Lessons from the Financial Crisis for Risk Management *

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I. Introduction

Estimates prior to the demise of Lehman Brothers suggested that U.S. banks and investment banks stood lose up to $250 billion from their exposure to residential mortgages securities.[1] With the sharp downturn that began in the fall of 2008, the losses ultimately look to be much higher. But even before the global economic collapse in late 2008, the resulting depletion of bank capital has led to unprecedented disruptions in the market for interbank funds and to sharp contractions in credit supply, with adverse consequences for the larger economy. A number of questions arise immediately. Why were banks so vulnerable to problems in the mortgage market? What does this vulnerability say about the effectiveness of current regulation? How should regulatory objectives and actual regulation change to minimize the risks of future crises? These are the questions that consider in this paper.

Our brief answers are as follows. The proximate cause of the credit crisis (as distinct from the housing crisis) was the interplay between two choices made by banks. First, substantial amounts of mortgage-backed securities with exposure to subprime risk were kept on bank balance sheets even though the "originate and distribute" model of securitization that many banks ostensibly followed was supposed to transfer risk to those institutions better able to bear it, such as unleveraged pension funds.[2] Second, across the board, banks financed these and other risky assets with short-term market borrowing.

This combination proved problematic for the system. As the housing market deteriorated, the perceived risk of mortgage-backed securities increased, and it became difficult

[1] See Bank for International Settlements (2008, chapter 6), Bank of England (2008), Bernanke (2008), Borio (2008), Brunnermeier (2008), Dudley (2007, 2008), Greenlaw et al (2008), IMF (2008), and Knight (2008) for comprehensive descriptions of the crisis.

[2] Throughout this paper, I use the word "bank" to refer to both commercial and investment banks. I say "commercial bank" when I refer to only the former

to roll over short-term loans against these securities. Banks were thus forced to sell the assets they could no longer finance, and the value of these assets plummeted, perhaps even below their fundamental values—i.e., funding problems led to fire sales and depressed prices. And as valuation losses eroded bank capital, banks found it even harder to obtain the necessary short-term financing—i.e., fire sales created further funding problems, a feedback loop that spawned a downward spiral.[3] Bank funding difficulties spilled over to bank borrowers, as banks cut back on loans to conserve liquidity, thereby slowing the whole economy.

The natural regulatory reaction to prevent a future recurrence of these spillovers might be to mandate higher bank capital standards, so as to buffer the economy from financial-sector problems. But this would overlook a more fundamental set of problems relating to corporate governance and internal managerial conflicts in banks—broadly termed agency problems in the finance literature. The failure to offload subprime risk may have been the leading symptom of these problems during the current episode, but they are a much more chronic and pervasive issue for banks—one need only to think back to previous banking troubles involving developing country loans, highly-leveraged transactions, and commercial real estate to reinforce this point. In other words, while the specific manifestations may change, the basic challenges of devising appropriate incentive structures and internal controls for bank management have long been present.

These agency problems play an important role in shaping banks' capital structures. Banks perceive equity to be an expensive form of financing, and take steps to use as little of it as possible; indeed a primary challenge for capital regulation is that it amounts to forcing banks

[3] See Brunnermeier and Pedersen (2008) for a detailed analysis of these kinds of spirals and Adrian and Shin (2008) for empirical evidence on the spillovers.

to hold more equity than they would like. One reason for this cost-of-capital premium is the high level of discretion that an equity-rich balance sheet grants to bank management. Equity investors in a bank must constantly worry that bad decisions by management will dissipate the value of their shareholdings. By contrast, secured short-term creditors are better protected against the actions of wayward bank management. Thus the tendency for banks to finance themselves largely with short-term debt may reflect a privately optimal response to governance problems.

This observation suggests a fundamental dilemma for regulators as they seek to prevent banking problems from spilling over onto the wider economy. More leverage, especially short-term leverage, may be the market's way of containing governance problems at banks; this is reflected in the large spread between the costs to banks of equity and of short-term debt. But when governance problems actually emerge, as they invariably do, bank leverage becomes the mechanism for propagating bank-specific problems onto the economy as a whole. A regulator focused on the proximate causes of the crisis would prefer lower bank leverage, imposed for example through a higher capital requirement. This will reduce the risk of bank defaults. However, the higher capital ratio will also increase the overall cost of funding for banks, especially if higher capital ratios in good times exacerbate agency problems.

Moreover, given that the higher requirement holds in both good times and bad, a bank faced with large losses will still face an equally unyielding tradeoff—either liquidate assets or raise fresh capital. As we have seen during the current crisis, and as discussed in more detail below, capital-raising tends to be sluggish. Not only is capital a relatively costly mode of funding at all times, it is particularly costly for a bank to raise new capital during times of great uncertainty. Moreover, at such times many of the benefits of building a stronger balance sheet

accrue to other banks and to the broader economy, and thus are not properly internalized by the capital-raising bank.

There is considerable work underway in the regulatory community to reform capital standards to try to make the financial system more stable. I will argue that a natural complement to these efforts must be to better understand the nature of gambles that banks took in the last crisis that destabilized the system. More specifically, not all banks got into the same type of trouble. It is essential to understand why risk management practices at some firms worked better than at others. This is a particularly challenging task because so many of the critical factors that led to better or worse outcomes are not easily observed using standard publicly available data. Fortunately, this commission has the power of subpoena which makes it possible to shed light on some of the most difficult to understand aspects of the crisis.

Put differently, the costs of poor risk management during the crisis were very high and the benefits of bringing better practices to the industry would be large. Through standard channels gathering the kind of information necessary to affect this change would be prohibitively expensive. This commission has a unique toolkit and opportunity to make progress on these questions. Hence there is a strong case to be made for having the commission make these questions

The rest of the paper is organized as follows. In Section II., we describe the causes of the current financial crisis, and its spillover effects onto the real economy. In section III. we discuss the limited evidence on how risk management differences across organizations influenced outcomes. Section IV concludes with some open questions about risk management practices that I encourage the commission to investigate.

II. The Credit-Market Crisis: Causes and Consequences

I begin by asking why so many mortgage-related securities ended up on bank balance sheets, and why banks funded these assets with so much short-term borrowing.

II.A. Agency problems and the demand for low-quality assets

My preferred explanation for why bank balance sheets contained problematic assets, ranging from exotic mortgage-backed securities to covenant-light loans, is that there was a breakdown of incentives and risk control systems within banks.[4] A key factor contributing to this breakdown is that, over short periods of time, it is very hard, especially in the case of new products, to tell whether a financial manager is generating true excess returns adjusting for risk, or whether the current returns are simply compensation for a risk that has not yet shown itself but that will eventually materialize. Consider the following specific manifestations of the problem.

Incentives at the top

The performance of CEOs is evaluated based in part on the earnings they generate relative to their peers. To the extent that some leading banks can generate legitimately high returns, this puts pressure on other banks to keep up. Follower-bank bosses may end up taking excessive risks in order to boost various observable measures of performance. Indeed, even if managers recognize that this type of strategy is not truly value-creating, a desire to pump up their stock prices and their personal reputations may nevertheless make it the most attractive option for them (Stein (1989), Rajan (1994)).

[4] See Hoenig (2008) and Rajan (2005) for a similar diagnosis.

There is anecdotal evidence of such pressure on top management. Perhaps most famously, Citigroup Chairman Chuck Prince, describing why his bank continued financing buyouts despite mounting risks, said:

"When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."[5]

Flawed internal compensation and control

Even if top management wants to maximize long-term bank value, it may find it difficult to create incentives and control systems that steer subordinates in this direction. Retaining top traders, given the competition for talent, requires that they be paid generously based on performance. But high-powered pay-for-performance schemes create an incentive to exploit deficiencies in internal measurement systems. For instance, at UBS, AAA-rated mortgage-backed securities were apparently charged a very low internal cost of capital. Traders holding these securities were allowed to count any spread in excess of this low hurdle rate as income, which then presumably fed into their bonuses.[6] No wonder that UBS loaded up on mortgage-backed securities.

More generally, traders have an incentive to take risks that are not recognized by the system, so they can generate income that appears to stem from their superior abilities, even though it is in fact only a market risk premium.[7] The classic case of such behavior is to write

[5] Financial Times, July 9, 2007.

[6] *Shareholder Report on UBS Writedowns*, April 18th 2008, http://www.ubs.com/1/e/investors/agm.html.

[7] Another example of the effects of uncharged risk is described in the *Shareholder Report on UBS Writedowns* on page 13: "The CDO desk received structuring fees on the notional value of the deal, and focused on Mezzanine ("Mezz") CDOs, which generated fees of approximately 125 to 150 bp (compared with high-grade CDOs, which generated fees of approximately 30 to 50 bp)." The greater fee income from originating riskier, lower quality mortgages fed directly to the originating unit's bottom line, even though this fee income was, in part, compensation for the greater risk that UBS would be stuck with unsold securities in the event that market conditions turned.

insurance on infrequent events, taking on what is termed "tail" risk. If a trader is allowed to boost her bonus by treating the entire insurance premium as income, instead of setting aside a significant fraction as a reserve for an eventual payout, she will have an excessive incentive to engage in this sort of trade.

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, because tail risks are by their nature rare, and therefore hard to quantify with precision before they occur. Absent an agreed-on model of the underlying probability distribution, risk managers will be forced to impose crude and subjective-looking limits on the activities of those traders who are seemingly the bank's most profitable employees. This is something that is unlikely to sit well with a top management that is being pressured for profits.[8] As a run of good luck continues, risk managers are likely to become increasingly powerless, and indeed may wind up being most ineffective at the point of maximum danger to the bank.

II.B. Agency problems and the (private) appeal of short-term borrowing

The specific manifestations just described are broadly known in the finance literature as managerial agency problems. The poor investment decisions that result from these agency

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[8] As the Wall Street Journal (April 16, 2008) reports, "Risk controls at [Merrill Lynch], then run by CEO Stan O'Neal, were beginning to loosen. A senior risk manager, John Breit, was ignored when he objected to certain risks…Merrill lowered the status of Mr. Breit's job...Some managers seen as impediments to the mortgage-securities strategy were pushed out. An example, some former Merrill executives say, is Jeffrey Kronthal, who had imposed informal limits on the amount of CDO exposure the firm could keep on its books ($3 billion to $4 billion) and on its risk of possible CDO losses (about $75 million a day). Merrill dismissed him and two other bond managers in mid-2006, a time when housing was still strong but was peaking. To oversee the job of taking CDOs onto Merrill's own books, the firm tapped …a senior trader but one without much experience in mortgage securities. CDO holdings on Merrill's books were soon piling up at a rate of $5 billion to $6 billion per quarter." Bloomberg (July 22, 2008, "Lehman Fault-Finding Points to Last Man Fuld as Shares Languish") reports a similar pattern at Lehman Brothers whereby "at least two executives who urged caution were pushed aside." The story quotes Walter Gerasimowicz, who worked at Lehman from 1995 to 2003, as saying "Lehman at one time had very good risk management in place. They strayed in search of incremental profit and market share."

problems would not be so systemically threatening if banks were not also highly levered, and if such a large fraction of their borrowing was not short-term in nature.

Why is short-term debt such an important source of finance for banks? One answer is that short-term debt is an equilibrium response to the agency problems described above.[9] If instead banks were largely equity financed, this would leave management with a great deal of unchecked discretion, and shareholders with little ability to either restrain value-destroying behavior, or to ensure a return on their investment. Thus banks find it expensive to raise equity financing, while debt is generally seen as cheaper.[10] This is particularly true if the debt can be collateralized against a specific asset, since collateral gives the investor powerful protection against managerial misbehavior.

The idea that collateralized borrowing is a response to agency problems is a common theme in corporate finance (see, e.g., Hart and Moore (1998)), and of course this is how many assets—from real estate to plant and equipment—are financed in operating firms. What distinguishes collateralized borrowing in the banking context is that it tends to be very short-term in nature. This is likely due to the highly liquid and transformable nature of banking firms' assets, a characteristic emphasized by Myers and Rajan (1998). For example, unlike with a plot of land, it would not give a lender much comfort to have a long-term secured interest in a bank's overall trading book, given that the assets making up this book can be completely reshuffled overnight. Rather, any secured interest will have to be in the individual

[9] The insight that agency problems lead banks to be highly levered goes back to Diamond's (1984) classic paper.

[10] By analogy, it appears that the equity market penalizes too much financial slack in operating firms with poor governance. For example, Dittmar and Mahrt-Smith (2007) estimate that $1.00 of cash holdings in a poorly-governed firm is only valued by the market at between $0.42 and $0.88.

components of the trading book, and given the easy resale of these securities, will tend to short-term in nature.

This line of argument helps to explain why short-term, often secured, borrowing is seen as significantly cheaper by banks than either equity or longer-term (generally unsecured) debt. Of course, short-term borrowing has the potential to create more fragility as well, so there is a tradeoff. However, the costs of this fragility may in large part be borne systemically, during crisis episodes, and hence not fully internalized by individual banks when they pick an optimal capital structure.[11] It is to these externalities that we turn next.

II.C. Externalities during a crisis episode

When banks suffer large losses, they are faced with a basic choice: either they can shrink their (risk-weighted) asset holdings, so that they continue to satisfy their capital requirements with their now-depleted equity bases, or they can raise fresh equity. For a couple of reasons, equity-raising is likely to be sluggish, leaving a considerable fraction of the near-term adjustment to be taken up by asset liquidations. One friction comes from what is known as the debt overhang problem (Myers (1977)): by bolstering the value of existing risky debt, a new equity issue results in a transfer of value from existing shareholders. A second difficulty is that equity issuance may send a negative signal, suggesting to the market that there are more losses to come (Myers and Majluf (1984)). Thus banks may be reluctant to raise new equity when under stress. It may also be difficult for them to cut dividends to stem the outflow

[11] A more subtle argument is that the fragile nature of short-term debt financing is actually part of its appeal to banks: precisely because it amplifies the negative consequences of mismanagement, short-term debt acts as a valuable ex ante commitment mechanism for banks. See Calomiris and Kahn (1991). However, when thinking about capital regulation, the critical issue is whether short-term debt has some social costs that are not fully internalized by individual banks.

of capital, for such cuts may signal management's lack of confidence in the firm's future. And a loss of confidence is the last thing a bank needs in the midst of a crisis.

Figure 1 plots both cumulative disclosed losses and new capital raised by global financial institutions (these include banks and brokerage firms) during the year of the credit crisis (before the TARP transfers occurred). As can be seen, while there was substantial capital raising, it trailed far behind aggregate losses. The gap was most pronounced in the fourth quarter of 2007 and the first quarter of 2008, when cumulative capital raised was only a fraction of cumulative losses. For example, through 2008Q1, cumulative losses stood at $394.7 billion, while cumulative capital raised was only $149.1 billion, leaving a gap of $245.6 billion. The situation improved in the second quarter of 2008, when reported losses declined, while the pace of capital raising accelerated.

While banks may have good reasons to move slowly on the capital-raising front, this gradual recapitalization process imposes externalities on the rest of the economy.

The fire sale externality

If a bank does not want to raise capital, the obvious alternative will be to sell assets, particularly those that have become hard to finance on a short-term basis.[12] This creates what might be termed a fire-sale externality. Elements of this mechanism have been described in theoretical work by Allen and Gale (2005), Brunnermeier and Pedersen (2008), Kyle and Xiong (2001), Gromb and Vayanos (2002), Morris and Shin (2004), and Shleifer and Vishny

[12]In a Basel II regime, the pressure to liquidate assets is intensified in crisis periods because measured risk levels—and hence risk-weighted capital requirements—go up. One can get a sense of magnitudes from investment banks, who disclose firm-wide "value at risk" (VaR) numbers. Greenlaw et al (2008) calculate a simple average of the reported VaR for Morgan Stanley, Goldman Sachs, Lehman Brothers and Bear Stearns, and find that it rose 34% between August 2007 and February 2008.

(1992, 1997) among others, and it has occupied a central place in accounts of the demise of Long-Term Capital Management in 1998.

When bank A adjusts by liquidating assets—e.g., it may sell off some of its mortgage-backed securities—it imposes a cost on another bank B who holds the same assets: the mark-to-market price of B's assets will be pushed down, putting pressure on B's capital position and in turn forcing it to liquidate some of its positions. Thus selling by one bank begets selling by others, and so on, creating a vicious circle.

This fire-sale problem is further exacerbated when, on top of capital constraints, banks also face short-term funding constraints. In the example above, even if bank B is relatively well-capitalized, it may be funding its mortgage-backed securities portfolio with short-term secured borrowing. When the mark-to-market value of the portfolio falls, bank B will effectively face a margin call, and may be unable to roll over its loans. This too can force B to unwind some of its holdings. Either way, the end result is that bank A's initial liquidation—through its effect on market prices and hence its impact on bank B's price-dependent financing constraints—forces bank B to engage in a second round of forced selling, and so on.

The credit crunch externality

What else can banks do to adjust to a capital shortage? Clearly, other more liquid assets (e.g. Treasuries) can be sold, but this will not do much to ease the crunch since these assets do not require much capital in the first place. The weight of the residual adjustment will fall on other assets that use more capital, even those far from the source of the crisis. For instance, banks may cut back on new lending to small businesses. The externality here stems from the fact that a constrained bank does not internalize the lost profits from projects the small businesses terminate or forego, and the bank-dependent enterprises cannot obtain finance

elsewhere (see, e.g., Diamond and Rajan (2005)). Adrian and Shin (2008) provide direct evidence that these balance sheet fluctuations affect various measures of aggregate activity, even controlling for short-term interest rates and other financial market variables.

Ivashina and Scharfstein (2009) study lending patterns during 2007 and 2008 to assess the importance of the credit crunch hypothesis. They emphasize that most bank credit is extended as a loan commitment that gives the borrower the right to draw the credit when it is needed. They collect news reports suggesting that there was a post-Lehman surge in borrowing largely because many firms opted to access their lines of credit prophylactically out of fear of subsequently losing access to credit. This complicates the interpretation of simple lending volumes.

To overcome the loan commitment complications, Ivashina and Scharfstein look at syndicated credit lines involving multiple lenders that included Lehman. They show that loan pools that included Lehman were disproportionately tapped after Lehman's failure – presumably because the borrower was worried about whether new credit could be arranged. They demonstrate that banks which happened to be in more loan pools that involved Lehman tended to cut significantly their new lending in the months after Lehman's demise.

The presumption that credit availability declined during the crisis is buttressed by survey data. For example, the Federal Reserve's survey of loans officers report that credit conditions were progressively tightened during 2008. Campello, Graham and Harvey (2009) survey the chief financial officers of large firms, asking them about their perceptions of credit conditions and corporate decisions as of late November 2008. They find more than half the U.S. respondents report that their firms were either "somewhat or very affected by the cost or availability of credit".

Recapitalization as a public good

From a social planner's perspective, what is going wrong in both the fire-sale and credit-crunch cases is that bank A should be doing more of the adjustment to its initial shock by trying to replenish its capital base, and less by liquidating assets or curtailing lending. When bank A makes its privately-optimal decision to shrink, it fails to take into account the fact that were it to recapitalize instead, this would spare others in the chain the associated costs. It is presumably for this reason that Federal Reserve officials, among others, have been urging banks to take steps to boost their capital bases, either by issuing new equity or by cutting dividends.[13]

A similar market failure occurs when bank A chooses its initial capital structure up front and must decide how much, if any, "dry powder" to keep. In particular, one might hope that bank A would choose to hold excess capital well above the regulatory minimum, and not to have too much of its borrowing be short-term, so that when losses hit, it would not be forced to impose costs on others. Unfortunately, to the extent that a substantial portion of the costs are social, not private costs, any individual bank's incentives to keep dry powder may be too weak.

II.D. Alternatives for regulatory reform

Since the banking crisis (as distinct from the housing crisis) has roots in both bank governance and capital structure, reforms could be considered in both areas. Start first with governance. Regulators could play a coordinating role in cases where action by individual

[13] For instance, Bernanke (2008) says: "I strongly urge financial institutions to remain proactive in their capital-raising efforts. Doing so not only helps the broader economy but positions firms to take advantage of new profit opportunities as conditions in the financial markets and the economy improve."

banks is difficult for competitive reasons—for example, in encouraging the restructuring of employee compensation so that some performance pay is held back until the full consequences of an investment strategy play out, thus reducing incentives to take on tail risk. More difficult, though equally worthwhile, would be to find ways to present a risk-adjusted picture of bank profits, so that CEOs do not have an undue incentive to take risk to boost reported profits.

But many of these problems are primarily for corporate governance, not regulation, to deal with, and given the nature of the modern financial system and the tools available to regulators incredibly difficult to improve upon. This diagnosis explains why the official community has devoted so much energy to revising and refining capital regulation.

But this commission has several advantages that make the prospects for making progress much brighter. One unique edge is the ability to investigate firms all through the financial system, not just in one corner. The fractured nature of our regulatory system creates problems for any other entity to conduct this kind of investigation because no single regulator has comprehensive authority.

Second, the commission has an arm's length relationship with the firms it will be investigating. The regulators have a co-dependency on the firms they supervise, without some cooperation it becomes much more difficulty for the supervisors to function. Likewise, the existing regulators face a difficult problem if they uncover problems now that they should have found earlier.

Finally, press accounts of what happened at many of the most troubled firms present many conflicting reports. The subpoena power should allow it to get to the bottom of many of these issues.

III. The Role of Risk Management

There is a nearly unanimous view amongst the regulators that lapses in risk management played a critical role in exacerbating the crisis. For instance, the President's Working Group on Financial Regulation (2008), writing in March just before the Bear Stearns collapse, cited "risk management weaknesses at some large U.S. and European financial institutions" as one of "the principal underlying causes of the turmoil in financial markets". That report faulted "regulatory policies, including capital and disclosure requirements that failed to mitigate risk management weaknesses".

The President's Working Group argued, without presenting any data, that "firms that suffered significant losses tended to exhibit the following risk management weaknesses: (a) weak controls over potential balance sheet growth, including ineffective limits on the growth of business lines and poor monitoring of off-balance sheet exposures; (b) inadequate communications among senior management, business lines, and risk management functions."

Ellul and Yerramilli (2010) confirm these claims. Their study collects data from public regulatory filings for 74 of the top 100 U.S. bank holding companies (for which information is available) to assess the connection between bank risk-taking and the structure of risk management in the organization. To my knowledge, theirs is the only study to use systematic data to analyze the role of risk management weaknesses in the crisis, but even their investigation is severely constrained by the limits of what firms disclose.

Ellul and Yerramilli proceed in three steps. They first assemble a number of proxies for the importance and attention given to risk management at these large banks. Several of the indicators are simple flags that describe whether the risk management does or does not have certain features. Remarkably, as of 2006, 33% of the banks do not even have a chief risk

officer (CRO). They also check whether the CRO was one of the firm's five highest paid employees (and hence had compensation information disclosed). In 2006, only 15 percent of the banks had a CRO who was amongst the five best-compensated employees. Another descriptor is whether the CRO is an executive officer of the company, which happens for 57 percent of the banks in 2006.

A third measure compares the compensation of the CRO to that of the CEO. In this case, the salary for the CRO must be imputed for most of the firms. They assume that CROs whose salaries are not observed are just below the salary of the 5th highest employee, which is surely an upper bound for the CRO's compensation.[14] These estimates bounce around from year to year, but even when averaged over the period 2003 to 2006, there is substantial variation in the relative pay of CROs, with the 75th percentile estimate being 32 percent of CEO pay, and the 25th percentile being 19 percent of CEO compensation.

Overall they construct seven proxies for risk management practices. The second contribution of their paper is to condense these different indicators to a single statistic that they call their risk management index (RMI). The RMI is constructed by extracting the common component for each characteristic for each bank.[15]

The final step in their analysis is to relate various indicator of risk taking to the RMI. Some of the measures they consider pertain to the asset composition of the banks. These include the percent of mortgage backed securities relative to total bank assets, the ratio of total trading assets (excluding government securities) relative to total bank assets, and the ratio of the total gross notional amount of derivative contracts held for trading relative to total assets.

[14] If there is no CRO, then they use the CFO's compensation. They use the CRO designation to cover anyone identified in a bank's 10K statement who is listed as either chief risk officer, chief credit officer, or chief lending officer. The banks without any CRO tend to be the smaller organizations.
[15] Formally, this is done by calculating the first principal component of the seven series.

These statistics are available for all 74 of their banks. For a subset of 59 banks, there are publicly traded put options on the banks' stock. For these banks the put options can be used to back out the market's estimate of implied volatility of the equity. The implied volatility is a more direct and comprehensive measure of market beliefs about the riskiness of the bank.

Table 1 compares the asset characteristics of the banks in 2007 and 2008 to two risk management proxies in 2006, the indicator of whether the CRO is an executive or one of the top five compensated employees. By focusing on the risk management conditions in 2006 I am hoping to see whether the organizational structure before the crisis hit predicts the risk taking that proved problematic during the crisis.

All of the contrasts reported in the table are indicative of banks with weaker risk management practices taking more risks. In particular, the presence of mortgage backed securities, the size of the banks' trading book (excluding government securities which are likely to be used for hedging), and the amount of derivatives in the trading book are all higher for banks where the CROs have less status in the organization. The statistical significance of the greater risk-taking at the banks with weaker risk-management varies, usually being larger at about a 10 percent level of significance.

A more nuanced comparison is presented in Figure 2. This picture shows the implied volatility of bank share prices (during 2007 and 2008) along with the ratio of CRO pay to CEO pay (averaged between 2003 and 2006). This more comprehensive measure of bank risk is significantly lower for banks where the CROs were better compensated. The fitted line has a downward slope that is statistically significant.

The more sophisticated analysis of Ellul and Yerramilli (2010) using their risk management index delivers many further results beyond those that I have presented. These

include the ability to explain year to year changes in risk taking between 2001 and 2008, showing that firms with better risk management had better operating performance during the crisis years, and documenting that these patterns are robust to controlling for a host of other influences.

I conclude that based on existing evidence we can be fairly confident that the failure of risk management did play an important role in the crisis. But, there are many open questions both about why risk management did not work well at some firms and which aspects are the most important.

IV. Open Questions about Risk Management

The commission could help us fill in two gaps in our understanding of the contribution of risk management practices to the crisis. One involves collecting some basic data and disseminating it to spur further research. The other involves providing more details about the firms where risk management worked well and where it did not.

IV.A. Missing data

Perhaps the major impediment to assessing the importance of risk-management problems is the lack of comprehensive, consistently defined and measured data for major institutions. The commission could perform a major public service by using its authority to mandate disclosure of a number of key pieces of information for the period from 2002 through 2009. The long time series is needed for statistical analysis. To keep the task manageable I recommend that the data collection be confined to the 19 banks that were included in the Federal Reserve's Supervisory Capital Assessment Program, plus GMAC Finance, Fannie Mae, Freddie Mac, Countrywide Financial, Washington Mutual, Wachovia, Bear Stearns,

Lehman, Merrill Lynch, and AIG. These firms, that I will refer to subsequently as the "systemic institutions", were at the center of the crisis and are the ones for which the taxpayers have the greatest interest.

The basic data to be collected should include at a minimum the total compensation and compensation break-down of the CRO, and a detailed organization chart of risk management (along the lines of information reported in FR Y-6 forms). The latter should include the names of management level risk committees and an explanation of who these committees report to.

This information should be supplemented with the answers to some more specific questions about how risk management was carried out. This would include asking whether here an executive officer monitoring the risks taken by the firm's derivative trading desks. The compensation of this executive officer in relation to the traders should be determined. The firm's policy regarding the use of options to compensate the CRO should be documented. The basis used to determine which directors were assigned to the Risk Management Committee or the Audit and Risk Management Committee should be explained. The frequency of the use of forward-looking stress tests should be reported. Finally, a description of the firm's strategy for measuring and managing liquidity risk should be provided. These data could be merged with other publicly available data to allow scholars everywhere to expand the kind of analysis pioneered by Ellul and Yerramilli.

IV.B. Understanding Best and Worst Practices

Perhaps the hardest issue to understand regarding risk management is how an organization deals with the tension between short run profits available through the use of new products and potential risks if such products unravel. There is an inherent tendency for the optimists about the products to push aside the more cautious within the organization and as

discussed earlier, the cautious lost out at many of the firms that failed or required substantial assistance.

I believe the commission could help improve our understanding of this problem in two ways. The first would be to ask some open ended questions of the people in charge of risk management in 2006 and 2007 at the systemic institutions. These questions should include asking what the risk managers thought were the biggest mistakes that were made. Another important avenue to explore is how differences of opinion were mediated. The hope would be that the answers to these questions would uncover some additional differences between the better performing and worse performing firms, and that this could inform future regulatory requirements for improving risk management.

Beyond questions about how policies were implemented, it would be desirable to know more about career considerations for people involved in risk management. This function necessarily requires understanding a great deal about the entire organization. But risk management is not a profit center (or should not be!), and creating incentives to attract talented individuals into these jobs is, therefore, likely to be difficult. It would be useful to document the rotation policies and the career paths of people who have had the senior risk management positions. For this type of information to useful for identifying patterns, it would likely be necessary to collect this information going back at least a decade.

V. Conclusions

My analysis of the current crisis suggests that governance problems in banks played a key role in the crisis. Yet, risk management at almost all large banks is essentially a black box. The commission has a unique opportunity to open the box and allow us to understand better

what policies worked and why, and conversely some policies failed. This sort of investigation should be a high priority for the commission.

References

Adrian, Tobias and Hyun Shin, (2008), "Financial Intermediaries, Financial Stability and Monetary Policy", paper prepared for Federal Reserve Bank of Kansas City symposium on "Maintaining Stability in a Changing Financial System", Jackson Hole, Wyoming, August 21-23, 2008

Allen, Franklin, and Douglas Gale, (2005), "From Cash-in-the-Market Pricing to Financial Fragility," *Journal of the European Economic Association* 3, 535-546.

Bank for International Settlements, (2008), *78th Annual Report: 1 April 2007 – 31 March 2008*, Basel, Switzerland.

Bank of England, (2008), *Financial Stability Report*, April 2008, Issue Number 23, London.

Bernanke, Ben S., (2008), "Risk Management in Financial Institutions", Speech delivered at the Federal Reserve Bank of Chicago's Annual Conference on Bank Structure and Competition, Chicago, Illinois, May 15.

Borio, Claudio (2008), "The Financial Turmoil of 2007-?: A Preliminary Assessment and Some Policy Considerations", BIS working paper no. 251.

Brunnermeier, Markus K., (2008), "Deciphering the 2007-08 Liquidity and Credit Crunch", *Journal of Economic Perspectives*, forthcoming.

Brunnermeier, Markus K., and Lasse Pedersen, (2008), "Market Liquidity and Funding Liquidity", *Review of Financial Studies*, forthcoming.

Calomiris, Charles W., and Charles M. Kahn, (1991), "The Role of Demandable Debt in Structuring Optimal Banking Arrangements", *American Economic Review* 81, 495-513.

Campello, Murillo, Graham, John R. and Campbell R. Harvey, 2010, "The Real Effects of Financial Constraints: Evidence from a Financial Crisis", *Journal of Financial Economics*, forthcoming.

Diamond, Douglas W., (1984), "Financial Intermediation and Delegated Monitoring", *Review of Economic Studies* 51, 393-414.

Diamond, Douglas W., and Raghuram G. Rajan, (2005), "Liquidity Shortages and Banking Crises", *Journal of Finance* 60, 615-647.

Dittmar, Amy, and Jan Mahrt-Smith, (2007), "Corporate Governance and the Value of Cash Holdings", *Journal of Financial Economics* 83, 599-634.

Dudley, William C., (2007), "May You Live in Interesting Times", Remarks at the Federal Reserve Bank of Philadelphia, October 17.

Dudley, William C., (2008), “May You Live in Interesting Times: The Sequel”, Remarks at the Federal Reserve Bank of Chicago's 44th Annual Conference on Bank Structure and Competition, Chicago, Illinois, May 15.

Ellul, Andrew and Vijay Yerramilli, “Stronger Risk Controls, Lower Risk: Evidence from U.S. Bank Holding Companies”, working paper, University of Indiana.

Greenlaw, David, Jan Hatzius, Anil K Kashyap, and Hyun Song Shin, (2008), “Leveraged Losses: Lessons from the Mortgage Market Meltdown”, U.S. Monetary Policy Forum Report No. 2 ,Rosenberg Institute, Brandeis International Business School and Initiative on Global Markets, University of Chicago Graduate School of Business.

Hart, Oliver and John Moore, (1998), “Default and Renegotiation: A Dynamic Model of Debt”, *Quarterly Journal of Economics* 113, 1-41.

Hoenig, Thomas M., (2008), “Perspectives on the Recent Financial Market Turmoil”, Remarks at the 2008 Institute of International Finance Membership Meeting, Rio de Janeiro, Brazil, March 5.

Gromb, Denis, and Dimitri Vayanos, (2002), “Equilibrium and Welfare in Markets With Financially Constrained Arbitrageurs”, *Journal of Financial Economics* 66, 361-407.

IMF, (2008), *Global Financial Stability Report*, April, Washington DC.

Ivashina, Victoria and David Scharfstein, 2009, “Bank Lending During the Financial Crisis of 2008”, *Journal of Financial Economics*, forthcoming.

Knight, Malcolm, (2008), “Now You See It, Now You Don’t: The Nature of Risk and the Current Financial Turmoil”, speech delivered at the Ninth Annual Risk Management Convention of the Global Association of Risk Professionals, February 26-27.

Kyle, Albert S., and Wei Xiong, (2001), “Contagion as a Wealth Effect”, *Journal of Finance* 56, 1401-1440.

Morris, Stephen, and Hyun Song Shin, (2004), “Liquidity Black Holes”, *Review of Finance* 8, 1-18.

Myers, Stewart C., (1977), “Determinants of Corporate Borrowing”, *Journal of Financial Economics* 5, 147-175.

Myers, Stewart C., and Nicholas S. Majluf, (1984), “Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have”, *Journal of Financial Economics* 13, 187-221.

Myers, Stewart C., and Raghuram G. Rajan, (1998), “The Paradox of Liquidity”, *Quarterly Journal of Economics* 113, 733-771.

President's Working Group on Financial Markets, 2008, "Policy Statement of Financial Market Developments", US Treasury, http://treas.gov/press/releases/reports/pwgpolicystatemktturmoil_03122008.pdf

Rajan, Raghuram G., (1994), "Why Bank Credit Policies Fluctuate: A Theory and Some Evidence", *Quarterly Journal of Economics* 109, 399-442.

Rajan, Raghuram G. (2005), "Has Financial Development Made the World Riskier", Proceedings of the Jackson Hole Conference organized by the Kansas City Fed.

Shleifer, Andrei, and Robert W. Vishny, (1992), "Liquidation Values and Debt Capacity: A Market Equilibrium Approach", *Journal of Finance* 47.

Shleifer, Andrei, and Robert W. Vishny, (1997), "The Limits of Arbitrage", *Journal of Finance* 52, 35-55.

Stein, Jeremy C., (1989), "Efficient Capital Markets, Inefficient Firms: A Model of Myopic Corporate Behavior", *Quarterly Journal of Economics* 104, 655-669.

Table 1
Comparison of Asset Composition for Banks with Different Risk Management Characteristics

Differences by CRO Top 5 (2006)

CRO Top5 =	**0**	**1**	p-value (for Difference>0)
Mortgage Backed Securities/Assets	0.40%	0.01%	0.073
Trading Assets (excl. Govt. Securites)/Assets	2.08%	0.13%	0.025
Derivatives Trading/Assets	1.741	0.048	0.115

Differences by CRO Executive (2006)

CRO Executive =	**0**	**1**	p-value (for Difference>0)
Mortgage Backed Securities/Assets	0.50%	0.22%	0.069
Trading Assets (excl. Govt. Securities)/Assets	2.39%	1.31%	0.068
Derivatives Trading/Assets	2.077	1.032	0.153

Notes: Asset characteristics are measured as an average of 2007 and 2008.

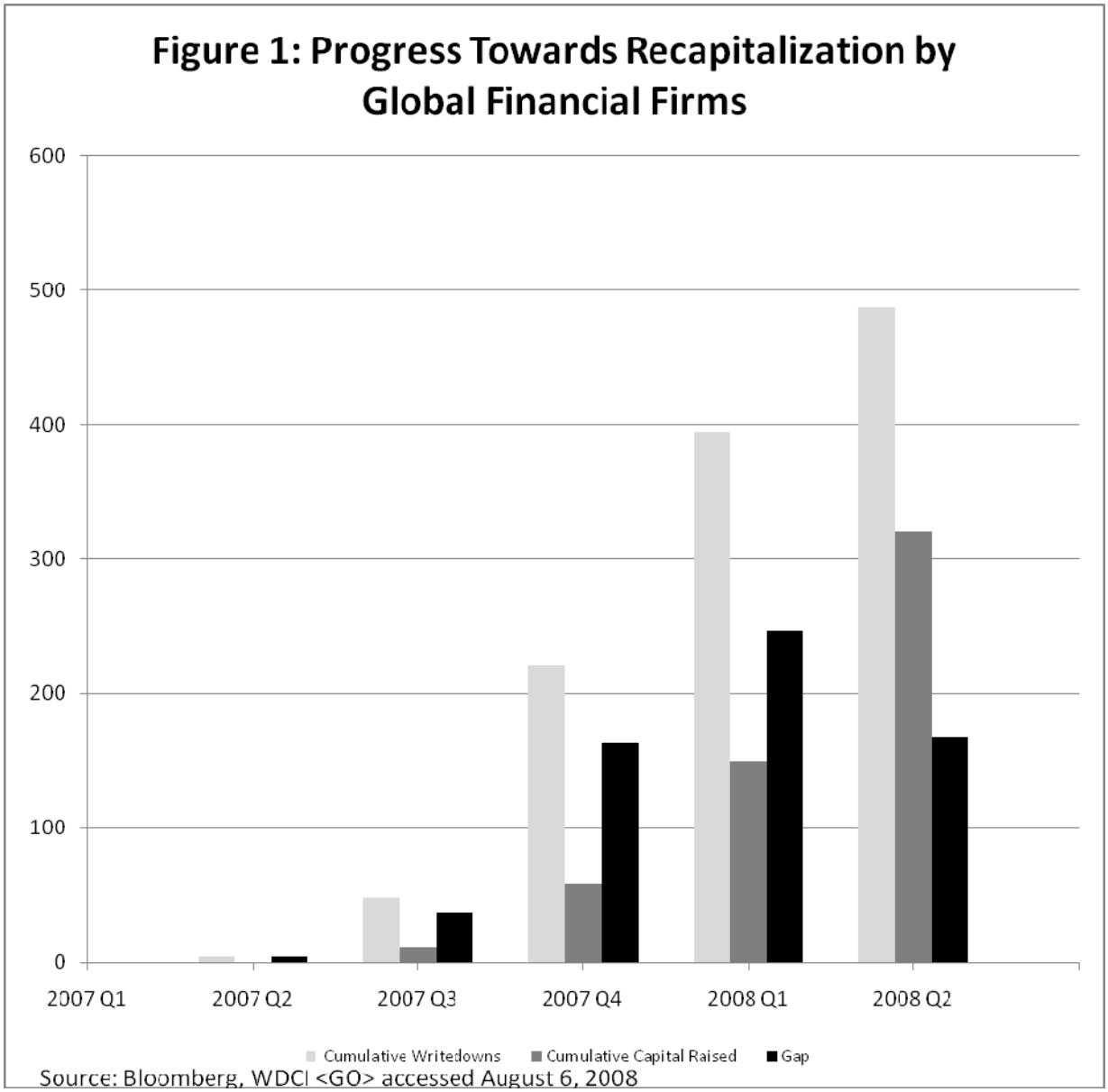
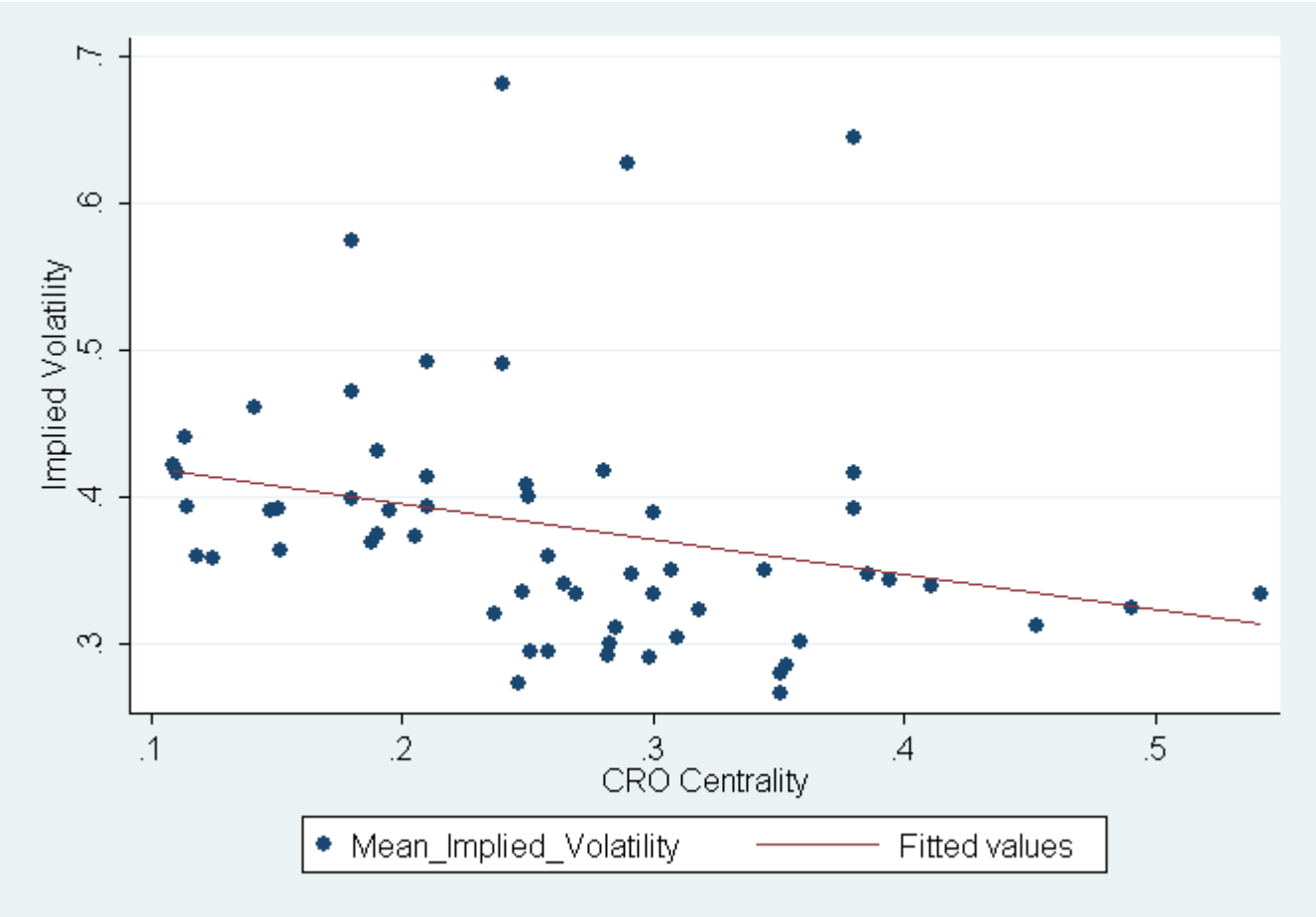


Figure 1: Progress Towards Recapitalization by Global Financial Firms
600
500
400
300
200
100
0
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
Cumulative Writedowns
Cumulative Capital Raised
Gap
Source: Bloomberg, WDCI <GO> accessed August 6, 2008

Figure 2: Bank Risk-Taking and Chief Risk Officer Compensation



Note: CRO centrality is defined as the average compensation of the CRO relative to the CEO compensation during the period 2003 to 2006. The implied volatility of the stock price is inferred from put option prices in 2007 and 2008 for each bank.