Bank Bailouts and Market Discipline: How Bailout Expectations Changed During the Financial Crisis

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Abstract

We show that market discipline, defined as the extent to which firm specific risk characteristics are reflected in market prices, eroded during the recent financial crisis in 2008. We design a novel test of changes in market discipline based on the relation between firm specific risk characteristics and debt-to-equity hedge ratios. We find that market discipline already weakened after the rescue of Bear Stearns before disappearing almost entirely after the failure of Lehman Brothers. The effect is stronger for investment banks and large financial institutions, while there is no comparable effect for non-financial firms.

Keywords: Bailout, Implicit Guarantees, Too-Big-To-Fail, Market Discipline
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1 Introduction

Public interventions in the financial sector during the recent financial crisis have been discussed controversially. A major concern has been the fear of a decline in market discipline: market participants may react to interventions by adjusting their expectations about the likelihood of future bailouts of distressed financial institutions. This would weaken market participants' incentives to monitor and control banks' risk-taking, which in turn increases the probability of future crises. Hence, whether a troubled bank should be supported also depends on the question how strongly market participants adjust their expectations after public interventions.

In this paper, we test how major events during the crisis affected market discipline for large US financial institutions. In particular, we analyze the effect of the bailout of Bear Stearns in March 2008 and the bankruptcy of Lehman Brothers and subsequent events in October 2008. We define market discipline as a situation in which changes of security prices reflect the riskiness of the underlying firm. Market participants ultimately care about actual cash flows resulting from their claims. Thus, the extent to which they incorporate individual bank risk into market prices depends on how strongly bank risk affects these cash flows. However, government interventions typically change the relation between individual bank risk and investors' claims, for example by guaranteeing debt in order to prevent bankruptcy. Thus, if rational investors perceive the probability of future support by the government to increase, this should lead to a reduction of the sensitivity of market prices to bank risk. In order to measure changes in the degree of market discipline, we develop a novel model-free test that exploits the asymmetric treatment of debt and equity holders during public bailouts. The fundamental idea of our test approach is that bailouts change the structural link between CDS and equity returns and affect the sensitivity of the debt-to-equity hedge ratio to firm specific risk characteristics. We find that market discipline eroded during 2008, which can be linked to the events surrounding the failure of Lehman Brothers as well as the rescue of Bear Stearns.

The failures of these investment banks provide two particularly interesting events in order to analyze the relation between government interventions and market discipline. During the bailout of Bear Stearns in March 2008, the Federal Reserve supported J.P. Morgan in acquiring Bear Stearns by guaranteeing creditors' claims worth of $30 billion. Although the notion of "Too-big-to-fail" (TBTF) was widely recognized prior to March 2008[1], Bear Stearns was the first case where the TBTF doctrine was applied to a large investment bank.[2] Thus, it seems reasonable to assume that market participants perceived this as an increase in the likelihood of future support measures in case of bank distress. Accordingly, we would expect market discipline to decline in the period after March 2008.

Furthermore, we analyze the failure of Lehman Brothers in September 2008, including actions taken during the subsequent financial turmoil, e. g. the bailout of AIG and the introduction of TARP and other worldwide financial sector rescue packages. For this series of events, it is not clear a priori what the overall effect on market discipline might be. One might interpret the failure of a large investment bank like Lehman Brothers as the inverse event to the rescue of Bear Stearns. Accordingly, one could expect an increase in market discipline, reflecting declining expectations of future bailouts. However, the magnitude of the financial turmoil following the Lehman Brothers bankruptcy has been unexpected by market participants as well as policy makers. One can thus interpret the Lehman default as revealing the actual costs of letting systemically important institutions fail. As these costs turned out to be substantially higher than expected, this might have convinced the market that policy makers will not allow comparable events to ever take place again. As a result, the perceived likelihood of future support measures might have increased even further. Actions taken in the aftermath of the Lehman failure support this interpretation: The bailout of AIG as well as the introduction of TARP oppose the view, that governmental support for financial institutions would be less likely in the future. Given the opposing nature of these events, it remains an empirical question whether the net effect on market discipline has been positive or negative.

Our analysis shows that the rescue of Bear Stearns was followed by a reduction in market discipline: The sensitivity of the hedge ratio[3] to bank specific risk characteristics weakens after March 2008 for investment banks and large financial institutions. With respect to the Lehman failure and subsequent events, we find that the pre-crisis level of market discipline has not been re-established. In fact, compared to the period after the rescue of Bear Stearns,

[1] O'Hara and Shaw (1990) provide early evidence, that market participants care about TBTF. Stern and Feldman (2004) stress the fundamental role TBTF plays for financial regulation.

[2] In 1998, the hedge fund Long Term Capital Management was bailed out. However, in that case the FED only acted as a coordinator among other banks and did not put up public money.

[3] The hedge ratio is defined as the ratio of the first derivatives of debt and equity with respect to the firm value. See section 2 for details.

market discipline declined even further, rendering debt-to-equity hedge ratios insensitive to all risk characteristics. Analyzing the heterogeneity of the effects, we find that the decline in market discipline is more pronounced for the largest banks and for investment banks. Furthermore, we conduct the same kind of analysis for a broad set of non-financial firms. In contrast to financial institutions, we find that debt-to-equity hedge ratios remain sensitive to underlying risk characteristics throughout the whole sample for non-financial companies. This rules out the possibility that our results for the financial sector just capture a general change in the market environment.

Overall, our results indicate that letting Lehman Brothers fail was not sufficient to convince market participants that the probability of future bailouts had decreased. Apparently, the subsequent turmoil including the respective actions taken by policy makers[4] strengthened the belief in future support to the financial sector. In summary, our results cast a damning light on the behavior of policy makers during the crisis. A main motivation for letting Lehman Brothers fail was to re-establish market discipline.[5] Our results suggests that policy measures taken have not been successful in reaching this goal.

In general, our paper adds to the empirical literature analyzing market discipline. From a theoretical point of view, market discipline as a regulatory tool has been advocated by, amongst others, Calomiris and Kahn (1991) and Calomiris (1999). Flannery (2001), Bliss and Flannery (2001) as well as Hellwig (2005) discuss the ambiguous use of the term in the literature and provide a structured view on what should and what should not be called market discipline. As Bliss and Flannery (2001) point out, market discipline consists of two distinct components: First, *monitoring* refers to market prices reflecting the condition of a bank, most importantly its probability of default. However, the mere fact that information about bank behavior can be extracted from market prices does not yet imply a disciplining function of the market. Second, *influence* describes how this market information translates into incentives for bank managers to adhere to a proper risk behavior. By analyzing how the riskiness of banks is reflected in its different securities, our paper relates to the first category in this classification.

Avery et al. (1988) and Gorton and Santomero (1990) are early studies analyzing the *mon-*

[4]See Panetta et al. (2009) for an overview of the measures.

[5]Sorkin (2011) describes discussions and lines of reasoning during this period, indicating that this has indeed been the main motivation, especially put forward by several senate members in the US.

itoring function of market discipline. They reject the notion that yield spreads reflect individual bank risk. In a more recent study, Krishnan et al. (2005) confirm this result by analyzing spreads adjusted to liquidity and market characteristics. By contrast, Flannery and Sorescu (1996), Hannan and Hanweck (1988), Hancock and Kwast (2001), Jagtiani et al. (2002), Morgan and Stiroh (2001), Sironi (2003) and Gropp et al. (2006) find significant relations between debt spreads and bank risks.[6] In the literature on sovereign risk, the paper by Dell'Ariccia et al. (2006) shows how changes in bailout expectations affect the pricing of risk.

All the aforementioned papers deal with the reaction of market prices to individual risk, i. e. testing the functioning of *monitoring*. Another strand of the literature looks at the interaction of implicit or explicit guarantees and banks' risk-taking, thereby testing the *influence* channel of market discipline. These papers argue that such guarantees weaken market discipline, which in turn leads to excessive risk taking by banks. Papers in this area are Keeley (1990), Demirguc-Kunt and Detragiache (2002), Gropp and Vesala (2004), Gropp et al. (2011), and Dam and Koetter (2012). Overall, the literature confirms the link between banks' risk-taking and the strength of explicit or implicit guarantees.

A paper similar in spirit to ours is that by Schweikhard and Tsesmelidakis (2012). They compare equity-implied CDS spreads to actual market prices and ascribe the wedge between the two to bailout expectations. In line with our results, they find that during and after the crisis this wedge increased, reflecting an increase in perceived bailout probabilities. However, in order to derive their results they have to rely on a correct calibration of a specific firm value model. By contrast, our approach is independent of any specific modeling assumption and mainly draws upon the general insight that the hedge ratio can be approximated by a function of risk characteristics (see for instance Campello et al. (2008), even though their ultimate research aim is different). Considering the aim of the test to compare pricing relations during crisis times, this robustness of our methodology to changes in underlying structural parameters is particularly beneficial.

[6] Flannery (1998) provides an extensive survey on the early evidence in this literature strand.

2 Theory

Market discipline requires market prices to mirror individual company risk: In a regime of perfect market discipline investors demand a fairly-priced risk premium in order to provide funds. If market prices of debt and equity reflect refinancing costs of banks, the sensitivity of market prices to individual bank risk incentivizes banks to adhere to proper risk behavior. In this paper we restrict the analysis to the monitoring function, i. e. we test to what extent market prices actually reflect individual bank risk. Thus, our first step is to derive a relation between market prices and individual bank risk that holds in the presence of market discipline, i. e. *defines* a regime of market discipline. In a second step, we show that this relation weakens if market participants perceive a higher probability of bank bailouts in the future.

When constructing a test for changes in market discipline, it is crucial to impose as few assumptions about structural relations between market prices as possible. As we aim to analyze a period of high financial distress, we want to base the analysis only on relations that are unlikely to change fundamentally even in times of crises. Thus, in order to derive a relation between market prices and individual bank risk, we start from only two general assumptions. First, we make use of a fundamental insight from a parsimonious firm value model. In particular, we rely on the fact that the CDS to equity semi-elasticity is fundamentally driven by the unobservable ratio of the first derivatives of debt and equity with respect to the firm value, also known as the debt-to-equity hedge ratio (HR). While the true functional form of the hedge ratio is unknown and highly model-dependent, it is straightforward to show that the hedge ratio unambiguously increases in absolute value for declining firm values and increases in a firm's risk. Second, we draw upon the fact that public bailouts favor debt over equity holders. Introducing a discrete bailout probability PB for bondholders only, we show that the new hedge ratio HR^* in the presence of possible bailouts is equal to the product of the old hedge ratio HR and the non-bailout probability $(1 - PB)$. Given these two insights, we estimate the hedge ratio as a function of company specific risk characteristics in a control period before the crisis and evaluate how this relation changes during the crisis as a consequence of government actions.

As outlined above, we draw upon the fundamental insights of the structural firm value approach, which was pioneered by Merton (1974). It states that the prices of equity E_t and debt D_t can be interpreted as derivatives on the fundamental firm value V_t and thus can be valued using option pricing theory, i. e.

$$V_t = E_t + D_t \tag{1}$$

$$E_t = f(V_t) \tag{2}$$

$$D_t = g(V_t) \tag{3}$$

In particular, equity can be seen as a call option on the firm value with a strike price equal to the face value of debt. Accordingly, debt is equivalent to a risk-free investment plus a short put option on the firm value. Furthermore, the credit spread CS_t for the risky bond can be written as

$$CS_t = -\frac{1}{T} log(\frac{D_t}{B_t}) = -\frac{1}{T} log(D_t) - r_f \tag{4}$$

with r_f being the yield of a risk-free zero coupon bond B_t, where both D_t and B_t refer to a risky and risk-free bond with the same notional and the same time to maturity T.

Following the firm value approach, changes in the value of equity and debt (and hence the credit spread) are both driven by the same changes in the underlying firm value and should therefore be structurally linked. In particular, after some re-arranging the semi-elasticity of credit spread changes to equity returns $\beta_{CS,E}$ can be written as

$$\begin{aligned} \beta_{CS,E} &= \frac{\partial CS}{\frac{\partial E}{E}} = \frac{\partial CS}{\partial D} \frac{\partial D}{\partial V} \frac{\partial V}{\partial E} E = -\frac{1}{T \cdot D} \frac{D_V}{E_V} E \\ &= -\frac{1}{T} \frac{E}{D} \frac{D_V}{E_V} = -\frac{1}{T} (\frac{1}{L} - 1) \cdot HR \end{aligned} \tag{5}$$

with the market leverage L being defined as the ratio of the debt to firm value, i. e. $L = D/V$. The semi-elasticity itself depends on the time to maturity, leverage as well as the ratio of two non-observable inputs, i. e. the derivatives of debt and equity with respect to the firm value. As the time to maturity and leverage can be proxied by market data reasonably well, our focus is on the theoretical behaviour of this hedge ratio. In particular, we derive how the hedge ratio changes if the firm value and the fundamental risk of a company changes. For that, we need to take a look at the first derivative of the hedge ratio with respect to the firm value:

$$\frac{\partial HR}{\partial V} = \frac{\partial \frac{D_V}{E_V}}{\partial V} = \frac{D_{VV} \cdot E_V - D_V \cdot E_{VV}}{E_V^2}$$
$$= \frac{D_{VV} \cdot (1 - D_V) + D_V \cdot D_{VV}}{E_V^2} = \frac{D_{VV}}{E_V^2} < 0 \quad (6)$$

as $D_{VV} < 0$. Equation (6) shows that the hedge ratio unambiguously declines in the firm value. Note that this insight is most general and in particular does not rely on any particular modelling assumption such as the form of the firm value process (e. g. diffusion and/or jump process) or the default trigger (default only at maturity or exogenous or endogenous default barrier).

Still, the question remains how to measure the unobservable hedge ratio. Schaefer and Strebulaev (2008) estimate the hedge ratio based on a simple Merton model and show that their estimated hedge ratio can successfully explain the comovement between stock and bond prices for non-financial firms. When applied to financial companies however, there are several drawbacks of calculating the hedge ratio directly from any particular firm value model. First of all, banks are highly leveraged firms with low implied asset volatilities. A simple Merton model as well as most of its diffusion-only extensions (e. g. Black and Cox, 1976) cannot be reasonably calibrated to capture this. Most of the time, traditional firm value models imply a flat zero default probability and hence a zero credit spread even for longer time horizons. Modelling positive credit spread levels requires additional uncertainty about the distance to default, for instance by introducing jumps (Zhou, 2001) or a non-observable default barrier (Finger et al., 2002), but even then it appears to be difficult to calibrate those models for reasonable parameter values. Even by introducing additional uncertainty, those extensions still inherit a feature of classical firm value models that misses out on the special characteristics of financial institutions. In classical firm value models, a company only defaults if its asset value drops below a certain critical threshold. This in turn implies that the entire risk of a company is measurable via its distance to default.[7] While this might be a reasonable assumption for non-financial firms, it entirely ignores the funding risks of banks. As outlined in the theoretical literature on bank runs started by

[7] The distance to default is usually interpreted as the number of asset value standard deviations the firm value exceeds the critical default barrier.

Diamond and Dybvig (1983) and as witnessed in the recent financial crisis, an omnipresent risk for financial firms with illiquid assets is the inability to fund those assets, even when the overall financial status is relatively solid. That is, banks are severely prone to default due to liquidity and funding problems, a feature which lies outside the theoretical firm value approach. While asset values and funding problems are often interrelated, they represent two distinct risks and should therefore be treated separately. As a consequence, we refrain from using theoretical model-dependent hedge ratios as these models do not feature some of the main sources of risk for financial companies.

Instead we base our analysis on a more fundamental insight from general option pricing theory. As the hedge ratio is the ratio of the first derivatives of two options on the firm value with the same strike price, it depends on the moneyness of the underlying options and hence on the riskiness of the firm itself. Intuitively, when the firm is very healthy, the risk of bankruptcy is very low and changes in the firm value mainly affect the residual claim, i. e. the stock price. The hedge ratio thus becomes very small for low risk companies. If, however, the firm value is very low and the company is very likely to default, small changes in firm value strongly affect the value of bonds but to a lesser extent the value of equity, i. e. $D_V(E_V)$ strongly increases (decreases) relative to the low risk case. Hence, the hedge ratio increases when the firm value declines. A similar intuition applies to other characteristics, for instance asset volatility, which affect a firm's risk profile. As a consequence, the hedge ratio generally increases in a company's risk exposure. We assume a simple linear relation between the hedge ratio and the company risk characteristics X, i. e.

$$HR_{i,t} = \alpha_0 + \sum_{j=1}^{k} \alpha_j X_{i,t}^j, \tag{7}$$

which is very similar to the approach taken by Campello et al. (2008) who estimate the debt-to-equity sensitivity as a function of leverage, stock volatility and interest rates.[8] Combining equations (5) and (7) yields the following relation between CDS changes and equity returns:

$$\Delta CDS_{i,t} = (\alpha_0 + \sum_{j=1}^{k} \alpha_j X_{i,t}^j) \cdot (-\frac{1}{T})(\frac{1}{L_t} - 1) \cdot \frac{\Delta E_{i,t}}{E_{i,t}} \tag{8}$$

[8]See Appendix C for a further discussion of the restrictiveness of the linearity assumption.

Equation (8) thus represents a fundamental relation between market prices and individual bank risk that defines the regime of market discipline. From Equation (7) we see that the hedge ratio is increasing in individual bank risk as long as $\alpha_j > 0 \; \forall \; j$.

We now derive how the relation between the hedge ratio and individual bank risks changes when there is a non-zero bailout probability PB for bondholders only. The assumption that only bondholders but not stockholders will be bailed out is motivated by the fact that bailing-out financial institutions aims at avoiding a market-wide collapse of the financial system. To achieve this, it is necessary to prevent a bank from bankruptcy, which can be achieved via guaranteeing or actually repaying debt obligations, but does not require to compensate equity holders in addition.[9]

Hence we adjust the general firm value model by including the possibility of a public bailout in the following way. The new firm value V^* is the sum of the fundamental firm value V and the expected value of the government payment which recovers the defaulted debt to treasury[10] with a probability PB, i. e.

$$V_t^* = V_t + PB \cdot GovGuarantee_t = D_t^* + E_t^* \tag{9}$$

$$GovGuarantee_t = E^Q(e^{-r_f \cdot (\tau - t)}(B_\tau - V_\tau)^+ 1(\tau \leq T)) \tag{10}$$

τ is thereby the timing of the first default after t and PB is assumed to be independent of the fundamental firm value. Because the bailout payment is only made when the company is already in default and the full firm value is transferred to the debt holders, the equity holders remain unaffected by the potential bailout.

$$E_t^* = E_t \tag{11}$$

$$D_t^* = (1 - PB)D_t + PB \cdot B_t > D_t \tag{12}$$

[9] For example over the weekend of the Bear Stearns rescue, the 5 year CDS rate on Bear Stearns improved by over 350 bps but the stock price plummeted by 90% as a direct response to the bailout. The Economist (2008) notes that the real value of the bank probably actually substantially exceeded the acquisition price shareholders received. This would imply that shareholders did not only not benefit from the bailout but even suffered from it.

[10] The assumption of recovery to treasury is made for analytical convenience but can be easily adjusted without changing the underlying rationale.

This in turn implies for the partial derivatives with respect to the firm value

$$E_V^* = E_V,\ D_V^* = (1 - PB)D_V \tag{13}$$

such that in the presence of an exogenous bailout probability the new hedge ratio HR^* adjusts to

$$HR^* = (1 - PB)\frac{D_V}{E_V} < HR. \tag{14}$$

Of course, one can argue that the effects of public interventions went beyond the securing of individual companies' bond repayments. In particular, actual government bailouts involved equity injections and had a stabilizing effect on the market as a whole. In addition, equity holders should also benefit from improved refinancing conditions due to increased bailout expectations. The important point to note is that all these effects do not affect the fundamental relation between hedge ratios and risk characteristics. In our framework, such indirect effects of public interventions already enter via a change of the fundamental firm value.

Equations (14) and (7) now imply that

$$\frac{\partial HR^*}{\partial X^j} = (1 - PB) \cdot \alpha_j < \frac{\partial HR}{\partial X^j}, \tag{15}$$

and therefore

$$\frac{\partial \frac{\partial HR^*}{\partial X^j}}{\partial PB} = -\alpha_j < 0, \tag{16}$$

i. e. that the sensitivity of the hedge ratio to individual risk is declining in the bailout probability.

This relation is the fundamental link between bailout expectations and market discipline that we will base our analysis on. Equation (16) states that a higher perceived bailout probability weakens the marginal effect of risk on the hedge ratio. Put differently, changes in bailout expectations affect the link between individual bank risks and market prices. This link is an important prerequisite for market discipline to work: Only if market prices correctly reflect changes in banks' individual risks, banks have an incentive to manage their risks accordingly. Equation (16) thus builds the theoretical framework how to analyze perceived bailout expectations and the implied decline in market discipline: One can test for changes in bailout expectations by testing for structural declines in the relation between bank risks and hedge ratios.

Following those theoretical considerations, the empirical implementation of this test is straightforward. To capture the relation between the hedge ratio and individual risks we employ the following baseline estimation equation:

$$\begin{aligned} \Delta CDS_{i,t} &= c + (\alpha_0 + \alpha_j X^j_{i,t}) \cdot (-\frac{1}{T})(\frac{1}{L_t} - 1) \cdot r_{E,i,t} + \epsilon_{i,t} \\ &= c + \beta_1 \cdot r_{AE,i,t} + \beta_2 \cdot X^j_{i,t} \cdot r_{AE,i,t} + \epsilon_{i,t} \end{aligned} \tag{17}$$

where $r_{E,i,t}$ is the percentage equity return of company i and the adjusted equity return $r_{AE,i,t}$ being defined as:

$$r_{AE,i,t} = \frac{1}{T}(\frac{1}{L_t} - 1) \cdot r_{E,i,t} \tag{18}$$

Equation (17) explicitly allows for the hedge ratio to depend on the current level of company risks. Equation (16) now states a higher perceived bailout probability implies a lower HR sensitivity to fundamental company risks. This implies that testing for changes in perceived bailout probabilities corresponds to testing for changes in β_2. Accordingly, we interact Equation (17) with dummy variables reflecting the different time periods of interest. Finally, we compare coefficients over time where significant differences can be contributed to changes in market discipline.

3 Hypotheses

As the previous section has shown, our empirical strategy provides a rigorous test of changes in market discipline: Changes in the perceived probability of bailouts are reflected in changes in the sensitivity of the hedge ratio to individual bank risk. This sensitivity is captured by β_2 in the regression equation (17). To assess the change of the degree of market discipline, we first estimate equation (17) in a control period, prior to any events of interest. First, this serves as a check of the reliability of our approach: Assuming that there has been at least some degree of market discipline prior to the rescue of Bear Stearns, we should observe a significant influence of individual bank risks on the hedge ratio. Second, those estimates can be interpreted as a benchmark level of market discipline, which then serves as a comparison for the strength of the relation after our events of interest.

Hypothesis 1: In the period after the rescue of Bear Stearns, β_2 is significantly lower in absolute terms than in the control period.

The first event of interest is the bailout of Bear Stearns in March 2008. The Federal Reserve supported J.P. Morgan in acquiring Bear Stearns by guaranteeing creditors' claims worth of $30 billion. Of course, already prior to this event banks had been supported by the government, giving rise to the notion of "Too-Big-To-Fail". Nevertheless, the event can be assumed to have a high informational value, as it was the first time that an investment bank was explicitly supported by the government. As a result, market participants should subsequently have adjusted their expectations about the likelihood of future bailouts upwards, resulting in a lower degree of market discipline.

The second event we analyze is actually a series of incidences starting with the failure of Lehman Brothers in September 2008 and additionally includes the bailout of AIG and the introduction of TARP as well as other worldwide financial sector rescue packages. Given the short time spans between these events, it is not possible to robustly distinguish their isolated effects on market discipline and we rather test their joint effect. Given this multiplicity of events as well as the fact that for some of them the effects on market discipline are not a priori clear, there are different possible results to expect:

Hypothesis 2a: In the period after the failure of Lehman Brothers, β_2 is significantly larger in absolute value compared to the period between Bear Stearns and Lehman Brothers.

First, one might expect that the failure of Lehman Brothers led to a re-establishment of market discipline. Contrary to the Bear Stearns bailout, Lehman Brothers was not supported. Accordingly, these two events should have opposing effects on future bailout expectations and market discipline.

Hypothesis 2b: In the period after the failure of Lehman Brothers, β_2 is signifi-

cantly lower or equal in absolute value compared to the control period.

However, the failure of Lehman Brothers was not an isolated incident but rather the starting point of a series of events, most importantly the bailout of AIG and the introduction of TARP. Both events oppose the view that governmental support for financial institutions had become less likely in the future. In addition, the magnitude of the financial turmoil following the Lehman Brothers bankruptcy might have convinced the market that policy makers would not allow comparable events to take place ever again. This might have increased the perceived likelihood of future support measures even further. Overall, this could have led to a further decline in market discipline, overshadowing the potential signal sent out by the non-intervention in the Lehman filing. As a result, market discipline might be even lower than prior to Bear Stearns or at least not back to its level in the control period.

Hypothesis 3: The effects on market discipline are particularly pronounced for large financial institutions.

It is unlikely that the effects on market discipline were homogeneous across all financial institutions. As already noted above, the rationale to prevent banks from failure is to avoid a complete breakdown of the financial system. However, the systemic risk of any particular bank should depend on its characteristics. Thus, a common belief is that the failure of larger banks represents a bigger threat to the stability of the economy than the collapse of a small bank, a notion typically captured by the expression "Too-Big-To-Fail".[11] As a result, the changes in the degree of market discipline should depend on its size: For large banks there should be a stronger effect than for small banks.

Hypothesis 4: The effects on market discipline are particularly pronounced for investment banks.

A further important characteristic is an institution's business model. As investment banks have been at the focus of the crisis, the effects should be stronger for investment banks than for other institutions. As a result, we should observe a particular strong effect for the remaining investment banks. In particular, this should hold true for the time period immediately after Bear Stearns rescue, as this was the first time that an investment bank

[11] Admittedly, size is typically not regarded as the only determinant of systemic importance of financial institutions (see for instance Acharya et al., 2010; Adrian and Brunnermeier, 2011; Barth and Schnabel, 2013). However, it seems uncontroversial to assume that a larger bank is ceteris paribus more systemic important than a smaller bank.

received public support.

Hypothesis 5: The effects on market discipline for non-financial firms are less pronounced.

Given that the majority of governmental interventions in the period of interest concerns financial institutions, we expect that non-financial firms are less affected with respect to changes in market discipline. Thus, if the sensitivity of the hedge ratio to firm specific risk weakens for non-financial firms to the same extent as for financial institutions, it might be that our test simply picks up changes in pricing structures not necessarily related to changes in bailout expectations. Hence, the analysis of the non-financial sector also serves as a robustness check and can thus be interpreted in the spirit of a placebo treatment.

4 Risk proxies and data summary

4.1 Measuring individual bank risks

In order to cover the various risks for financial institutions, we employ several risk measures. Equity volatility can be identified as a key variable for asset value risk. In addition we calculate an liquidity and funding risk measure and an option-implied skewness measure to capture default risk implied in equity markets.

4.1.1 Asset value risk

Classical firm value models emphasize the importance of leverage and asset volatility as the main determinants of credit risk. Gorton and Santomero (1990) use the framework proposed by Black and Cox (1976) in order to test whether implied asset volatilities of junior bank debt are related to other credit risk proxies but find no significant relation. By contrast, Flannery and Sorescu (1996) and Balasubramnian and Cyree (2011) find that junior bank debt yield spreads were sensitive to variables such as leverage and stock volatility. This was particularly true for time periods when financial companies were not perceived to be too-big-too-fail. Their results remain robust to the addition of other conventional balance sheet risk characteristics such as loan composition and performance. In our setup, we prefer forward-looking option-implied volatilities to historical volatilities as these should employ more information about associated future risks. Thus, we proxy asset value risk by using 1y at-the-money (ATM) call option volatilities.

4.1.2 Liquidity and funding risk

As financial institutions are refinancing a large portion of their debt by rolling over of short-term debt, they are subject to potential liquidity and funding shortages. In order to control for this important risk source, we compute the average spread of Financial Commercial Paper (FCP) to Non-Financial Commercial Paper (NFCP) with a remaining time to maturity of one month. As the FCP-spread is based on a broad range of commercial paper, it should largely mirror the relative ease and difficulty of financial institutions to acquire short-term funding. Nevertheless, not all financial institutions rely on short-term funding to the same extent, so that funding risk might be very different for individual firms. In order to account for this heterogeneity, we interact the spread with the company specific ratio of short- and long-term debt, i. e.

$$FCP - funding_{i,t} = (FCP_t - NFCP_t) * \frac{STD_{i,t}}{LTD_{i,t}} \tag{19}$$

Short-term debt (STD) is thereby defined as current debt maturing within one year. It does not include deposits, as the yield spreads mainly apply to wholesale funding.

4.1.3 Option-implied skewness

Recent contributions to the empirical asset pricing literature have shown that option surfaces contain information about the implied distribution of future stock returns. Various measures of idiosyncratic implied skewness have been successfully used in order to establish the link between skewness and stock returns. For instance Yan (2011) examines the steepness of the implied volatility curve for short ATM options as a proxy for the average jump size and finds that stocks with higher slopes underperform. Rehman and Vilkov (2012) use the model-free implied skewness measure from Bakshi et al. (2003) and find that stocks with a more negatively skewed return distribution perform significantly worse in the future. A similar finding was made by Xing et al. (2010), who employ the difference between OTM and ATM option volatilities as an indicator of implied skewness. While Rehman and Vilkov (2012) find that the return differences stem from stock over- and undervaluations relative to their industry peers, Xing et al. (2010) show that the most negatively skewed stocks experience the worst earnings shocks in the next quarter.

While these papers differ with respect to the presumed sources of risk, they stress the importance of option-implied information for the riskiness of a firm and the implied default probability, as any default comes along with large negative stock returns. The riskier a company and the more likely it is to default on its debt, the higher should be the implied probabilities of very large negative stock returns, especially relative to large positive returns. As our particular interest lies in the distribution of very large negative stock returns and due to its computational simplicity, we follow Xing et al. (2010) by calculating our skewness measure as the difference between the 1y implied volatilities of OTM put and ATM calls with stock deltas of 0.2 and 0.5 respectively:

$$skewness_{t,i} = vol_{OTM\ Put} - vol_{ATM\ Call} \tag{20}$$

The higher the skewness measure, the more likely are very large negative stock returns relative to very positive ones, which we interpret as a signal for higher implied default risk.

4.1.4 Leverage

Besides asset volatility, leverage is one of the key determinants of a company's risk profile and an integral part of any reasonable firm value model. Nevertheless, in our baseline estimation (17) the inclusion of leverage as a separate risk characteristic turns out out to be problematic as leverage already enters the regression equation via the calculated adjusted stock return $r_{AE,i,t}$. This leaves the information content on a possible $\beta_{Leverage}$-coefficient highly questionable in the base case. Yet, we do not question the overall importance of leverage for company risks and hedge ratios. In the robustness analysis of Section 6, we therefore repeat our regression analysis using unadjusted equity returns $r_{E,i,t}$ on the right-hand side of regression (17) and include leverage as an additional risk characteristic. Its inclusion in the baseline estimation is further complicated by the fact that theoretical firm value models suggest a possible non-linear leverage effect on the hedge ratio, especially when leverage is measured as $L = D/(D + E)$. The non-linearity problem, however, is mitigated when leverage is measured as $L^* = D/E$ (see Appendix C). Given the latter leverage definition, halfing the equity value doubles the leverage proxy regardless of the size of the debt value. Thus, for the risk characteristic analysis, we prefer to define leverage as the ratio of debt to equity value. In the regression with unadjusted returns, the estimated coefficients are determined by the overall debt-to-equity sensitivity rather than the hedge ratio. While strictly speaking Section 2 only derives the theoretical link between hedge ratios and risk characteristics, the empirical results by Campello et al. (2008) suggest a similar relation for the debt-to-equity sensitivity.

4.2 Construction of the data set

We rely on a data set constructed from different sources. For the period from January 1 2004 to September 30 2010, it contains information on 31 of the largest US financial institutions. Starting from the 50 largest US financial institutions by market capitalization in 2007, we eliminate all companies for which no time series of CDS and option quotes are available. We also drop the government sponsored enterprises Fanny Mae, Freddy Mac, and Sally Mae. Daily equity prices and CDS quotes are obtained from CRSP and Thomson Datastream, equity option quotes from Optionmetrics, interest rate data from the Federal Reserve Bank and quarterly balance sheet information from Compustat.

Regarding data cleansing, we ignore daily observations where market information on either the change in CDS level or the equity return for a given institution is not available. Furthermore, we omit observations where the CDS level did not change at all or by more than 100 basis points in absolute value relative to the day before. As some of the CDS time series show signs of illiquidity and lack of trading activity, these omissions take care of CDS quotes that are not updated on a daily basis. We delete all observations for credit spreads of more than 2000bps as we expect very low liquidity in CDS markets for extremely distressed companies. In addition, we ignore all observations for Bear Stearns, Merrill Lynch, Wachovia, Lehman Brothers, Washington Mutual and CIT after their announced take-overs or bankruptcies in 2008. Finally, we winsorize all included variables at the 1% level.

As there is a well-known phenomenon of excess correlation in times of extreme market distress, our findings could be substantially biased during the heights of the turmoil. To avoid this, we exclude all observations from March 2008 and September 2008, i. e. those months in which our main events took place. Thereby we also circumvent the problem of precisely defining the point in time at which new information about bailouts entered the market and thus the actual cutoff dates for our periods of interest. Numbers from the quarterly or (semi-)annual reports are used from the day of their announcements onwards.

Those adjustments leave us with a total of 8,760 observations over the whole sample, with 6,064 observations falling into the control period, 548 observations in the period after Bear Stearns and 2,148 observations after September 2008.

As can be seen from Table 1, average variable values differ substantially between the subperiods.[12] The average CDS spread increases from 46 bps in the control period to 218 bps and 299 bps after the Bear Stears and Lehman Brothers collapses, indicating a strong increase in the market perception of risks in the financial sector. The higher risk can also be seen from our risk proxies where implied volatilities and skewness as well as funding spreads strongly increase after Bear Stearns relative to the control period.[13]

Figures 1 and 2 depict the evolution of the risk characteristics we consider in our analysis. Until the first half of 2007, they remain relatively stable. With the beginning of the crisis in second half of 2007, however, our risk proxies mirror developments in the financial markets, with implied volatility and skewness almost doubling and the funding risk measure rising from 0.04 to 0.21. After equity valuations for financial companies had reached their maxima in mid-2007, declining stock prices lowered equity buffers and increased effective leverage, a trend that continued until mid 2009.

After the bailout of Bear Stearns, the following short recovery is only of temporary nature as concerns regarding the health of the whole financial system drive volatility and skewness proxies further up and reach all time highs after the bankruptcy of Lehman Brothers. After staying at elevated levels for the rest of the year, the subsequent declines of the risk measure do not take place prior to early or mid-2009.

[12]The minimum and maximum values are very similar across all subperiods due to the 1% winsorization of all variables.

[13]Following the definition of the skewness indicator a higher positive value implies a more pronounced negatively skewed distribution.

5 Results

Table 2 reports the results from the baseline specification using weekly data. Note that as the relation between CDS changes and adjusted stock returns should be negative, a more negative coefficient reflects a stronger sensitivity of the hedge ratio to risk, i. e. a stronger degree of market discipline.

We see that in the control period the hedge ratio systematically varies with all included risk characteristics, as the interactions of adjusted stock returns with skewness, implied volatility, and funding risk are each negative and statistically highly significant. This finding is in line with the prediction from the theoretical firm value model. Hence, we can confidently conclude that in the control period at least some degree of market discipline was in place. Note that our methodology is not able to identify a regime of perfect market discipline. Changes in the coefficient estimates only indicate relative changes over time. However, bailout certainty and the absolute absence of market discipline would empirically correspond to a total insensitivity of the hedge ratio to individual risk characteristics. Hence, the significance of the coefficients of the individual risk characteristics reflects the existence of some market discipline, and a structural decline of this relation a weakening in market discipline.

Regarding Hypothesis 1, namely the effect of the bailout of Bear Stearns on market discipline, we see that the sensitivity of the hedge ratio to skewness as well as to funding risk decreases. However, as these changes are not statistically significant we cannot conclude that market discipline decreased significantly after the rescue of Bear Stearns - at least not for the total sample of financial institutions included in our data set.

Regarding the two opposing hypotheses about the post Lehman effects, our results are strongly in favor of Hypothesis 2b, i. e. that market discipline declined after the autumn of 2008. First, the point estimates of the interactions are quantitatively smaller in absolute values than in both subperiods prior to the Lehman collapse. Second, looking at the coefficients of the individual risk factors, we see that they are only marginally significant or not at all. In turn, this result implies that we cannot reject the hypothesis of the complete absence of market discipline anymore. Formal equality tests for the risk sensitivity coefficient reject the null hypothesis in all post-Lehman test setups (see bottom of Table 3). This confirms the finding that market discipline decreased significantly after September 2008.

We now turn to Hypotheses 3 and 4 that take a closer look at the heterogeneity of the effects on market discipline. First, Table 3 reports the results for the subsample of financial institutions whose asset value is above the sample median, i. e. that can be regarded as relatively large.[14] Again, we find that the sensitivity of the hedge ratio to individual risk characteristics is statistically significant in the control period, confirming the existence of market discipline. Yet, in contrast to the earlier results based on the full sample, we now observe a stronger drop of market discipline with respect to skewness and implied volatility already after March 2008. Here, the influence of skewness and implied volatility on the hedge ratio turns statistically insignificant after the rescue of Bear Stearns. However, the changes in these sensitivities are still not statistically significant across all specifications. Analyzing the period after the Lehman default, the results resemble those from the full sample: The hedge ratio is entirely insensitive to individual bank risk characteristics and the difference to the control period is statistically highly significant. Overall, those results provide some support for Hypothesis 3: The effect on market discipline is particularly strong for large banks, as we see a decline in market discipline already as a reaction to the Bear Stearns rescue. After the Lehman bankruptcy, market discipline has disappeared entirely, as was the case in the total sample.

Table 4 reports the estimation results for the subsample of investment banks. The findings allow us to analyze Hypothesis 4, i. e. whether the effect on market discipline was particularly pronounced for those institutions.[15] Again, as in all previous specifications, in the control period the hedge ratio depends on the banks' individual risk characteristics. This relation between hedge ratios and risks entirely collapses after March 2008 for skewness and implied volatility, as those variables turn statistically insignificant. The differences in sensitivities between the periods are also highly significant. While this indicates a strong drop in market discipline after Bear Stearns already, the sensitivity of the hedge ratio to funding risk only drops significantly after the Lehman default. Overall, those results are in line with Hypothesis 4, suggesting that the decline in market discipline was particularly severe for investment banks in the sense that it took place already after Bear Stearns.

With respect to Hypothesis 5, Table 7 reports the estimation results for the sample of non-financial firms. As short-term funding risks are specific to financial institutions, we

[14] See Appendix D for the list of institutions classified as large.
[15] See Appendix D for the list of institutions classified as investment banks.

focus on the volatility and skewness effects for the non-financial firms. Even though the coefficient estimates decline to some extent over time, we find them to be negative and strongly significant in every subperiod. As a result, we can confidently conclude that there are no comparable effects for non-financial firms to those reported for financial institutions. This finding further confirms the interpretation of our main results. With no similar effects for non-financial companies, the change in the hedge ratio risk sensitivity is specific to financial institutions and strengthens the argument for a decline in market discipline due to higher bailout expectations.

To summarize, we find a significant relation between the hedge ratio and individual risk characteristics in the control period in all specifications. This is in line with the finding by Campello et al. (2008) and confirms the existence of market discipline prior to the rescue of Bear Stearns. Another robust finding across all specifications is the decline in market discipline after the failure of Lehman Brothers, as we observe significant drops in the coefficients of the risk characteristics. Yet, the results are heterogeneous with respect to the Bear Stearns rescue: Here, we only find significant declines in the two subsamples of large institutions and investment banks, while there are no significant differences in the baseline specification.

6 Robustness analysis

In addition, we perform a series of robustness checks along various dimensions: First, previous results were all based on weekly averages of all included variables. To address the potential concern that the drop in the sensitivity of the hedge ratio to individual risk characteristics is just a result of too much noise in the data, we perform the same analysis using monthly averages. With monthly data we trade off the benefits of a higher number of observations against the benefit of a reduction of noise in the data, such that the analysis is based on more stable relations. Second, as outlined in Section 4.1.4 we repeat our estimation procedure using unadjusted equity returns and leverage as an additional risk characteristic.

The results when using monthly instead of weekly averages can be found in Table 5. Overall, the results are in line with the baseline specification of Table 2, with the only difference being that the funding risk measure is insignificant in the control period. Apart from that, the results of Table 5 confirm the earlier findings. In particular, the coefficients of all risk proxies are still negative and significant after the Bear Stearns rescue but strongly decline after October 2008.

The regression results from the unadjusted equity return data can be found in Table 6. Again, the coefficients of the risk proxies are negative in all control periods and highly significant with only one exception. For the skewness, implied volatility and funding risk proxies, the coefficients become notably smaller and turn insignificant already after the Bear Stearns rescue. Of particular interest, however, are the results from the last row columns of Table 6, as we could not include the leverage risk proxy in the baseline regression (17). In contrast to Campello et al. (2008), we find a significant influence of the leverage proxy on the debt-to-equity sensitivity, at least in the control period. In addition, we find that the leverage factor remains negative after March 2008 and the difference to the control period being insignificant. Only after the Lehman default, the leverage proxy turns insignificant as well.

Finally, we repeat our analysis using the (quasi-) market value leverage instead of values in order to calculate the adjusted stock returns. As the results are qualitatively and quantitatively similar to the ones in Table 2, we refrain from reporting them separately.

7 Conclusion

In this paper, we develop a novel test for changes in the degree of market discipline that stem from changes in the perceived probability of future bailouts. We apply this method to analyze the strength of market discipline during the recent financial crisis. A particular advantage of our methodology is its robustness to specific assumptions about the underlying firm value model. Instead we exploit the sensitivity of the hedge ratio to changes in firm specific risk characteristics - a relation that already follows from a parsimonious firm value model.

We find that overall market discipline significantly weakened for all financial institutions after September 2008, i. e. after the events surrounding and following the failure of Lehman Brothers. This result is robust across all specifications. We find the effects to be more pronounced for the subsamples of large financial institutions and investment banks. In particular, some of the loss in market discipline took place already after the rescue of Bear Stearns in March 2008 for those institutions. Furthermore, we find no comparable effects for non-financial firms. This adds further confidence that the declining sensitivity of the hedge ratio to individual risk characteristics for financial institutions can indeed be attributed to the change in perceived bailout probabilities.

Our results cast additional doubt on the decision to let Lehman Brothers fail. Given that the hope to re-establish market discipline was an important reason for the non-intervention, the further deterioration of market discipline in the aftermath of September 2008 indicates that this goal has not been accomplished. In addition, the nature of the heterogeneity of the effect suggests that market participants in fact adjust expectations about future bailout probabilities in a sophisticated manner: After the rescue of Bear Stearns market participants altered their bailout expectations only for investment banks. This can be rationalized as Bear Stearns had been the first investment bank to be bailed out by the government. Thus, the event should have mattered more for remaining investment banks compared to other financial institutions. Only after the Lehman bankruptcy and the broad government interventions across the whole financial sector (like TARP, for example) market discipline vanishes across the entire sample.

Overall, we find strong evidence that market participants rationally adjust their bailout expectations in response to government interventions. Given these findings, policymakers should take into account the potential effects on market discipline when deciding about public bailouts in future crises.

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8 Appendix A: Tables

Variable	Obs	Mean	Median	Std. Dev.	Min	Max	Min Win	Max Win
Full Sample								
CDS	8,760	119.08	44.19	219.25	1.00	1986.80		
CDS change	8,760	0.02	-0.02	4.71	-20.50	21.10	-92.55	95.23
Stock return	8,760	0.00	0.00	0.01	-0.05	0.05	-0.25	0.26
adjusted stock return	8,760	0.00	0.00	0.02	-0.25	0.26		
Asset size (in bn)	7,745	502.72	187.65	586.56	4.73	2220.87		
Book leverage	8,760	10.28	7.55	10.32	1.16	72.23	1.08	285.50
Short-long-funding	8,177	0.85	0.30	1.16	0.00	5.44		
FCP-NFCP spread	8,715	0.08	0.03	0.17	-0.06	1.86		
Fundingrisk	8,134	0.05	0.01	0.13	-0.01	0.87	-0.12	3.60
Implied volatility	8,756	0.32	0.25	0.18	0.15	1.04	0.12	1.47
Skewness	8,756	0.06	0.05	0.04	0.01	0.25	-0.15	0.57
Control Period								
CDS	6,064	46.34	29.94	61.02	1.00	1126.58		
CDS change	6,064	0.18	0.00	2.77	-20.50	21.10	-60.10	95.23
Stock return	6,064	0.00	0.00	0.01	-0.05	0.05	-0.11	0.06
adjusted stock return	6,064	0.00	0.00	0.01	-0.11	0.06		
Asset size (in bn)	5,427	491.45	312.22	565.98	4.73	2220.87		
Book leverage	6,064	7.90	6.84	5.51	1.16	35.05	1.08	35.05
Short-long-funding	5,676	1.01	0.34	1.28	0.00	5.44		
FCP-NFCP spread	6,042	0.04	0.03	0.04	-0.06	0.36		
Fundingrisk	5,655	0.04	0.01	0.07	-0.01	0.87	-0.12	1.15
Implied volatility	6,064	0.24	0.22	0.07	0.15	1.03	0.12	1.03
Skewness	6,064	0.05	0.04	0.02	0.01	0.25	-0.15	0.33
After Bear Stearns, before Lehman Brothers								
CDS	548	218.23	133.82	260.79	40.17	1986.80		
CDS change	548	0.48	0.46	6.95	-20.50	21.10	-65.10	58.90
Stock return	548	0.00	0.00	0.02	-0.05	0.05	-0.10	0.15
adjusted stock return	548	0.00	0.00	0.02	-0.10	0.15		
Asset size (in bn)	482	552.28	345.65	591.22	4.73	2220.87		
Book leverage	548	14.00	12.64	10.36	1.42	43.00	1.42	43.00
Short-long-funding	526	0.72	0.30	0.94	0.00	3.53		
FCP-NFCP spread	546	0.31	0.33	0.11	0.13	0.55		
Fundingrisk	524	0.21	0.07	0.28	0.00	0.87	0.00	1.75
Implied volatility	548	0.46	0.39	0.18	0.24	1.04	0.24	1.24
Skewness	548	0.09	0.07	0.05	0.01	0.25	-0.07	0.26
After Lehman Brothers								
CDS	2,148	299.14	187.37	344.05	37.23	1975.41		
CDS change	2,148	-0.54	-0.44	7.49	-20.50	21.10	-92.55	74.26
Stock return	2,148	0.00	0.00	0.02	-0.05	0.05	-0.25	0.26
adjusted stock return	2,148	0.00	0.00	0.03	-0.25	0.26		
Asset size (in bn)	1,836	523.00	187.65	641.66	4.73	2220.87		
Book leverage	2,148	16.06	11.46	16.39	1.56	72.23	1.56	285.50
Short-long-funding	1,975	0.45	0.14	0.59	0.00	1.99		
FCP-NFCP spread	2,127	0.15	0.05	0.28	-0.04	1.86		
Fundingrisk	1,955	0.06	0.01	0.16	-0.01	0.87	-0.05	3.60
Implied volatility	2,144	0.52	0.46	0.22	0.18	1.04	0.18	1.47
Skewness	2,144	0.11	0.09	0.06	0.01	0.25	-0.09	0.57

Table 1: **Summary statistics.** Above are the summary statistics for weekly data for the total sample of financial institutions as well as for each subsample: The period prior to the rescue of Bear Stearns (control period), the period between the rescue of Bear Stearns and the failure of Lehman Brothers, and the period after the failure of Lehman Brothers. Variables used in the final regressions are winsorized at the 1% level. For winsorized variables, the columns “Min Win” and “Max Win” refer to minimum and maximum values before winsorizing. Detailed variable descriptions are given in the text.

	(1) ΔCDS	(2) ΔCDS	(3) ΔCDS	(4) ΔCDS	(5) ΔCDS	(6) ΔCDS
$D_C \cdot r_{AE}$	259.2***	253.7***	696.2**	687.0**	-99.91	-97.39
	(46.11)	(46.56)	(293.5)	(301.0)	(63.52)	(62.23)
$D_{BS} \cdot r_{AE}$	155.1	159.4	912.6**	919.5**	-335.5	-333.5
	(248.6)	(247.1)	(343.8)	(340.8)	(226.8)	(226.0)
$D_{LEH} \cdot r_{AE}$	-173.2	-170.3	-13.91	-14.92	-337.8***	-335.8***
	(173.6)	(174.4)	(163.9)	(163.4)	(117.6)	(118.3)
$D_C \cdot r_{AE} \cdot Skewness$	-10,267***	-10,068***				
	(1,277)	(1,307)				
$D_{BS} \cdot r_{AE} \cdot Skewness$	-9,247***	-9,279***				
	(1,948)	(1,943)				
$D_{LEH} \cdot r_{AE} \cdot Skewness$	-2,174	-2,176				
	(1,358)	(1,366)				
$D_C \cdot r_{AE} \cdot Implied\ Vol$			-3,277***	-3,237**		
			(1,176)	(1,208)		
$D_{BS} \cdot r_{AE} \cdot Implied\ Vol$			-3,489***	-3,505***		
			(633.0)	(626.7)		
$D_{LEH} \cdot r_{AE} \cdot Implied\ Vol$			-697.7*	-693.5*		
			(344.0)	(345.3)		
$D_C \cdot r_{AE} \cdot Funding\ Risk$					-7,644***	-7,661***
					(2,768)	(2,776)
$D_{BS} \cdot r_{AE} \cdot Funding\ Risk$					-5,574**	-5,574**
					(2,316)	(2,315)
$D_{LEH} \cdot r_{AE} \cdot Funding\ Risk$					-1,265	-1,268
					(766.4)	(765.5)
Bank fixed effects	yes	no	yes	no	yes	no
Observations	8,756	8,756	8,756	8,756	8,134	8,134
R-squared	0.065	0.064	0.071	0.070	0.057	0.057
Number of banks	31	31	31	31	31	31
Period 0 = Period 1	0.65	0.73	0.88	0.85	0.44	0.44
Period 0 = Period 2	0.00	0.00	0.05	0.06	0.03	0.03
Period 1 = Period 2	0.00	0.00	0.00	0.00	0.07	0.07

Table 2: **Regression results for full sample.** Above are the results from regression (17) for the full sample of financial institutions, using weekly return data and skewness, implied volatility and funding risk as the main risk proxies. r_{AE} is the adjusted equity return according to Equation (18) and using book leverage values. D_C, D_{BS} and D_{LEH} are dummy variables that are one before March 2008, between March and September 2008 and after September 2008, respectively, and zero otherwise. Standard errors clustered at the bank level are given in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. "Period 0 = Period 1" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. "Period 0 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period after Lehman Brothers. "Period 1 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. Detailed variable descriptions are given in the text.

	(1) ΔCDS	(2) ΔCDS	(3) ΔCDS	(4) ΔCDS	(5) ΔCDS	(6) ΔCDS
$D_C \cdot r_{AE}$	750.0**	744.1**	2,039**	2,030**	-699.5***	-700.1***
	(320.7)	(323.1)	(692.9)	(688.3)	(117.6)	(117.8)
$D_{BS} \cdot r_{AE}$	-685.4	-693.6	-579.4	-561.1	-705.1*	-701.2*
	(657.3)	(660.3)	(1,618)	(1,615)	(379.4)	(378.8)
$D_{LEH} \cdot r_{AE}$	-1,174*	-1,165*	-2,135**	-2,157**	-1,797***	-1,798***
	(611.0)	(622.7)	(919.2)	(929.4)	(410.9)	(411.5)
$D_C \cdot r_{AE} \cdot Skewness$	-33,794***	-33,710***				
	(7,158)	(7,220)				
$D_{BS} \cdot r_{AE} \cdot Skewness$	-14,887	-14,689				
	(8,575)	(8,575)				
$D_{LEH} \cdot r_{AE} \cdot Skewness$	-3,977	-4,047				
	(3,884)	(3,968)				
$D_C \cdot r_{AE} \cdot Implied\ Vol$			-11,465***	-11,435***		
			(3,397)	(3,378)		
$D_{BS} \cdot r_{AE} \cdot Implied\ Vol$			-2,578	-2,602		
			(3,236)	(3,233)		
$D_{LEH} \cdot r_{AE} \cdot Implied\ Vol$			608.9	637.5		
			(1,321)	(1,336)		
$D_C \cdot r_{AE} \cdot Funding\ Risk$					-6,466**	-6,482**
					(2,489)	(2,495)
$D_{BS} \cdot r_{AE} \cdot Funding\ Risk$					-4,886*	-4,887*
					(2,310)	(2,305)
$D_{LEH} \cdot r_{AE} \cdot Funding\ Risk$					593.9	592.9
					(901.8)	(899.7)
Bank fixed effects	yes	no	yes	no	yes	no
Observations	4,610	4,610	4,610	4,610	4,432	4,432
R-squared	0.171	0.170	0.171	0.171	0.167	0.167
Number of banks	15	15	15	15	15	15
Period 0 = Period 1	0.06	0.06	0.12	0.12	0.37	0.37
Period 0 = Period 2	0.00	0.00	0.01	0.01	0.02	0.02
Period 1 = Period 2	0.30	0.32	0.34	0.33	0.03	0.03

Table 3: **Regression results for largest financial Institutions.** Above are the results from regression (17) for the largest financial institutions, using weekly return data and skewness, implied volatility and funding risk as the main risk proxies. The relevant size classification of the financial institutions can be found in Table 8 in Appendix D. r_{AE} is the adjusted equity return according to Equation (18) and using book leverage values. D_C, D_{BS} and D_{LEH} are dummy variables that are one before March 2008, between March and September 2008 and after September 2008, respectively, and zero otherwise. Standard errors clustered at the bank level are given in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. "Period 0 = Period 1" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. "Period 0 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period after Lehman Brothers. "Period 1 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. Detailed variable descriptions are given in the text.

	(1) ΔCDS	(2) ΔCDS	(3) ΔCDS	(4) ΔCDS	(5) ΔCDS	(6) ΔCDS
$D_C \cdot r_{AE}$	5,254***	5,394***	8,660***	8,805***	-1,768***	-1,732***
	(690.0)	(722.6)	(864.1)	(924.2)	(143.2)	(143.4)
$D_{BS} \cdot r_{AE}$	-5,293	-5,421	-8,585**	-8,601**	685.4	432.9
	(4,128)	(4,084)	(2,168)	(2,197)	(1,235)	(1,326)
$D_{LEH} \cdot r_{AE}$	-3,573***	-3,579***	-5,604***	-5,602***	-4,291***	-4,272***
	(335.8)	(343.7)	(162.8)	(168.5)	(16.34)	(31.57)
$D_C \cdot r_{AE} \cdot Skewness$	-147,100***	-149,407***				
	(10,794)	(11,408)				
$D_{BS} \cdot r_{AE} \cdot Skewness$	-8,431	-7,398				
	(27,281)	(26,984)				
$D_{LEH} \cdot r_{AE} \cdot Skewness$	3,686	3,744				
	(2,301)	(2,198)				
$D_C \cdot r_{AE} \cdot Implied\ Vol$			-40,882***	-41,354***		
			(3,166)	(3,439)		
$D_{BS} \cdot r_{AE} \cdot Implied\ Vol$			3,877	3,897		
			(2,742)	(2,784)		
$D_{LEH} \cdot r_{AE} \cdot Implied\ Vol$			4,334**	4,323**		
			(1,018)	(1,017)		
$D_C \cdot r_{AE} \cdot Funding\ Risk$					-6,934**	-7,050**
					(1,332)	(1,275)
$D_{BS} \cdot r_{AE} \cdot Funding\ Risk$					-9,233***	-8,906***
					(347.6)	(468.9)
$D_{LEH} \cdot r_{AE} \cdot Funding\ Risk$					2,375	2,345
					(1,091)	(1,117)
Bank fixed effects	yes	no	yes	no	yes	no
Observations	1,144	1,144	1,144	1,144	1,141	1,141
R-squared	0.355	0.354	0.388	0.389	0.367	0.363
Number of banks	4	4	4	4	4	4
Period 0 = Period 1	0.02	0.02	0.00	0.00	0.17	0.25
Period 0 = Period 2	0.00	0.00	0.00	0.00	0.01	0.01
Period 1 = Period 2	0.69	0.71	0.87	0.88	0.00	0.00

Table 4: **Regression results for investment banks.** Above are the results from regression (17) for the largest financial institutions, using weekly return data and skewness, implied volatility and funding risk as the main risk proxies. The relevant business type classification of the financial institutions can be found in Table 8 in Appendix D. r_{AE} is the adjusted equity return according to Equation (18) and using book leverage values. D_C, D_{BS} and D_{LEH} are dummy variables that are one before March 2008, between March and September 2008 and after September 2008, respectively, and zero otherwise. Standard errors clustered at the bank level are given in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. "Period 0 = Period 1" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. "Period 0 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period after Lehman Brothers. "Period 1 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. Detailed variable descriptions are given in the text.

	(1) ΔCDS	(2) ΔCDS	(3) ΔCDS	(4) ΔCDS	(5) ΔCDS	(6) ΔCDS
$D_C \cdot r_{AE}$	479.6***	477.5***	949.3***	955.8***	-158.0	-141.6
	(36.72)	(31.46)	(68.45)	(80.00)	(95.33)	(87.21)
$D_{BS} \cdot r_{AE}$	542.8	576.1	1,259**	1,286**	-145.0	-125.5
	(370.3)	(367.4)	(509.2)	(510.0)	(308.6)	(307.6)
$D_{LEH} \cdot r_{AE}$	-407.5	-391.1	142.0	147.0	-463.5***	-444.8***
	(370.2)	(364.3)	(312.5)	(306.2)	(137.5)	(135.8)
$D_C \cdot r_{AE} \cdot Skewness$	-16,961***	-16,526***				
	(809.3)	(937.0)				
$D_{BS} \cdot r_{AE} \cdot Skewness$	-11,572***	-11,835***				
	(2,917)	(2,849)				
$D_{LEH} \cdot r_{AE} \cdot Skewness$	-1,436	-1,420				
	(3,171)	(3,105)				
$D_C \cdot r_{AE} \cdot Implied\ Vol$			-4,455***	-4,425***		
			(285.9)	(342.0)		
$D_{BS} \cdot r_{AE} \cdot Implied\ Vol$			-3,919***	-3,961***		
			(893.9)	(881.8)		
$D_{LEH} \cdot r_{AE} \cdot Implied\ Vol$			-1,251*	-1,232*		
			(617.3)	(608.2)		
$D_C \cdot r_{AE} \cdot Funding\ Risk$					-4,231	-3,647
					(3,289)	(3,260)
$D_{BS} \cdot r_{AE} \cdot Funding\ Risk$					-5,612*	-5,730*
					(3,116)	(3,154)
$D_{LEH} \cdot r_{AE} \cdot Funding\ Risk$					-2,215	-2,265
					(1,370)	(1,341)
Bank fixed effects	yes	no	yes	no	yes	no
Observations	2,088	2,088	2,088	2,088	1,966	1,966
R-squared	0.108	0.104	0.116	0.113	0.068	0.065
Number of banks	31	31	31	31	31	31
Period 0 = Period 1	0.07	0.10	0.53	0.55	0.70	0.58
Period 0 = Period 2	0.00	0.00	0.00	0.00	0.55	0.68
Period 1 = Period 2	0.00	0.00	0.04	0.04	0.24	0.24

Table 5: **Regression results for full sample and monthly returns.** Above are the results from regression (17) for the full sample of financial institutions, using monthly return data and skewness, implied volatility and funding risk as the main risk proxies. r_{AE} is the adjusted equity return according to Equation (18) and using book leverage values. D_C, D_{BS} and D_{LEH} are dummy variables that are one before March 2008, between March and September 2008 and after September 2008, respectively, and zero otherwise. Standard errors clustered at the bank level are given in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. "Period 0 = Period 1" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. "Period 0 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period after Lehman Brothers. "Period 1 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. Detailed variable descriptions are given in the text.

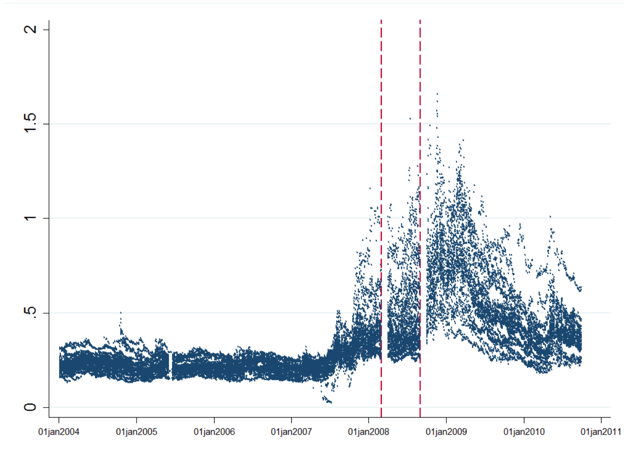
	(1) ΔCDS	(2) ΔCDS	(3) ΔCDS	(4) ΔCDS	(5) ΔCDS	(6) ΔCDS	(7) ΔCDS	(8) ΔCDS
$D_C \cdot r_{AE}$	-5.166	-7.533	85.63**	85.21**	-103.3***	-103.5***	-55.71***	-55.59***
	(14.44)	(15.10)	(38.57)	(40.99)	(16.54)	(16.70)	(17.00)	(16.63)
$D_{BS} \cdot r_{AE}$	-130.9***	-131.0***	-98.74*	-98.21*	-168.1***	-168.6***	-126.6***	-125.7***
	(38.75)	(39.68)	(48.91)	(48.70)	(28.50)	(28.68)	(31.62)	(31.84)
$D_{LEH} \cdot r_{AE}$	-155.5***	-154.8***	-191.2***	-192.7***	-151.4***	-151.5***	-122.3***	-122.3***
	(49.43)	(50.22)	(53.39)	(53.73)	(20.59)	(20.62)	(27.63)	(27.70)
$D_C \cdot r_{AE} \cdot Skewness$	-1,734***	-1,699***						
	(245.1)	(258.9)						
$D_{BS} \cdot r_{AE} \cdot Skewness$	-555.3*	-556.4*						
	(304.3)	(311.6)						
$D_{LEH} \cdot r_{AE} \cdot Skewness$	108.0	102.1						
	(321.4)	(326.1)						
$D_C \cdot r_{AE} \cdot Implied\ Vol$			-634.2***	-633.0***				
			(141.7)	(151.2)				
$D_{BS} \cdot r_{AE} \cdot Implied\ Vol$			-154.5**	-155.7**				
			(75.19)	(74.74)				
$D_{LEH} \cdot r_{AE} \cdot Implied\ Vol$			70.99	72.87				
			(79.84)	(80.28)				
$D_C \cdot r_{AE} \cdot Funding\ Risk$					-140.7	-141.7		
					(83.13)	(84.47)		
$D_{BS} \cdot r_{AE} \cdot Funding\ Risk$					-103.8	-102.7		
					(62.34)	(62.78)		
$D_{LEH} \cdot r_{AE} \cdot Funding\ Risk$					72.52	72.43		
					(65.61)	(65.48)		
$D_C \cdot r_E \cdot Leverage$							-6.070***	-6.122***
							(1.779)	(1.779)
$D_{BS} \cdot r_E \cdot Leverage$							-3.286**	-3.339**
							(1.554)	(1.589)
$D_{LEH} \cdot r_E \cdot Leverage$							-0.761	-0.762
							(1.516)	(1.521)
Bank fixed effects	yes	no	yes	no	yes	no	yes	no
Observations	8,756	8,756	8,756	8,756	8,134	8,134	8,760	8,760
R-squared	0.164	0.163	0.170	0.170	0.151	0.151	0.154	0.154
Number of banks	31	31	31	31	31	31	31	31
Period 0 = Period 1	0.01	0.01	0.02	0.03	0.56	0.55	0.30	0.30
Period 0 = Period 2	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03
Period 1 = Period 2	0.17	0.18	0.04	0.04	0.04	0.04	0.24	0.24

Table 6: **Regression results for unadjusted returns.** Above are the regression results, using weekly unadjusted return data and skewness, implied volatility, funding risk and leverage as the main risk proxies. r_E is the unadjusted equity return and leverage is defined as $L^* = D/E$. D_C, D_{BS} and D_{LEH} are dummy variables that are one before March 2008, between March and September 2008 and after September 2008, respectively, and zero otherwise. Standard errors clustered at the bank level are given in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. "Period 0 = Period 1" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. "Period 0 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period after Lehman Brothers. "Period 1 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. Detailed variable descriptions are given in the text.

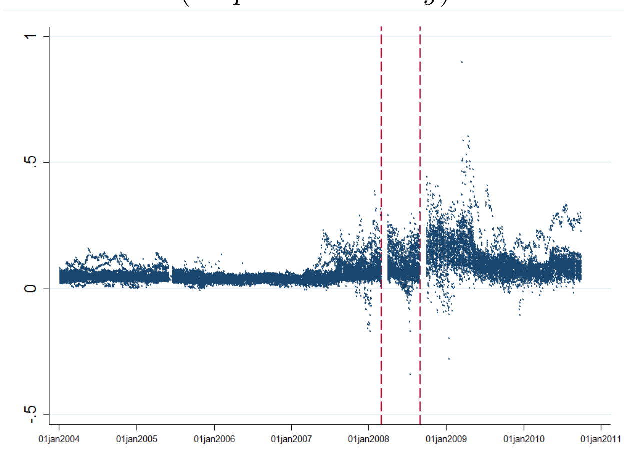
	(1) ΔCDS	(2) ΔCDS	(3) ΔCDS	(4) ΔCDS
$D_C \cdot r_{AE}$	48.11***	48.81***	196.2***	197.6***
	(13.82)	(13.91)	(21.95)	(21.98)
$D_{BS} \cdot r_{AE}$	-67.91**	-68.19**	-32.64	-31.75
	(29.10)	(29.05)	(40.52)	(40.46)
$D_{LEH} \cdot r_{AE}$	-87.75**	-88.86**	90.45***	91.08***
	(36.62)	(36.52)	(29.89)	(29.86)
$D_C \cdot r_{AE} \cdot Skewness$	-2,459***	-2,464***		
	(357.8)	(362.2)		
$D_{BS} \cdot r_{AE} \cdot Skewness$	-2,300***	-2,293***		
	(328.2)	(325.6)		
$D_{LEH} \cdot r_{AE} \cdot Skewness$	-1,343***	-1,328***		
	(356.4)	(355.5)		
$D_C \cdot r_{AE} \cdot Implied\ Vol$			-888.6***	-892.7***
			(79.66)	(79.93)
$D_{BS} \cdot r_{AE} \cdot Implied\ Vol$			-460.1***	-461.7***
			(85.08)	(85.06)
$D_{LEH} \cdot r_{AE} \cdot Implied\ Vol$			-606.3***	-607.4***
			(71.30)	(71.25)
Firm fixed effects	yes	no	yes	no
Observations	25,294	25,294	25,294	25,294
R-squared	0.157	0.157	0.175	0.175
Number of firms	78	78	78	78
Period 0 = Period 1	0.78	0.76	0.00	0.00
Period 0 = Period 2	0.01	0.01	0.00	0.00
Period 1 = Period 2	0.05	0.05	0.17	0.17

Table 7: **Regression results for non-financial firms.** Above are the results from regression (17) for the full sample of non-financial institutions, using weekly return data and skewness and implied volatility as the main risk proxies. r_{AE} is the adjusted equity return according to Equation (18) and using book leverage values. D_C, D_{BS} and D_{LEH} are dummy variables that are one before March 2008, between March and September 2008 and after September 2008, respectively, and zero otherwise. Standard errors clustered at the firm level are given in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. "Period 0 = Period 1" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. "Period 0 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period after Lehman Brothers. "Period 1 = Period 2" refers to the p-value of a test on the equality of the coefficient of the interaction of the respective risk characteristic with adjusted equity returns in the control period and the period between Bear Stearns and Lehman Brothers. Detailed variable descriptions are given in the text.

9 Appendix B: Figures

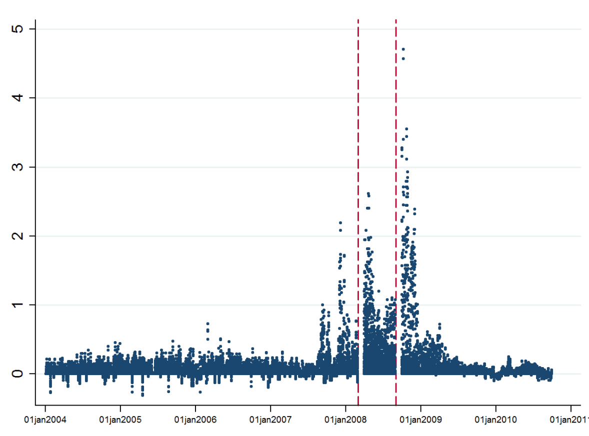


(*Implied volatility*)

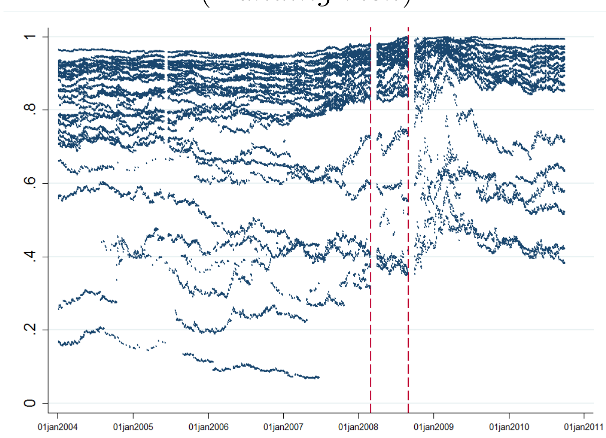


(*Skewness*)

Figure 1: **Time series evolution of implied volatility and skewness proxies.** Above graphs depict the time series evolution of the company specific implied volatility and skewness proxies for the full sample of financial institutions. The vertical dashed lines mark the rescue of Bear Stearns and the bankruptcy of Lehman Brothers.



($Funding\ risk$)



($Leverage$)

Figure 2: **Time series evolution of funding risk and leverage proxies.** Above graphs depict the time series evolution of the company specific funding risk and leverage proxies for the full sample of financial institutions. Leverage is defined as $L = D/(D+E)$. The vertical dashed lines mark the rescue of Bear Stearns and the bankruptcy of Lehman Brothers.

10 Appendix C: Discussion of the linearity of the hedge ratio in risk

Assuming a linear functional form is a restriction by itself and comes at a potential cost. The cost however is limited if standard firm value models imply a close to linear relation as well. In order to visualize the effect for two main risk proxies, volatility and leverage, we use a market standard model from Finger et al. (2002) in order to derive theoretical debt-to-equity sensitivities and hedge ratios for a set of realistic market parameter, as experienced during the crisis. Figures 3 and 4 depict the credit spread-to-equity semi-elasticity (beta) and the debt-to-equity hedge ratio for various values of the stock volatility and two different definitions of leverage ($L = \frac{D}{D+E}$ and $L^* = \frac{D}{E}$). The figure inputs are based on the same balance sheet data for J.P. Morgan Chase and calibrated to match the CDS level for June 2007, right before the onset of the financial crisis.[16] As can be seen in all four figures, the beta and the hedge ratio are approximately linear in the stock volatility regardless of the leverage definition. Scrutinizing the two different leverage definitions, the beta and the hedge ratio are rather non-linear in L. By contrast, the beta function is much less concave in L^* while the hedge ratio is almost linear in L^*. Thus, at least for the stock volatility and the leverage definition $L^* = D/E$ the cost of the linearity assumption seems small relative to the possible gains of including non-traditional risk proxies. Those risk proxies enable us to include factors which are beyond the scope of traditional firm value models such as funding and liquidity proxies or option-implied information about future return distributions.

[16] In order to ease comparability, the assumed exogenous parameters are the same as in Schweikhard and Tsesmelidakis (2012). Our CDS level calibration for June 2007 yields a mean recovery rate of $\overline{L} = 0.08$ which is comparable in size with the estimated pre-crisis level of 0.03 estimated by Schweikhard and Tsesmelidakis (2012).

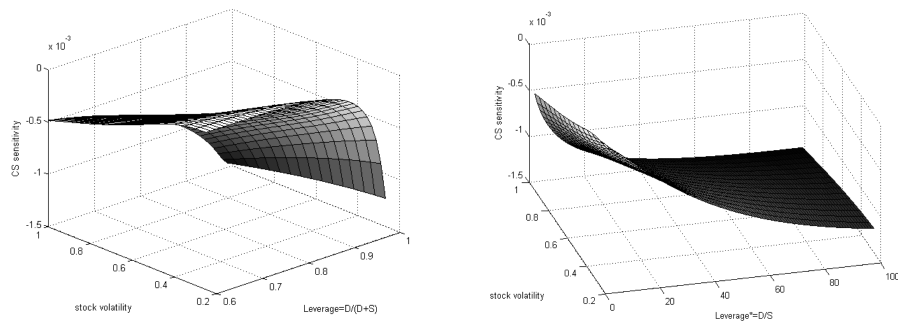


Figure 3: **Illustration of theoretical credit spread semi-elasticities.** Above are the theoretical credit spread semi-elasticities as functions of stock volatility and two different definitions of leverage, derived from Finger et al. (2002). On the left, leverage is defined as $L = D/(D+E)$, while on the right leverage is defined as $L^* = D/E$. The fundamental leverage and the other firm characteristics are the same in both figures. The model is calibrated using data for J.P. Morgan Chase in June 2007.

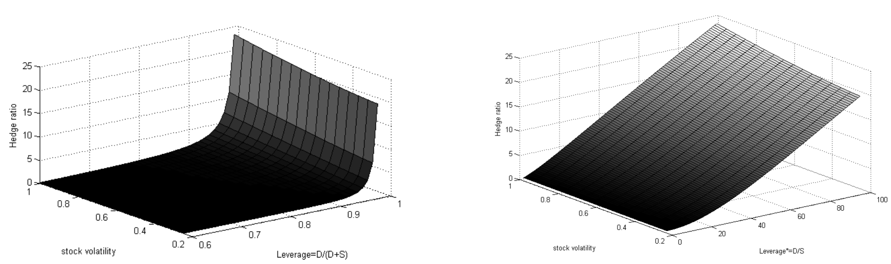


Figure 4: **Illustration of theoretical hedge ratios.** Above are the theoretical hedge ratios as functions of stock volatility and two different definitions of leverage, derived from Finger et al. (2002). On the left, leverage is defined as $L = D/(D+E)$, while on the right leverage is defined as $L^* = D/E$. The fundamental leverage and the other firm characteristics are the same in both figures. The model is calibrated using data for J.P. Morgan Chase in June 2007.

11 Appendix D: List of included financial and non-financial institutions

Ticker ID	Company	Investment bank	Size
AIG	AMERICAN INTERNATIONAL GROUP	no	Large
ALL	ALLSTATE CORP	no	Small
AOC	AON CORP	no	Small
AXP	AMERICAN EXPRESS CO	no	Large
BAC	BANK OF AMERICA CORP	no	Large
BEN	FRANKLIN RESOURCES INC	no	Small
BSC	BEAR STEARNS COMPANIES INC	yes	Large
C	CITIGROUP INC	no	Large
CIT	CIT GROUP INC	no	Small
CNAFC	CNA FINANCIAL CORP	no	Large
COF	CAPITAL ONE FINANCIAL CORP	no	Small
CVH	COVENTRY HEALTH CARE INC	no	Small
GS	GOLDMAN SACHS GROUP INC	yes	Large
HIG	HARTFORD FINANCIAL SERVICES	no	Large
HNT	HEALTH NET INC	no	Small
JPM	JPMORGAN CHASE & CO	no	Large
LBTR	LEHMAN BROTHERS HOLDINGS INC	yes	Large
LNC	LINCOLN NATIONAL CORP	no	Small
MBI	MBIA INC	no	Small
MER	MERRILL LYNCH & CO INC	yes	Large
MET	METLIFE INC	no	Large
MMC	MARSH &MCLENNAN	no	Small
MWD	MORGAN STANLEY	yes	Large
PGR	PROGRESSIVE CORP-OHIO	no	Small
STI	SUNTRUST BANKS INC	no	Small
TMK	TORCHMARK CORP	no	Small
UNM	UNUM GROUP	no	Small
UNP	UNION PACIFIC CORP	no	Small
WB	WACHOVIA CORP	no	Large
WFC	WELLS FARGO & CO	no	Large
WM	WASHINGTON MUTUAL INC	no	Small

Table 8: **List of financial institutions**

Ticker ID	Company	Ticker ID	Company
T	A T & T CORP	IBM	INTERNATIONAL BUSINESS MACHS COR
AL	ALCAN INC	KFT	KRAFT FOODS INC
AA	ALCOA INC	KR	KROGER COMPANY
MO	ALTRIA GROUP INC	LEN	LENNAR CORP
AMGN	AMGEN INC	LTD	LIMITED BRANDS INC
ARW	ARROW ELECTRONICS INC	LMT	LOCKHEED MARTIN CORP
AZO	AUTOZONE INC	M	MACYS INC
BAX	BAXTER INTERNATIONAL INC	MAR	MARRIOTT INTERNATIONAL INC NEW
BA	BOEING CO	MCD	MCDONALDS CORP
BMY	BRISTOL MYERS SQUIBB CO	MCK	MCKESSON H B O C INC
CSX	C S X CORP	MOT	MOTOROLA INC
CVS	C V S CAREMARK CORP	NWL	NEWELL RUBBERMAID INC
CPB	CAMPBELL SOUP CO	JWN	NORDSTROM INC
CCL	CARNIVAL CORP	NSC	NORFOLK SOUTHERN CORP
CAT	CATERPILLAR INC	NOC	NORTHROP GRUMMAN CORP
CTX	CENTEX CORP	OMC	OMNICOM GROUP INC
CMCSA	COMCAST CORP NEW	PGN	PROGRESS ENERGY INC
CSC	COMPUTER SCIENCES CORP	PHM	PULTE GROUP INC
CAG	CONAGRA INC	DGX	QUEST DIAGNOSTICS INC
COP	CONOCOPHILLIPS	RTN	RAYTHEON CO
DRI	DARDEN RESTAURANTS INC	ROH	ROHM & HAAS CO
DE	DEERE & CO	SWY	SAFEWAY INC
DVN	DEVON ENERGY CORP NEW	SRE	SEMPRA ENERGY
DIS	DISNEY WALT CO	SHW	SHERWIN WILLIAMS CO
D	DOMINION RESOURCES INC VA NEW	SPG	SIMON PROPERTY GROUP INC NEW
DOW	DOW CHEMICAL CO	LUV	SOUTHWEST AIRLINES CO
DD	DU PONT E I DE NEMOURS & CO	HOT	STARWOOD HOTELS & REST WLDWD INC
DUK	DUKE ENERGY CORP NEW	TGT	TARGET CORP
EMN	EASTMAN CHEMICAL CO	TXT	TEXTRON INC
FE	FIRSTENERGY CORP	TOL	TOLL BROTHERS INC
GCI	GANNETT INC	RIG	TRANSOCEAN LTD
GIS	GENERAL MILLS INC	UHS	UNIVERSAL HEALTH SERVICES INC
GR	GOODRICH CORP	VLO	VALERO ENERGY CORP NEW
HAL	HALLIBURTON COMPANY	WMT	WAL MART STORES INC
HPQ	HEWLETT PACKARD CO	WY	WEYERHAEUSER CO
HD	HOME DEPOT INC	WHR	WHIRLPOOL CORP
HON	HONEYWELL INTERNATIONAL INC	WYE	WYETH
IR	INGERSOLL RAND PLC		

Table 9: **List of non-financial institutions**