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

Andrew Ellul† *Vijay Yerramilli*‡

Preliminary

Abstract

In this paper, we investigate whether U.S. bank holding companies (BHCs) with strong and independent risk management functions had lower aggregate risk and downside risk. We hand-collect information on the organization structure of the 75 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 exposures to mortgage-backed securities and risky trading assets, were less active in trading off-balance sheet derivatives, and generally fared better in terms of operating performance and lower downside risk during the crisis years (2007 and 2008). In a panel spanning 8 years, we find that BHCs with higher RMIs had lower aggregate risk and downside risk, and higher stock returns, 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 simultaneity bias. Overall, these results suggest that strong internal risk controls are effective in lowering risk 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 across the board 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 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 and independent risk management functions in place had lower enterprise-wide risk, both in terms of aggregate risk and downside 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. For example, to gauge the importance attached to the risk management function, we examine if the BHC has a designated Chief Risk Officer (CRO), whether the CRO is is among the top five highly paid executives, and how the CRO's pay compares with that of the Chief Executive

[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.

Officer (CEO). Similarly, 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 whether the key management-level risk committees report directly to the board or to the CEO.

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 comprises of several independent subsidiaries, each with its own management

[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.

and board of directors, involved in a wide variety of financial activities. This kind of an 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 (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 75 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 eight year period, 2000–2007. Financial information on BHCs is obtained from the FR Y-9C reports that they file with the Federal Reserve System. To measure enterprise-wide risk, we obtain data on stock returns from CRSP which we use to compute the standard deviation of returns, and data on option prices from the OptionMetrics database which we use to estimate the implied volatility of the underlying stock. 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 (2008), Cremers and Weinbaum (2008) and Xing et al. (2008)).

As a preamble to our analysis, and in keeping with the motivation of our paper, we begin by examining whether BHCs that had strong risk management functions 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 to offload holdings of mortgage-backed securities and CDOs, and was relatively

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

cheaper to hedge risks. Consistent with the idea that BHCs with stronger risk management structures were more judicious in their risk taking, we find that BHCs with a high 2006 RMI had lower exposure to mortgage-backed securities and trading assets, were less active in trading off-balance sheet derivative securities. Moreover, BHCs with a high 2006 RMI were more profitable, fared (weakly) better in terms of stock return performance, and had lower downside risk during the crisis years.

Next, we examine a panel spanning the 8 year period from 2001–2008 to investigate whether BHCs with stronger risk management functions had lower enterprise-wide risk. 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 management functions (i.e., higher values of RMI) in the previous year had both lower aggregate risk and lower downside risk in the current year. In terms of economic significance, a one standard deviation increase in RMI is associated with a 25% decrease (a decrease of 0.8 standard deviations) in downside risk and a 34% decrease (a decrease of 0.5 standard deviations) 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 a BHC's "risk culture" to the extent that it is time-invariant. Therefore, our results reflect a within-BHC decrease in aggregate risk and downside risk from a strengthening of the risk management function.

We use the same panel regression specification to investigate whether BHCs with stronger risk management functions also had better stock return performance. After controlling for all the BHC characteristics mentioned above, and including BHC fixed effects and year fixed effects, we find that BHCs with higher values of RMI in the previous year had higher annual stock returns in the current year. This evidence suggests that the stock market rewards BHCs with strong risk management functions.

So far, we have treated the RMI as an exogenous variable, and examined the association between RMI and BHC risk. However, causation could run in both directions; i.e., BHC risk characteristics might determine the choice of RMI, and the RMI in turn affects BHC risk. 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

[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.

take lower risks and put in place stronger risk management systems, while aggressive BHCs take higher risks and 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.

Given that causation can run both ways, it is critical to account for how BHC risk and the centrality of the risk management function are jointly determined. Accordingly, we estimate a simultaneous equations model. Even with this approach, we find that BHCs with stronger risk management functions had lower aggregate risk and lower downside risk. However, consistent with the risk culture view, the economic significance of this relationship drops when compared with our panel regression.

To summarize, our results support the idea that strong and independent risk management functions are necessary to effectively manage risks 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 8 years, we find that BHCs with stronger risk management functions had lower aggregate risk and lower downside risk, after controlling for size, profitability, and a variety of risk characteristics. This result holds even after controlling for any simultaneity bias.

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 risk management functions in place before the financial crisis hit were more judicious in exposing themselves to mortgage-backed securities and off-balance sheet derivative trading activity, and 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 by banks.

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, and describe our data sources and construction of variables in Section 2. We describe our empirical specifications and preliminary results in Section 3, and present our main results 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, both in terms of aggregate risk and downside risk. 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 is 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.

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.

In our empirical analysis, we account for how BHC risk and the strength of the risk management function are jointly determined.

2 Sample collection and construction of variables

2.1 Data Sources

Our data comes from several sources. We hand-collect data on the organization structure of the risk management function at BHCs from the 10-k statements and proxy statements filed by the BHCs with the Securities and Exchange Commission (SEC), and from their annual reports. We use this information to create a unique risk management index (RMI) that measures the strength and independence of the risk management function at the given BHC. Given the effort involved in hand-collecting and validating the information for each BHC, we restrict ourselves to the time period 2000–2007, 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 75 BHCs, that accounted for 78% of the total assets of the banking system in 2007. Overall, we are able to construct the RMI for 75 BHCs over the time period 2000–2007. 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 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 BHCs, and the Gompers et al. (2003) G-Index from the IRRC database.

2.2 The risk management index (RMI)

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, denoted *RMI*, to measure the strength and independence of the risk management function.

Our first set of variables capture 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*, a dummy variable that identifies if the BHC has a designated Chief Risk Officer (CRO); *CRO Executive*, a dummy variable that identifies if the CRO is an executive officer; *CRO-Top5*, a dummy variable that identifies if the CRO is among the five highest paid executives; and *CRO Centrality*, defined as the ratio of the CRO's total compensation to the CEO's total compensation.[8]

A technical difficulty in defining *CRO Centrality* is that publicly-listed firms usually only disclose the compensation packages of their five highest paid executives. Thus, we only have information on the CRO's compensation when he/ she is among the five highest paid executives. We overcome this difficulty as follows: 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. Thus, we implicitly set the CRO just below the fifth-highest paid executive. To the extent that the CRO's true compensation is much lower, this method only biases against us. If the BHC does not have a CRO, then we define *CRO Centrality* based on the compensation of the Chief Financial Officer. Another alternative is to code *CRO Centrality*=0 when the BHC does not have a designated CRO. Not surprisingly, our results become stronger when we use this more stringent definition of *CRO Centrality*.

Our next set of variables are intended to capture how well quantitative and qualitative information on risk is shared between the top management and business segments. In this regard, we examine the characteristics of the board committee designated with overseeing and managing risk. *Board Committee Experience* is a dummy variable that identifies whether at least one of the directors serving on the board's risk committee has some banking experience. 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 Board 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. *Reports to Board* is 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.

We obtain the *RMI* by taking the first principal component of the following seven risk management variables: *CRO Present*, *CRO Executive*, *CRO-Top5*, *CRO Centrality*, *Board Committee Experience*, *Active Board Risk Committee*, and *Reports to Board*. 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.

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

3 Empirical specifications and preliminary results

3.1 Empirical specifications

As a preamble to our analysis, and in keeping with our motivation, we begin by examining whether BHCs that had strong and independent risk management functions in place before the current financial crisis hit, were more judicious in terms of their investment and financing decisions, and performed relatively better during the crisis years. Accordingly, we estimate cross-sectional regressions only for the crisis years, 2007 and 2008, that are of the following form:

$$Y_{j,t} = \beta_0 + \beta_1 * \text{RMI}_{j,2006} + \beta_2 * X_{j,2006} + \text{Year FE} \tag{1}$$

In the above equation, subscript 'j' denotes the BHC and 't' denotes the year. The dependent variables (Y) we examine are the following: *MBS* and *MBS/Assets*, where *MBS* denotes the book value of mortgage-backed securities held by the BHC; *Trading Assets* and *Trading Assets/Assets*, where *Trading Assets* are defined as the BHC's total trading assets less investments in relatively safe securities such as U.S. treasury securities, U.S. government agency obligations, and securities issued by states and political subdivisions in the U.S.; *Deriv. Trading* and *Deriv. Trading/Assets*, where *Deriv. Trading* is defined as the total gross notional amount of off-balance sheet derivative contracts held for trading purposes; *ROA*, which is defined as the ratio of the BHC's income before extraordinary items to its assets, and is a measure of overall operating performance; *Stock return*, which is defined as the excess return (over the S&P500) on the BHC's stock over the calendar year; and *Downside Risk*, which is defined as the mean implied volatility estimated using put options written on the BHC's stock. Our main independent variable is $RMI_{j,2006}$, the BHC's risk management index in 2006.

Our main set of tests are aimed at understanding whether BHCs that had strong and independent risk management functions in place (i.e., high RMI) 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:

$$\text{Risk}_{j,t} = \beta_0 + \beta_1 * \text{RMI}_{j,t-1} + \beta_2 * X_{j,t-1} + \text{BHC FE} + \text{Year FE} \tag{2}$$

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 2001–2008. The dependent variable is one of the following: *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 year; and *Downside Risk*, which is defined as the mean implied volatility estimated from put options written on the BHC's stock. We include both BHC and year fixed effects in this regression.

We control the regression for important BHC financial characteristics from the previous year. The definitions of all the variables we use in our analysis are listed in Appendix B. We control for size using the natural logarithm of the book value of total assets (*Size*), and for profitability using the ratio of the BHC's income before extraordinary items to its assets (*ROA*). We control for loan performance using the ratio *Bad Loans/Assets*, where 'bad' loans include non-accrual loans and loans past due 90 days or more. We proxy for the BHC's reliance on off-balance sheet activity using the ratio *Risky Non-Int. Income/Income* (see Boyd and Gertler (1994)), where *Risky Non-Int. Income* is defined as the total non-interest income *less* income from fiduciary activities, service charges on deposit accounts, and other non-interest income. More specifically, *Risky Non-Int. Income* includes income from security brokerage, investment banking and advisory fee, underwriting income, insurance income, fee from annuity sales, venture capital revenue, securitization income, and gains from sale of loans and assets.

We control for balance sheet composition using the ratios *Deposits/Assets*, *Tier1 Cap/Assets* and *Loans/Assets*. The ratios *Real Estate Loans/Assets*, *C&I Loans/Assets*, *Consumer Loans/Assets*, *Agri. Loans/Assets* and *Other Loans/Assets* control for the BHC's exposure to loans secured by real estate, commercial and industrial loans, consumer loans, agricultural loans and other loans, respectively. The variable *Loan Concentration* measures the concentration of the BHC's loan portfolio among these loan segments. It is computed as a Herfindahl Index using the share of each loan segment in the overall loan portfolio; i.e., the sum of squares of the loan segment shares. Thus, a high value of *Loan Concentration* means that BHC's loans are heavily concentrated in one or more segments.

Apart from BHC financial characteristics, we also control for the institutional ownership in the BHC, and for its governance using the G-Index. We control for CEO compensation using the sensitivity of the CEO's compensation to share price, *Delta*, and sensitivity to stock return volatility, *Vega* (see Core and Guay (1999)).

Given that the causation between risk and the strength of the risk management function can run both ways, it is critical to account for how BHC risk and RMI are jointly determined. Accordingly, we estimate the following simultaneous equation model. We estimate the system using three-stage least squares (3SLS). To conform to the underlying reasoning for simultaneous equations, we use contemporaneous values of risk and RMI in this model.

$$\begin{aligned}\text{BHC Risk}_{j,t} &= \alpha_0 + \alpha_1 * \text{RMI}_{j,t} + \alpha_2 * X_{j,t-1} + \text{Year FE} \\ \text{RMI}_{j,t} &= \beta_0 + \beta_1 * \text{BHC Risk}_{j,t} + \beta_2 * Z_{j,t-1} + \text{Year FE}\end{aligned} \tag{3}$$

3.2 Summary 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 2000-07; 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 75 BHCs that are publicly listed.

As can be seen from Table I, the mean value of the risk management index is 1.213. Examining the descriptive statistics regarding the components of the RMI, we find that a designated Chief Risk Officer (CRO) was present and had an executive rank in 57.3% and 48.9% of BHCs, respectively. Further, the CRO was among the top five highly-paid executives in only 19% of BHCs. As can be seen from the descriptive statistics of the *CRO Centrality* variable, on average, the CRO's total compensation was 29% that of the CEO's total compensation. However, there is significant variability in this ratio across BHCs.

The mean of 0.33 on *Board Risk Committee* indicates that only 33% of BHCs had a board committee exclusively focussed on overseeing enterprise-wide risk. We classify a BHC as having an active board 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, 36.2% of BHCs in our sample had active board risk committees. 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 BHCs.

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 $12.7 billion, while the average BHC had assets with book value of $96.7 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 67% of liabilities plus equity, and loans constitute 62% of the assets. Although loan composition varies from BHC to BHC, loans secured by real estate are by far the largest component, accounting for 39.3% of assets, on average.[9] Commercial and industrial loans constitute 12% of assets, and consumer loans constitute 5.9% of assets, on average. In terms of loan performance, the average BHC has 0.7% of its assets in 'bad' 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 *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 47.21% of its shares held by institutional investors, and had a G-index of 9.75.

3.3 Correlations among key variables

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

Panel A lists the correlations between our risk measures, RMI and BHC financial characteristics. The correlation between *Downside Risk* and *RMI* is strongly negative at -0.457. Similarly, *Aggregate Risk* is also negatively correlated with RMI, albeit less strongly compared with downside risk. While these findings are consistent with the idea that BHCs with strong and independent risk management controls have lower downside risk and lower aggregate risk, they must be interpreted with caution because they do not control for important BHC characteristics like size, profitability, capital ratios, etc.

Both risk measures are negatively correlated with size. Somewhat surprisingly, both risk measures are positively correlated with Tier-1 capital ratio, which goes against the idea that well-capitalized banks take lower risks. Similarly surprising are the positive correlations between risk measures and the CEO's Delta (because greater exposure to the bank's equity should make the CEO more risk averse), and the negative correlations between risk measures and the CEO's Vega (because higher option pay should induce the CEO to take on greater risks). We must once again caution that these correlations do not take into account other BHC characteristics. In particular, note that *Size* is negatively correlated with *Tier1 Cap/Assets* and *CEO's Delta*, and is positively correlated with *CEO's Vega*. Therefore, the puzzling correlations we document can arise because large BHCs that experience lower risks are also less well-capitalized, rely less on stock compensation, and rely more on option-based

[9] Loans secured by real estate include the following sub-categories: (a) Construction, land development, and other land loans; (b) Loans secured by farmland; (c) Loans secured by single family or multi-family residential properties; and (d) loans secured by non-farm non-residential properties.

compensation.

Panel B lists the correlations between our risk measures and the various components of the RMI. As can be seen, both *Downside Risk* and *Aggregate Risk* are negatively correlated with the individual components of the RMI, although, once again, the correlations are stronger in case of *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 were more judicious in terms of exposing themselves to mortgage-backed securities and complex derivatives, and generally fared better in the early months of the crisis. So it is natural to begin our analysis by asking whether BHCs that had stronger risk management functions in place before the crisis hit, say in 2006, fared better during the crisis years, 2007 and 2008.

To answer this question, we estimate the cross-sectional regression (1) on all the BHCs in our sample for the crisis years 2007 and 2008. Our main independent variable of interest is the BHC's risk management index in 2006, RMI_{2006}. We also control for BHC characteristics at the end of calendar year 2006.[10] The results of our estimation are presented in Table III. We include 2007 and 2008 year dummies in all specifications.

In Columns (1) and (2), we examine whether BHCs with a high RMI in 2006 had lower exposure to mortgage-backed securities during the crisis years, 2007 and 2008. We are interested in exposure to mortgage-backed securities because the crisis itself was caused by a housing crisis in the U.S., and there was considerable uncertainty regarding the true values of these securities during 2007 and 2008. The dependent variable in Column (1) is *MBS*, the book value of mortgage-backed securities (in $ million) on the BHC's balance sheet, while the dependent variable in Column (2) is *MBS/Assets*, the book value of mortgage-backed securities scaled by the book value of total assets. The coefficient on RMI_{2006} in Column (1) is negative, suggesting that BHCs with stronger RMI in 2006 had lower exposure to mortgage-backed securities. While the coefficient is also negative in Column (2), it is not statistically significant.

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

In Columns (3) and (4), we examine whether BHCs with a high RMI in 2006 had lower exposure to risky trading assets during the crisis years. Recall that our measure of *Trading Assets* excludes relatively safe securities such as U.S. Treasury securities, U.S. government obligations, and securities issued by states and political subdivisions in the U.S. The negative and significant coefficients on RMI_{2006} in columns (3) and (4) indicates that BHCs with a high RMI in 2006 had lower exposure to risky trading assets, both in terms of dollar amounts and as a proportion of total assets.

In Columns (5) and (6), we examine the off-balance sheet derivative trading activities of BHCs during the crisis years. The dependent variable in Column (5) is *Deriv. Trading*, which is the gross notional amount (in $ million) of derivative contracts held for trading, while the dependent variable in Column (6) is *Deriv. Trading/Assets*. The negative and significant coefficients on RMI_{2006} in columns (5) and (6) indicates that BHCs with a high RMI in 2006 had lower exposure to off-balance sheet derivative trading activity, both in dollar terms as well as in relation to their total assets.

In Column (7), we examine whether BHCs that had high RMI in 2006 were more profitable during the crisis years. Accordingly, the dependent variable in this regression is *ROA*. The positive and significant coefficient on RMI_{2006} confirms our hypothesis. In unreported tests, we also find weak support for the idea that BHCs with a higher RMI in 2006 had fewer bad loans during the crisis years.

In Column (8), we examine whether BHCs that had high RMI in 2006 experienced relatively better stock return performance during the crisis years. The dependent variable in this regression is the annual excess return (over the S&P500) on the BHC's stock. While the coefficient on RMI_{2006} is positive confirming our hypothesis, it is not statistically significant at the conventional levels (the p-value on the coefficient is 12.3%).

Finally, in Column (9), we examine the downside risk of BHCs during the crisis years, as measured by the implied volatility estimates from put options written on the BHCs' stocks. This regression only includes 49 BHCs in the year 2007 for which we have the implied volatility measures. The negative and significant coefficient on RMI_{2006} indicates that BHCs with a high RMI in 2006 had lower downside risk in 2007.

Overall, the results in Table III are supportive of the argument in the Senior Supervisors Group (2008) report that BHCs with strong and independent risk management functions in place before the crisis hit, were more judicious in their investment decisions, and fared better during the crisis years.

4.2 Impact of RMI on BHC Risk

Next, we examine whether BHCs that had strong and independent risk management functions in place (i.e., high RMI) had lower aggregate risk and lower downside risk, after controlling for the underlying risk of the BHC's business activities. We do this by estimating the panel regression (2). The dependent variables for this regression are downside risk, as measured by *Downside Risk*, and aggregate risk, as measured by *Std. Dev. Excess Return*, and the main independent variable is the lagged value of RMI, i.e., $RMI_{j,t-1}$. Each observation in the panel corresponds to a BHC-year pair. The panel spans the time period 2001-2008, and includes the 75 BHCs whose names are listed in Appendix A. We include year fixed effects, as well as BHC fixed effects to control for any unobserved BHC characteristics that might affect risk; e.g., the BHC's risk culture. The results of our estimation are presented in Table IV.

Impact on downside risk

In Panel A, we present the results of regressions aimed at understanding how the BHC's downside risk varies with its RMI. The dependent variable in these regressions is *Downside Risk*. We have fewer observations in this regression because we do not have the implied volatility measures for all BHCs. 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 downside risk in the current year.

In terms of the coefficients on the control variables, we fail to detect any relationship between BHC size and downside risk. Thus, at least in our sample (which only consists of the 75 largest publicly listed BHCs), there is no evidence that large BHCs take larger risks because of implicit too-big-to-fail guarantees. Moreover, we also do not find any strong support for the argument that moral hazard induced by deposit insurance causes BHCs to take higher risks. While the coefficient on *Deposits/Assets* is positive, it is not statistically significant. Consistent with the idea that well-capitalized banks take lower risks, we find a negative and significant coefficient on *Tier1 Cap/Assets*. Another variable that has a strong relationship with downside risk is *Bad Loans/Assets*. Recall that bad loans include non-accrual loans and loans that are 90 days past due and are still accruing. Therefore, the positive and significant coefficient on *Bad Loans/Assets* indicates that BHCs with a poorly performing loan portfolio have higher downside risk.

In Column (2), we repeat our analysis after replacing the *Loans/Assets* variable with its five segment components (real estate loans, commercial and industrial loans, consumer loans, agricultural loans, and all other loans), and the *Loan Concentration* measure that captures how concentrated the BHC's loan portfolio is among the five segments, to see if exposure to any particular loan segment is associated with higher or lower downside risk. However, the coefficients on all these measures are statistically insignificant, and the coefficient on $RMI_{j,t-1}$ continues to be negative and significant.

It has been argued that bank CEO compensation packages contribute to higher risk taking. 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 of banks during the crisis period, Fahlenbrach and Stulz (2009) find that option compensation did not have an adverse impact on bank performance.

To take into account the impact of CEO compensation on risk taking, in Column (3), we repeat our estimation after including the sensitivity of the CEO's compensation to the firm's stock price (*Delta*) and stock return volatility (*Vega*) as additional controls. The negative coefficient on *Delta* indicates that BHCs with CEOs whose compensation is highly sensitive to the BHC's stock price have lower downside risk. This could be because greater exposure to the BHC's equity causes the CEO to become more risk averse. However, we fail to detect any positive relationship between the CEO's Vega and downside risk. Moreover, the negative coefficient on $RMI_{j,t-1}$ becomes stronger when compared with Column (1) after we control for CEO compensation, even though we have fewer observations in this column.

Past research has highlighted that high insider ownership is generally associated with higher risk, as insiders try to take advantage of deposit insurance (Saunders et al. (1990), Demsetz et al. (1997), Laeven and Levine (2008)).[11] Therefore, in Column (4), we repeat our estimation after including *Log(Inst. Ownership)* as an additional control. We also control for the BHC's corporate governance, by including its G-Index as a control variable. While the coefficient on *Log(Inst. Ownership)* is positive, it is not statistically significant. We also fail to detect any relationship between the G-Index and downside risk. More importantly, the negative coefficient on $RMI_{j,t-1}$ only becomes stronger when compared with Column (1).

Overall, the results in Panel A indicate that BHCs that had strong and independent risk management functions in place had lower downside risk. In terms of economic significance, the coefficient of -0.430 on $RMI_{j,t-1}$ in Column (1) indicates that a one standard deviation increase in RMI is associated with a decrease of 0.087 in downside risk, which is equivalent to a 25% decrease or a 0.8 standard deviation decrease in downside risk.

[11] Demsetz et al. (1997) argue that this problem exists only at low franchise value banks.

Impact on aggregate risk

In Panel B, 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 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 aggregate risk in the current year.

The coefficients on the control variables are somewhat different from those in Panel A. In particular, the positive coefficient on *Deposits/Assets* indicates that BHCs that rely more on deposits to fund themselves had higher aggregate risk. This could be because the presence of deposit insurance encourages BHCs with higher deposits to take higher risks. The negative coefficient on *Loans/Assets* indicates that BHCs that held more loans (and hence, fewer securities and other trading assets) had less volatile stock returns. Profitable BHCs have less volatile stock returns (negative coefficient on *ROA*). In Column (2), we find that BHCs with higher exposure to loans secured by real estate loans and agricultural loans have less volatile stock returns (negative coefficients on *Real Estate Loans/Assets* and *Agri. Loans/Assets*), while BHCs with highly concentrated loan portfolios have more volatile stock returns (positive coefficient on *Loan Concentration*). As in Panel A, we find that BHCs with a poorly performing loan portfolio have higher aggregate risk (positive coefficient on *Bad Loans/Assets*).

As in Panel A, the negative coefficient on $RMIj, t-1$ is robust to controlling for institutional ownership, CEO's compensation characteristics, and the BHC's G-Index. However, we have far fewer observations in Columns (3) and (4), because we do not have CEO compensation and G-Index for all BHCs in our sample. Overall, the findings in Panel B indicate that BHCs with strong and independent risk management functions in place have lower aggregate risk. In terms of economic significance, the coefficient of -0.064 on $RMIj, t-1$ in Column (1) indicates that a one standard deviation increase in RMI is associated with a decrease of 0.013 in aggregate risk, which is equivalent to a 34% decrease or a 0.5 standard deviation decrease in aggregate risk.

4.3 How does the impact of RMI 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 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. The results of our estimation are presented in Table V.

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. Because an effective risk management function can make a bigger impact in BHCs with poorer operating performance, where the scope for improvement is larger, 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 negative and significant coefficient on $Low\ ROA\ BHC_{t-1}*RMI_{t-1}$ in Column (4) indicates that the effect of RMI in lowering aggregate risk is stronger in BHCs with low profitability. We do not detect a similar effect with respect to downside risk, as the coefficient on the interaction term in Column (3) 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 limited presence in banking, and a larger presence in other financial activities like underwriting, insurance, etc. As per this interpretation, the effect of RMI in lowering risk should be stronger for BHCs that rely less on deposits. 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 BHCs that rely less on deposits. Again, the coefficient on the interaction term in the downside risk regression in Column (5) is not significant.

In Columns (7) and (8), we examine whether the impact of RMI in lowering risk is stronger at 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. The negative and significant coefficient on *High Deriv. Trading* BHC_{t-1}*RMI_{t-1} in Column (8) suggests that the impact of RMI in lowering aggregate risk is stronger at BHCs that are more active in trading derivatives. We do not detect a similar effect with respect to downside risk, as the coefficient on the interaction term in Column (7) is not statistically significant.

4.4 Impact of RMI on BHC stock returns

So far, we have shown that BHCs with strong and independent risk management functions in place had lower enterprise-wide risk, both in terms of aggregate risk and downside risk. A natural question that arises is whether the stock market rewards BHCs with high RMI. To investigate this question, 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 the same as in Table IV. Each observation in the panel corresponds to a BHC-year pair. The panel spans the time period 2001-2008, and includes the 75 BHCs whose names are listed in Appendix A. We include year fixed effects, as well as BHC fixed effects in all specifications. The results of our estimation are presented in Table VI.

The positive and statistically significant coefficient on RMI_{t-1} in all the specifications indicates that BHC's with strong and independent risk management functions 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 20% 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, so that the 20% increase corresponds to a 0.7 standard deviation increase in annual stock returns. (The magnitude of the economic significance decreases only slightly when we repeat our tests after winsorizing the annual stock returns.)

4.5 Simultaneous equations models

So far, we have treated the RMI as an exogenous variable, and examined the association between RMI and BHC risk. However, causation could run in both directions; i.e., BHC risk characteristics might determine the choice of RMI, and the RMI in turn affects BHC risk. This can bias our inferences depending on how causation affects the choice of RMI.

As we explained in Section 1, there are two possible hypotheses in this regard. The endogenous choice hypothesis suggests that BHCs exposed to greater risk choose stronger internal risk controls. Observe that, if this hypothesis is true, it should bias against us finding a negative association between BHC Risk and RMI. On the other hand, the risk culture hypothesis suggests 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. If the risk-culture hypothesis is correct, it will tend to exaggerate the positive association between BHC risk and RMI.

Given that causation can run both ways, it is critical to account for how BHC risk and the strength of the risk management system are jointly determined. Accordingly, we estimate the simultaneous equations model (3) using three-stage least squares (3SLS). To conform to the underlying reasoning for simultaneous equations, we use contemporaneous values of risk and RMI in this model. The results of our estimation are presented in Table VII.

In Panel A, we estimate how downside risk and *RMI* are simultaneously determined by BHC characteristics. The underlying restrictions we impose should be clear from the tables. As the negative and significant coefficient on *RMI* indicates, even after controlling for simultaneity, we find that BHCs with stronger risk management functions have lower downside risk.

The negative coefficient on *Downside Risk* in Column (2) indicates that BHCs with greater downside risk have lower RMI, which is consistent with the risk culture view, but is inconsistent with the idea that BHCs exposed to greater risk choose stronger internal risk controls. In terms of other coefficients, we find that large and well-capitalized BHCs choose stronger risk controls (positive coefficients on *Size* and *Tier1 Cap*), while profitable BHCs and BHCs that use a lot of derivatives for hedging purposes choose weaker risk controls (negative coefficients on *ROA* and *Deriv. Hedging*). The negative coefficient on *Deriv. Hedging* further suggests that BHCs probably view hedging and internal risk controls as substitutes.

Our findings in Panel B are similar. As the negative and significant coefficient on *RMI* in Column (3) indicates, even after controlling for simultaneity, we find that BHCs with stronger risk management functions have lower aggregate risk.

Overall, the findings in Table VII support the idea that BHCs with stronger internal risk controls have lower downside risk and lower aggregate risk. However, consistent with the risk culture view, the economic significance of this relationship drops when compared with our panel regression in Table IV.

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 75 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 mortgage-backed securities and trading assets, were less active in trading off-balance sheet derivative securities, had better operating and stock return performance, 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 8 year period from 2001–2008, we find that BHCs with stronger internal risk controls in the previous year have both lower aggregate risk and lower downside 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.

Our results support the idea that strong and independent risk management functions are necessary to effectively manage risks in 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.	2190.00	2001-2008
BANK OF AMERICA CORPORATION	1720.00	2001-2008
JPMORGAN CHASE & CO.	1560.00	2001-2008
WACHOVIA CORPORATION	783.00	2001-2007
WELLS FARGO & COMPANY	575.00	2001-2008
BARCLAYS GROUP US INC.	344.00	2005-2008
U.S. BANCORP	238.00	2001-2008
BANK OF NEW YORK MELLON CORP.	198.00	2001-2008
SUNTRUST BANKS, INC.	180.00	2001-2008
CAPITAL ONE FINANCIAL CORP	151.00	2001-2008
NATIONAL CITY CORPORATION	150.00	2001-2007
STATE STREET CORPORATION	143.00	2001-2008
REGIONS FINANCIAL CORPORATION	141.00	2002-2008
PNC FINANCIAL SERVICES GROUP	139.00	2001-2008
BB&T CORPORATION	133.00	2001-2008
FIFTH THIRD BANCORP	111.00	2001-2008
KEYCORP	99.57	2001-2008
BANCWEST CORPORATION	74.21	2001-2008
NORTHERN TRUST CORPORATION	67.61	2001-2008
M&T BANK CORPORATION	64.88	2001-2008
COMERICA INCORPORATED	62.76	2001-2008
MARSHALL & ILSLEY CORPORATION	59.86	2001-2008
UNIONBANCAL CORPORATION	55.73	2001-2008
HUNTINGTON BANCSHARES INC.	54.63	2001-2008
ZIONS BANCORPORATION	52.95	2001-2008
POPULAR, INC.	44.41	2001-2008
FIRST HORIZON NATIONAL CORP.	37.02	2000-2008
SYNOVUS FINANCIAL CORP.	33.02	2001-2008
NEW YORK COMMUNITY BANCORP	30.60	2001-2008
COLONIAL BANCGROUP, INC.,	25.97	2001-2008
ASSOCIATED BANC-CORP	21.59	2001-2008
BOK FINANCIAL CORPORATION	20.90	2001-2008
W HOLDING COMPANY, INC.	18.00	2001-2008
WEBSTER FINANCIAL CORPORATION	17.21	2001-2008
FIRST BANCORP	17.19	2001-2008
FIRST CITIZENS BANCSHARES,	16.23	2001-2008
COMMERCE BANCSHARES, INC.	16.21	2000-2008
TCF FINANCIAL CORPORATION	16.07	2001-2008
FULTON FINANCIAL CORPORATION	15.92	2001-2008

Continued on next page...

Name of BHC	2007 Assets ($ bn)	Time span in panel
CITY NATIONAL CORPORATION	15.89	2001-2008
SOUTH FINANCIAL GROUP, THE	13.87	2001-2008
CULLEN/FROST BANKERS, INC.	13.65	2001-2008
CITIZENS REPUBLIC BANCORP,	13.52	2001-2008
BANCORPSOUTH, INC.	13.20	2001-2008
SUSQUEHANNA BANCSHARES, INC.	13.08	2001-2008
VALLEY NATIONAL BANCORP	12.75	2001-2008
STERLING FINANCIAL CORPORATION	12.15	2001-2008
EAST WEST BANCORP, INC.	11.85	2001-2008
UCBH HOLDINGS, INC.	11.80	2001-2008
WILMINGTON TRUST CORPORATION	11.62	2001-2008
INTERNATIONAL BANCSHARES C	11.17	2001-2008
WHITNEY HOLDING CORPORATION	11.03	2001-2008
BANK OF HAWAII CORPORATION	10.47	2001-2008
FIRSTMERIT CORPORATION	10.41	2001-2008
FRANKLIN RESOURCES, INC.	9.63	2001-2008
WINTRUST FINANCIAL CORPORATION	9.37	2001- 2008
UMB FINANCIAL CORPORATION	9.34	2001-2008
DORAL GP LTD.	9.26	2001-2008
SANTANDER BANCORP	9.15	2001-2008
TRUSTMARK CORPORATION	8.97	2001-2008
CORUS BANKSHARES, INC.	8.93	2001-2007
FIRSTBANK HOLDING COMPANY	8.69	2001-2008
UMPQUA HOLDINGS CORPORATION	8.35	2001-2008
UNITED COMMUNITY BANKS, INC.	8.21	2001-2008
FIRST MIDWEST BANCORP, INC.	8.10	2001-2008
ALABAMA NATIONAL BANCORPORATION	8.00	2001-2007
UNITED BANKSHARES, INC.	7.99	2001-2008
OLD NATIONAL BANCORP	7.85	2001-2008
MB FINANCIAL, INC	7.83	2001-2008
CHITTENDEN CORPORATION	7.44	2001-2007
PACIFIC CAPITAL BANCORP	7.39	2001-2008
BOSTON PRIVATE FINANCIAL HOLDINGS, INC.	6.83	2001-2007

Appendix B: Definitions of key variables

BHC risk measures:

- *Downside Risk*: Mean implied volatility estimated from put options written on the BHC's stock.
- *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.

BHC risk management measures:

- *CRO Present*: A dummy variable that identifies if the BHC has a designated Chief Risk Officer.
- *CRO Executive*: A dummy variable that identifies if the CRO is an executive officer.
- *CRO-Top5*: A dummy variable that identifies if the CRO is among the five highest paid executives.
- *CRO Centrality*: Ratio (expressed as a percentage) of the CRO's total compensation to the CEO's total compensation. When 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. If the BHC does not have a CRO, then we define *CRO Centrality* based on the compensation of the Chief Financial Officer.
- *Board Committee Experience*: A dummy variable that identifies whether at least one of the directors serving on the board's risk committee has some banking experience.
- *Active Board Risk Committee*: A dummy variable that identifies if the BHC's board risk committee met more frequently during the year compared to the average board risk committee across all BHCs.
- *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 7 risk management measures defined above.

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.
- *Tier1 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.
- *Risky Non-Int. Income*: Defined as non-interest income (BHCK4079) *less* income from fiduciary activities (BHCK4070), service charges on deposit accounts (BHCK4483), and other non-interest income (BHCKB497). It includes income from security brokerage, investment banking and advisory fee, underwriting income, insurance income, fee from annuity sales, venture capital revenue, securitization income, and gains from sale of loans and assets.
- *Risky Non-Int. Income/Income*: Ratio of *Risky Non-Int. Income* to the sum of interest income (BHCK4107) and non-interest income (BHCK4079).
- *MBS*: Book value of mortgage-backed securities (BHCK3534+BHCK3535+BHCK3536) held by the BHC.
- *Trading Assets*: Total trading assets (BHCK3545) *less* investments in U.S. treasury securities (BHCK3531), U.S. government agency obligations (BHCK3532), and securities issued by states and political subdivisions in the U.S. (BHCK3533).
- *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).

Other BHC variables:

- *Inst. Ownership*: Percentage of shares owned by institutional investors.
- *G-Index*: Gompers, Ishii and Metrick (2003) governance index.
- *CEO Delta*: Sensitivity of CEO compensation to share price.
- *CEO Vega*: Sensitivity of CEO compensation to stock return volatility.

Table I: Summary Statistics

This table presents the descriptive statistics for the key variables used in our analysis. *Downside Risk* measures a BHC's downside risk, and is defined as the mean implied volatility estimated from put options written on the BHC's stock. *Std. Dev. Excess Return* and *Std. Dev. Return* measure a BHC's aggregate risk, and are defined as the standard deviation of the BHC's weekly excess return (over S&P500) and weekly return, respectively, 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.**	**Min**	**p25**	**p75**	**Max**	**N**
Downside Risk	0.347	0.335	0.105	0.184	0.272	0.404	1.140	358
Aggregate Risk	0.038	0.031	0.024	0.013	0.022	0.044	0.180	667
RMI	.400	.399	.202	.032	.265	.552	.903	567
CRO Present	0.573	1	0.495	0	0	1	1	569
CRO Executive	0.489	0	0.500	0	0	1	1	569
CRO Top5	0.191	0	0.393	0	0	0	1	561
CRO Centrality	.290	.230	.171	.100	.190	.350	.910	568
Board Committee Experience	.232	0	.422	0	0	0	1	569
Active Board Risk Committee	0.362	0	0.481	0	0	1	1	569
Report to Board	0.518	1	0.500	0	0	1	1	569
Assets (in $ billion)	96.7	12.7	270	.388	7.679	52.9	2190	707
Size	16.852	16.355	1.527	12.868	15.854	17.785	21.506	707
ROA	0.012	0.011	0.014	-0.053	0.009	0.014	0.194	707
Deposits/Assets	0.670	0.686	0.155	0.000	0.622	0.761	0.935	703
Tier1 Cap/Assets	0.080	0.075	0.043	0.005	0.066	0.085	0.568	707
Loans/Assets	0.618	0.672	0.164	0.028	0.572	0.721	0.859	707
Real Estate Loans/Assets	0.393	0.410	0.153	0	0.301	0.494	0.845	707
C&I Loans/Assets	0.120	0.116	0.075	0	0.072	0.157	0.477	707
Consumer Loans/Assets	0.059	0.045	0.055	0	0.018	0.091	0.577	707
Agri. Loans/Assets	0.003	0.001	0.004	0	0.000	0.005	0.024	706
Loan concentration	0.512	0.484	0.164	0.260	0.388	0.600	1.002	706
Bad Loans/Assets	0.007	0.004	0.010	0	0.003	0.007	0.183	707
Risky Income/Income	0.087	0.049	0.138	-0.088	0.023	0.094	0.936	575
Deriv. Hedging/Assets	0.102	0.030	0.198	0	0.002	0.110	2.010	704
Deriv. Trading/Assets	1.173	0	5.221	0	0	0.125	49.231	704
Inst. Ownership (in %)	47.210	48.768	21.758	.424	31.095	63.629	96.864	647
Delta (in $ '000)	0.016	0.005	0.033	0.000	0.002	0.014	0.219	470
Vega (in $ '000)	0.137	0.056	0.231	0	0.015	0.141	1.505	445
G-Index	9.747	10	2.829	2	8	12	15	534

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 A 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. *Aggregate Risk* is defined as the standard deviation of the BHC's weekly excess return (over S&P500), computed over the calendar 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	Aggregate Risk	RMI_{t-1}	$Size_{t-1}$
Downside Risk	1.000			
Aggregate Risk	0.550	1.000		
RMI_{t-1}	-0.457	-0.215	1.000	
$Size_{t-1}$	-0.273	-0.093	0.459	1.000
ROA_{t-1}	0.055	-0.012	-0.125	-0.166
$(\text{Tier1 Cap/Assets})_{t-1}$	0.115	0.058	-0.141	-0.252
$(\text{Deposits/Assets})_{t-1}$	-0.023	-0.080	-0.088	-0.418
$(\text{Bad Loans/Assets})_{t-1}$	-0.001	0.079	0.186	0.262
$(\text{Frac. risky income})_{t-1}$	-0.030	-0.035	0.058	0.200
Inst. $Ownership_{t-1}$	0.025	0.167		0.303
CEO's Delta	0.262	0.162	-0.288	-0.287
CEO's Vega	-0.215	-0.121	0.185	0.476
G-Index	0.099	-0.017	-0.042	-0.384
$(\text{Deriv. Trading/Assets})_{t-1}$	-0.012	0.114	0.189	0.612
$(\text{Deriv. Hedging/Assets})_{t-1}$	-0.143	-0.094	0.046	0.492

Panel B: Correlations between BHC Risk and Components of RMI

	Downside Risk	Aggregate Risk	RMI_{t-1}
CRO $Present_{t-1}$	-0.263	-0.077	0.715
CRO $Executive_{t-1}$	-0.250	-0.099	0.696
CRO $Top5_{t-1}$	-0.017	0.027	0.349
CRO $Centrality_{t-1}$	-0.007	-0.047	0.343
Board Committee $Experience_{t-1}$	-0.306	0.008	0.533
Report to $Board_{t-1}$	-0.146	-0.112	0.059
Active Board Risk $Committee_{t-1}$	-0.193	-0.142	0.321

Table III: RMI and performance during crisis years

This table reports the results of the cross-sectional regression (1) that examines whether BHCs with strong and independent risk management functions 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. The key independent variable is the RMI in 2006. We include year fixed effects in the regression. Standard errors are reported in parentheses. Asterisks denote statistical significance at the 1% (***), 5% (**) and the 10% (*) levels.

Dep. Variable=	MBS holdings		Trading Assets		Deriv. Trading		ROA	Stock Return	Imp. Vol.
	Raw ($mn)	Scaled	Raw ($mn)	Scaled	Raw ($mn)	Scaled			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RMI in 2006	-13.205	-.003	-110.578	-.039	-9350.833	-4.100	.013	.261	-.207
	(6.266)**	(.003)	(46.557)**	(.017)**	(4237.401)**	(2.137)*	(.007)*	(.187)	(.072)***
Size 2006	5.742	.0007	43.987	.021	5729.065	3.167	-.003	-.087	-.008
	(1.631)***	(.0008)	(12.465)***	(.005)***	(1881.627)***	(1.006)***	(.0008)***	(.040)**	(.010)
ROA in 2006	-284.656	-.082	-2193.123	-.974	-377111.100	-204.985	1.262	12.783	-4.608
	(161.225)*	(.146)	(1190.537)*	(.597)	(215229.100)*	(116.766)*	(.230)***	(7.752)*	(1.987)**
Tier1 Cap/Assets in 2006	51.975	-.075	586.646	.221	107356.200	56.929	-.055	-3.638	.962
	(47.752)	(.049)	(369.482)	(.176)	(64777.210)*	(35.138)	(.068)	(2.225)	(.604)
Bad loans/Assets in 2006	-312.984	-.488	-1179.532	-1.139	-213323.000	-133.572	-.274	.468	14.277
	(148.745)**	(.170)***	(1006.356)	(.476)**	(146321.700)	(77.919)*	(.429)	(13.748)	(7.057)**
Deposits/Assets in 2006	-11.567	-.049	5.390	-.048	5629.184	4.311	-.007	.244	-.017
	(6.013)*	(.012)***	(57.410)	(.022)**	(8333.520)	(4.574)	(.012)	(.408)	(.206)
ROA in 2006	-11.201	-.015	-56.557	-.063	-9536.008	-7.318	-.018	-.182	-.291
	(7.347)	(.008)*	(45.730)	(.020)***	(7098.122)	(3.368)**	(.010)*	(.312)	(.190)
Const.	-73.871	.045	-669.506	-.253	-92340.210	-50.729	.047	1.659	.709
	(27.602)***	(.024)*	(219.949)***	(.088)***	(34110.180)***	(18.445)***	(.018)***	(.878)*	(.239)***
Obs.	134	134	134	134	134	134	134	128	49
R^2	.523	.654	.476	.66	.384	.422	.783	.309	.541
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

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 2001-2008. In Panel A, the dependent variable is *Downside Risk*, while in Panel B, the dependent variable is *Aggregate Risk*. 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 A: Impact of RMI on Downside Risk

	(1)	(2)	(3)	(4)
RMI_{t-1}	-.430	-.471	-.479	-.504
	(.222)*	(.229)**	(.245)*	(.253)**
$Size_{t-1}$	-.00008	.003	.008	.013
	(.039)	(.040)	(.047)	(.048)
ROA_{t-1}	1.719	1.861	5.484	6.522
	(1.779)	(1.830)	(3.230)*	(3.507)*
$(Deposits/Assets)_{t-1}$	.229	.239	.273	.287
	(.164)	(.170)	(.193)	(.200)
$(Tier1\ Cap/Assets)_{t-1}$	-1.093	-1.169	-1.404	-1.477
	(.622)*	(.648)*	(.859)	(.890)*
$(Bad\ Loans/Assets)_{t-1}$	8.303	7.428	10.572	10.711
	(3.270)**	(3.492)**	(3.824)***	(4.009)***
$(Loans/Assets)_{t-1}$	-.067		-.110	-.105
	(.157)		(.173)	(.183)
$(Real\ Estate\ Loans/Assets)_{t-1}$		-.116		
		(.169)		
$(C\&I\ Loans/Assets)_{t-1}$		.206		
		(.391)		
$(Consumer\ Loans/Assets)_{t-1}$		.063		
		(.334)		
$(Agri.\ Loans/Assets)_{t-1}$		-1.926		
		(6.297)		
$(Other\ Loans/Assets)_{t-1}$		-.077		
		(.363)		
$(Loan\ Concentration)_{t-1}$		.020	-.115	-.201
		(.180)	(.170)	(.187)
$(Risky\ Income/Income)_{t-1}$	-.139	-.150	-.325	-.337
	(.181)	(.186)	(.226)	(.245)
Log(Ownership)				.067
				(.079)
(CEO's Delta)			-2.397	-2.456
			(1.209)**	(1.243)**
(CEO's Vega)			-.021	-.013
			(.039)	(.041)
(G-Index)				.0003
				(.017)
Const.	.479	.424	.408	.100
	(.738)	(.776)	(.895)	(.992)
Obs.	247	247	204	199
R^2	.65	.652	.644	.647
BHC FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Panel B: Impact of RMI on Aggregate Risk

	(1)	(2)	(3)	(4)
RMI_{t-1}	-.064	-.061	-.048	-.056
	(.029)**	(.029)**	(.029)*	(.030)*
$Size_{t-1}$	.0002	.0005	-.007	-.006
	(.005)	(.005)	(.004)	(.005)
ROA_{t-1}	-.314	-.375	-.363	-.142
	(.166)*	(.172)**	(.342)	(.387)
$(Deposits/Assets)_{t-1}$	.030	.033	.042	.040
	(.019)	(.019)*	(.020)**	(.021)*
$(Tier1\ Cap/Assets)_{t-1}$	.040	.031	.006	-.006
	(.078)	(.079)	(.090)	(.097)
$(Bad\ Loans/Assets)_{t-1}$	.993	.886	1.298	1.333
	(.308)***	(.314)***	(.372)***	(.418)***
$(Loans/Assets)_{t-1}$	-.043		-.033	-.025
	(.020)**		(.019)*	(.021)
$(Real\ Estate\ Loans/Assets)_{t-1}$		-.052		
		(.022)**		
$(C\&I\ Loans/Assets)_{t-1}$		.017		
		(.049)		
$(Consumer\ Loans/Assets)_{t-1}$		-.043		
		(.042)		
$(Agri.\ Loans/Assets)_{t-1}$		-.950		
		(.465)**		
$(Other\ Loans/Assets)_{t-1}$		-.042		
		(.041)		
$(Loan\ Concentration)_{t-1}$		.040	.032	.023
		(.020)**	(.019)	(.021)
$(Risky\ Income/Income)_{t-1}$	-.052	-.056	-.006	.008
	(.024)**	(.024)**	(.024)	(.028)
Log(Ownership)				.007
				(.007)
CEO's Delta			-.118	-.109
			(.150)	(.154)
CEO's Vega			-.007	-.005
			(.004)	(.005)
G-Index				.002
				(.002)
Const.	.060	.033	.144	.072
	(.087)	(.089)	(.082)*	(.103)
Obs.	436	436	284	268
R^2	.798	.803	.851	.855
BHC FE	Yes	Yes	Yes	Yes
Year FE	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 are reported in parentheses. 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	-.327	-.056	-.429	-.060	-.445	-.053	-.422	-.059
	(.225)	(.029)*	(.223)*	(.029)**	(.229)*	(.030)*	(.223)*	(.029)**
Large BHC	.799	.039						
	(.384)**	(.027)						
Large BHC*RMI	-1.155	-.075						
	(.532)**	(.043)*						
Low ROA BHC			.008	.017				
			(.051)	(.006)***				
Low ROA BHC*RMI			-.017	-.033				
			(.099)	(.013)**				
Low Deposits BHC					.019	.016		
					(.110)	(.010)		
Low Deposits BHC*RMI					.008	-.033		
					(.178)	(.017)*		
High Deriv. Trading BHC							.033	.023
							(.080)	(.012)*
High Deriv. Trading BHC*RMI							-.040	-.041
							(.139)	(.021)*
Const.	.164	.062	.418	.047	.316	.049	.501	.063
	(.747)	(.087)	(.757)	(.087)	(.782)	(.090)	(.744)	(.087)
Obs.	247	436	247	436	247	436	247	436
R^2	.659	.8	.65	.802	.652	.8	.65	.8
BHC FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table VI: Impact of RMI on Stock Returns, 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 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.

Dep. Variable = Annual Return on BHC's Stock

	(1)	(2)	(3)	(4)
RMI_{t-1}	1.007	1.003	.947	1.008
	(.399)**	(.401)**	(.437)**	(.445)**
$Size_{t-1}$	-.407	-.412	-.392	-.449
	(.064)***	(.064)***	(.075)***	(.079)***
ROA_{t-1}	-4.438	-4.222	-12.719	-15.352
	(2.271)*	(2.362)*	(5.546)**	(6.004)**
$(Deposits/TA)_{t-1}$	-.117	-.151	-.503	-.619
	(.258)	(.265)	(.321)	(.327)*
$(Tier1\ Cap/TA)_{t-1}$	.647	.780	-.314	-.566
	(1.066)	(1.084)	(1.510)	(1.580)
$(Bad\ Loans/TA)_{t-1}$	-2.937	-1.356	-8.922	-8.065
	(4.209)	(4.316)	(5.961)	(6.403)
$(Loans/TA)_{t-1}$	-.056		-.065	-.094
	(.275)		(.320)	(.333)
$(Real\ Estate\ Loans/TA)_{t-1}$		.061		
		(.300)		
$(C\&I\ Loans/TA)_{t-1}$		-.727		
		(.677)		
$(Consumer\ Loans/TA)_{t-1}$		-.354		
		(.583)		
$(Agri.\ Loans/TA)_{t-1}$		12.195		
		(6.402)*		
$(Other\ Loans/TA)_{t-1}$		-.052		
		(.558)		
$(Loan\ Concentration)_{t-1}$		-.195	.024	.099
		(.276)	(.306)	(.324)
$(Risky\ Income/Income)_{t-1}$	.307	.380	.620	.915
	(.334)	(.337)	(.400)	(.445)**
$Log(Ownership)_{t-1}$				.002
				(.119)
CEO's $Delta_{t-1}$			.050	.058
			(1.614)	(1.615)
CEO's $Vega_{t-1}$			.102	.096
			(.077)	(.085)
$G\text{-}Index_{t-1}$				-.008
				(.034)
Const.	6.528	6.728	6.632	7.833
	(1.192)***	(1.224)***	(1.474)***	(1.675)***
Obs.	436	436	294	277
R^2	.657	.663	.697	.721
BHC FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table VII: Simultaneous Equations Model

This table reports the results of the simultaneous equations regressions model (3) designed to account for how risk and RMI are jointly determined. The risk measure in Panel A is *Downside Risk*, while the risk measure in Panel B is *Aggregate Risk*. Variable definitions are listed in Appendix B. We estimate the model using three-stage least squares (3SLS). Standard errors are reported in parentheses. Asterisks denote statistical significance at the 1% (***), 5% (**) and 10% (*) levels.

	Panel A		**Panel B**	
	Downside Risk	RMI	Aggregate Risk	RMI
	(1)	(2)	(3)	(4)
RMI	-.266		-.022	
	(.087)***		(.010)**	
Downside Risk		-1.342		
		(.693)*		
Aggregate Risk				-9.145
				(3.818)**
Size_{t-1}	.0006	.066	-.0009	.070
	(.007)	(.023)***	(.0008)	(.015)***
ROA_{t-1}	-3.578	-7.293	-.408	-5.579
	(1.258)***	(3.077)**	(.116)***	(2.348)**
$(\text{Deposits/Assets})_{t-1}$	-.077		-.012	
	(.044)*		(.004)***	
$(\text{Tier1 Cap/Assets})_{t-1}$	.854	1.771	.057	.894
	(.342)**	(.817)**	(.031)*	(.590)
$(\text{Loans/Assets})_{t-1}$		.134		.193
		(.104)		(.071)***
$(\text{Loan Concentration})_{t-1}$	.055		.010	
	(.033)*		(.004)***	
$(\text{Bad Loans/Assets})_{t-1}$	1.870	3.640	.683	10.293
	(1.833)	(4.148)	(.183)***	(3.545)***
$(\text{Risky Income/Income})_{t-1}$	.024	.170	.008	.283
	(.064)	(.145)	(.007)	(.122)**
$(\text{Deriv. Hedging})_{t-1}$		-3.54e-10		-3.60e-10
		(1.52e-10)**		(1.01e-10)***
Obs.	242	242	368	368
R^2	.307	.35	.336	.278
Year FE	Yes	Yes	Yes	Yes