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# Do Bank Bail-Outs cause Moral Hazard? Evidence from the Subprime Crisis

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## Abstract

In this paper we develop a methodology to test for changes in the strength of market discipline in the corporate bond market. Based on the relationship between equities and bonds of a firm, our method examines the relationship between equity implied information about default probabilities and corporate bond spreads. We interpret a structural change in this relationship as change in market discipline. We then apply this approach to study major events during the current financial crisis, in particular the rescue of Bear Stearns as well as the failure of Lehman Brothers and thereby test popular opinions about the effects of these events. Thereby we rely on the asymmetric effects of bail-outs, as they favor debt holders more than equity holders. We find that the rescue of Bear Stearns led to a significant decline in market discipline. This result is in line with the idea of the bail-out being a signal to market participants that the concept of "Too-Big-To-Fail" applies to Investment Banks. Regarding the Lehman case we find that it did re-establish some lost market discipline.

*Keywords: bail-out, too-big-to-fail, bond spreads, market discipline, moral hazard*

*JEL: G14, G21, G28, H81*

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*‘Any Aid to a present bad bank is the surest mode of preventing the establishment of a future good bank.’* (Walter Bagehot, 1873)

## 1 Introduction

The current financial crisis<sup>1</sup> has been subject to an unprecedented extent of policy interventions in the financial markets. At the same time however there emerged an intense public debate about the reasonability of these public interventions. The main argument is that public support of banks, such as public guarantees, massive capital injections or complete bail-outs by the government, affect expectations about the behaviour in future crises in an economically undesirable way as it stimulates moral hazard and weakens market discipline. Because economic theory suggests that market discipline is an important prerequisite for the proper functioning of financial markets, public interventions could therefore lead to more pronounced future crises even if short-term effects might actually be stabilizing. This paper aims at testing empirically whether market discipline has been weakened or strengthened since the outbreak of the financial crisis. More precisely, we evaluate the effects of the public bailout of Bear Stearns and the non-bailout of Lehman Brothers.

In order to do so, we first develop a methodology to compare the degree of market discipline that prevails at different points in time. In our study, we focus on the corporate bond market of US financial institutions. In the present context, market discipline corresponds to the pressure that market participants put on bond issuers. By demanding a higher risk premium in the case of a decline of repayment probability, they increase the costs of external refinancing for potential bond issuers. This threat creates an incentive for corporations to

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<sup>1</sup>For a summary of events during the time period relevant for this paper see Brunnermeier (2009) or Hellwig (2009).

aspire a high probability of repayment and thus a reasonable level of risk. In an environment of low market discipline, bond issuers can increase the riskiness of their business without the fear of being punished by market participants via higher demanded risk premia for their debt.

Our analysis proceeds as follows: In a first step we calculate the sensitivity of bond spreads to changes in equities in our control period, i.e. the year prior to the Bear Stearns intervention in March 2008. We thereby allow for a nonlinear relationship, i.e. that the sensitivity varies with the level of the credit spreads. As we will show later, equity returns contain information on the probability of default. This setup provides sufficient flexibility to avoid problems stemming from varying spread levels in different time periods. In the second step the impact of actual public interventions on market discipline is then derived by a comparison of the marginal effects of equity return on bond spreads in the control period and after the intervention.

Our results in the first step are in line with our predictions: In the control period, the relationship between changes in bond spreads and equity returns is negative and highly significant. Therefore our findings are in line with the theoretical corporate bond literature and previous empirical research on bond spreads determinants. Our method is therefore eligible to test for changes in market discipline. For the Bear Stearns event our results turn out to be as expected as well: Following the rescue, market discipline declines. As the event can be interpreted as new information that the likelihood of future bailouts increased, a reduction in market discipline is the natural reaction by market participants. For the Lehman Brothers event it is a priori not clear, if market discipline strengthened or weakened: On the one hand - inverse to the Bear Stearns case - the absence of public support can be interpreted as a signal of a strong commitment to principles of market discipline by the policy makers

and thus an information that the probability of further bailouts declined. Arguably, this could have been one of the major factors behind the decision to let Lehman Brothers go down. On the other hand, the tremendous disturbances after the bankruptcy can also be interpreted as a threat point to policy makers strong enough to never let a major bank fail again. In this case, market discipline should have further weakened.

Our analysis does not allow for a clear answer here. Our findings imply that the non-bailout of Lehman Brothers indeed reestablished some market discipline as our relative measure for market discipline lies between the levels of the pre- and post Bear Stearns bailout but are not statistically different from either of the two.

## 2 Literature Review

The question if and when to bail out banks has received large interest in the literature. It can be roughly divided into two "camps".

One argues against bail-outs: Besides the pure fiscal costs of a bailout (see Calomiris and White (1994) and Baer and Klingebiel (1995) for empirical data on measurements of fiscal costs of bail-outs), it focuses on the incentive-compatibility of public policies and thus stresses the moral hazard component of bailing-out banks. In their view, banks should not be bailed-out as this creates the expectation of future bail-outs and thus weakens market discipline. Market discipline thereby means, that claim holders put pressure on banks to behave in a proper way. As their motivation to do so stems from the fear of a decline of the value of their claims (i.e. that bonds will not repay) this mechanism weakens if future bail-outs are expected with a higher probability. This argument can be seen as an application of the concept of time inconsistency by Kydland and Prescott (1977): Allowing a bank to fail can provide a signal of commitment to the non-bailout policy and thus reshape market participants expectations in a favorable direction and thus overcome the dilemma for the policy makers.

The consequences of missing market discipline, and thus implicitly the costs of bank bailouts, have been emphasized by Calomiris and Kahn (1991), Rochet and Tirole (1996), and Diamond and Rajan (2001). They show that the risk of losing their claims is necessary to give market participants the incentive to monitor banks which then solves the inherent principal agent conflict in banking (see Jensen and Meckling (1976)). Following the latter, banks have an incentive to exploit debt holders, especially when they are hit by heavy losses, by choosing more risky investments. This is often called "gamble for resurrection". If debt holders fear

to lose their stakes, they prevent banks from doing so by executing market discipline. But if they think they will be saved anyway, nothing will stop the bank to invest in high-risk assets. Merton (1977) shows in an option pricing framework that the credit insurance a bail-out implicitly generates is equivalent to a put option with a strike price in the amount of outstanding debt. Thus, bank and debt holders jointly exploit the government by maximizing the value of the option by driving up volatility. Merton's analysis also shows that this effect is the stronger the weaker the condition of the bank is, which also follows the idea of "gambling for resurrection". Keeley (1990) provides empirical evidence for this mechanism.

The contrary position obviously stresses the possible benefits of bailing-out banks. Economic literature provides two important mechanisms for that:

First, based on fundamental models of banking by, for example, Diamond (1984), Fama (1985), Sharpe (1990), and Rajan (1992), one can argue that bank-client relationships can not be allowed to disappear as they are important for the functioning of financial intermediation. But as they would get lost due to a bank failure, one needs to save troubled banks. The work of Rajan and Petersen (1994) as well as James (1987) show empirical evidence for this.

The second and even more forceful and present argument is the threat of contagion and systemic risk, which can follow a bank failure. Several channels are discussed in the literature: Chan and Jagannathan (1988) as well as Chen (1999) show theoretically, that in a framework of imperfect information, single bank failures can trigger the collapse of other banks, even if they would survive otherwise. They thereby rely on the mechanics of the seminal work by Diamond and Dybvig (1983). Freixas, Parigi and Rochet (2000) Dasgupta (2004) and Allen and Gale (1998, 2000) show that due to the structure of interbank linkages and their interconnections "chain effects" can occur, which then are responsible for system wide banking crises in the subsequence to individual bank failures. Finally, most recent

work focuses on contagion effects of bank failures through common market exposure. Here the idea is that due to their involvement in similar markets, other institutions hurt from bank failures because it triggers price declines (Diamond and Rajan (2005), Allen and Gale (1994), Brunnermeier and Pedersen (2009)). Building up on these insights, Cifuentes, Ferrucci and Shin (2005) show that this problem can be multiplied if regulatory regimes oppose mark-to-market-accounting solvency constraints.



### 3 General Methodology

To test whether bailouts or non-bailouts have an effect on market discipline, requires two essential factors: a measure for the actual probability of a credit event and one for the probability of a default event in the absence of any government interventions. The use of corporate bond spreads as a measure for the actual probability is straightforward. Due to their simple structure they are also well accessible to an empirical analysis. A more difficult task is to find a proper measure of the probability of a default when bail-outs are perceived to be impossible. At first glance, one might think that this coincides with the first measure. However, in this particular analysis, the two measures differ due to the following reason: the intention of our analysis is to explore whether the price of debt reflects the ability of the bank to go concern even in the absence of a bail-out. Only such a measure allows testing the hypothesis that market participants anticipate further bail-outs and thus do not rely on this measure anymore. As credit spreads reflect only the actual default, i.e. the real absence of repayment, they do not satisfy this criterion. Hence another measure is required.

Following the seminal paper by Merton (1974), a large fraction of the financial literature derives the price of risky debt as a derivative on the underlying firm value under different frameworks while the equity value equals firm value less debt value. Therefore new information about the value of a firm should affect bond spreads as well as equity returns, because they contain information about future earnings and thus the probability of a future default. Earlier work of Kwan (1996) and Hotchkiss and Ronen (2002) already found evidence for this mechanism. Nevertheless, the above mentioned relationship between bond and stock return only holds if market participants don't incorporate the possibility of a bail-out of bondholders in their expectations. The government bailouts experienced during the recent crisis usually secured all payments under the (senior) bonds but left the equity holders with

almost nothing. Thus the expectation of a bail-out is equivalent to a perceived guarantee of senior debt. Hence, bond spreads should become less sensitive to changes of the underlying firm value if the expectation of bail-outs increases and market discipline should weaken. Unfortunately firm values are not directly observable in the market place. We overcome this problem by using the observable equity returns as an indicator for changes in the firm value.

However the same theoretical models of credit spreads suggest that the relationship between bondspreads and stock returns is non-linear. Under the Merton framework, an increase in stock prices indeed indicates a decrease in the probability of default and thus lower credit spreads, but depending on the actual level of leverage this impact should differ. In order to control for this fact, our model allows for non-linear marginal effects of stock returns on credit spreads. To get a better idea of the actual functional form we derive the dependence of credit spreads on bond returns.

From Merton (1974) we know

$$CS = -\frac{1}{t} \ln(\phi(h2) + \frac{1}{d}\phi(h1)) \quad (1)$$

$$F = Be^{-rt}(\phi(h2) + \frac{1}{d}\phi(h1)) \Leftrightarrow \frac{F}{Be^{-rt}} = \phi(h2) + \frac{1}{d}\phi(h1) \quad (2)$$

where  $CS$  is the credit spread,  $F$  is the market value of debt, and  $B$  is the nominal value of debt. Inserting (2) into (1) and taking the derivative with respect to  $F$  yields

$$\frac{\partial CS}{\partial F} = -\frac{1}{tF} \quad (3)$$

Starting from  $\partial CS = \partial CS$ , expanding and inserting (3) gives

$$\partial CS = -\frac{1}{t} \frac{\partial F}{F} \frac{\partial A \partial S A S}{\partial A \partial S A S} \quad (4)$$

Rearranging and using the definition of an elasticity then yields

$$\partial CS = -\frac{1}{t} \frac{\epsilon_{F,A}}{\epsilon_{S,A}} \frac{\partial S}{S} \quad (5)$$

which is the structural form of our equation of interest, which we want to estimate: It states the relationship of credit spread changes and changes in the stock price. In order to extract a suitable functional form of this relationship we take a deeper look at the "slope" of equation (5). Lets define  $Z \equiv -\frac{1}{t} \frac{\epsilon_{F,A}}{\epsilon_{S,A}}$  and analyse its structure:

$$\begin{aligned} \frac{\partial F}{\partial A} &= (1 - \phi(d1)) \frac{A}{F} \\ \frac{\partial S}{\partial A} &= \phi(d1) \\ \Rightarrow Z &= -\frac{1}{t} \frac{(1 - \phi(d1))}{\phi(d1)} \left( \frac{A}{F} - 1 \right) \end{aligned} \quad (6)$$

where the last step uses  $A = F + S$ .

In order to find a proper and applicable functional form of  $Z$  we calculate some numerical examples. Figure 1 seems to justify a declining and convex functional form of  $Z$  for our sample. Thus, we approximate this relationship by assuming  $Z$  to follow a logarithmic form in  $CS$ .

[FIGURE 1 about here.]

## 4 Data

In order to estimate our structural equation, we rely on a dataset obtained from Bloomberg. For the period from June 1 2007 to Nov 11 2009, the dataset contains information on 42 bonds of the US investment banks Bear Stears, Merrill Lynch, Morgan Stanley and Goldman Sachs as well as the corresponding stock prices of the companies. In order to guarantee a certain degree of homogeneity within the sample and keep the liquidity problem as small as possible, we restricted our sample to uncallable senior unsecured fixed rate bonds with a minimum outstanding notional of at least USD 1bn and a remaining maturity of at least 6 months over the whole sample. For these 42 bonds we obtain quotes for credit spreads from Bloomberg (BLP SPRD TO BENCH LAST) for the relevant period as well as corresponding closing stock prices of the companies (PX LAST). Additionally we obtained Bloomberg quotes of the CDX series for the relevant period for some test specifications. For the CDX time series we use data of the series 8 -12 5y CDX levels, always switching on the roll-over date from on the older series to the latest. Regarding data cleansing, we ignore observations where we do not have the full set of information for the bond, i.e. credit spread, according stock price and CDX level of that specific date. Also we ignore all observations for Bear Stearns and Merrill Lynch after their announced take-overs on Mach 24 2008 and September 14 2008. As there is a well known phenomenon of excess correlation in times of extreme market distress, we would expect our findings to be seriously biased during the heights of the turmoil. Thus we exlude all observations one week before and after the the Bear Stearns bailout from the sample as well as all observations from the announcement of the USD 3.9bn loss of Lehman Brothers on September 10 2008 until April 1 2009. While the length of this exlusion period is certainly exaggerated from a pure excess correlation point of view, the advantage is that the remaining period exhibits on average similiar credit spreads level as the period between

the Bear Stearns bailout and the Lehman Brothers bankruptcy. As our analysis will show, the fit of our estimated relationship works better for out of sample spread levels close to the ones observed in the control period and the comparison between the individual periods is facilitated by more homogenous spread environments. These adjustments leave us with a total of 11,374 observations over the whole sample, with 4,323 observations falling into the control period, 3,571 observations in the post- Bear Stearns period and 3480 observations after April 1 2009.

## 5 Estimation and Results

We estimate the following equation:

$$\begin{aligned}
 CSdiff_{i,j,t} = & \beta_0 + \beta_1 * EqReturn_{j,t} * \ln(CS_{i-1,j,t}) \\
 & + \beta_2 * EqReturn_{j,t} * \ln(CS_{i-1,j,t}) * d_B S_t \\
 & + \beta_3 * EqReturn_{j,t} * \ln(CS_{i-1,j,t}) * d_L B_t
 \end{aligned} \tag{7}$$

where  $CSdiff_{i,j,t}$  is the change of the credit spread of bond  $i$  from bank  $j$  at time  $t$ ,  $EqReturn$  is the relative change of the corresponding stock price of bank  $j$  at time  $t$ ,  $d_B S$  is dummy which is 1 between the rescue of Bear Stearns and the failure of Lehman Brothers and zero otherwise, and  $d_L B$  is a dummy which is 1 after the failure of Lehman Brothers and zero otherwise. We use lagged values of the credit spreads on the right hand side in order to avoid endogeneity stemming from the correlation between the change of the credit spread and the level of the credit spread both in time  $t$ . The lagged credit spread should still apply as a control for the general spread level but overcomes the endogeneity problem, as the change of the spread should not be correlated with its level, in order to be consistent with the efficient market hypothesis. Recall that  $EqReturn_{j,t} * \ln(CS_{i-1,j,t})$  represents  $Z$  from above. As shown theoretically the marginal effect depends on the current level of the credit spread.

We then include dummies interacted with our marginal effect  $Z$  in order to estimate the difference of sensitivity between our three different periods of interest:

- Control Period (Before Bear Stearns, no dummy)

- after Bear Stearns, Before Lehman Brothers (dummy  $d_B S_t$ )
- after Lehman Brothers (dummy  $d_L B_t$ ).

Our hypotheses therefore are:

**Hypothesis 0:  $\beta_1$  is significantly smaller than zero, following from the theoretical derivation of  $Z$ .**

As our derivation above has shown, the reaction of bond spreads to changes of equity returns should be negative.

**Hypothesis 1:  $\beta_2$  is significantly larger than zero, representing a decline in market discipline due to the bailout of Bear Stearns.**

The rescue of Bear Stearns should reshape the expectations of market participants such, that they increase their perceived probability of further bailouts of other investment banks. Therefore we expect a decline in market discipline after the bailout. This should be reflected in a lower sensitivity of credit spreads to equity returns and thus a positive and significant coefficient  $\beta_1$ .

For the case of Lehman Brothers, the expected sign of the coefficient  $\beta_3$  is not a priori clear. There are explanations for either sign:

**Hypothesis 2a:  $\beta_3$  is insignificant, representing the reestablishment of market discipline due to the failure of Lehman Brothers.**

It might be negative, as the fact, that a large investment bank has not been bailed out, could be interpreted as a decrease in the willingness to bailout banks in the future.

**Hypothesis 2b:  $\beta_3$  is significantly larger than zero, representing a further decline**



**of market discipline due to the failure of Lehman Brothers.** It also might be positive, as the tremendous disturbances after the bankruptcy can also be interpreted as a threat point to policy makers strong enough to never let a major bank fail again.

Regressor	Coefficient	Std.Error	t-statistic	p-value
$EqReturn * ln(CS)$	<b>-0.1462</b>	0.033227	-4.40	<b>0.000</b>
$EqReturn * ln(CS) * d_{BS}$	<b>0.0844</b>	0.044014	1.92	<b>0.055</b>
$EqReturn * ln(CS) * d_{LB}$	<b>0.0502</b>	0.038683	1.03	<b>0.302</b>
<i>Constant</i>	-0.3592	0.310697	-1.16	0.248
$R^2$	0.0028			
$R^2_{adj.}$	0.0025			
Number of obs	11195			
dependent variable: Credit Spread Change				

Table 1: Regression Results

The first result following our analysis is that the sign of the marginal effect  $Z$  has the expected sign, as  $\beta_1$  is negative and highly significant and therefore supports **hypothesis 0**. Regarding **hypothesis 1** our results show that the sensitivity of credit spread changes to changes of equity returns is significantly smaller in the control period than in the period between Bear Stearns and Lehman Brothers, as  $\beta_2$  is positive and significant with a p-value of 0.055. We interpret this result as support to hypothesis 1. Regarding **hypothesis 2a** and **hypothesis 2b** the estimates are neither able to rejected nor to support it, as  $\beta_3$  is not significantly different from zero, as the p-value of 0.302 implies. The absence of an unambiguous effect after the Lehman Brothers event and the sign of  $\beta_3$ , which is positive, indicate that the effect of the failure of Lehman Brothers on the reestablishment of market discipline was rather weak, if existing at all. Nevertheless, as no significance occurs, this hypothesis needs further examination as it is not supported by significant coefficients.

[FIGURE 2 about here.]

Figure 2 illustrates the results in an clear way. As the graph shows, the effect of the sensitivity

of credit spreads to equity returns is strictly stronger in the control period than in our two periods of interest. In line with the ambiguity of the impact of the Lehman Brothers failure its marginal effect lies between the control period and the Bear Stearns period.

There are several possibilities to improve our empirical investigation in order to provide further robustness checks for the results. First, as shown above, the nonlinearity of the connection between credit spreads and equity returns is crucial for a sound test of our hypotheses. Therefore, the analysis would benefit from a considerably longer control period, as this would allow us to estimate the marginal effect for a wider range of credit spread levels. Additionally, this would permit the use of additional observations in the Lehman period: As the credit spread levels in the time after the failure and prior to April 1 2009 highly exceeds the spread levels of the control period, incorporating them into our estimation would introduce the possibility of an "out-of-sample-prediction"-bias. Including observations with high spread levels into the control period would allow to use the additional observations of the Lehman period as well and thus might shed further light on the effects of this particular event.

Additional omitted factors, which might be worth considering, are changes in market liquidity and changing variance of credit spreads and equity returns over time. Although the data clearly contains a panel structure, we do not explicitly incorporate this time dimension in our analysis. This provides the possibility to expand the analysis in this direction and control for these effects.

## 6 Conclusion

In this paper we examined the question whether policy interventions, as bank bailouts, cause moral hazard in the sense of a weakening of market discipline. We therefore developed a framework which exploits the connection between equity returns and credit spreads, which follows from option pricing theory and in particular from Merton (1974). The results of our estimation support our methodology, as the theoretical prediction about the effect of the Bear Stearns rescue are met: Following our analysis, the rescue of Bear Stearns did in fact weaken market discipline. This is in line with the idea of the bail-out being a signal to market participants that the concept of "Too-Big-To-Fail" applies to Investment Banks.

Regarding the case of Lehman Brothers, our results are not as clear in favor of one of the two hypotheses. As described above, further improvements of the analysis might help to grasp additional insights on this event, as well.

Although the empirical analysis confirmed the existence of a negative effect of bailouts on market discipline, it is important to note that this does not provide a sufficient justification to abandon bail-outs as a policy option. Even if theoretical considerations imply that the absence of market discipline might lead to a decrease of financial market stability, it is not necessarily clear that this effect overcompensates the stabilizing effect a bank bail-out can provide in the short run. In fact, the absence of a clear reestablishment effect of market discipline in the case of the Lehman Brothers failure in combination with the subsequent time of turmoil moreover suggests that the decision whether to bailout or not can not be answered in general, but rather has to be examined regarding the circumstances of each particular case.

## References

- [1] Allen, F. and D. Gale (1994). Limited Market Participation and Volatility of Asset Prices. *The American Economic Review* 84:4, 933-955.
- [2] Allen, F. and D. Gale (1998). Optimal Financial Crises. *The Journal of Finance* 53:4, 1245-1284.
- [3] Allen, F. and D. Gale (2000). Financial Contagion. *Journal of Political Economy* 108:1, 1-33.
- [4] Bagehot, W. (1873). *Lombard Street*. H.S. King, London.
- [5] Barro, R.J. and D.B. Gordon (1983). A Positive Theory of Monetary Policy in a Natural Rate Model. *The Journal of Political Economy* 91:4, 589-610.
- [6] Brunnermeier, M.K. and L.H. Pedersen (2009). Market Liquidity and Funding Liquidity. *Review of Financial Studies*, forthcoming.
- [7] Brunnermeier, M.K. (2009). Deciphering the Liquidity and Credit Crunch 2007-2008. *Journal of Economic Perspectives* 23:1, 77-100.
- [8] Calomiris, C.W. and C.M. Kahn (1991). The Role of Demandable Debt in Structuring Optimal Banking Arrangements. *The American Economic Review* 81:3, 497-513.
- [9] Calomiris, C.W. and E.N. White (1994). The Origins of Federal Deposit Insurance. *in Goldin, C. and G. Libecap (Eds.), The Regulated Economy*, University of Chicago Press, Chicago, 145-188.
- [10] Chari, V.V. and R. Jagannathan (1988). Banking Panics, Information, and Rational Expectations Equilibrium. *The Journal of Finance* 43:3, 749-761.

- [11] Chen, Y. (1999). Banking Panics: The Role of the First-Come, First-Served Rule and Information Externalities. *The Journal of Political Economy* 107:5, 946-968.
- [12] Cifuentes, R., H.S. Shin and G. Ferrucci (2005). Liquidity Risk and Contagion. *Journal of the European Economic Association* 3:2, 556-566.
- [13] Dasgupta, A. (2004). Financial Contagion Through Capital Connections: A Model of the Origin and Spread of Bank Panics. *Journal of the European Economic Association* 2:6, 1049-1084.
- [14] Diamond, D.W. and P.H. Dybvig (1983). Bank Runs, Deposit Insurance, and Liquidity. *The Journal of Political Economy* 91:3, 401-419.
- [15] Diamond, D.W. (1984). Financial Intermediation and Delegated Monitoring . *The Review of Economic Studies* 51:3, 393-414.
- [16] Diamond, D.W. (1991). Monitoring and Reputation: The Choice between Bank Loans and Directly Placed Debt. *The Journal of Political Economy* 99:4, 689-721.
- [17] Diamond, D.W. and R.G. Rajan (2005). Liquidity Shortages and Banking Crises. *The Journal of Finance* 60:2, 615-647.
- [18] Fama, E.F. (1985). What's different about banks? *Journal of Monetary Economics* 15:1, 29-39.
- [19] Freixas, X., B.M. Parigi and J.C. Rochet (2000). Systemic Risk, Interbank Relations, and Liquidity Provision by the Central Bank. *Journal of Money, Credit and Banking* 32:3, 611-638.

- [20] Hellwig, M. (2008). Systemic Risk in the Financial Sector: An Analysis of the Subprime-Mortgage Financial Crisis. *Preprints of the Max Planck Institute for Research on Collective Goods* 2008/43.
- [21] Hotchkiss, E.S. and T. Ronen (2002). The Informational Efficiency of the Corporate Bond Market: An Intraday Analysis. *The Review of Financial Studies* 15, 1325-1354.
- [22] James, C. (1987). Some evidence on the uniqueness of bank loans. *Journal of Financial Economics* 19:2, 217-235.
- [23] Jensen, M.C. and W.H. Meckling (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics* 3:4, 305-360.
- [24] Keeley, M.C. (1990). Deposit Insurance, Risk, and Market Power in Banking. *The American Economic Review* 80:5, 1183-1200.
- [25] Kwan, S.H. (1996). Firm-specific information and the correlation between individual stocks and bonds. *Journal of Financial Economics* 40:1, 63-80.
- [26] Kydland, F.E. and E.C. Prescott (1977). Rules Rather than Discretion: The Inconsistency of Optimal Plans. *The Journal of Political Economy* 85:3, 473-492.
- [27] Merton, R.C. (1974). On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. *The Journal of Finance* 29:2, 449-470.
- [28] Merton, R.C. (1977). An analytic derivation of the cost of deposit insurance loan guarantees: An application of modern option pricing theory. *Journal of Banking and Finance* June, 3-11.
- [29] Petersen, M.A. and R.G. Rajan (1994). The Benefits of Lending Relationships: Evidence from Small Business Data. *The Journal of Finance* 49:1, 3-37.

- [30] Rajan, R.G. (1992). Insiders and Outsiders: The Choice between Informed and Arm's-Length Debt. *The Journal of Finance* 47:4, 1367-1400.
- [31] Rochet, J.C. and J. Tirole (1996). Interbank Lending and Systemic Risk. *Journal of Money, Credit and Banking* 28:4, 733-762.
- [32] Sharpe, S.A. (1990). Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships. *The Journal of Finance* 45:4, 1069-1087.

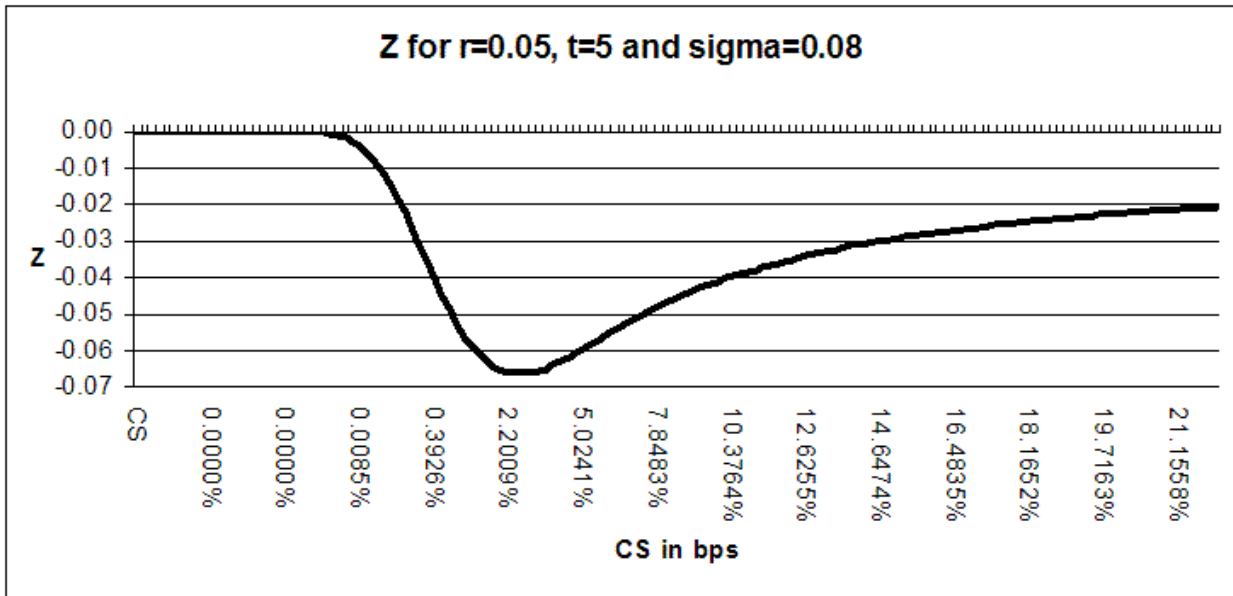


Figure 1: Numerical Example of Z.

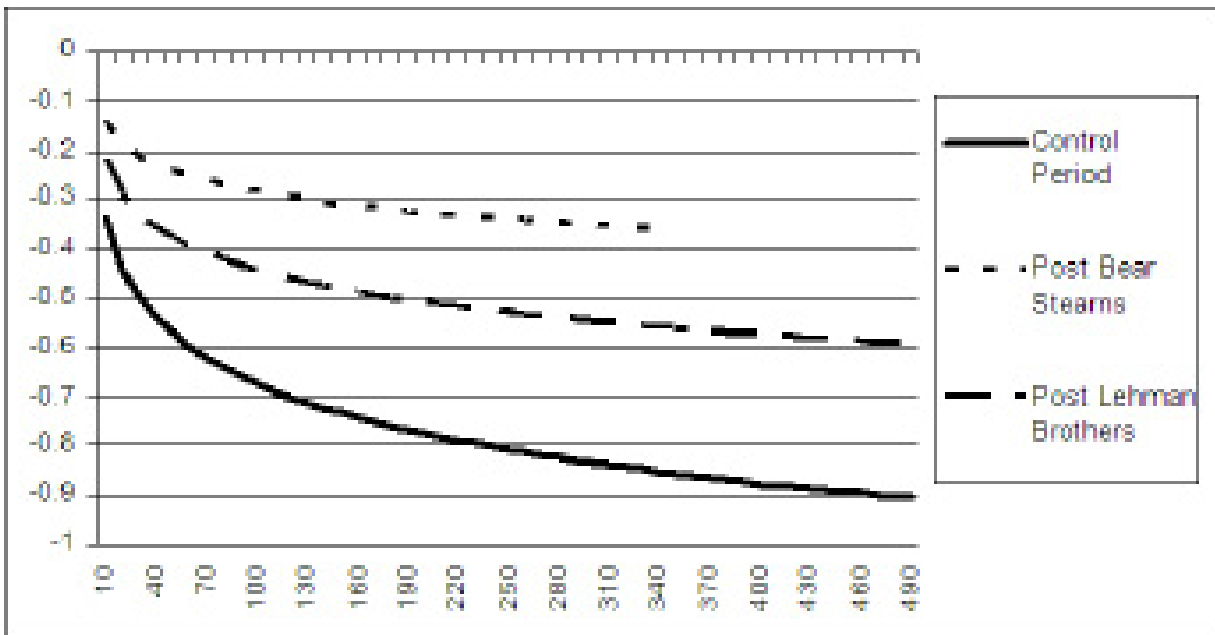


Figure 2: marginal effect Z and credit spread level