CRO Executive*, *CRO-Top5*, *CRO Centrality*, *Risk Committee Experience*, *Active Risk Committee*, and *Experienced Board*.

[12] *CRO Centrality* is the single factor identified by the principal components methodology that captures the maximum variation of all the variables used, whether we use five, six or seven variables. The principal components analysis performs a singular value decomposition of the correlation matrix of the variables

3 Descriptive Statistics and Preliminary Results

3.1 Descriptive Statistics

We present summary statistics of the key risk management variables and financial variables for the BHCs in our panel in Table I. The overall panel includes 100 BHCs and spans the time period 2000-08; each observation corresponds to a BHC-year combination. However, information on risk management characteristics and standard deviation of stock returns is only available for the 74 BHCs that are publicly listed.

[Insert Table I here]

The summary statistics on *Downside Risk* indicate that the mean implied volatility estimated from put options written on BHC stocks has a sample average of 0.397, and a median of 0.350. The mean of 0.025 on *Tail Risk* indicates that the mean return on the average BHC stock on the 5% worst days for the S&P500 during the year is -2.5%. The mean of 0.038 on *Aggregate Risk* indicates that the standard deviation of weekly excess return on the average BHC's stock during the year is 3.8%. As can be seen, the average annual return on a BHC stock during our sample period is 4.6%. However, this variable is highly variable: the BHC at the 25^{th} percentile cutoff had an annual return of -12.1%, while the BHC at the 75^{th} percentile cutoff had an annual return of 21.5%.

The summary statistics on *RMI* indicate that our index is not highly skewed, and does not suffer from the presence of outliers. The mean and median values of *RMI* are 0.451 and 0.410, respectively, and the standard deviation is modest in comparison to the mean.

Examining the descriptive statistics regarding the components of RMI, we find that a designated Chief Risk Officer (or an equivalent designation) was present in only 61.8% of the BHC-year observations in our sample. While this number may seem surprisingly low, it could arise because of teh reporting issues we highlighted above in Section 2.2. Therefore, we choose not to include this measure in our *RMI*.

As can be seen from the summary statistics on *CRO Executive* and *CRO Top5*, the designated CRO had an executive rank in 51.9% of BHC-year observations, and was among the top five highly-paid executives in only 19.5% of BHC-year observations. As we explained in Section 2.2, these variables are less subject to reporting bias when compared with the *CRO Present* variable. The summary statistics on the *CRO Centrality* variable indicate that, on average, the CRO's total compensation was 32.4% that of the CEO's total compensation.

measured over the period of time in our analysis. *CRO Centrality* is the eigenvector in the decomposition with the highest eigenvalue (with a value of 0.52).

The mean value of 0.232 on *Risk Committee Experience* indicates that, in around 77% of BHC-year observations, not even one of the grey or independent directors on the board's risk committee had any prior banking experience. As the summary statistics on the *Freq. Meetings: Risk Committee* variable indicate, the board risk committee meets 5.052 times each year on average, although a number of banks have risk committees that meet much more frequently, some even twice or more every quarter (the 75^{th} percentile cutoff for this variable is 8). We classify a BHC as having an *Active Risk Committee* during a given year if the frequency with which its board risk committee met during the year was higher than the average frequency across all BHCs during the year. By this classification, 46.2% of BHCs in our sample had active board risk committees.

We also examine the banking/ financial industry experience of all the grey or independent directors on the BHC's board of directors. As can be seen from the summary statistics on *Frac. Experienced Directors*, in the average BHC in our sample, only 22.5% of the non-inside directors have prior banking or financial industry experience. We classify a BHC as having an *Experienced Board* if *Frac. Experienced Directors* for the BHC is higher than the average value across all BHCs during the year. By this definition, 48.2% of BHCs in our sample have boards with a high level of banking or financial industry experience. The mean of 0.518 on *Report to Board* indicates that the principal management-level risk committee reported directly to the board of directors (instead of the CEO) in 51.8% of BHC-year observations.

The size distribution of BHCs, in terms of the book value of their assets, is highly skewed. Total assets vary from $387 million at the lower end to over $2 trillion at the higher end. The median BHC had assets with book value of $12.4 billion, while the average BHC had assets with book value of $86 billion. Given the skewness of the size distribution we use the logarithm of the book value of assets, denoted *Size*, as a proxy for BHC size in all our empirical specifications.

On average, deposits constitute 66% of liabilities plus equity, and loans constitute 61% of the assets. In terms of the health of the loan portfolio, the average BHC has 0.7% of its assets in 'bad' or non-perfoming loans, i.e., non-accrual loans and loans that are 90 days past due and still accruing. As can be seen from the summary statistics on *UW Assets/Assets* and *Ins. Assets/Assets*, subsidiaries engaged in underwriting or dealing securities, on average, constitute 1.3% of the total assets of the BHC, while subsidiaries engaged in insurance, on average, constitute 0.8% of the total assets of the BHC.

As can be seen from the summary statistics on *Deriv. Hedging/Assets* and *Deriv. Trading/Assets*, there is a great deal of variation among BHCs in terms of their use of derivatives for hedging purposes, and their trading of derivatives. The median BHC uses derivatives for

hedging that amount to only 3% of its assets, and does not hold any derivatives for trading purposes. However, there are a few BHCs that have very large exposures to derivatives, especially for purposes other than hedging.

In terms of governance characteristics, the average BHC had 46.8% of its shares held by institutional investors, and had a G-index of 9.62. We must note that there is a clear time-trend in these two variables, with the institutional ownership increasing through our sample period, and the G-index improving over the same period.

3.2 Correlations among key variables

In Table II, we list the correlations among the key variables used in our analysis.

[Insert Table II here]

Panel A lists the pair-wise correlations between our risk measures, RMI and BHC financial characteristics. All three risk measures are negatively correlated with RMI_{t-1}, although the correlation is strongest for *Downside Risk*. All three risk measures are negatively correlated with the profitability measure, *ROA*, and with the Tier-1 capital ratio, which is consistent with the idea that profitable banks and well-capitalized banks take lower risks. The correlation between the risk measures and $Bad\ Loans/Assets_{t-1}$ is strongly positive, which indicates that BHCs with a high proportion of non-performing loans are more risky. On the other hand, the negative correlation between the risk measures and $(Non\text{-}int\ income/Income)_{t-1}$ indicates that BHCs with more diversified sources of income are less risky.

Consistent with the idea that, in the presence of deposit insurance, institutional investors have incentives to take on higher risks (Saunders et al. (1990)), we find a strong positive correlation between the risk measures and *Inst. Ownership*. The correlation between the risk measures and the CEO's Delta is also positive, which is surprising because greater exposure to the bank's equity should make the CEO more risk averse. Not surprisingly, we find a positive correlation between CEO's Vega and the risk measures.

We must, however, caution against over-interpreting the results from Panel A because these are simple pair-wise correlations that do not take into account other BHC characteristics.

Panel B lists the correlations between our risk measures and the various components of the RMI. As can be seen, the correlations between our risk measures and the index components are mostly negative. The negative correlations are the strongest in case of *Downside*

Risk. It should also be noted that, among all the RMI components, *CRO Centrality* has the strongest negative correlation with *Tail Risk* and *Aggregate Risk*, and has the second strongest negative correlation with *Downside Risk*.

We now proceed to our multivariate analysis where we examine the relationship between BHC risk measures and RMI after controlling for important BHC characteristics.

4 Empirical Results

4.1 RMI and performance during crisis years

In motivating our paper, we cited the Senior Supervisors Group (2008) report which suggested that institutions with stronger risk management functions fared better in the early months of the crisis. So it is natural to begin our analysis by asking whether BHCs that had stronger internal risk controls in place before the onset of the financial crisis were more judicious in their exposure to risky investments and fared better during the crisis years, 2007 and 2008. Accordingly, we begin by investigating the univariate relationship between the BHC's RMI in the years prior to the onset of the financial crisis and the enterprise-wide risk during the crisis years. For each BHC, we calculate the average value of its RMI over the period 2003-2006 as a measure of the strength of its risk management function in the years before the onset of the financial crisis. We then plot the relationship between the actual and fitted values of the BHCs' average downside risk during the crisis years (2007–08) versus their pre-crisis RMI in Figure 1.[13]

[Insert Figure 1 here]

This univariate test reveals a clear and statistically significant negative relationship between pre-crisis RMI and downside risk during the financial crisis years, providing the first preliminary indication that BHCs with stronger risk controls in place before the onset of the financial crisis had lower enterprise-wide risk during the crisis years. To investigate this further, we examine how downside risk varied with pre-crisis *CRO Centrality*, which we obtain by taking the average of *CRO Centrality* over the period 2003–2006. We choose CRO centrality for this investigation because the principal component analysis revealed this to be a key constituent of the RMI. We then plot the relationship between the actual and

[13]The fitted values are the predicted values obtained from an OLS regression of BHCs' average downside risk during the crisis years on a constant and the pre-crisis RMI. The t-statistic of the coefficient estimate is -2.25. We obtain similar results when we use alternative measures of risk (*Tail Risk* or *Aggregate Risk*), or when we use just the 2006 RMI instead of the average RMI across 2003–2006.

fitted values of the BHCs' average downside risk during the crisis years (2007–2008) versus their pre-crisis RMI in Figure 2.[14]

[Insert Figure 2 here]

Our findings in Figure 2 are consistent with what we found in Figure 1: BHCs with powerful CROs in the years before the onset of the financial crisis had lower downside risk during the crisis years.

Following the univariate tests, we proceed to we estimate cross-sectional regressions only for the crisis years, 2007 and 2008, that are of the following form:

$$Y_{j,t} = \alpha + \beta * \text{RMI}_{j,2006} + \boldsymbol{\gamma} * X_{j,2006} + \text{Year FE} \tag{1}$$

In the above equation, subscript 'j' denotes the BHC and 't' denotes the year. Our main independent variable of interest is the BHC's risk management index in 2006, $RMI_{j,2006}$. We choose RMI in 2006 as the independent variable because institutions with strong risk controls would have identified risks and started taking corrective actions as early as in 2006, when it was easier to offload holdings of mortgage-backed securities and CDOs, and was relatively cheaper to hedge risks. We also control for BHC characteristics at the end of calendar year 2006.[15] The results of our estimation are presented in Table III. We include 2007 and 2008 year dummies in all specifications. The standard errors are robust to heteroskedasticity and are clustered at the BHC level.

[Insert Table III here]

In Column (1), we examine whether BHCs with stronger risk controls in 2006 had lower exposure to mortgage-backed securities during the crisis years, 2007 and 2008. The dependent variable, *Private MBS*, denotes the total value of private-label mortgage-backed securities (in $ million) held in both trading and investment portfolios; i.e., we exclude mortgage-backed securities that are either issued or guaranteed by government sponsored enterprises (GSEs), because these are less risky. We are interested in exposure to mortgage-backed securities because the financial crisis was itself triggered by a housing crisis in the U.S., and there was considerable uncertainty regarding the true values of these securities

[14] The fitted values are the predicted values obtained from an OLS regression of BHCs' average downside risk during the crisis years on a constant and the pre-crisis CRO Centrality. The t-statistic of the coefficient estimate is -2.88.

[15] We obtain qualitatively similar results when we use lagged BHC characteristics, instead of 2006 characteristics, as control variables.

during 2007 and 2008. The coefficient on RMI_{2006} in Column (1) is negative, suggesting that BHCs with stronger risk controls in place before the crisis had lower exposure to private-label mortgage-backed securities during the crisis years.

The dependent variable in Column (2) is *Risky Trading Assets*, which is the book value of assets in the BHC's trading portfolio, after excluding relatively safe securities such as U.S. Treasury securities, U.S. government obligations, securities issued by states and political subdivisions in the U.S, and securities issued or guaranteed by GSEs. The negative and significant coefficient on RMI_{2006} in Column (2) indicates that BHCs with stronger risk controls in place before the crisis hit had lower exposure to risky trading assets during the crisis years.

In Column (3), we examine the off-balance sheet derivative trading activities of BHCs during the crisis years. The dependent variable is *Deriv. Trading*, which is the gross notional amount (in $ billion) of derivative contracts held for trading. The negative and significant coefficient on RMI_{2006} indicates that BHCs with stronger risk controls also had lower exposure to off-balance sheet derivative trading activity during the crisis years.

The dependent variable in Column (4) is *Bad Loans/Assets*, where *Bad Loans* include loans past due 90 days or more and non-accrual loans. Thus, *Bad Loans/Assets* is a measure of the health of the BHC's loan portfolio. The negative coefficient on RMI_{2006} indicates that BHCs with stronger risk controls before the crisis hit had relatively healthier loan portfolios during the crisis years. The dependent variable in Column (5) is ROA, which is the ratio of income before extraordinary items to total assets. As the insignificant coefficient on RMI_{2006} indicates, we fail to find any evidence that BHCs with high RMI in 2006 were more profitable during the crisis years.

In Columns (6), we examine whether BHCs with strong internal risk controls experienced better stock return performance during the crisis years. The dependent variable in this regression is the annual return on the BHC's stock. As can be seen, while the coefficient on RMI_{2006} is positive, it is not statistically significant.

In Columns (7) and (8), we examine two measures of enterprise-wide risk. The dependent variable in Column (7) is *Aggregate Risk*, which is estimated as the standard deviation of weekly excess return on the BHC's stock during the calendar year. The dependent variable in Column (8) is *Downside Risk*, which is the mean implied volatility estimated using put options written on the BHC's stock. Accordingly, the sample for the regression in Column (8) is smaller because it only includes those BHCs with tradable put options. The negative and significant coefficient on RMI_{2006} in Column (8) indicates that BHCs with strong internal risk controls had lower downside risk during the crisis years. As opposed to this, the coefficient on RMI_{2006} in Column (7) while negative is not statistically significant.

Overall, the results in Table III are broadly supportive of the argument in the Senior Supervisors Group (2008) report that BHCs with strong and independent risk management functions in place before the onset of the financial crisis, were more judicious in their risk exposures, and fared better during the crisis years. We must reiterate that the regressions in Table III are simple cross-sectional regressions that are confined to the crisis years, and do not control for unobserved heterogeneities across BHCs. However, these results do indicate that internal risk controls could have an impact on the risk taking behavior of BHCs. It is natural to ask whether the results hold more generally even during non-crisis years, and whether they are robust to controlling for unobserved heterogeneity across BHCs. To address these questions, we next proceed to panel regressions where we examine a longer time span, and are able to control for unobserved heterogeneity using BHC fixed effects.

4.2 Impact of RMI on BHC Risk

In this section, we examine whether BHCs that had strong and independent risk management functions in place had lower aggregate risk and lower downside risk, after controlling for the underlying risk of the BHC's business activities. Accordingly, we estimate panel regressions that are variants of the following form:

$$\text{Risk}_{j,t} = \alpha + \beta * \text{RMI}_{j,t-1} + \gamma * X_{j,t-1} + \text{BHC FE} + \text{Year FE} \tag{2}$$

We estimate this regression on a panel that has one observation for each BHC-year combination, includes the BHCs listed in Appendix A, and spans the time period 2000–2008. In the above equation, subscript 'j' denotes the BHC and 't' denotes the year. The dependent variable is a measure of the BHC's enterprise-wide risk, while the main independent variable is its lagged RMI. We use three different measures of risk: *Downside Risk*, *Tail Risk* and *Aggregate Risk*. We include year fixed effects, as well as BHC fixed effects to control for any time-invariant unobserved BHC characteristics that might affect risk; e.g., the BHC's risk culture. The results of our estimation are presented in Table IV. In all specifications, the standard errors are robust to heterogeneity and are clustered at the individual BHC level.

We control these regressions for important BHC financial characteristics from the previous year ($X_{j,t-1}$). The definitions of all the variables we use in our analysis are listed in Appendix B. We control for the BHC's size using the natural logarithm of the book value of total assets (*Size*), for profitability using the ratio of income before extraordinary items to assets (*ROA*), and for past performance using its *Annual Stock Return*. We control for balance sheet composition using the ratios *Deposits/Assets*, *Tier-1 Cap/Assets* and *Loans/Assets*, and for the quality of loan portfolio using the ratio *Bad Loans/Assets*, where

Bad Loans include non-accrual loans and loans past due 90 days or more. We also include controls for the BHC's overall business portfolio. We proxy for the BHC's reliance on off-balance sheet activity using the ratio *Non-Int. Income/Income* (see Boyd and Gertler (1994)). The ratios *UW Assets/Assets* and *Ins. Assets/Assets* proxy for the BHC's reliance on underwriting and insurance activity, respectively.

The identifying assumption behind the panel regression (2) is that $RMI_{j,t-1}$ is exogenous, after conditioning on all the control variables ($X_{j,t-1}$) and BHC fixed effects. This assumption may not be valid if some time-varying omitted variable affects both the RMI and the BHC's risk in the subsequent year, or if the relationship between risk and RMI is dynamically endogeneous; i.e., if causation between risk and RMI runs in both directions such that past values of risk may affect both current risk and RMI. As far as possible, we attempt to mitigate the omitted variable bias by controlling for other BHC characteristics that are likely to be related to BHC Risk. These include institutional characteristics such as *Inst. Ownership* and quality of governance (*G-Index*), CEO compensation characteristics (*CEO's Delta* and *CEO's Vega*), and the BHC's reliance on derivatives for hedging (*Deriv Hedging/Assets*) and trading purposes (*Deriv Trading/Assets*). In Section 4.4, we estimate a dynamic panel GMM estimator to directly control for the dynamic endogeneity problem.

Impact on Downside Risk

In Panel A, we report the results of regressions with *Downside Risk*, which denotes the mean implied volatility estimated from put options written on the BHC's stock, as the dependent variable. Accordingly, the sample for this regression only includes BHCs that have tradable put options which we can use to estimate implied volatility.

[Insert Table IV here]

As can be seen, the coefficient on RMI_{t-1} in Column (1) is negative and statistically significant at the 5% level, which indicates that BHCs that had strong internal risk controls in place in the previous year have lower downside risk in the current year. In terms of economic significance, the coefficient of -0.359 on $RMI_{j,t-1}$ indicates that a one standard deviation increase in RMI is associated with a decrease of 0.074 in downside risk, which is equivalent to a 0.43 standard deviation decrease in downside risk.

In terms of the coefficients on the control variables, we fail to detect any relationship between BHC size and downside risk. The negative coefficient on $Return_{t-1}$ indicates that well-performing BHCs have lower downside risk; in a similar vein, the coefficient on ROA_{t-1} is negative, but is not statistically significant. The coefficient on $(Deposits/Assets)_{t-1}$ is

positive and significant, which is consistent with the argument that moral hazard induced by deposit insurance causes BHCs to take higher risks. One variable that has a strong positive relationship with downside risk is *(Bad Loans/Assets)*$_{t-1}$, which indicates that implied volatilities are higher for BHCs that have a larger fraction of non-performing loans. Finally, the negative and significant coefficients on *(UW Assets/Assets)*$_{t-1}$ and *(Ins. Assets/Assets)*$_{t-1}$ suggest that BHCs with a more diversified business portfolio have lower downside risk.

Even though we include year fixed effects, and BHC fixed effects to control for the effect of time-invariant omitted variables, it is possible that the negative association between *Downside Risk* and RMI_{t-1} in Column (1) is being driven by some time-varying omitted variable that affects both the RMI and the BHC's risk in the subsequent year. In the remaining specifications in Panel A, we attempt to rule out this explanation by explicitly controlling for other BHC characteristics that the existing literature has shown to be related to risk.

Past research has highlighted that, in the presence of deposit insurance, diversified stockholders such as institutional investors may have incentives to take on higher risk (Saunders et al. (1990), Demsetz et al. (1997), Laeven and Levine (2009)). Therefore, in Column (2), we estimate the regression after including *Inst. Ownership*$_{t-1}$, the fraction of stock owned by institutional investors, as an additional control. We also control for the BHC's overall corporate governance, using the lagged value of its G-Index. As can be seen, the coefficient on *Inst. Ownership*$_{t-1}$ is indeed positive and significant, while there is no relationship between risk and the G-index. More importantly, the coefficient on RMI_{t-1} not only remains negative and significant, but actually becomes larger in magnitude when compared with Column (1).

In Column (3), we attempt to proxy for the time-varying omitted risk characteristics by including two new ratios, *Deriv Hedging/Assets*$_{t-1}$ and *Deriv Trading/Assets*$_{t-1}$, which measure the BHC's reliance on derivatives for hedging purposes and trading, respectively. The idea here is that if a BHC changes its risk exposure or the way it manages risk, it should be captured by these two additional ratios. As can be seen, the coefficient on *Deriv Hedging/Assets*$_{t-1}$ is negative and significant, which indicates that BHCs that rely more on derivatives for hedging have lower downside risk. More importantly, the coefficient on RMI_{t-1} continues to be negative and significant.

It is commonly argued in the popular press that bank CEO compensation packages have contributed to higher risk taking.[16] In Column (4), we repeat our regression after controlling

[16]However, the findings in the empirical literature in this regard are somewhat mixed. Examining bank behavior during the period 1992–2002, Mehran and Rosenberg (2007) find that equity volatility and asset volatility of banks increase as their CEO stock option holdings increase. However, examining the behavior

for the following characteristics of CEO compensation: *CEO Delta*, which is the sensitivity of the CEO's compensation to stock price; and *CEO Vega*, which is the sensitivity of compensation to stock return volatility (see Core and Guay (1999)). This lowers our sample size significantly, because the ExecuComp database, from which we obtain information on CEO compensation, does not cover all the BHCs in our sample. As can be seen, while the coefficient on $CEO\ Delta_{t-1}$ is negative, suggesting that a large equity component in the CEO's compensation is associated with lower risk, it is not statistically significant. More importantly, the inclusion of CEO compensation characteristics only strengthens the negative coefficient on RMI_{t-1}.

In Column (5), we repeat our estimation in Column (4) with an alternative index of the strength of risk management, *Alt.* RMI_{t-1}. The negative and significant on *Alt.* RMI_{t-1} highlights that our result is robust to our definition of RMI.

Overall, the results in all the columns of Panel A indicate that BHCs with strong internal risk controls in place in the previous year have lower downside risk in the current year.

Impact on Tail Risk

In Panel B, we present the results of regressions aimed at understanding how the BHC's tail risk varies with its RMI. We do this by using a measure of tail risk proposed by Acharya et al. (2009), *MES*, as our dependent variable. Recall that, in any calendar year, the *MES* is defined as the negative of the average return on the BHC's stock over the 5% worst days for the S&P500. Thus, it is a measure of the BHC's Tail-β. The empirical specification and control variables are exactly the same as in Panel A. The negative and significant coefficient on $RMI_{j,t-1}$ in Column (1) indicates that BHCs that had strong and independent risk management functions in place in the previous year have lower tail risk in the current year. In terms of economic significance, a one standard deviation increase in $RMI_{j,t-1}$ is associated with a decrease of 0.015 in tail risk, which is equivalent to a 0.62 standard deviation decrease in tail risk.

The coefficients on the control variables are somewhat different from those in Panel A. In particular, the coefficient on $Size_{t-1}$ is negative, which indicates that larger BHCs were exposed to greater tail risk. On the other hand, the coefficient on $(Bad\ Loans/Assets)_{t-1}$ is insignificant, which means that tail risk is not related to the fraction of non-performing loans on the BHC's balance sheet. The tail risk also does not seem to depend on institutional ownership or derivative usage for hedging, factors which were significantly related to downside risk.

of banks during the crisis period, Fahlenbrach and Stulz (2009) find that option compensation did not have an adverse impact on bank performance.

As in Panel A, the negative association between $RMIj, t-1$ and tail risk is robust to controlling for institutional ownership, governance and derivative usage. However, the negative coefficient on $RMIj, t-1$ becomes statistically insignificant at conventional levels of significance (the p-value is 0.19) once we condition on the CEO's compensation characteristics. As can be seen from Column (4), there is a strong negative association between tail risk and CEO's Delta; i.e., banks whose CEO's have a high equity component in their compensation package have lower tail risk. When we repeat our estimation with an alternative index of the strength of risk management, *Alt.* RMI_{t-1}, we find that the negative association between RMI and tail risk is also robust to controlling for the CEO's compensation characteristics (see Column (5)).

Impact on Aggregate Risk

In Panel C, we present the results of regressions aimed at understanding how the BHC's aggregate risk varies with its RMI. The dependent variable in these regressions is *Std. Dev. Excess Return*. The empirical specification and control variables are exactly the same as in Panel A. The negative and significant coefficient on $RMI_{j,t-1}$ in Column (1) indicates that BHCs that had strong internal risk controls in place in the previous year have lower aggregate risk in the current year.

The coefficients on the control variables are similar to those in Panel A. There is no relationship between size and aggregate risk, while well-performing BHCs have lower aggregate risk (negative and significant coefficients on ROA_{t-1} and $Return_{t-1}$). Although the coefficient on $(Bad\ Loans/Assets)_{t-1}$ is positive, it is not statistically significant in all specifications. The positive coefficient on *Inst. Ownership* suggests that BHCs with high institutional ownership have more volatile stock returns. The main difference compared to the earlier panels is the negative and significant coefficient on $CEO\ Vega_{t-1}$, which suggests that banks whose CEO compensation is highly sensitive to stock volatility have lower aggregate risk.

The negative association between RMI_{t-1} and $Aggregate\ Risk_t$ is robust to controlling for institutional ownership, CEO's compensation characteristics, and the BHC's G-Index. The negative association is also robust to alternative definitions of the index (Column (5). Overall, the findings in Panel C indicate that BHCs with strong internal risk controls in place have lower aggregate risk. In terms of economic significance, the coefficient of -0.071 on RMI_{t-1} in Column (4) indicates that a one standard deviation increase in RMI is associated with a decrease of 0.015 in aggregate risk, which is equivalent to a 0.6 standard deviation decrease in aggregate risk.

4.3 How does the impact of RMI on risk vary with BHC characteristics?

In our next set of tests, we interact the RMI variable with key BHC characteristics, such as size and profitability, to understand how the impact of RMI on risk varies with these BHC characteristics. The empirical specification and control variables we employ are exactly the same as in Column (1) of Table IV. However, to conserve space, we do not report the coefficients on control variables all over again. We also restrict our analysis to downside risk and aggregate risk only. The results of our estimation are presented in Table V.

[Insert Table V here]

In Columns (1) and (2), we examine how the effect of RMI on downside risk and aggregate risk varies with the size of the BHC. The idea is to see if a strong and independent risk management function matters more in large BHCs that are more likely to have multiple subsidiaries and multiple business segments. Given the highly skewed size distribution of BHCs that we highlighted in Table I, we define the dummy variable *Large BHC* to identify, in each year, the BHCs that are in the top decile in terms of their book value of assets. We then estimate the panel regression (2) after including *Large* BHC_{t-1} and *Large* BHC_{t-1}*RMI_{t-1} as additional regressors. The negative and significant coefficients on *Large* BHC_{t-1}*RMI_{t-1} in Columns (1) and (2) indicate that the effect of RMI in lowering downside risk and aggregate risk is stronger in large BHCs.

In Columns (3) and (4), we examine how the impact of RMI varies with the profitability of the BHC. We define the dummy variable *Low ROA BHC* to identify, in each year, BHCs that are in the lowest quartile in terms of their *ROA*. The positive and significant coefficient on *Low ROA* BHC_{t-1}*RMI_{t-1} in Column (3) indicates that the effect of RMI in lowering downside risk is weaker in BHCs with low profitability. We do not detect a similar effect with respect to aggregate risk, as the coefficient on the interaction term in Column (4) is not statistically significant.

In Columns (5) and (6), we examine how the impact of RMI varies with the BHC's reliance on deposits to fund itself. There are two possible ways in which the effect might vary. On the one hand, BHCs that have a low deposits to assets ratio tend to be those with a presence in a wide variety of financial activities apart from traditional banking, such as asset management, underwriting, and insurance. Hence, the effect of RMI in lowering risk should be stronger at such institutions. On the other hand, if deposit insurance induces BHCs to take on more risks, then the impact of RMI should be felt more strongly at BHCs that rely heavily on deposits. To test these hypotheses, we define the dummy variable *Low Deposits BHC* to identify, in each year, BHCs that are in the lowest quartile in terms of their

deposits to assets ratio. Consistent with the former interpretation, the coefficient on *Low Deposits* BHC_{t-1}*RMI_{t-1} in Column (6) is negative and significant, which suggests that the impact of RMI in lowering aggregate risk is stronger at institutions that rely relatively less on deposits for their funding. The coefficient on the interaction term in the downside risk regression in Column (5), while negative, is not significant.

In Columns (7) and (8), we examine whether the impact of RMI in lowering risk is stronger in BHCs that are more active in trading derivatives off-balance sheet. Accordingly, we define the dummy variable *High Deriv. Trading BHC* to identify, in each year, BHCs that are in the top quartile in terms of the *Deriv. Trading/Assets* ratio. While the coefficient on *High Deriv. Trading* BHC_{t-1}*RMI_{t-1} in Column (7) is negative, which is consistent with our hypothesis, it is not statistically significant at conventional levels of significance. We also find no evidence that the impact of RMI on aggregate risk varies with the BHC's derivative trading activity.

4.4 Adjusting for Dynamic Endogeneity

As we noted earlier, the identifying assumption behind the panel regression model (2) is that RMI_{t-1} is exogenous, after controlling for the BHC's financial characteristics, ownership, governance, executive compensation, BHC and year fixed effects. This allows us to interpret the coefficient on RMI_{t-1} as signifying the impact of RMI_{t-1} on $Risk_t$. However, our identifying assumption may not be valid if some unobserved time-varying omitted variable jointly affects both RMI and risk, or if the relationship between RMI and risk is *dynamically endogenous*; i.e., causation runs both ways, such that a BHC's past risk determines both current RMI and current risk (see Wintoki et al. (2010) for a discussion of dynamic endogeneity in a corporate finance setting).

In the context of our paper, dynamic endogeneity could arise in two different ways. The first possibility, which we refer to as the *endogenous choice hypothesis* is that BHCs exposed to greater risk endogenously choose stronger internal risk controls. If this hypothesis is true, it should bias against us finding a negative association between BHC Risk and RMI. Alternatively, it could be that the BHC's underlying risk culture determines both the choice of the risk and the strength of the risk management system; i.e., conservative BHCs take lower risks and put in place stronger risk management systems, while aggressive BHCs take higher risks and also have weaker internal risk controls. In this case, dynamic endogeneity will arise because past risk will itself be a proxy for the unobserved risk culture that affects both RMI and future risk. If the *risk-culture hypothesis* is correct, it will tend to exaggerate the positive association between BHC risk and RMI.

The difficulty in dealing with dynamic endogeneity is that we do not have any exogenous

instruments that we can use to consistently identify the impact of RMI on risk, because any observable variable that affects RMI also affects risk. In this section, we use a dynamic panel GMM estimator developed by Arellano and Bond (1991), that enables us to use the information from the BHC's history, in the form of lags of risk and other BHC characteristics, to provide instruments for identifying the relationship between RMI and risk. Specifically, we estimate the following dynamic model:

$$\text{Risk}_{j,t} = \alpha + \beta * \text{RMI}_{j,t-1} + \kappa_1 \text{Risk}_{j,t-1} + \kappa_2 \text{Risk}_{j,t-2} + \gamma * X_{j,t-1} + \eta_i + \epsilon_{it} \qquad (3)$$

Observe that model (3) employs two lags of the risk measure as regressor variables. This means that historical risk measures and BHC characteristics that are lagged three periods or more are available for use as exogenous instruments. The estimation of the model itself involves two steps: (i) first-differencing equation (3) to eliminate the unobserved η_i; and (ii) estimating the first-differenced equation via GMM using lagged values of risk and other BHC characteristics as possible instruments.

[Insert Table VI here]

The results of our estimation are presented in Table VI. The dependent variable in Columns (1) and (2) is *Downside Risk*. In Column (2), we employ the full set of control variables that we employed in Column (4) of Table IV, while in Column (1), we employ all the control variables with the exception of the CEO's Delta and Vega. As can be seen, the coefficient on RMI_{t-1} continues to be negative and significant. In each column, we also present the results of the Sargan test for the validity of instruments employed in the model. The Sargan test yields a statistic which is distributed χ^2 under the null hypothesis of the validity of our instruments. The p-values of 0.142 and 0.607 in Columns (1) and (2) indicate that we cannot reject the null hypothesis that our instruments are valid.

In Columns (3) and (4), we repeat the estimation with *Tail Risk* and *Aggregate Risk* as the dependent variable, respectively. The empirical specification is the same as in Column (2). The negative coefficients on RMI_{t-1} in both columns indicates that BHCs with strong internal risk controls have lower risk, even after controlling for the dynamic endogeneity between risk and RMI. The Sargan p-values of 0.432 and 0.474 in Columns (3) and (4) indicate that we cannot reject the null hypothesis that our instruments are valid.

4.5 Impact of RMI on BHC stock returns

So far, we have shown that BHCs with strong internal risk controls have lower enterprise-wide risk, regardless of the risk measure employed. In this section, we examine if the stock

market rewards or penalizes BHCs that have strong internal risk controls. If strong internal risk controls cause the BHC to forgo profitable but risky activities like asset management or derivatives trading, then it is possible that the stock returns are lower for BHCs with high RMI. On the other hand, if strong risk controls can help a BHC avoid taking on excessive idiosyncratic risk, then the stock market should reward BHCs with high RMI. To test these hypotheses, we estimate the panel regression (2), with the annual return on the BHC's stock as the dependent variable, and the lagged value of RMI as the main independent variable. The empirical specification and control variables are exactly the same as in Table IV. The results of our estimation are presented in Table VII.

[Insert Table VII here]

The positive and statistically significant coefficient on RMI_{t-1} in Column (1) indicates that BHCs with strong internal risk controls in place in the previous year had higher stock returns in the current year. In terms of economic significance, the coefficient estimate indicates that a one standard deviation increase in RMI is associated with a 19.6% increase in annual stock return. While the magnitude of this increase in annual returns seems very large, we must note that annual returns are highly variable in our sample, so that the 19.6% increase corresponds to a 0.7 standard deviation increase in annual stock return.

The positive association between RMI_{t-1} and *Annual Return*$_t$ is robust to controlling for the BHC's institutional ownership and corporate governance. However, the coefficient on RMI_{t-1} loses statistical significance once we control for the CEO's compensation characteristics in Column (3). In this specification, we find that *CEO's Delta* becomes strongly positively significant, indicating that the annual returns are higher for BHCs whose CEOs have a large equity component in their compensation.

In Column (4), we estimate the Arellano-Bond specification to adjust for any dynamic endogeneity between stock return performance and strength of internal risk controls. The empirical specification is similar to what we employed in Table VI. As can be seen, the coefficient on RMI_{t-1} in Column (4) is positive and significant. Moreover, the Sargan p-value of 0.269 means that we cannot reject the hypothesis of validity of our instruments.

5 Conclusion

A prominent explanation for why many banks took excessive risks in the lead up to the financial crisis is that there was a failure of risk management functions at these banks. It is suggested that risk managers at banks either failed to identify or correctly measure risks,

or failed to communicate risk exposures to their top management, or failed to monitor or manage risks adequately. As a result, they could not restrain traders and bank executives who, given their high-powered pay-for-performance schemes, had incentives to take excessive risks.

In this paper, we examine the organizational structure of the risk management function at bank holding companies (BHCs) in the United States, and the effect it had on BHC risk. The question we ask is whether BHCs with strong and independent risk controls in place had lower enterprise-wide risk. To this end, we construct an innovative risk management index that measures the strength and independence of the risk management function at each BHC, among the 74 largest publicly-listed BHCs.

We first show that BHCs with stronger risk controls in place before the onset of the financial crisis (i.e., higher levels of RMI in 2006) were more judicious in their risk taking, and fared relatively better during the crisis years. Specifically, such BHCs had lower exposure to private-label mortgage-backed securities and trading assets, were less active in trading off-balance sheet derivative securities, had a smaller fraction of non-performing loans, and had lower downside risk during the crisis years, 2007 and 2008.

We then show that the relationship between the strength of internal risk controls and enterprise-wide risk is not just confined to the crisis period, but also holds more generally during normal times. Examining a panel spanning the 9 year period from 2000–2008, we find that BHCs with stronger internal risk controls in the previous year have lower downside risk, lower tail risk, and lower aggregate risk in the current year. These results are obtained after controlling for various BHC characteristics like size, profitability, asset and liability composition including capital ratios, other risk characteristics, executive compensation, corporate governance, and BHC fixed effects. The results are also robust to controlling for any dynamic endogeneity between risk and internal risk controls.

Taken together, our results support the view that strong internal risk controls do matter, and play an important role in lowering enterprise-wide risk at banking institutions. One important policy recommendation that follows from our analysis is that bank supervisors should more closely monitor the effectiveness of internal risk controls at banking institutions.

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Appendix A: List of BHCs in our sample

Name of BHC	2007 Assets ($ bn)	Time span in panel
CITIGROUP INC.	2188	2000-2008
BANK OF AMERICA CORPORATION	1721	2000-2008
JPMORGAN CHASE & CO.	1562	2000-2008
WACHOVIA CORPORATION	783	2000-2007
WELLS FARGO & COMPANY	575	2000-2008
METLIFE, INC.	559	2002-2008
BARCLAYS GROUP US INC.	344	2005-2008
U.S. BANCORP	238	2000-2008
SUNTRUST BANKS, INC.	180	2000-2008
CAPITAL ONE FINANCIAL CORPORATION	151	2005-2008
NATIONAL CITY CORPORATION	150	2000-2007
STATE STREET CORPORATION	143	2000-2008
REGIONS FINANCIAL CORPORATION	141	2005-2008
PNC FINANCIAL SERVICES GROUP, INC., THE	139	2000-2008
BB&T CORPORATION	133	2000-2008
FIFTH THIRD BANCORP	111	2000-2008
KEYCORP	100	2000-2008
BANCWEST CORPORATION	74	2001-2008
NORTHERN TRUST CORPORATION	68	2000-2008
M&T BANK CORPORATION	65	2000-2008
COMERICA INCORPORATED	63	2000-2008
UnionBancal Corp	56	2000-2008
HUNTINGTON BANCSHARES INCORPORATED	55	2000-2008
ZIONS BANCORPORATION	53	2000-2008
COMMERCE BANCORP, INC.	49	2000-2007
POPULAR, INC.	44	2000-2008
FIRST HORIZON NATIONAL CORPORATION	37	2000-2008
SYNOVUS FINANCIAL CORP.	33	2000-2008
NEW YORK COMMUNITY BANCORP, INC.	31	2000-2008
COLONIAL BANCGROUP, INC., THE	26	2000-2008
ASSOCIATED BANC-CORP	22	2000-2008
BOK Financial Corp	21	2000-2008
W HOLDING COMPANY, INC.	18	2000-2008
WEBSTER FINANCIAL CORPORATION	17	2005-2008
FIRST BANCORP	17	2000-2008
FIRST CITIZENS BANCSHARES, INC.	16	2000-2008
COMMERCE BANCSHARES, INC.	16	2000-2008
TCF FINANCIAL CORPORATION	16	2000-2008
FULTON FINANCIAL CORPORATION	16	2000-2008

Continued on next page...

Name of BHC	2007 Assets ($ bn)	Time span in panel
CITY NATIONAL CORPORATION	16	2000-2008
SOUTH FINANCIAL GROUP, THE	14	2000-2008
CULLEN/FROST BANKERS, INC.	14	2000-2008
CITIZENS REPUBLIC BANCORP, INC.	14	2000-2008
BANCORPSOUTH, INC.	13	2000-2008
SUSQUEHANNA BANCSHARES, INC.	13	2000-2008
VALLEY NATIONAL BANCORP	13	2000-2008
STERLING FINANCIAL CORPORATION	12	2006-2008
EAST WEST BANCORP, INC.	12	2000-2008
UCBH HOLDINGS, INC.	12	2000-2008
WILMINGTON TRUST CORPORATION	12	2000-2008
INTERNATIONAL BANCSHARES CORPORATION	11	2000-2008
WHITNEY HOLDING CORPORATION	11	2000-2008
BANK OF HAWAII CORPORATION	10	2000-2008
FIRSTMERIT CORPORATION	10	2000-2008
CATHAY GENERAL BANCORP	10	2000-2008
FRANKLIN RESOURCES, INC.	10	2002-2008
WINTRUST FINANCIAL CORPORATION	9	2000-2008
UMB FINANCIAL CORPORATION	9	2000-2008
SANTANDER BANCORP	9	2001-2008
TRUSTMARK CORPORATION	9	2000-2008
CORUS BANKSHARES, INC.	9	2000-2007
FIRSTBANK HOLDING COMPANY	9	2000-2008
UMPQUA HOLDINGS CORPORATION	8	2000-2008
NEWALLIANCE BANCSHARES, INC.	8	2005-2008
UNITED COMMUNITY BANKS, INC.	8	2000-2008
FIRST MIDWEST BANCORP, INC.	8	2000-2008
ALABAMA NATIONAL BANCORPORATION	8	2000-2007
UNITED BANKSHARES, INC.	8	2000-2008
OLD NATIONAL BANCORP	8	2000-2008
MB FINANCIAL, INC	8	2000-2008
CHITTENDEN CORPORATION	7	2000-2007
PACIFIC CAPITAL BANCORP	7	2000-2008
BOSTON PRIVATE FINANCIAL HOLDINGS, INC.	7	2000-2008
PARK NATIONAL CORPORATION	7	2000-2007

Appendix B: Definitions of key variables

BHC risk measures:

- *Aggregate Risk*: Standard deviation of the BHC's weekly excess return (i.e., weekly return on BHC stock less weekly return on the S&P500) over the year.
- *Downside Risk*: Mean implied volatility estimated from put options written on the BHC's stock.
- *Tail Risk*: This is the marginal expected shortfall (MES) measure proposed by Acharya et al. (2009). In a given year, the MES is defined as the negative of the average return on the BHC's stock during the 5% worst days for the S&P500.

BHC risk management measures:

- *CRO Present*: A dummy variable that identifies if the BHC reports that it has a designated Chief Risk Officer (or a Chief Credit Officer or a Chief Lending Officer).
- *CRO Executive*: A dummy variable that identifies if the Chief Rrisk Officer (or Chief Lending Officer or Chief Credit Officer) is an executive officer.
- *CRO-Top5*: A dummy variable that identifies if the Chief Risk Officer (or Chief Lending Officer or Chief Credit Officer) is among the five highest paid executives.
- *CRO Centrality*: Ratio of the CRO's total compensation to the CEO's total compensation. When the BHC has a CRO who does not figure among the five highest paid executives, we calculate *CRO Centrality* based on the compensation of the fifth highest-paid executive, and subtract a percentage point from the resultant ratio. In case of BHCs that do not report having a CRO, we define *CRO Centrality* based on the total compensation of the Chief Financial Officer if that is available; if CFO compensation is not available, then we compute *CRO Centrality* based on the compensation of the fifth highest-paid executive, and subtract a percentage point from the resultant ratio.
- *Risk Committee Experience*: A dummy variable that takes the value of 1 if at least one of the directors serving on the board's risk committee has prior banking experience, and 0 otherwise.
- *Freq. Meetings of Risk Committee*: The number of times the BHC's board risk committee met during the year.
- *Active Risk Committee*: A dummy variable that the value of 1 if the frequency with which the BHC's board risk committee met during the year is higher than the average frequency across all BHCs during the year, and 0 otherwise.

- *Frac. Experienced Directors*: The fraction of non-inside directors on the BHC's board of directors that have prior banking or financial industry experience.

- *Experienced Board*: A dummy variable that takes the value of 1 if *Frac. Experienced Directors* for the BHC is higher than the average value across all BHCs during the year, and 0 otherwise.

- *Reports to Board*: A dummy variable that identifies whether the key management-level risk committee (usually called the "Asset and Liability Committee") reports directly to the BHC's board of directors, instead of to the CEO.

- *RMI*: Computed as the first principal component of the following five risk management variables over the time period 1999-2007: *CRO Executive*, *CRO-Top5*, *CRO Centrality*, *Risk Committee Experience*, and *Active Risk Committee*.

- *Alt. RMI*: Computed as the first principal component of the following seven risk management variables over the time period 1999-2007: *CRO Present, CRO Executive*, *CRO-Top5*, *CRO Centrality*, *Risk Committee Experience*, *Reports to Board* and *Active Risk Committee*.

- *Alt. RMI 2*: Computed as the first principal component of the following six risk management variables over the time period 1999-2007: *CRO Executive*, *CRO-Top5*, *CRO Centrality*, *Risk Committee Experience*, *Active Risk Committee*, and *Experienced Board*.

BHC financial characteristics: The expressions within the parentheses denote the corresponding variable names in the FR Y-9C reports.

- *Size*: Natural logarithm of the book value of total assets (BHCK2170).

- *ROA*: Ratio of the income before extraordinary items (BHCK4300) to assets.

- *Deposits/Assets*: Ratio of total deposits (BHDM6631+BHDM6636+BHFN6631+BHFN6636) to assets.

- *Tier-1 Cap/Assets*: Ratio of Tier1 capital (BHCK8274) to assets.

- *Loans/Assets*: Ratio of total loans (BHCK2122) to assets.

- *Real Estate Loans/Assets*: Ratio of loans secured by real estate (BHCK1410) to assets.

- *C&I Loans/Assets*: Ratio of commercial and industrial loans (BHDM1766) to assets.

- *Consumer Loans/Assets*: Ratio of consumer loans (BHDM1975) to assets.

- *Agri. Loans/Assets*: Ratio of agricultural loans (BHCK1590) to assets.

- *Other Loans/Assets*: Ratio of all other loans to assets.

- *Loan Concentration*: Measures the concentration of the BHC's loan portfolio among the five loan segments defined above. It is computed as the sum of squares of each segment's share in the total loan portfolio.

- *Bad Loans/Assets*: Ratio of the sum of loans past due 90 days or more (BHCK5525) and non-accrual loans (BHCK5526) to assets.

- *Non-Int. Income/Income*: Ratio of non-interest income (BHCK4079) to the sum of interest income (BHCK4107) and non-interest income (BHCK4079).

- *UW Assets/Assets*: The ratio of the assets of subsidiaries engaged in underwriting or dealing securities (BHCKC252) to the total assets of the BHC.

- *Ins. Assets/Assets*: The ratio of the assets of subsidiaries engaged in insurance and reinsurance (BHCKC253) to the total assets of the BHC.

- *Private MBS*: The total value of private-label mortgage backed securities held in both trading and investment portfolios; i.e., this excludes mortgage-backed securities that are either issued or guaranteed by government sponsored enterprises. This measure is computed as summing the following variables: BHCK1709, BHCK1733, BHCK1713, BHCK1736 and BHCK3536.

- *Risky Trading Assets*: Total trading assets (BHCK3545) *less* investments in U.S. treasury securities (BHCK3531), U.S. government agency obligations (BHCK3532), securities issued by states and political subdivisions in the U.S. (BHCK3533), and mortgage backed securities issued or guaranteed by government sponsored enterprises (BHCK3534 and BHCK3535).

- *Deriv. Trading*: Total gross notional amount of derivative contracts held for trading, obtained by adding amounts on interest rate contracts (BHCKA126), foreign exchange contracts (BHCKA127), equity derivative contracts (BHCK8723), and commodity and other contracts (BHCK8724).

- *Deriv. Hedging*: Value of derivatives used for hedging purposes. Obtained by adding the following variables: BHCK8725, BHCK8726, BHCK8727 and BHCK8728.

Other BHC variables:

- *Inst. Ownership*: Percentage of shares owned by institutional investors.

- *G-Index*: Gompers, Ishii and Metrick (2003) governance index.

- *CEO's Delta*: Sensitivity of CEO compensation to share price, expressed in $ '000.

- *CEO's Vega*: Sensitivity of CEO compensation to stock return volatility, expressed in $ '000.

Figure 1. Downside Risk during crisis years vs. pre-crisis RMI

This figure plots the average *Downside Risk* of each BHC over the crisis years (2007 and 2008) versus its corresponding *pre-crisis RMI*, which is defined as the average RMI of the BHC over the period 2003–2006. The solid straight line in the figure is a plot of predicted values obtained from a regression of Downside Risk versus a constant and the pre-crisis RMI.

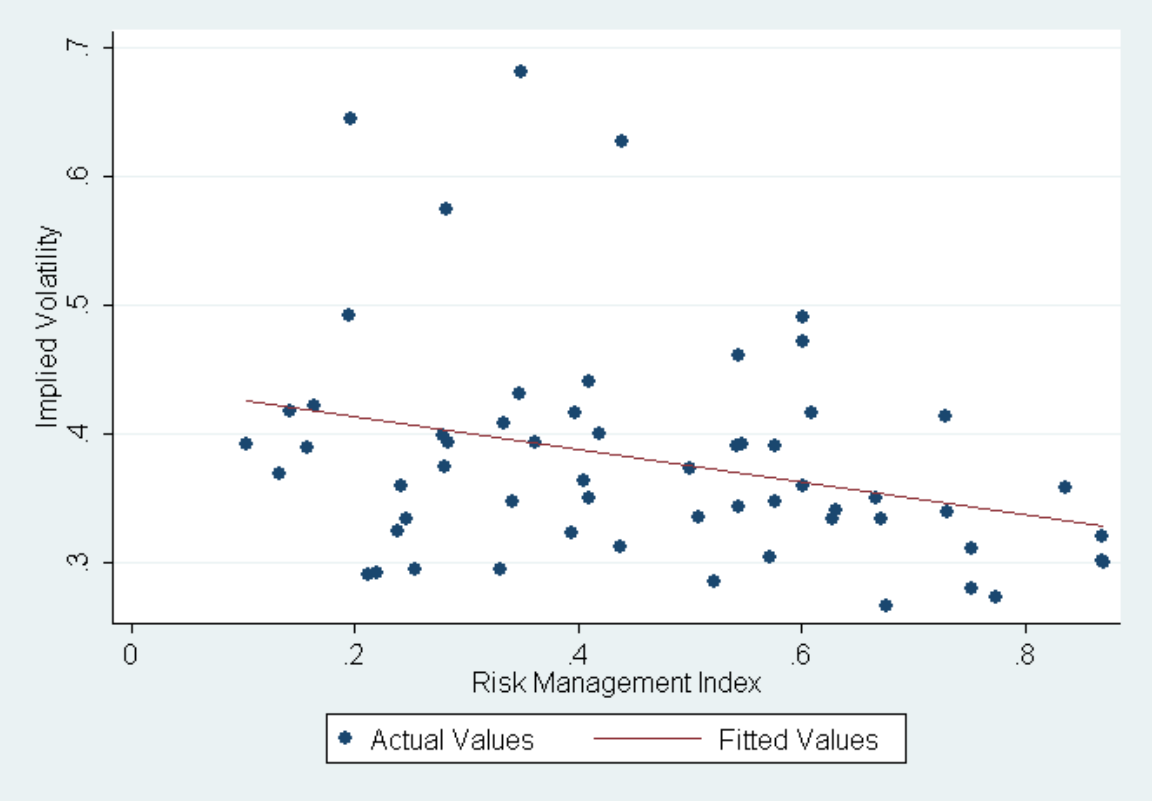

Figure 2. Downside Risk during crisis years vs. pre-crisis CRO Centrality

This figure plots the average *Downside Risk* of each BHC over the crisis years (2007 and 2008) versus its corresponding *pre-crisis CRO Centrality*, which is defined as the average CRO Centrality of the BHC over the period 2003–2006. The solid straight line in the figure is a plot of predicted values obtained from a regression of Downside Risk versus a constant and the pre-crisis CRO Centrality.

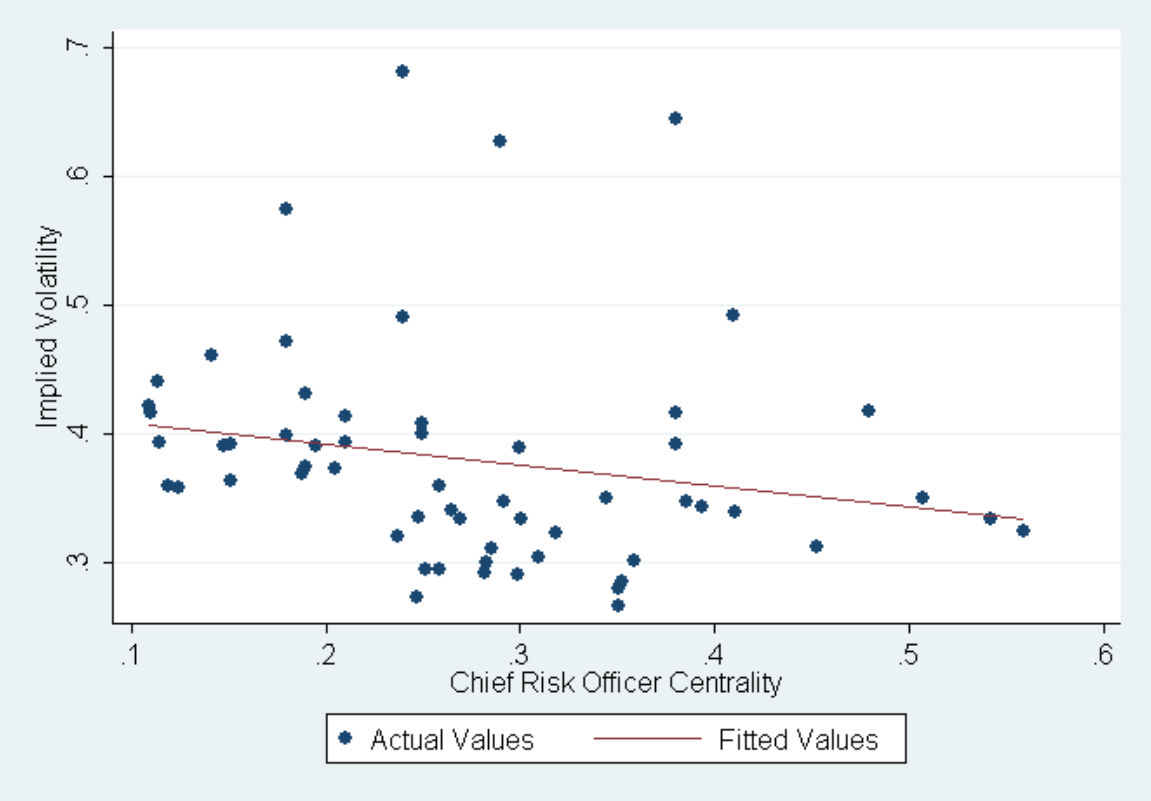

Table I: Summary Statistics

This table presents the descriptive statistics for the key variables used in our analysis. *Downside Risk* is defined as the mean implied volatility estimated from put options written on the BHC's stock. *Tail Risk* is defined as the negative of the average return on the BHC's stock over the 5% worst days for the S&P500 during the year. *Aggregate Risk* is the standard deviation of the BHC's weekly excess return (over S&P500), computed over the year. *RMI* measures the strength and independence of the risk management function at a BHC. All other variables are defined in Appendix B.

	Mean	**Median**	**Std. Dev.**	**p25**	**p75**	**N**
Downside Risk	0.397	0.350	0.172	0.281	0.451	400
Tail Risk	0.025	0.016	0.024	0.011	0.028	697
Aggregate Risk	0.038	0.031	0.024	0.022	0.044	698
Annual Return	0.046	0.046	0.293	-0.121	0.215	698
RMI	0.451	0.410	0.207	0.309	0.609	673
Alt. RMI	0.427	0.392	0.201	0.297	0.583	673
CRO Present	0.618	1	0.482	0	1	673
CRO Executive	0.519	0	0.479	0	1	673
CRO Top5	0.195	0	0.393	0	0	673
CRO Centrality	.324	.262	.182	.194	.352	673
Risk Committee Experience	.232	0	.422	0	0	673
Frac. Experienced Directors	0.225	0.217	0.092	0.200	0.360	673
Experienced Board	.482	0	.402	0	1	673
Freq. of meetings: Risk Committee	5.052	3	5.321	0	8	673
Active Risk Committee	0.462	0	0.481	0	1	673
Report to Board	0.518	1	0.500	0	1	673
Assets (in $ billion)	86.083	12.437	244.625	7.298	45.587	904
Size	16.806	16.336	1.473	15.803	17.635	904
ROA	0.010	0.011	0.013	0.008	0.014	904
Deposits/Assets	0.661	0.686	0.170	0.614	0.765	900
Tier-1 Cap/ Assets	0.077	0.074	0.040	0.065	0.084	899
Loans/ Assets	0.611	0.664	0.165	0.561	0.716	904
Bad Loans/Assets	0.007	0.005	0.010	0.003	0.008	904
Non-int Income/Income	0.235	0.211	0.131	0.148	0.298	904
UW Assets/Assets	0.013	0	0.071	0	0	904
Ins. Assets/Assets	0.008	0	0.082	0	0	904
Deriv. Hedging/Assets	0.092	0.030	0.179	0.002	0.101	904
Deriv. Trading/Assets	0.974	0.000	4.646	0	0.117	904
Inst. Ownership	0.468	0.486	0.217	0.305	0.632	625
G-Index	9.623	9	2.814	8	12	509
CEO's Delta (in $ '000)	0.011	0.004	0.021	0.002	0.012	405
CEO's Vega (in $ '000)	0.144	0.054	0.270	0.015	0.140	384

Table II: Correlations among key variables

This table presents the correlations between the key variables used in our analysis. Panel A presents the correlations between BHC risk measures, RMI, and BHC characteristics. Panel B presents the correlations between BHC risk measures and components of the RMI. *Downside Risk* is defined as the mean implied volatility estimated from put options written on the BHC's stock. *Tail Risk* is defined as the negative of the average return on the BHC's stock over the 5% worst days for the S&P500 during the year. *Aggregate Risk* is the standard deviation of the BHC's weekly excess return (over S&P500), computed over the year. *RMI* measures the strength and independence of the risk management function at a BHC. All other variables are defined in Appendix B.

Panel A: Correlations between BHC Risk, RMI, and BHC Characteristics

	Downside Risk	Tail Risk	Aggregate Risk	RMI_{t-1}	$Size_{t-1}$
Downside Risk	1				
Tail Risk	0.728	1			
Aggregate Risk	0.802	0.877	1		
RMI_{t-1}	-0.262	-0.017	-0.093	1	
$Size_{t-1}$	-0.135	0.13	0.031	0.44	1
ROA_{t-1}	-0.065	-0.041	-0.091	-0.089	-0.137
$(\text{Tier-1 Cap/Assets})_{t-1}$	-0.004	-0.015	-0.051	-0.134	-0.249
$(\text{Deposits/Assets})_{t-1}$	-0.004	-0.104	-0.068	-0.039	-0.49
$(\text{Bad Loans/Assets})_{t-1}$	0.182	0.212	0.251	0.279	0.186
$(\text{Non-int income/Income})_{t-1}$	-0.186	-0.085	-0.19	0.099	0.385
$(\text{UW Assets/Assets})_{t-1}$	0.038	0.12	0.073	0.061	0.365
$(\text{Ins. Assets/Assets})_{t-1}$	-0.044	-0.007	-0.014	-0.135	0.223
$(\text{Deriv Trading/Assets})_{t-1}$	-0.035	0.069	0.019	0.155	0.599
$(\text{Deriv Hedging/Assets})_{t-1}$	-0.171	-0.029	-0.111	0.112	0.435
$\text{Inst. Ownership}_{t-1}$	0.175	0.208	0.173	-0.172	-0.015
G-Index_{t-1}	0.125	0.059	0.065	-0.034	-0.35
CEO's Delta_{t-1}	0.142	0.02	0.044	-0.219	-0.281
CEO's Vega_{t-1}	0.017	0.258	0.103	0.204	0.508

Panel B: Correlations between BHC Risk and Components of RMI

	Downside Risk	Tail Risk	Aggregate Risk	RMI_{t-1}
$\text{CRO Executive}_{t-1}$	-0.210	-0.079	-0.085	0.521
CRO Top5_{t-1}	-0.019	-0.010	0.019	0.372
$\text{CRO Centrality}_{t-1}$	-0.189	-0.112	-0.151	0.488
$\text{Risk Committee Experience}_{t-1}$	-0.096	0.008	0.009	0.412
$\text{Active Risk Committee}_{t-1}$	-0.153	-0.009	-0.118	0.308
CRO Present_{t-1}	-0.272	-0.078	-0.0815	0.511
$\text{Experienced Board}_{t-1}$	-0.198	-0.011	-0.092	0.380

Table III: RMI and performance during crisis years

This table reports the results of the cross-sectional regression (1) that examines whether BHCs with high RMI in 2006 fared better during the crisis years. We confine the regression to the crisis years, 2007 and 2008. Definitions of variables are listed in Appendix B. We include year fixed effects in the regression. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the BHC level. Asterisks denote statistical significance at the 1% (***), 5% (**) and the 10% (*) levels.

Dep. Variable=	Private MBS	Risky Trading Assets	Deriv. Trading	Bad Loans/Assets	ROA	Stock Return	Aggr. Risk	Downside Risk
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RMI_{2006}	-10.481	-67.927	-6.765	-.016	.008	.094	-.019	-.172
	(5.803)*	(34.288)**	(3.654)*	(.008)*	(.006)	(.174)	(.015)	(.070)**
$Size_{2006}$	5.821	36.044	5.301	.0009	-.002	-.064	-.0001	-.011
	(1.591)***	(11.373)***	(1.832)***	(.0009)	(.0009)***	(.036)*	(.003)	(.011)
ROA_{2006}	75.000	-871.240	-215.977	-.158	1.156	4.563	-.647	-3.991
	(112.374)	(800.629)	(153.793)	(.184)	(.188)***	(7.359)	(.507)	(3.579)
$(\text{Tier-1 Cap/Assets})_{2006}$	-20.744	307.760	72.309	.056	-.025	-1.334	.107	.799
	(40.675)	(249.691)	(48.374)	(.048)	(.055)	(2.204)	(.144)	(1.046)
$(\text{Bad Loans/Assets})_{2006}$	50.792	-387.483	-125.392	2.761	-.287	-4.650	1.416	12.941
	(145.144)	(798.644)	(126.117)	(.936)***	(.418)	(13.692)	(.882)	(5.802)**
$(\text{Deposits/Assets})_{2006}$	3.464	59.450	11.269	.018	-.009	.186	-.028	.057
	(7.034)	(44.661)	(7.579)	(.023)	(.010)	(.360)	(.016)*	(.140)
ROA_{2006}	-8.047	-34.143	-6.664	-.011	-.016	-.182	.009	-.169
	(3.973)**	(33.122)	(5.798)	(.022)	(.010)	(.304)	(.016)	(.136)
Const.	-88.287	-599.803	-91.073	-.006	.040	1.358	.103	.977
	(29.264)***	(197.753)***	(33.247)***	(.019)	(.018)**	(.799)*	(.048)**	(.253)***
Obs.	143	143	143	143	143	141	141	112
R^2	.514	.37	.327	.369	.774	.317	.537	.65

Table IV: Impact of RMI on Risk, 2001–2008

This table reports the results of the panel regression (2) that examines the impact of a BHC's risk management index (RMI) on its risk. The panel has one observation for each BHC-year combination, and spans the time period 2000-2008. The dependent variable in Panel A is *Downside Risk*, which is defined as the mean implied volatility estimated from put options written on the BHC's stock. All variables are defined in Appendix B. We include BHC fixed effects and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the BHC level. Asterisks denote statistical significance at the 1% (***), 5%(**) and 10% (*) levels.

Panel A: Impact of RMI on Downside Risk

	Mean Implied Volatility of Put Options				
	(1)	(2)	(3)	(4)	(5)
RMI_{t-1}	-.359 (.176)**	-.407 (.174)**	-.442 (.193)**	-.526 (.261)**	
Alt. RMI_{t-1}					-.714 (.368)*
$Size_{t-1}$	.006 (.033)	-.015 (.042)	-.013 (.042)	-.023 (.049)	-.021 (.051)
ROA_{t-1}	-.757 (1.045)	-.394 (1.197)	-.558 (1.186)	-.979 (2.838)	-.706 (2.981)
Annual Stock $Return_{t-1}$	-.069 (.019)***	-.077 (.018)***	-.072 (.019)***	-.068 (.021)***	-.070 (.021)***
$(Deposits/Assets)_{t-1}$	.282 (.160)*	.240 (.157)	.248 (.157)	.148 (.167)	.137 (.168)
$(Tier\text{-}1\ Cap/Assets)_{t-1}$	-.331 (.517)	-.555 (.621)	-.489 (.585)	-1.062 (.578)*	-1.167 (.580)**
$(Loans/Assets)_{t-1}$	-.101 (.152)	.015 (.113)	.024 (.115)	.026 (.124)	.021 (.120)
$(Bad\ Loans/Assets)_{t-1}$	8.776 (3.362)***	5.675 (3.576)	5.752 (3.484)*	5.594 (2.887)*	5.399 (2.823)*
$(Non\text{-}int.\ income/Income)_{t-1}$	.018 (.139)	.041 (.135)	.047 (.133)	.068 (.139)	.056 (.143)
$(UW\ Assets/Assets)_{t-1}$	-.318 (.105)***	-.236 (.114)**	-.160 (.111)	-.229 (.113)**	-.221 (.118)*
$(Ins.\ Assets/Assets)_{t-1}$	-.039 (.020)*	-.049 (.020)**	-.044 (.022)**	.349 (4.298)	1.023 (4.701)
Inst. $Ownership_{t-1}$		.314 (.111)***	.305 (.110)***	.286 (.141)**	.283 (.139)**
G-$Index_{t-1}$		-.004 (.013)	-.004 (.013)	-.00009 (.014)	-.0009 (.016)
$(Deriv\ Trading/Assets)_{t-1}$			-.001 (.002)	-.0003 (.002)	.00008 (.002)
$(Deriv\ Hedging/Assets)_{t-1}$			-.075 (.043)*	-.060 (.046)	-.061 (.048)
CEO's $Delta_{t-1}$				-.839 (.626)	-.767 (.607)
CEO's $Vega_{t-1}$				-.014 (.029)	-.017 (.028)
Obs.	391	366	366	279	279
R^2	.844	.847	.849	.852	.854
BHC & Year FE	Yes	Yes	Yes	Yes	Yes

The dependent variable in Panel B is *Tail Risk*, which is defined as the negative of the average return on the BHC's stock over the 5% worst days for the S&P500 during the year. All other variables are defined in Appendix B. We include BHC fixed effects and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the BHC level. Asterisks denote statistical significance at the 1% (***), 5%(**) and 10% (*) levels.

Panel B: Impact of RMI on Downside Risk

	Marginal Expected Shortfall (MES)				
	(1)	(2)	(3)	(4)	(5)
RMI_{t-1}	-.073	-.062	-.065	-.047	
	(.024)***	(.025)**	(.027)**	(.036)	
Alt. RMI_{t-1}					-.072
					(.034)**
$Size_{t-1}$	.008	.005	.005	.001	.002
	(.003)***	(.003)*	(.003)*	(.004)	(.004)
ROA_{t-1}	.038	-.035	-.026	-.150	-.143
	(.100)	(.095)	(.091)	(.265)	(.276)
Annual Stock $Return_{t-1}$	-.003	-.006	-.006	-.009	-.009
	(.002)	(.003)**	(.003)**	(.004)**	(.003)***
$(Deposits/Assets)_{t-1}$	.008	.016	.015	.029	.029
	(.017)	(.015)	(.015)	(.017)*	(.017)*
$(Tier1\ Cap/Assets)_{t-1}$	.010	.043	.046	.058	.055
	(.055)	(.051)	(.052)	(.090)	(.094)
$(Loans/Assets)_{t-1}$	-.003	.0004	.0008	-.007	-.009
	(.017)	(.018)	(.018)	(.022)	(.022)
$(Bad\ Loans/Assets)_{t-1}$	.342	-.360	-.352	.166	.118
	(.404)	(.379)	(.379)	(.475)	(.493)
$(Non\text{-}int.\ income/Income)_{t-1}$	-.017	-.022	-.023	.0009	.0007
	(.017)	(.021)	(.021)	(.024)	(.024)
$(UW\ Assets/Assets)_{t-1}$	-.066	-.055	-.066	-.030	-.029
	(.011)***	(.014)***	(.019)***	(.022)	(.021)
$(Ins.\ Assets/Assets)_{t-1}$	-.007	-.003	-.003	-.501	-.388
	(.006)	(.005)	(.005)	(.371)	(.414)
Inst. $Ownership_{t-1}$		.007	.007	.019	.017
		(.011)	(.011)	(.018)	(.017)
G-$Index_{t-1}$		.0004	.0004	.001	.001
		(.0009)	(.0009)	(.001)	(.001)
$(Deriv\ Trading/Assets)_{t-1}$			.0004	-4.65e-06	.00006
			(.0005)	(.0004)	(.0004)
$(Deriv\ Hedging/Assets)_{t-1}$			-.0004	-.003	-.002
			(.006)	(.006)	(.005)
CEO's $Delta_{t-1}$				-.130	-.127
				(.050)***	(.050)**
CEO's $Vega_{t-1}$				.0007	.0005
				(.003)	(.003)
Obs.	603	484	484	321	321
R^2	.855	.9	.9	.92	.921
BHC & Year FE	Yes	Yes	Yes	Yes	Yes

The dependent variable in Panel C is *Aggregate Risk*, which is defined as the standard deviation of the weekly excess return on the BHC's stock (over the S&P500) during the year. All other variables are defined in Appendix B. We include BHC fixed effects and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the BHC level. Asterisks denote statistical significance at the 1% (***), 5%(**) and 10% (*) levels.

Panel C: Impact of RMI on Aggregate Risk

	Standard Deviation of Weekly Return				
	(1)	(2)	(3)	(4)	(5)
RMI_{t-1}	-.119	-.089	-.091	-.071	
	(.030)***	(.033)***	(.035)***	(.040)*	
Alt. RMI_{t-1}					-.066
					(.030)**
$Size_{t-1}$	-.002	-.005	-.005	-.007	-.006
	(.002)	(.003)	(.003)	(.005)	(.005)
ROA_{t-1}	-.287	-.303	-.296	-.034	-.029
	(.123)**	(.132)**	(.121)**	(.291)	(.308)
Annual Stock $Return_{t-1}$	-.008	-.011	-.011	-.010	-.010
	(.003)***	(.003)***	(.004)***	(.004)**	(.004)**
$(Deposits/Assets)_{t-1}$	.011	.022	.022	.017	.017
	(.021)	(.018)	(.018)	(.025)	(.025)
$(Tier\text{-}1\ Cap/Assets)_{t-1}$	.026	.044	.045	-.058	-.069
	(.064)	(.062)	(.061)	(.087)	(.088)
$(Loans/Assets)_{t-1}$	-.027	-.019	-.018	-.025	-.026
	(.016)	(.019)	(.019)	(.026)	(.026)
$(Bad\ Loans/Assets)_{t-1}$	.845	.985	.991	.887	.851
	(.565)	(.666)	(.664)	(.496)*	(.508)*
(Non-int. income/Income)	-.030	-.035	-.035	-.010	-.010
	(.021)	(.027)	(.027)	(.020)	(.020)
$(UW\ Assets/Assets)_{t-1}$	.026	.041	.034	-.025	-.020
	(.021)	(.017)**	(.017)**	(.031)	(.031)
$(Ins.\ Assets/Assets)_{t-1}$	-.008	-.009	-.009	.353	.289
	(.006)	(.006)	(.006)	(.535)	(.607)
Inst. $Ownership_{t-1}$		.024	.025	.037	.037
		(.015)	(.015)*	(.023)*	(.021)*
G-$Index_{t-1}$		.0004	.0004	.002	.002
		(.001)	(.001)	(.001)	(.001)*
$(Deriv\ Trading/Assets)_{t-1}$			.0003	.0003	.0002
			(.0005)	(.0004)	(.0003)
$(Deriv\ Hedging/Assets)_{t-1}$			.0003	-.003	-.001
			(.006)	(.006)	(.006)
CEO's $Delta_{t-1}$				-.101	-.093
				(.067)	(.064)
CEO's $Vega_{t-1}$				-.007	-.008
				(.004)*	(.004)**
Obs.	604	484	484	321	321
R^2	.8	.838	.838	.868	.867
BHC & Year FE	Yes	Yes	Yes	Yes	Yes

Table V: Impact of RMI on Risk – Variation by BHC characteristics

This table reports the results of regressions aimed at understanding how the impact of RMI on risk varies with BHC characteristics. The empirical specification and control variables are the same as in the panel regression (2). The panel has one observation for each BHC-year combination, and spans the time period 2001-2008. All variables are defined in Appendix B. We include BHC fixed effects and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the BHC level. Asterisks denote statistical significance at the 1% (***), 5% (**) and 10% (*) levels.

	Downside Risk	Aggr. Risk	Downside Risk	Aggr. Risk	Downside Risk	Aggr. Risk	Downside Risk	Aggr. Risk
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RMI_{t-1}	-.376	-.117	-.421	-.112	-.405	-.115	-.374	-.120
	(.179)**	(.030)***	(.197)**	(.030)***	(.186)**	(.030)***	(.195)*	(.032)***
$Large_{t-1}$	-.012	.003						
	(.021)	(.004)						
$Large_{t-1}$*RMI_{t-1}	-.109	-.025						
	(.056)*	(.014)*						
Low ROA_{t-1}			-.014	.004				
			(.016)	(.004)				
Low ROA_{t-1}*RMI_{t-1}			.137	-.013				
			(.081)*	(.021)				
Low $Deposits_{t-1}$					.025	.001		
					(.024)	(.003)		
Low $Deposits_{t-1}$*RMI_{t-1}					-.047	-.027		
					(.062)	(.010)***		
High Deriv. $Trading_{t-1}$							-.004	-.006
							(.023)	(.002)**
High Deriv. $Trading_{t-1}$*RMI_{t-1}							-.091	-.006
							(.067)	(.012)
Const.	.135	.133	.262	.133	.136	.132	.212	.137
	(.691)	(.053)**	(.660)	(.054)**	(.678)	(.055)**	(.698)	(.052)***
Obs.	391	606	391	606	391	606	391	606
R^2	.84	.797	.841	.798	.84	.799	.84	.797
BHC & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table VI: Dynamic Panel GMM Estimation

This table reports the results of a dynamic panel GMM estimator developed by Arellano and Bond (1991) applied to the dynamic model (3), which seeks to understand the impact of lagged RMI on risk. *Downside Risk* is defined as the mean implied volatility estimated from put options written on the BHC's stock. *Tail Risk* is defined as the negative of the average return on the BHC's stock over the 5% worst days for the S&P500 during the year. *Aggregate Risk* is the standard deviation of the BHC's weekly excess return (over S&P500), computed over the year. All other variables are defined in Appendix B. Asterisks denote statistical significance at the 1% (***), 5% (**) and 10% (*) levels.

Y Variable=	Downside Risk		Tail Risk	Aggregate Risk
	(1)	(2)	(3)	(4)
RMI_{t-1}	-2.528	-1.995	-.135	-.285
	(.160)***	(.334)***	(.025)***	(.017)***
Y_{t-1}	-.255	-.380	1.062	.074
	(.049)***	(.060)***	(.099)***	(.088)
Y_{t-2}	-.666	-.799	-.620	-.554
	(.038)***	(.046)***	(.075)***	(.058)***
$Size_{t-1}$	-.002	-.125	.017	-.018
	(.028)	(.035)***	(.004)***	(.006)***
ROA_{t-1}	-.074	-16.054	-.858	-1.256
	(.324)	(6.695)**	(.306)***	(.241)***
Annual Stock $Return_{t-1}$	-.134	-.128	.005	-.012
	(.016)***	(.030)***	(.002)*	(.002)***
$(Deposits/Assets)_{t-1}$	-.242	-.205	.036	-.044
	(.112)**	(.220)	(.027)	(.022)**
$(Tier\text{-}1\ Cap/Assets)_{t-1}$	-1.536	-1.874	-.062	-.322
	(.309)***	(3.377)	(.118)	(.114)***
$(Loans/Assets)_{t-1}$	.015	-.421	.068	.059
	(.122)	(.393)	(.015)***	(.019)***
$(Bad\ Loans/Assets)_{t-1}$	33.696	29.243	2.555	3.982
	(1.672)***	(4.046)***	(.334)***	(.586)***
$(Non\text{-}int.\ income/Income)_{t-1}$	.074	.343	-.019	-.019
	(.062)	(.165)**	(.015)	(.012)
$(UW\ Assets/Assets)_{t-1}$	-.519	-1.062	-.025	-.083
	(.160)***	(.450)**	(.032)	(.025)***
$(Ins.\ Assets/Assets)_{t-1}$	.507	-6.763	-.944	-1.764
	(.469)	(30.004)	(2.356)	(2.719)
Inst. $Ownership_{t-1}$	.964	1.164	.114	.163
	(.080)***	(.106)***	(.017)***	(.017)***
G-$Index_{t-1}$	-.027	-.025	-.0004	-.0007
	(.013)**	(.012)**	(.001)	(.002)
$(Deriv\ Trading/Assets)_{t-1}$	.019	.030	.002	.002
	(.002)***	(.010)***	(.0007)***	(.0009)**
$(Deriv\ Hedging/Assets)_{t-1}$	.010	.118	.003	-.007
	(.039)	(.061)*	(.006)	(.006)
CEO's $Delta_{t-1}$		.137	-.013	-.145
		(1.204)	(.091)	(.079)*
CEO's $Vega_{t-1}$		.059	.027	.013
		(.035)*	(.004)***	(.003)***
Obs.	215	164	234	234
Sargan χ^2	33.747	24.426	35.766	34.886
Sargan p-value	0.142	0.607	0.432	0.474

Table VII: Impact of RMI on Stock Returns, 2000-2008

This table reports the results of the panel regression (2) that examines the impact of a BHC's risk management index (RMI) on its stock return. The panel has one observation for each BHC-year combination, and spans the time period 2001-2008. The dependent variable in the regression is the annual return (computed over the calendar year) on the BHC's stock. All variables are defined in Appendix B. We include BHC fixed effects and year fixed effects in all specifications. Standard errors are reported in parentheses. Asterisks denote statistical significance at the 1% (***), 5% (**) and 10% (*) levels.

	Panel Regression			Arellano-Bond
	(1)	(2)	(3)	(4)
RMI_{t-1}	.950	.947	.760	3.325
	(.411)**	(.485)*	(.619)	(.669)***
Annual $Return_{t-1}$				-.399
				(.037)***
Annual $Return_{t-2}$				-.324
				(.026)***
$Size_{t-1}$	-.221	-.299	-.245	-.657
	(.065)***	(.071)***	(.067)***	(.074)***
ROA_{t-1}	-4.643	-4.186	-5.075	-8.736
	(2.164)**	(2.582)	(6.052)	(5.701)
$(Deposits/Assets)_{t-1}$	-.200	-.323	.069	.170
	(.266)	(.289)	(.328)	(.250)
$(Tier\text{-}1\ Cap/Assets)_{t-1}$	-.086	.105	-3.394	-4.435
	(1.179)	(1.403)	(2.506)	(2.662)*
$(Loans/Assets)_{t-1}$	.173	-.010	-.154	-1.382
	(.218)	(.293)	(.337)	(.277)***
$(Bad\ Loans/Assets)_{t-1}$	.547	-.265	-.656	-2.675
	(6.224)	(8.758)	(9.002)	(7.776)
$(Non\text{-}int.\ income/Income)_{t-1}$	.355	.299	.404	.999
	(.198)*	(.227)	(.253)	(.305)***
$(UW\ Assets/Assets)_{t-1}$	.988	.978	.557	.681
	(.513)*	(.519)*	(.982)	(1.379)
$(Ins.\ Assets/Assets)_{t-1}$	.383	.389	12.680	-4.252
	(.044)***	(.057)***	(9.447)	(15.601)
Inst. $Ownership_{t-1}$		-.154	-.036	-.783
		(.224)	(.285)	(.198)***
G-$Index_{t-1}$		.034	.015	.032
		(.018)*	(.022)	(.017)*
$(Deriv\ Trading/Assets)_{t-1}$		.005	.013	-.022
		(.006)	(.007)*	(.009)**
$(Deriv\ Hedging/Assets)_{t-1}$		.020	.072	.013
		(.080)	(.104)	(.107)
CEO's $Delta_{t-1}$			2.377	2.182
			(.923)***	(3.341)
CEO's $Vega_{t-1}$			-.023	-.136
			(.084)	(.064)**
Obs.	606	484	321	234
R^2	.568	.626	.677	
Sargan chi^2				38.944
Sargan p-value				0.297