Transmission of CDS spreads among major financial institutions during the global financial crisis:

Liquidity squeeze, AIG's bailout and monoline crisis*

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[Abstract]

The recent global financial crisis triggered by the subprime loan debacle has highlighted the reemergence of counterparty risk. The financial market structure has become increasingly complex primarily as a result of an expansion in financial guarantee trading and various derivative transactions. This paper presents examination of the transmission mechanism of the global financial crisis onto credit default swap (CDS) spreads of major financial institutions including commercial banks, investment banks, and insurance companies.

This paper uses a structural VAR model to analyze interdependence among major financial institutions as well as effects of funding liquidity and macroeconomic conditions as common factors. The methodology used for the analyses presented in this paper shows that the expected slowdown of world economic activities and the tightened interbank market exerted large impacts on CDS spreads of financial institutions which had increased their financial leverage tremendously, and on those which incurred huge losses because of the decline in the value of mortgage-backed securities. Although banks were likely to be more vulnerable to liquidity tightening than insurance companies holding longer-maturity debts, this paper presents the observation that insurance companies, which had been major providers of variable annuities with guaranteed minimum benefits, were fragile to the international liquidity crunch.

This paper also shows that the hikes of the CDS spreads of the two largest monoline insurers and AIG spilled over worldwide. Concerns about bankruptcy of AIG, the largest underwriter of credit derivative products, might have extensively affected banks and

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insurance companies, including those which sought a way to mitigate capital requirements and to liberate capital for additional loan intermediation. The monoline crisis is presumed to have exerted a larger impact on insurance companies than on banks because insurance companies have been more closely connected with financial reinsurance business and investment for securitized products with guarantees.

1. Introduction

Recent years have been disastrous for financial institutions because of sharp and abrupt asset price declines, liquidity dry-ups, and fear for chain risk transfers of counterparty risks. This paper presents examination of the transmission mechanism of the global financial crisis onto credit default swap (CDS) spreads of major financial institutions including commercial banks, investment banks, and insurance companies. Special attention is devoted to the effect of common factors on the CDS spreads as well as their interdependence.

During the global financial crisis, we observed CDS spreads skyrocket, which can be explained only slightly by changes in the probability of default. That soaring of the CDS spreads should reflect changes in market participants' attitude related to risks as well as their perception of uncertainty in future macroeconomic conditions. Gai and Vause (2006) argue that risk premia must depend not only on the riskiness of assets but also on the degree to which investors accept uncertainty (risk aversion) and the level of uncertainty itself (uncertainty about macroeconomic prospects). Hermosilo (2008) describes that the periodic shifts in market sentiment witnessed over time are more likely to be driven by the macroeconomic environment rather than by changes in the risk aversion of investors. The Bank of Japan (2008b) also asserts that a market participant's attitude related to risk can further depend on liquidity constraints; financial institutions under severe liquidity constraints are unwilling to bear risk. Funding liquidity and uncertainty in the macroeconomic environment are therefore likely to affect CDS spreads as common factors[1].

A CDS is a bilateral contract between the buyer and seller of protection. Its price is presumably determined reflecting conditions affecting their behaviors. When the seller of protection is facing a liquidity constraint, the seller might raise the CDS spread even though the solvency of a reference entity does not decrease. The tighter the liquidity, the more the seller might require a risk premium for bearing fundraising risk. The seller, who has a pessimistic expectation about future macroeconomic conditions, is also likely to

[1] Brunnermeier (2009) emphasizes the difference in concepts of funding liquidity and market liquidity.

raise the spread.

Bankruptcy scenarios for financial institutions include two types: insolvency because of excessive debt, and bankruptcy caused by fundraising difficulties. Therefore, the abrupt hike of CDS spreads of financial institutions during the midst of the global turmoil, especially those that had used highly leveraged, short-term financing, might also be a result of market participants' assessment of the probability of bankruptcy[2]. In fact, investors can buy and sell protection without owning any debt of the reference entity. In a case in which investors who do not own the underlying debt rush into speculation on bankruptcy of the reference entity which is on the verge of bankruptcy because of a liquidity squeeze, and sellers of protection, on the other hand, evaporate for fear of loss, its CDS spread presumably soars sharply.

A reverse transmission might also exist. During the global financial crisis, financial institutions raised their doubts and fears of one another in the interbank market, triggering a sharp rise in the interbank interest rate. Under such circumstances, the rise in the CDS spread of financial institutions, particularly those that had used highly leveraged, short-term financing, was likely to further deteriorate the credit tightening.

Recent studies of the global financial crisis include those of Frank, Hermosillo, and Hesse (2008) and Eichengreen, Mody, Nedeljkovic, and Sarno (2009) among others. Frank, Hermosillo, and Hesse (2008) used the dynamic conditional correlation – generalized autoregressive conditional heteroskedasticity (DCC-GARCH) model and estimated the conditional correlation coefficients between CDS spreads and the liquidity index. Eichengreen, Mody, Nedeljkovic, and Sarno (2009) used a principal component analysis of CDS spreads to examine the effect of the so-called Lehman shock. They suggested the influence of liquidity as a significant common factor.

In addition to the effects of the common factors including liquidity, the author specifically examines interdependence among the major financial institutions. The recent global financial crisis has highlighted the reemergence of counterparty risk. Asset-backed securities (ABS) or asset-backed security collateralized debt obligations (ABS-CDO) guaranteed by insurers such as monoline companies were sold to investors worldwide. In accordance with the worsening of the residential market, fears for credit downgrading of monoline insurers was followed by concerns related to the soundness of financial institutions holding enormous ABS-CDO with protection from the monolines.

[2] The effect of liquidity on increasing the probability of default aggravated by a funding squeeze and the effect of raising the risk premium accompanied by risk avoidance of market participants facing a liquidity constraint are not discriminated in these analyses. What is presented in this paper is an examination of the extent to which the liquidity crunch affected CDS spreads using a liquidity indicator.

The recent financial market structure has become increasingly complex primarily because of an expansion in financial guarantee trading and various derivative transactions. In such a highly complex financial market, how far the effect of bankruptcy event of a financial guarantor, or the effect of concerns to a financial guarantor on the verge of bankruptcy would reach is extremely unpredictable. A typical case is the crisis of American International Group, Inc. (AIG): the largest guarantor in the CDS market. During the financial crisis, its lack of transparency became a concern to regulators, as was the trillion dollar size of the market, which threatened the economy with systemic risk.[3]

Numerous studies of the yield spreads of corporate bonds, which, like CDS spreads, are regarded as an indicator of default risk of the issuing entity, have been made in the past (Collin-Dufresne, Goldstein and Martin (2001), Beber, Brandt and Kavajecz (2006), Shirasu and Yonezawa (2008), etc.), emphasizing the effect of liquidity. Jorion and Zhang (2007), however, point out that CDS spreads are superior to corporate bond yield spreads, which are sensitive to the choice of the benchmark risk-free rate and which can reflect other factors that are not related to default risk, such as tax differences between Treasury bonds and corporate bonds. Corporate bond yield spreads might depend also on issuing conditions such as the coupon rate and maturity (or the number of days due to the date of issue). Jorion and Zhang (2007) also argue that CDS spreads are preferred because they provide a direct measure of credit risk for the underlying reference entity from a very liquid market[4]. Zue (2006) also provides empirical evidence that the CDS market leads the bond market in terms of price discovery.

The impact of a struggling financial institution on surrounding financial institutions has been studied by numerous researchers using, for instance, event studies.[5] These studies designated positive ripple effects as a “contagion effect” and negative ripple effects as a “competitive effect” and investigated the consequences. The negative ripple effects can represent a situation in which the exit of an insolvent company from the market reduces market competitiveness while increasing profit opportunities for surviving companies.

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[3] Some have pointed out that the ambiguity of financial institutions engaging in insurance business or conglomerate financial institutions is high. Zhang, Cox, and Van Ness (2009) specifically examined the effect of ambiguity of financial institutions in their debt structures on the prices of stocks at the time of issuance. This study obtained the findings that, for outsiders, the assessment of non-life insurance is much more difficult than bank and life insurance and that large amounts of asymmetric information are involved; therefore, the bid–ask spread of stocks issued by non-life insurance companies largely reflects the elements of adverse selection. For this reason, when the trading partner is an insurance company or conglomerate financial institution, the effect of the insolvency of the financial institution might be increased further. This aspect will be examined further in detail in a future study.

[4] The CDS notional principal exceeded the loan balance of the reference entities.

[5] For example, Kaufman (1994), Fields, Ross, Ghosh, and Johnson (1994), Angbazo and Narayanan (1996), Fields, Klein, and Myskowski (1998).

Recent studies of this type include that of Egginton, Liebenberg, and Liebenberg (2009): they investigated the effect of AIG's financial distress on competing insurance companies and concluded that the competitive effect was dominant. Jorion and Zhang (2007) used CDS spreads to compare the effects on surrounding companies of companies filing for Chapter 11 bankruptcy protection and those filing for Chapter 7 bankruptcy.

This study has examined the factors affecting CDS spreads of financial institutions using a structural VAR model. In particular, emphasis is placed on the common factors and interdependence of the financial institutions. Indicators of uncertainty in the macroeconomic environment and an indicator of funding liquidity are used as the common factors. Moreover, this study was undertaken to examine the counterparty risks and attempts to examine the ripple effect from the monoline crisis and the AIG crisis specifically on the CDS spreads of other domestic and overseas financial institutions.

The remainder of this paper is organized as follows. Section 2 presents an overview of events worthy of special mention during the global financial turmoil. The data and the econometric methodology used for the analysis are presented respectively in section 3 and section 4. The empirical results are reported afterward. Finally, the major findings are summarized and the implications are presented.

2. Overview of the global financial crisis

The subprime loan crisis was initially recognized as a problem with the U.S housing market. However, in response to incidents such as the fund freeze of BNP Paribas -affiliated hedge funds in August of 2007, the impact of the crisis spread in the global financial market[6]. By autumn of the same year, financial institutions had announced massive financial losses one after another. Because the situation in which the credit risk of subprime loans had been spread widely through securitization and had surfaced in public, financial institutions' doubts and fears of one another increased, resulting in a sharp rise in interbank market rates. The effects of such tight liquidity were severe, particularly for those financial institutions that had overemphasized highly leveraged short-term financing.

In the course of the aggravation of the housing market, market participants had been increasingly devoting attention to the creditworthiness of monoline insurers. Monoline insurers had increased their guarantee business for securitized products and had earned substantial insurance premium income until the subprime shock began. The securitized

[6] As a result of the BNP Paribas shock, the realization grew that the subprime mortgage problem would not be confined within the US market, but was beginning to pose liquidity problems for financial institutions around the world, leading to the global credit crunch. This compelled major central banks to coordinated efforts to increase liquidity for the first time since the aftermath of the September 11, 2001 terrorist attacks.

products that included subprime loans were guaranteed by AAA-rated monoline insurers, which allowed them to be rated AAA and sold worldwide. The downturn of the housing market after the beginning of 2007 and the further decline in prices of mortgage-backed securities (MBS) and collateralized debt obligations (CDO) caused widespread concerns related to the downgrading of monoline insurers[7]. That downgrading had been predicted to trigger the downgrading of MBS and CDO, creating a considerable effect on the financial institutions holding securitized products and those involved in securitized product businesses.

Monoline insurers posted losses as insured structured products backed by residential mortgages appeared headed for default. On December 13, 2007, the stock of ACA Capital Holdings Inc. (ACA), an emerging monoline company with rating of single-A, was delisted from the NYSE because of its low market price and negative net worth. It was downgraded to CCC by S&P on December 19.

After the following month, the monoline insurers were downgraded one after another. Table 1 shows the evolution of ratings for the largest four monoline insurers[8]. On January 19, 2008, a rating company, Fitch Inc., announced the downgrading of the second largest monoline insurer, Ambac Assurance Corp., which was followed immediately by consecutive falls in global stock prices. In response to this situation, the Federal Reserve Board conducted an exceptional interest rate cut by 0.75% to 3.5%.

Among the large monoline insurers, Financial Guaranty Insurance Co. (FGIC) was the most damaged because of its business backing securities that relied on subprime mortgage payments. On January 30, FGIC lost its Fitch AAA credit rating and was downgraded consecutively afterward. A consortium of banks considered injecting money into the major monoline insurers, but the group was reluctant to present a rescue plan because banks had also incurred enormous losses from their business related to the structured products. Warren Buffett's proposal announced on February 12, to reinsure $800 billion worth of municipal debt, was rejected because the monoline insurers did not have alternative business to compensate for the backing of the structured products business, which had by then almost collapsed.

With the residential market worsening, the Municipal Bond Insurance Association, Inc. (MBIA), the largest monoline insurer, lost its Fitch AAA credit rating on April 4. On June 19, Moody's Investors Service announced the downgrading of MBIA and Ambac from

[7] For the three years up to 2006 when the housing markets remained in a boom, the after tax profits of the monoline insurers grew at around 15% on average. After the subprime loan shocks, however, they incurred extraordinary loss, which evaporated those accumulated profits.

[8] The largest four monoline insurers had retained about 90% market share in the bond insurance business.

AAA to A2 and to Aa3, respectively. The stock prices of MBIA and Ambac at the end of June respectively declined to 7% and 2% of those quoted one year prior.

In addition to the increase in the mortgage delinquency rate and the worsening of the creditworthiness of monoline insurers in the subsequent months, the uncertainty in the financial markets was intensified attributable to credit events such as the failure of Indymac Bank, the nationalization of US government-sponsored enterprises (Fannie Mae - FNMA and Freddie Mac - FDMC) and the sale of Merrill Lynch and Co. Inc. to Bank of America Corp. On September 15, Lehman Brothers Holdings Inc. filed for bankruptcy protection, and the financial crisis entered an acute phase of disruption thereafter.

On the following day, AIG, the largest insurance company as well as an important participant in the credit derivatives market, was set to receive public assistance. AIG sold large volumes of CDS protection, for which it was believed that there were many contracts that used Lehman Brothers as a reference company. The bankruptcy of AIG would nullify CDS hedges. If this were to happen, financial institutions that had dealings with AIG would be unable to fulfill their CDS contracts with other financial institutions, raising the specter of a chain reaction[9].

In September, AIG suffered from a liquidity crisis when its credit ratings were downgraded below AA level. Because of AIG's interconnectedness with the credit derivatives market, the Federal Reserve was forced to organize a bailout of $85 billion quickly. On October 9, AIG borrowed an additional $37.8 billion via a second secured asset credit facility created by FRBNY. On November 10, the U.S. Treasury announced it would purchase $ 40 billion in newly issued AIG senior preferred stock as a part of TARP.

3. Data used

This analysis uses weekly CDS spreads and indicators of macroeconomic conditions and funding liquidity, all of which were downloaded from *Data Stream*, Thomson Reuters. The sample period ranges from January 5, 2007 through November 20, 2009.

This study specifically examines CDS spreads for major international financial institutions presented in table 2.[10] All CDS spreads that are used are five-year spreads,

[9] According to the report released in the website of Bloomberg on December 17, 2008, European banks bought CDS to take advantage of European accounting rules that allow the banks to use the swaps to reduce the capital they were required to set aside as loss reserves. (http://www.bloomberg.com/apps/news?pid=20670001&sid=aQr2vnbm4Jww)

[10] In cases where data of both the CDS using a holding company of a financial institution as a reference entity and CDS using its affiliated banks, securities companies, and insurance companies as reference entities are available, the CDS of the holding company was used. When the CDS of the holding company was not available, CDS using its affiliated banks, securities companies, and insurance companies as reference entities are available were used.

whose liquidity is considered the highest, and which have been converted to US-dollar-based values.[11]

Assuming that the expected uncertainty in the future macroeconomic environment is reflected in stock prices, the MSCI world index denominated in US dollars is used as an indicator of uncertainty in the world macroeconomic environment. In addition, the ECRI weekly leading index published by the Economic Cycle Research Institute is used as an indicator of macroeconomic uncertainty. Although financial institutions outside the US are also included in the analysis, the ECRI index is used on the assumption that the US real economic condition is influential for the performance of financial institutions outside the US[12]. As for the indicator of funding liquidity, TED is employed: the three-month short-term U.S. government bond (T-Bill) yield subtracted from the three-month LIBOR.

Figure 1 depicts the five-year CDS spreads of the major monoline insurers and AIG as the reference entities. Since summer 2007, when the subprime loan crisis became apparent following incidents such as the worsening residential market stagnation and the fund freeze of the BNP Paribas -affiliated hedge fund, CDS spreads for those insurance companies had been moving upwards. The upward trend of those CDS spreads accelerated at the beginning of 2008, when the creditworthiness of the monoline insurers received much attention. The CDS spreads increased rapidly most notably after summer 2008, when financial conditions became extremely severe as the financial instability of the U.S. government-sponsored enterprises (GSE) surfaced, Lehman Brothers declared bankruptcy, and public assistance was provided to AIG. The upward trend of the CDS spread for AIG had been becoming prominent during the summer of 2008. It sharply hiked in the turmoil driven by the Lehman shock.

Figure 2 presents trends in the CDS spreads of the major financial institutions, which were considered as counterparty players of the monolines and AIG. Figure 2-1 and Figure 2-2 respectively report the CDS spreads of the selected US insurance companies and banks. Among the insurance companies, the rise was the most prominent for the CDS of Hartford, MetLife, and Prudential Financial, which had been damaged by the losses in their main business of variable annuities and insurance products. The increase was also rapid for those of the investment banks such as Morgan Stanley, Goldman Sachs and Merrill Lynch, and Citigroup incurred huge losses from the failures of its sponsoring SIVs that had been hit

[11] The CDS spreads used in the analysis include those issued in U.S. dollars and those issued in other currencies (euro and yen) that were converted to the U.S. dollar value. Because the Japanese CDS market is extremely small in comparison to the U.S. and European CDS markets, yen-based CDS spreads might be affected by the liquidity of the CDS market itself; the reliability of the prices might be reduced.

[12] Another reason for the adoption of the ECRI index is that there is probably no weekly leading indicator available except for it.

severely by the liquidity crunch.

Figure 2-3 and Figure 2-4 respectively show the CDS spreads of European insurance companies and banks. As with the US financial institutions, the hike of the CDS spreads during the turmoil in autumn of 2008 is prominent for Aegon, HBOS, UBS, Fortis, which received public assistance, and Swiss Reinsurance, which suffered huge losses in its financial guarantee business.

Figure 2-5 presents trends in the CDS spreads of the Japanese financial institutions. As in the case of the financial institutions outside Japan, the CDS spreads of the Japanese financial institutions had also been increasing since summer of 2007 when symptoms of the financial crisis became more evident. In particular, the CDS spread for Sompo Japan, which had incurred a substantial loss in its financial guarantee business and investment in ABS-CDO, soared in 2008. The increase was also rapid in the CDS spreads for two securities companies, Nomura Securities and Daiwa Securities, and the two nonlife insurance companies: Tokio Marine & Nichido Fire Insurance Co., Ltd. and Mitsui Sumitomo Insurance Co., Ltd.

As an indicator of uncertainty in the macroeconomic environment for reference, figure 3 presents the MSCI world index and ECRI weekly leading index as well as the yield spread for corporate bonds with credit ratings below investment grade. The MSCI index and ECRI index reveal a declining trend from the summer of 2007, which turned to a rapid fall during the following summer of 2008. The yield spread of non-investment grade bonds shows the reverse. Figure 4 shows, as funding liquidity indicators, TED and two other indicators: the yield spread of AA-rated three-month asset-backed commercial paper (ABCP) against three-month short-term government bonds, and the CFE-VIX index, representing the implied volatility of S&P 500 stock price index listed on the Chicago Board Options Exchange (CBOE)[13]. All of the indicators display upward trends from the summer of 2007, and reflect aggravated liquidity squeeze in summer of 2008, when the Lehman shock broke out.

4. Empirical Model

This study investigates the effect on the CDS spreads for major financial institutions using a structural VAR model. First, the following reduced form is estimated as

$$B(L)X_t = \varepsilon_t, \tag{1}$$

[13] Bank of Japan (2008a) lists the trading volume of stocks and foreign exchange, the bid–ask spread, and other indicators of liquidity in addition to those described above.

where X_t is a 5×1 vector of endogenous variables defined as the following.

$$X_t = \begin{bmatrix} MSCI_t \\ ECRI_t \\ TED_t \\ CDS_{guarantor,t} \\ CDS_{other,t} \end{bmatrix}$$

Therein, $MSCI_t$ and $ECRI_t$ respectively signify the weekly differences in the logarithmic MSCI and ECRI index. Here, TED_t represents the weekly difference in TED, which is a dollar-based three-month LIBOR minus the three-month US government bond yield. $CDS_{guarantor,\ t}$ and $CDS_{other,\ t}$, respectively represent the weekly differences in the CDS spreads of a guarantor facing financial crisis and its counterparty financial institution. In this analysis, the sample for guarantors includes two monoline insurers (MBIA and Ambac) and AIG; the sample for their counterparties includes 51 financial institutions listed in table 2.

$B(L)$ is matrix polynomials in the lag operator defined as

$$B(L) = B_0 - B_1 L - \cdots - B_k L^k,$$

where B_0 is the identity matrix and k is the maximum lag. Also, ε_t is a 5×1 vector of the reduced-form residuals with variance–covariance matrix $E[\varepsilon_t \varepsilon_t'] = \Sigma$.

It is then assumed that the economy can be described using a structural form as shown below.

$$A(L)X_t = u_t$$
$$A(L) = A_0 - A_1 L - \cdots - A_k L^k \qquad (2)$$

Therein, the structural form disturbances u are orthogonal.

The structural disturbances and reduced form residuals are related as

$$\varepsilon_t = A_0^{-1} u_t, \qquad (3)$$

which implies that

$$E[\varepsilon_t \varepsilon_t'] = E\left[A_0^{-1} u_t u_t' \left(A_0^{-1}\right)'\right] = A_0^{-1}\left(A_0^{-1}\right)'. \qquad (4)$$

In this analysis, the restrictions represented by the composition of the matrix A_0 are specified as the following recursive form.

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -a_{21} & 1 & 0 & 0 & 0 \\ -a_{31} & -a_{32} & 1 & 0 & 0 \\ -a_{41} & -a_{42} & -a_{43} & 1 & 0 \\ -a_{51} & -a_{52} & -a_{53} & -a_{54} & 1 \end{bmatrix}$$

First, it is assumed that the CDS spreads of both a guarantor and its counterparty contemporaneously react to shocks in common factors (the indicators of uncertainty in macroeconomic environment and funding liquidity). It is also assumed that the CDS spread of the counterparty financial institution contemporaneously responds to shocks in the CDS spread for the guarantor in addition to the common factors, and that the magnitude of the effect is measured by coefficient a_{54}.[14]

Coefficient a_{41} (a_{42}) and coefficient a_{51} (a_{52}) respectively denote the effect of the MSCI index (ECRI index) on the CDS spreads of the guarantor and its counterparty financial institution. The CDS spread is expected to rise when those indices decline and market participants' expectations for future economic conditions worsen, presumably making those coefficients show a negative sign. Coefficient a_{43} and coefficient a_{53} represent the effect of funding liquidity on the CDS spreads of those two financial institutions. Market participants' risk tolerance is likely to decrease when liquidity tightens. Therefore, those two coefficients are presumed to take a positive sign.

Coefficient a_{31} and coefficient a_{32}, which indicate the effect of uncertainty in macroeconomic environment on liquidity, are expected to show a negative sign on the assumption that financial institutions, which have observed the symptom of slowdown in economic activities, attempt to shrink their lending in the interbank market, leading to the strengthened liquidity crunch.[15] For these analyses, we assume a one-way contemporaneous causality from the MSCI index to the ECRI index.[16]

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[14] A positive sign indicated by coefficient a_{54} signifies the diffusion of soaring CDS spreads for a guarantor to the CDS spreads for its counterparty financial institution because of the reflection of emerging counterparty risk triggered by the worsening creditworthiness of the guarantor, or the overreactions of market participants to the hike in the CDS spreads for the guarantor. A negative coefficient can be estimated, implying the ripple effects attributable to the competitive effects.

[15] On the other hand, such a reverse causal relation exists by which the pressure on interbank markets leads to increasing pessimistic predictions for future economic activities. This study has assumed a causal relation from uncertainty in the macroeconomic environment to liquidity tightening as a result of the empirical test to check the exogeneity.

[16] This analysis attempted to execute the imposition of another set of restrictions on matrix A such as that making coefficient a_{21} zero and coefficient a_{12} free, and found that the impacts of MSCI index on ECRI index are larger than those of ECRI index on MSCI index, although the remaining empirical results are almost the same.

5. Results of empirical analyses

In this section, the results of investigations of transmission across the CDS spreads are reported. The estimation results of equation (2) are omitted because of space limitations, and the empirical evidence of impulse response functions, variance decompositions and historical decompositions are emphasized. Results of unit root tests reveal that all sample data used in this analysis satisfy stationarity[17].

5.1 Impulse response functions

In this sub-section, the estimation results for impulse response functions are reported. Figure 5-1 presents the impulse response functions for the structural VAR model where the CDS spreads of AIG (as a guarantor) and Goldman Sachs (as a counterparty of guarantor) as a reference entity are adopted. Black lines represent the point estimates of impulse responses and blue lines show the confidence bands measured using one standard deviation with a Monte Carlo simulation. Figure 5-2 shows results obtained using the CDS spread of Allianz as a reference entity instead of that of Goldman Sachs[18].

Figure 5-1 and Figure 5-2 show that the effects of the MSCI world index are dominant and the variables adopted in the VAR model contemporaneously react to shocks in the MSCI index. Negative responses of TED and the CDS spreads of financial institutions to shocks in the MSCI index indicate that liquidity provided in the interbank market of US dollar was squeezed and the market participants raised the prices of those CDS immediately after the decline in the world stock prices because of pessimistic expectations for future economic conditions. Reverse transmissions from the CDS spreads of AIG and Goldman Sachs to the MSCI index are observed, showing that the hikes in those CDS spreads followed the decline in stock prices two weeks later. Results also show that the CDS spread of Goldman Sachs is more influential on the MSCI index than those for AIG. The impacts on the MSCI index from the CDS spread of Allianz, which suffered less severe damage than Goldman Sachs in the global financial turmoil, are found to be insignificant.

The impacts of TED on the MSCI and ECRI indices as are the CDS spreads of the financial institutions are confirmed, implying that the tightened liquidity strengthened the pessimistic prospect for future economic environment and the market participants' risk

[17] Although the KPSS test and Perron test do not reject the null hypothesis of a unit root for the differenced logarithmic ECRI and a few CDS spreads, an ADF test utilizing the model with lags determined based on BIC criterion reveals stationarity for all sample data.

[18] It has been confirmed that similar results for the transmission mechanism among the common factors are estimated by replacing the CDS spread for AIG with the CDS spreads of two monoline insurers.

aversion to lead the increase in the CDS spreads. Transmissions from TED to the CDS spreads of AIG and Goldman Sachs are observed, and transmissions to the CDS spread of Allianz are not found. The result suggests that insurance companies are less vulnerable to liquidity crunches caused by holding longer-maturity liability than banks hold. Investment banks such as Goldman Sachs, on the other hand, have been shown as exposed heavily to a maturity mismatch because of their reliance on repo financing to increase their total assets[19]. Actually, AIG, for which the credit rating was downgraded in May and September of 2008, was required to post additional collateral with its trading counterparties and therefore suffered severely from a liquidity crunch. The results obtained in this analysis are consistent with the stories of those financial institutions facing with liquidity crisis. Results also confirm that reverse spillovers from the CDS spreads to TED existed; the CDS spread of Goldman Sachs was more influential.

The CDS spread of AIG had an immediate and positive impact on the CDS spreads of Goldman Sachs and Allianz, although the magnitude of the impact on the CDS spread of Goldman Sachs is more significant. The CDS spread of Goldman Sachs, in addition, positively affected the CDS spread of AIG four weeks after the occurrence of shock in the CDS of Goldman Sachs. The reverse impacts from Allianz to AIG are not confirmed.

The sheer number of estimation results is huge. For that reason, the impulse responses of the CDS spreads of counterparty financial institutions are specifically examined here because of space limitations. Figures 6 through 8 portray impulse responses to shocks in the MSCI, ECRI, and TED by adopting MBIA as a guarantor. These figures include only the impulse responses, which reveal the statistical significance[20].

The impulse responses to shocks in the MSCI world index are identified as statistically significant for all cases. The CDS spread of each financial institution contemporaneously and negatively react to shocks in the MSCI index, indicating that the CDS spreads rose quickly according to the declines in world stock prices. Financial institutions showing a strong reaction to the MSCI index are the three US insurance companies: Hartford, MetLife and Prudential Financial. Those insurance companies carried variable annuities as their major line of products. Although this analysis adopts the MSCI index as an indicator of the future world economic environment, the results can be interpreted as a reflection of their aggravated creditworthiness because of their eroding portfolio assets. Other financial institutions such as Morgan Stanley, Goldman Sachs, Merrill Lynch,

[19] A large part of the growth in repo financing was attributable to an increase in overnight repos (Brunnermeier (2009)).

[20] These figures report only the point estimates of the impulse response functions because of the limitation of space.

Citigroup, and American Express Co. also show strong reactions to the MSCI index. Citigroup received government financial aid after incurring a massive loss from its investments in the securitized products of its affiliate, SIV. American Express was also granted public assistance after suffering vast losses from bad debts of customers provided with credit card services in subprime lending. The EU financial institutions revealing strong responses to the MSCI index are Aegon and Fortis, which also received government bailout funds. The reaction of Swiss Reinsurance, which is said to have been involved extensively in the financial guarantee business, is also prominent. Among Japanese financial institutions, the reaction of the CDS spread of Sompo Japan, which incurred losses in the financial guarantee business and investment in the securitized financial products, is particularly high. This analysis reveals that financial institutions with aggravated financial standing were particularly affected severely by the worsening prospects of economic conditions and that the effects of stock prices are more influential on insurance companies, which hold a larger percentage of stocks in total assets, in contrast to banks and securities companies.

As for the impulse response to shocks in ECRI index, the CDS spreads of 18 financial institutions reveal statistical significance and negative responses with its peak reached two weeks later the occurrence of shocks, which suggests that market participants had been gradually adjusting the prices of CDS spreads in accordance with strengthening of their pessimistic expectations for the future economic outlook. The reactions of Hartford, MetLife, and Prudential Financial are dominant, with Fortis among EU financial institutions, and Sompo Japan and Daiwa Securities among Japanese financial institutions presenting stronger reactions. The CDS spreads of those financial institutions reveal strikingly large reactions to the ECRI as well as the MSCI. Therefore, the hypothesis that the stagnating macroeconomic prospect was one cause of the hike in risk premia required for the CDS spreads is apparently supported.

The impacts of TED on the CDS spreads are observed for many financial institutions, indicating that the CDS spreads sharply rose in reaction to a liquidity squeeze. Commercial banks and investment banks depending on short-term fundraising are more prone to be affected by liquidity conditions than insurance companies, and the reaction of the CDS spread of Morgan Stanley is exceptionally high. Other financial institutions presenting outstanding reactions to TED are Goldman Sachs, Fortis, and RBS, which received the public financial bailout funds. The effects of TED on the CDS spreads of the three US insurance companies named above and Aegon, whose major products are myriad variable annuities with guaranteed minimum payments through the extensive use of

derivatives in particular, have appeared especially high because the derivative markets were also in a severe liquidity crunch in the midst of financial crisis. The CDS spread of Swiss Reinsurance, which suffered from losses in financial guarantee business, is also identified as vulnerable to liquidity tightening. The results of the estimation reflect such a background. Investment banks that are overly dependent on short-term fundraising and financial institutions suffering from huge losses in financial guarantee businesses and investments in securitized products are susceptible to liquidity crises; their CDS spreads soured, reflecting the increased risk premium required by market participants who became more risk averse because of liquidity tightening.

Figures 9 through 13 display the impulse responses of the CDS spreads of financial institutions to shocks in the CDS spreads of guarantors. Financial institutions which show prominent reactions to the protection sellers are the three US insurance companies described above (Hartford, MetLife and Prudential Financial) and US commercial and investment banks such as Citigroup, Merrill Lynch and Morgan Stanley. The EU financial institutions which received considerable influence from the guarantors are listed as Aegon, ING Group N.V., Aviva, Prudential plc., Swiss Reinsurance, RBS, UBS, Fortis Barclays, HBOS, and Standard Chartered Bank, which were all severely damaged by the enormous losses in the securitized products investment or the financial guarantee business. In fact, HBOS, a major mortgage lender, suffered huge losses in the distressed residential market and was sold to Lloyds TSB. Standard Chartered Bank also incurred losses from the insolvency of its affiliated SIV. UBS wrote off a huge amount of subprime exposure and was forced to turn to the Government of Singapore for fresh funding. Although some Japanese financial institutions such as Sompo Japan and Nomura Securities were affected by the hike in the CDS spreads for guarantors, the magnitude of its received impacts is small relative to those of US and European financial institutions. Investment banks and commercial banks that declared huge losses in their SIV business are likely to be highly affected by the guarantors.

The impulse responses to shocks in the CDS spread for AIG, a largest player in the CDS market, are verified as statistically significant for almost all financial institutions, especially for those which participated heavily in the CDO transaction, although its positive impacts last for a short term. Some have argued that the AIG Financial Products division in London sold credit derivative products to many banks and insurance companies which sought a way to mitigate capital requirements and to liberate capital for additional loan intermediation. This analysis suggests that the AIG crisis spread to those financial institutions as counterparty risk.

Results imply that the monoline crisis had impacts on financial institutions inside and outside of US, and evidently spread to insurance companies in comparison with banks. The reason is conceivably the extensive involvement with monoline insurers ranging from the reinsurance business to investments in financial products with their guarantees. Some Japanese non-life insurance companies, particularly Sompo Japan, also declared losses in businesses related to the monoline insurers. Japanese securities companies such as Nomura Securities incurred losses in structured finance, although the magnitude of its damage was small relative to US and European investment banks. The results obtained from this analysis are consistent with those stories.

5.2 Variance decompositions

The results of variance decompositions are presented next. Table 3 portrays variance decompositions for the MSCI World index, the ECRI leading index, and TED, as estimated by adopting the CDS spread of AIG as a guarantor in the structural VAR model[21]. The numerical values in table 3 are the averaged contribution of variance of the one-step forecast error through that of the ten-step forecast error for each component. The numerical value in the last row of each panel is the average of the averaged contribution estimated using the CDS spread of each of 51 financial institutions[22]. Each panel also includes the averaged contribution estimated using the CDS spreads of specific financial institutions. Each presents results worthy of special mention.

Regarding the variance decomposition of the MSCI index, results show that, on average, 86.75% of its variance is explainable by shocks in the world stock markets; other structural shocks have negligible effects. For a case in which an investment bank such as Goldman Sachs or Morgan Stanley or a financial institution such as Fortis, which received the government financial bailout funds, is presumed as a counterparty financial institution for AIG, shocks in the CDS spreads of the financial institutions described above reveal a large contribution to the variance of the MSCI index. The CDS spread of Morgan Stanley, for example, explains 15.4% of the variance of the forecast error for the MSCI index. The CDS spread of another severely damaged financial institution in the turmoil, AIG, shows no significant impact on the MSCI index.

The analysis also reveals that, on average, 64.8% of variance of ECRI index is

[21] The VAR model employing the CDS spreads for two other guarantors report results that closely resemble the evidence presented below.

[22] The average of the averaged contribution for each component is calculated as follows: estimate the averaged contribution for each component in the method described above using the CDS spread of each of 51 financial institutions; then repeat estimation for 51 financial institutions; finally, average 51 the averaged contributions.

explainable by its own shocks and 27.62% by shocks in the MSCI index. Replacing the CDS spread of a counterparty with those of other financial institutions still produces results that closely resemble the result described above. This result implies that the US economy has been worsening according to the declines in the world stock markets.

Although the greater part of variance of TED—similar to that of the MSCI index, on average— can include a contribution from its own shocks resulting from the interbank market, some financial institutions are verified to have a strong impact on TED. Financial institutions that represent a markedly high impact on TED are those such as Goldman Sachs and RBS, whose contributions to TED exceed 20%. The results imply the possibility that hikes in the CDS spreads of the troubled financial institutions attributable to the fundraising difficulty aggravated the situation in which financial institutions' doubts and fears of one another had been increasing, resulting in a sharp rise in interbank market rates. The AIG CDS spread, contrary to our expectations, has a negligible effect on TED when any other financial institution is adopted as its counterparty[23].

Table 4 displays variance decompositions for the CDS spreads of the guarantors. The averaged contributions of their own shocks are 83.92%, 88.98% and 78.79%, respectively, for AIG, Ambac and MBIA. Regarding MBIA, the MSCI index reveals a somewhat high impact on the CDS spread of MBIA and its contribution increases to 11.65%. The guarantors were affected only slightly by their counterparties. The contributions of the CDS spread of Goldman Sachs, which was identified to be the most influential for AIG and MBIA, were 5.58% and 6.25% at most, respectively. A financial institution having the largest impact on the CDS spread of Ambac is Berkshire Hathaway, which offered the rescue plan of reinsuring municipal bonds for the three largest monolines including Ambac while fear of downgrading of monoline insurers had been intensifying. Even the CDS spread of Berkshire Hathaway has only a 6.08% contribution to variance of the CDS spread of Ambac.

Lastly, table 5 reports variance decompositions of the CDS spread of each counterparty financial institution. Table 5-1, table 5-2, and table 5-3 represent estimation results in a case in which AIG, Ambac, or MBIA is adopted as a guarantor. From each table, it is reported that, on average, shocks in the CDS spread of each financial institution explain nearly 70% of its own variance. Counterparty financial institutions were much more affected by other factors addressed in the analysis than guarantors. The contributions of financial institutions' own shocks, however, differ considerably. For some of financial institutions, their own shocks explain less than 50% of variance of their CDS spreads. For

[23] The CDS spreads for the two monoline insurers are not confirmed to have considerable effect on TED.

other financial institutions, the respective contributions of their own shocks exceeded 85%.

The impact of the MSCI index among the common factors is dominant; its averaged contribution to the variance of each CDS spread represents around 18%. This empirical evidence shows that insurance companies, notably MetLife and Aegon, tend to be affected strongly by stock prices relative to banks and securities companies, which presumably result from the differences in percentages of stocks held in their respective portfolios. This analysis has used the stock price index as an indicator of uncertainty in the macroeconomic environment. This presumption implies that worsening prospects for future economic conditions indicated by a decline in the stock price index make market participants raise prices of CDS to compensate for increased uncertainty. Moreover, declines in stock prices can directly degrade the creditworthiness of financial institutions whose equity capital is eroded by the downturn of stock markets. Insurance companies holding a large weight of stock investments are susceptible to falling stock prices.

Regarding Japanese financial institutions, the CDS spreads for non-life insurance companies such as Sompo Japan have presumably been affected by the plunge in world stock markets. The percentage of domestic and overseas stocks in the total assets of Japanese non-life insurance companies is higher than that of banks, securities companies, and surprisingly, life insurance companies (the general accounts held by Japanese life insurance companies, to be precise), which have been regarded as major institutional investors. Non-life insurance companies therefore constituted Japanese financial institutions whose corporate value was vulnerable to fluctuations in world stock markets.

Aside from insurance companies, investment banks including Goldman Sachs were confirmed to be affected considerably by changes in the MSCI index. Coupled with the evidence that the CDS spread of Goldman Sachs has shown a large contribution to the MSCI index, a vicious cycle between declines in stock prices and hikes in CDS spreads for financial institutions which were facing the deleveraging problem can be inferred[24].

Although the contribution of TED to CDS spreads of financial institutions as a whole is reported as only around 5%, its respective contributions to CDS spreads of some specific financial institutions including Hartford, MetLife, Prudential Financial American Express, Goldman Sachs, Aegon, Fortis, RBS, and UBS exceed 10%. A financial institution that was strikingly affected by TED is Morgan Stanley. The contribution of TED to its CDS spread reached 26.69%. These obtained results are consistent with results of impulse responses. Considering the result reported in table 3 that TED was influenced

[24] Brunnermeier (2009) argues that a loss spiral arises for leveraged investors because a decline in the value of assets erodes the investors' net worth much faster than their gross worth.

by the CDS spreads of the financial institutions described above, a vicious cycle probably emerged, whereby the increased CDS spreads attributable to tightened liquidity, which raised mutual doubts and fears in the interbank market, had reinforced the liquidity crunch.

Hartford, MetLife and Prudential Financial, major providers of variable annuity products with guaranteed minimum payments, are likely to have been deeply involved in derivative transactions and might have been vulnerable to tight global liquidity. It is also surmised that investment banks, which were overly dependent upon short-term fund raising such as overnight repo transactions, and other financial institutions suffering huge losses from investment in subprime-related products were remarkably influenced by the liquidity squeeze.

The results of variance decompositions also show a tendency whereby the CDS spreads of banks are responsive to shocks in TED to a comparable degree with insurance companies. These results are consistent with the evidence of impulse responses.

This empirical test results indicate that an impact of the guarantors on their counterparties is inconspicuous overall, and that the averaged contributions of the CDS spreads for AIG, Ambac, and MBIA are 5.01%, 6.47%, and 4.41%, respectively. The estimation conducted by adopting the CDS spreads of some specific financial institutions, however, yields different results. For example, the CDS spread of AIG can explain more than 10% of the variance of the CDS spreads of financial institutions such as Liberty Mutual Insurance, Bank of America, Citigroup, Wells Fargo, Merrill Lynch, Commerzbank and Standard Chartered Bank; moreover, its contribution to the CDS spread of Citigroup reach 17%. The CDS spread of Ambac is more dominant for insurance companies and its contribution exceeds 10% to the CDS spreads of MetLife, Prudential Financial, Aviva, Prudential plc., Swiss Reinsurance, Mitsui Sumitomo Insurance, Sompo Japan and Tokio Marine & Nichido Insurance. The result that the monoline crisis was more critical for insurance companies is consistent with the result obtained in the impulse response analysis. The impact on the CDS spread of Citigroup, which was expected to have suffered extensive damage from the downgrading of Ambac, is also identified. The CDS spread of MBIA reflects a negligible impact on almost all financial institutions.

5.3 Historical Decomposition

In the last subsection, the results of historical decomposition are reported. By rewriting equation (2) as the moving average representation, x at time $T+k$ can be formalized as

presented below.

$$X_{T+k} = \sum_{s=0}^{k-1} \Psi_s u_{T+k-s} + \sum_{s=k}^{\infty} \Psi_s u_{T+k-s} \qquad (5)$$

The first sum on the right hand side of equation (5) represents the part of X_{t+k} attributable to innovations during periods T+1 to T+j. The second term is the forecast based on information available at time T. Fluctuations of the five variables in vector x after time T+1 are traceable to the time path of the components in the first term.

Figure 14 displays a historical decomposition for the CDS of Goldman Sachs, Morgan Stanley, MetLife, and Aegon. The VAR model is estimated by regarding AIG as a guarantor. To observe impacts of each structural shock on an endogenous variable converted into a level, the estimated structural shock has been accumulated[25].

All four CDS spreads soared sharply during October 2008; an extraordinary hike is observed in the CDS spread of Morgan Stanley, which exceeded 1200 basis point at the peak. October 2008 is a period of severe financial market dysfunction with an accompanying substantial rise in interest rates. The hikes in CDS spreads are likely to be explained by the liquidity squeeze. The CDS spreads of investment banks such as Goldman Sachs and Morgan Stanley tend to be affected by their own shocks, especially in October 2008. After the filing for Chapter 11 by Lehman Brothers, the myth of “too big to fail” crumbled, and market participants had been searching for the next financial institution that was expected to go into bankruptcy. The results apparently imply market participants’ overreactions resulting from fear and skepticism. In contrast to investment banks, the CDS spreads of insurance companies such as MetLife and Aegon are identified as more affected by shocks in stock prices, which is consistent with the results of impulse responses and variance decompositions. The CDS spreads of those two insurance companies soared in March 2009, when the MSCI world index reached a new low. While the impacts of shocks in the CDS spread of AIG are not confirmed clearly for the CDS spreads of the two insurance companies, its contribution increases during the period of the autumn of 2008 and the spring of 2009, when AIG was on the verge of bankruptcy.

Figure 15 presents historical decompositions for the CDS spread of Merrill Lynch by adopting MBIA as a guarantor. As is true also with other investment banks, movements in the CDS spread are apparently attributed to its own shocks. Although the CDS spread of MBIA shows no significant impact on the CDS spread of Merrill Lynch for the whole

[25] Variables transformed in change rate fluctuate too much to identify effects of each structural shock on the CDS spread of financial institutions. Therefore, the estimated structural shocks are re-transformed in level in this historical decomposition analyses.

sample period, its impact increased during the first half of 2008, when the monoline crisis triggered by the credit downgrading became a distinct possibility. Merrill Lynch was considered one financial institution which would have incurred enormous losses from the crash of securitized financial products caused by the downgrading of monoline insurers. It is likely that consideration of counterparty risk from financial guarantees emerged during that period.

Figure 16 depicts the historical decomposition for TED, where AIG and Goldman Sachs are adopted respectively as a guarantor and its counterparty. It is apparent that shocks in the CDS spread of Goldman Sachs as well as shocks in TED strongly affected movements in TED. In March 2008, when Bear Sterns was sold to JP Morgan Chase and in October of the same year soon after the bankruptcy of Lehman Brothers, TED sharply increased, accompanied by the increase in the CDS spread of Goldman Sachs. Impulse responses and variance decompositions reflect the possibility that not only transmissions from TED to the CDS spreads of financial institutions facing severe difficulty in the global turmoil existed, but also the reverse transmission. Historical decompositions also imply this possibility. Results also show that the CDS spread of Goldman Sachs had larger impacts on TED than the CDS spread of AIG.

Figure 17 shows historical decomposition for the CDS spread of AIG by adopting Goldman Sachs as its counterparty. As we can see, sharp increases in the CDS spread of AIG are explicable by its own shocks.

Shocks in CDS spread of a counterparty financial institution is presumed to include other factors, besides the common factors and impact from a guarantor specified in the applied VAR model, affecting those CDS spreads. A sharp increase of shock in CDS spread of a financial institution might reflect changes in perceived probability of bankruptcy caused by other factors besides plunge in stock prices and global liquidity squeeze. Overreactions resulting from fear and skepticism can be a driving force for the soaring of CDS spreads. The increase might also be as a result of a sudden decrease in liquidity of an individual CDS market, partly affected by shifts in the market's perception of its creditworthiness.

Figure 18-1 shows bid-offer spreads of the CDS spread of Goldman Sachs and the historical decomposition of its own shocks displayed in Figure 14-1. Figure 18-2 reports equivalence for AIG and the historical decomposition is withdrawn from Figure 17. We can see that the two are highly correlated. The correlation coefficient is 0.69 in the case of Goldman Sachs, and 0.55 for AIG. The result implies that market liquidity of individual CDS markets drastically decreased under the situation where market

participants rushed into speculation on bankruptcy of Goldman Sachs and AIG, and sellers of protection evaporated for fear of loss, leading to the soaring of their CDS spreads. Under increased uncertainty, fear and skepticism might worsen imbalance in the CDS market.

To sum up, the following empirical evidence are observed. The CDS spreads of investment banks are prone to be affected by their own shocks; they were also susceptible to liquidity shocks, prominently in the liquidity squeeze in October 2008. The CDS spreads of insurance companies are likely to be influenced strongly by stock prices because their creditworthiness is definitely connected with the performance of stock investments. The impact of the CDS spread of guarantors is negligible for the whole sample period, but it is not to be denied that the counterparty risk from financial guarantees had intensified during the period in which market participants were becoming more cautious to the solvency of monoline insurers. Not only transmissions from TED to the CDS spreads of financial institutions but also the reverse transmissions are confirmed. The hike in the CDS spread of Goldman Sachs probably intensified the liquidity squeeze, although the impact of AIG was trivial.

6. Conclusion

The following describes the conclusions of the empirical analysis of this study.

First, uncertainty in the macroeconomic environment is implicated as a cause of an increase in the CDS spreads for various financial institutions. Although impacts of both the MSCI index and ECRI index on the CDS spreads were confirmed in the results of analysis of impulse responses, the effects of the MSCI index are dominant. Particularly, the corporate value of those financial institutions engaging in asset management as their core business was affected considerably by stock price trends. These results should therefore be interpreted in the following two ways. The first interpretation is that market participants, who observed declines in stock prices as a signal of stagnation of world economic activities, quoted higher prices on CDS to make up for unforeseeable losses. A second interpretation is that the hike in CDS spreads definitely reflected worsened creditworthiness of financial institutions whose equity capital was eroded because of the plunge in stock prices.

The effect of liquidity was especially significant for U.S. investment banks and other institutions with short-term debts comprising a large part of their fundraising structure. The effect of tight liquidity on the CDS of financial institutions that received public assistance also proved to be substantial. Banks tended to be more susceptible to the effects of liquidity than insurance companies were. The impact on insurance companies whose major line of

products was related to variable annuities with guaranteed minimum payments provided through the extensive use of derivatives was also prominent. The effect of liquidity can also be interpreted in two ways. Market participants facing with tightened liquidity probably increased prices of CDS to compensate the increased fundraising risks with a higher risk premium. Alternatively, the increased CDS spreads might reflect the possibility of failures of financial institutions which were on the verge of bankruptcy because of the liquidity squeeze.

Results of the analysis also suggest that the CDS spreads of financial institutions that were strongly affected by stock prices and liquidity furthermore had dominant impacts on the MSCI index and TED. A loss spiral and liquidity crunch spiral are inferred to have occurred, and the jagged plummeting of stock prices and tightened liquidity were amplified in accordance with the concerns to creditworthiness of financial institutions that had been severely harmed in the global turmoil. The causality among those variables should be confirmed rigorously.

The financial crisis of U.S. monoline insurers and AIG proved to have affected the markets both inside and outside the U.S. Although some argue that banks and insurance companies were using CDS as a measure to mitigate capital requirements and to liberate capital for additional loan intermediation, the study findings suggest that the crisis of AIG, which was the greatest seller of CDS, had spread to other banks and insurance companies as counterparty risk. The monoline crisis seems to have larger impacts on insurance companies than on banks because insurance companies were closely connected with monolines through the financial reinsurance business as well as investment in securitized products with guarantees. The impacts of the monoline and AIG crises on TED are not significant, which might be an unexpected result. The robustness of this result should be confirmed.

The analysis in the current study used the CDS spread with domestic and overseas financial institutions as reference entities, but similar analyses can be conducted using individual stocks in place of CDS spreads. The use of stocks will enable a wider range of financial institutions to be analyzed and the liquidity is higher. Therefore, analyses using stocks should be conducted in the future. Furthermore, although this study used TED as the indicator of funding liquidity and the world stock price index as the indicator of uncertainty in the world macroeconomic environment, the use of other indicators to support the results adequately will be necessary.

It has been pointed out that if the volatility of asset prices is increasing, the coefficients of correlation are estimated with an upward bias, mistakenly leading to the conclusion of

contagion. In this regard, studies such as Forbes and Rigobon (2002), Dungey, Fry, Hermosillo and Martin (2004) and Ohno (2008) have proposed a method of examining the contagion effect, which incorporates the time-varying volatility. Heteroskedasticity must be considered also in the analysis of the ripple effect of CDS spreads in the global financial crisis, which should be considered for future studies.

This study specifically addressed the effect of the CDS spreads for two monoline insurers and AIG on the CDS spreads of financial institutions surrounding them. Future studies should pursue a detailed examination of the respective influences of the complexity and ambiguity of insurance companies and conglomerate financial institutions on ripple effects of CDS spreads.

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Table 1: Past evolution of the ratings for insurers financial strength

	MBIA		Ambac		FGIC		FSA		AIG
	Moody's	Fitch	Moody's	Fitch	Moody's	Fitch	Moody's	Fitch	Fitch
August-07	Aaa	AAA	Aaa	AAA	Aaa	AAA	Aaa	AAA	AA
September-07									
October-07									
November-07									
December-07									
January-08				AA		AA			
February-08					A3				
March-08					Baa3	BBB			
April-08		AA							
May-08									AA-
June-08	A2		Aa3		B1				
July-08									
August-08						CCC			
September-08									A
October-08									
November-08	Baa1		Baa1				Aa3		
December-08					Caa1				
January-09									
February-09	B3								
March-09									
April-09									
May-09								AA+	BBB
June-09									
July-09			Caa2						
August-09									
September-09									
October-09								AA	
November-09									
December-09									
January-10									
February-10									
March-10									
April-10									

Data source: Bureau Van Dijk, *ISIS*

Table 2: Sample Financial Institutions

Guarantors		
Monoline insurers : MBIA, AMBAC AIG		
Commercial banks, Investment banks		
US	EU	Japan
Bank of America	Barclays	Fortis	Mitsubishi UFJ Financial Group
Citi Group	Banco Santander	HBOS	Mizuho Corporate Bank
JP Morgan Chase	Banco Commerce Portugues	HSBC	Sumitomo Mitsui Bank
Wells Fargo	BNP Paribas	Lloyds TSB	Nomura Securities
American Express	Credit Suisse	RBS	Daiwa Securities
Goldman Sachs	Credit Agricole	Societe Generale	
Merrill Lynch	Commerzbank	Standard Chartered Bank	
Morgan Stanley	Deutshebank	UBS	
Insurance Companies		
US	EU	Japan
Aetna	Allianz	Prudential plc	Tokio Marine & Nichido Fire Insurance
Berkshire Hathaway	AXA	Zurich	Sompo Japan
Cigna	Aegon	Swiss Reinsurance	Mitsui Sumitomo Fire Insurance
Hartford	Aviva	Munich Reinsurance	
MetLife	Hannover	AG	
Prudential Financial	ING		
Travellelrs			
Liberty Mutual			

Table 3: Variance Decompositions for MSCI, ECRI and TED

Counterparty Financial Institutions	Variance Decomposition for MSCI				
	MSCI	ECRI	TED	CDS of AIG	CDS of counterparty
GOLDMAN SACHS	73.96	5.40	3.33	2.62	14.69
MORGAN STANLEY	71.93	5.82	3.81	2.93	15.50
FORTIS	76.63	6.02	3.55	2.41	11.38
Avarage	86.75	3.71	3.86	2.89	2.79

	Variance Decomposition for ECRI				
	MSCI	ECRI	TED	CDS of AIG	CDS of counterparty
Average	27.62	64.80	3.89	1.24	2.45

Counterparty Financial Institutions	Variance Decomposition for TED				
	MSCI	ECRI	TED	CDS of AIG	CDS of counterparty
METLIFE	7.97	0.51	80.36	0.28	10.88
CITIGROUP	8.95	0.94	77.58	0.28	12.24
JP MORGAN CHASE	8.39	0.71	77.22	0.55	13.13
GOLDMAN SACHS	5.01	1.00	71.55	0.71	21.73
MORGAN STANLEY	5.62	0.87	78.29	0.44	14.78
BARCLAYS	3.90	1.02	76.45	0.48	18.15
BANCO COM. PORT.	7.02	0.95	81.14	0.84	10.06
CREDIT AGRICOLE	6.70	1.00	80.22	0.46	11.62
COMMERZBANK	6.18	0.88	81.92	0.25	10.77
FORTIS	4.08	1.35	81.47	0.63	12.48
HBOS	6.73	0.87	77.69	0.30	14.42
HSBC	5.98	0.91	80.02	0.55	12.53
LLOYDS TSB	5.46	1.37	76.86	0.72	15.59
RBS	4.50	1.29	73.21	0.61	20.40
SOCIETE GENERALE	5.35	1.07	79.44	0.46	13.68
STANDARD CHT. BANK	5.20	1.15	81.13	0.58	11.93
UBS	4.46	1.42	76.88	1.08	16.16
Average	6.69	0.77	84.89	0.35	7.30

Table 4: Variance Decompositions for CDS spreads of guarantors

Counterparty Financial Institutions	Variance Decomposition for CDS Spread of AIG				
	MSCI	ECRI	TED	CDS of AIG	CDS of counterparty
GOLDMAN SACHS	3.94	3.20	5.78	81.50	5.58
AEGON	5.51	3.72	7.96	78.56	4.25
Average	4.05	3.45	6.67	83.92	1.90

Counterparty Financial Institutions	Variance Decomposition for CDS Spread of AMBAC				
	MSCI	ECRI	TED	CDS of AMBAC	CDS of counterparty
BERKSHIRE HATH.	3.10	0.74	3.86	86.23	6.08
Average	4.97	0.95	3.88	88.98	1.21

Counterparty Financial Institutions	Variance Decomposition for CDS Spread of MBIA				
	MSCI	ECRI	TED	CDS of MBIA	CDS of counterparty
GOLDMAN SACHS	6.72	3.84	3.92	79.26	6.25
MORGAN STANLEY	7.02	3.50	4.32	80.00	5.17
Average	11.65	3.65	4.50	78.79	1.41

Table 5-1: Variance decompositions for CDS spreads of counterparties
(Estimation by adopting AIG as a guarantor)

Counterparty Financial Institutions	Variance Decomposition for CDS Spread of Counterparty Financial Institution				
	MSCI	ECRI	TED	CDS of AIG	CDS of counterparty
US Insurance Companies					
AETNA	16.25	2.11	5.19	5.76	70.69
BERKSHIRE HATH.	27.63	4.27	1.78	4.60	61.73
CIGNA	16.77	2.61	8.67	3.32	68.62
HARTFORD	24.44	2.82	11.57	2.51	58.66
METLIFE	33.50	2.55	12.87	3.72	47.36
PRUDENTIAL FIN.	26.76	4.40	11.44	6.09	51.30
LIBERTY MUTUAL	30.92	1.67	9.31	12.28	45.82
TRAVELLERS	26.66	3.99	5.85	8.68	54.82
US Banks					
BANK OF AMERICA	22.44	0.47	1.61	11.22	64.26
CITIGROUP	22.21	1.82	4.24	17.00	54.72
JP MORGAN CHASE	23.24	1.37	4.41	5.47	65.50
WELLS FARGO	23.23	1.10	3.08	11.06	61.54
AMERICAN EXPRESS	29.19	1.54	11.52	6.06	51.70
GOLDMAN SACHS	25.84	2.04	14.22	2.41	55.49
MERRILL LYNCH	12.56	0.61	2.19	12.21	72.43
MORGAN STANLEY	14.15	2.97	26.07	1.73	55.08
EU Insurance Companies					
AEGON	36.02	1.92	18.04	1.55	42.47
AG	23.69	1.78	2.83	3.43	68.28
ALLIANZ	29.29	1.10	1.57	2.27	65.77
AVIVA	25.27	1.25	1.94	2.26	69.28
AXA	33.22	1.42	7.73	1.80	55.83
HANNOVER	18.18	0.92	2.37	3.44	75.10
ING	15.99	3.13	5.14	9.08	66.65
MUNICH RE.	22.81	0.65	2.00	1.79	72.75
PRUDENTIAL PLC.	25.14	1.85	0.61	4.34	68.07
SWISS RE.	26.08	2.21	3.73	3.31	64.68
ZURICH	18.91	1.87	2.28	5.08	71.86
EU Banks					
BARCLAYS	4.53	4.27	10.34	4.39	76.47
BANCO COM. PORT.	14.90	0.84	3.97	8.01	72.27
BANCO SANTANDER	19.29	0.59	1.19	8.34	70.59
CREDIT AGRICOLE	11.96	1.57	3.35	6.72	76.41
COMMERZBANK	6.88	3.01	3.07	10.31	76.74
CREDIT SUISSE	14.51	2.44	1.75	6.26	75.04
DEUTSHEBANK	8.76	6.05	3.20	1.54	80.46
FORTIS	12.76	7.57	11.58	5.75	62.34
HBOS	8.19	1.73	6.55	2.36	81.17
HSBC	16.67	3.95	2.91	5.98	70.49
LLOYDS TSB	10.97	1.73	7.91	3.87	75.51
BNP PARIBAS	16.91	3.38	2.67	7.79	69.26
RBS	6.34	3.01	14.66	5.47	70.52
SOCIETE GENERALE	13.46	3.94	3.40	3.32	75.88
STANDARD CHT. BANK	19.45	1.85	5.12	13.24	60.34
UBS	8.12	1.96	10.96	5.22	73.74
Japanese Financial Institutions					
DAIWA SECURITIES	8.25	7.19	6.18	4.20	74.18
NOMURA SECURITIES	15.50	5.94	6.43	7.77	64.36
MIZUHO CORP. BANK	11.87	1.37	5.93	3.08	77.75
MITSUBISHI UFJ	16.81	1.99	12.56	2.95	65.69
SUMITOMO MITSUI BKG.	15.49	2.13	6.92	2.00	73.46
MITSUI SUMITOMO INS.	21.43	1.58	4.33	5.23	67.43
SOMPO JAPAN	28.90	2.36	3.26	6.83	58.65
TOKIO MARINE NICHIDO	18.17	3.20	1.71	6.46	70.47
Average	17.28	2.62	5.38	5.01	69.71

Table 5-2: Variance decompositions for CDS spreads of counterparties
(Estimation by adopting AMBAC as a guarantor)

Counterparty Financial Institutions	Variance Decomposition for CDS Spread of Counterparty Financial Institution				
	MSCI	ECRI	TED	CDS of AMBAC	CDS of counterparty
US Insurance Companies					
AETNA	16.55	2.47	3.89	3.12	73.96
BERKSHIRE HATH.	24.14	4.11	1.63	8.36	61.76
CIGNA	17.74	2.06	7.69	1.70	70.82
HARTFORD	23.31	2.32	10.68	7.82	55.87
METLIFE	31.89	2.01	11.40	10.46	44.23
PRUDENTIAL FIN.	27.26	3.58	9.90	12.08	47.17
LIBERTY MUTUAL	34.45	1.81	8.10	5.11	50.53
TRAVELLERS	29.78	3.99	4.40	7.16	54.68
US Banks					
BANK OF AMERICA	24.18	0.53	1.63	0.21	73.46
CITIGROUP	22.21	1.80	3.08	14.09	58.83
JP MORGAN CHASE	25.32	1.19	4.32	0.35	68.82
WELLS FARGO	24.97	0.74	2.98	0.36	70.95
AMERICAN EXPRESS	31.97	1.22	11.69	3.92	51.20
GOLDMAN SACHS	24.84	1.53	14.46	2.06	57.12
MERRILL LYNCH	14.84	0.75	2.22	2.57	79.62
MORGAN STANLEY	12.39	2.78	26.27	2.43	56.14
EU Insurance Companies					
AEGON	34.73	1.58	17.72	5.91	40.06
AG	22.86	1.19	2.32	6.71	66.91
ALLIANZ	28.92	0.77	1.32	4.78	64.22
AVIVA	23.88	1.18	1.19	13.47	60.29
AXA	31.19	1.13	7.16	7.85	52.66
HANNOVER	17.86	1.13	1.99	5.64	73.38
ING	16.56	2.01	4.17	7.74	69.52
MUNICH RE.	22.39	0.68	1.71	3.66	71.56
PRUDENTIAL PLC.	23.86	0.74	0.84	11.76	62.80
SWISS RE.	24.18	1.07	4.05	13.43	57.27
ZURICH	18.30	1.57	1.80	6.84	71.48
EU Banks					
BARCLAYS	5.94	3.20	8.53	4.16	78.17
BANCO COM. PORT.	16.49	0.52	2.97	3.70	76.31
BANCO SANTANDER	21.61	0.46	0.77	2.71	74.45
CREDIT AGRICOLE	12.76	1.72	2.86	3.68	78.97
COMMERZBANK	8.43	2.49	2.69	1.37	85.02
CREDIT SUISSE	13.44	2.16	1.87	6.68	75.85
DEUTSHEBANK	9.05	5.69	3.08	2.02	80.17
FORTIS	14.97	6.99	11.92	1.28	64.85
HBOS	9.38	1.24	5.37	4.03	79.97
HSBC	16.17	3.02	2.61	6.15	72.04
LLOYDS TSB	11.76	1.38	6.48	4.35	76.03
BNP PARIBAS	18.24	3.24	2.00	4.77	71.75
RBS	8.17	2.00	12.44	5.92	71.46
SOCIETE GENERALE	14.69	3.84	2.75	3.64	75.08
STANDARD CHT. BANK	21.33	0.85	4.75	3.87	69.21
UBS	8.05	1.00	8.78	9.33	72.84
Japanese Financial Institutions					
DAIWA SECURITIES	8.78	6.05	5.51	2.46	77.19
NOMURA SECURITIES	15.35	3.66	5.81	7.00	68.18
MIZUHO CORP. BANK	13.67	1.69	5.35	5.70	73.60
MITSUBISHI UFJ	18.12	1.95	11.38	3.27	65.28
SUMITOMO MITSUI BKG.	15.46	2.10	6.15	8.88	67.41
MITSUI SUMITOMO INS.	18.90	1.59	2.83	13.18	63.51
SOMPO JAPAN	27.99	1.97	1.23	15.91	52.90
TOKIO MARINE NICHIDO	16.00	3.02	0.90	14.76	65.32
Average	17.41	2.14	4.67	6.47	69.31

Table 5-3: Variance decompositions for CDS spreads of counterparties
(Estimation by adopting MBIA as a guarantor)

Counterparty Financial Institutions	Variance Decomposition for CDS Spread of Counterparty Financial Institution				
	MSCI	ECRI	TED	CDS of MBIA	CDS of counterparty
US Insurance Companies					
AETNA	17.18	2.08	4.31	4.98	71.45
BERKSHIRE HATH.	27.47	5.30	1.39	1.83	64.01
CIGNA	18.15	1.80	8.14	3.91	68.00
HARTFORD	26.65	3.02	10.64	1.55	58.14
METLIFE	36.76	2.77	11.93	1.75	46.79
PRUDENTIAL FIN.	30.73	5.10	9.88	2.79	51.50
LIBERTY MUTUAL	36.07	1.98	7.60	1.79	52.55
TRAVELLERS	31.55	4.23	4.74	1.50	57.98
US Banks					
BANK OF AMERICA	24.24	0.41	1.50	1.47	72.38
CITIGROUP	25.41	2.01	3.71	1.41	67.46
JP MORGAN CHASE	24.64	1.37	4.33	1.30	68.36
WELLS FARGO	24.75	0.88	2.89	1.44	70.03
AMERICAN EXPRESS	32.57	1.78	11.58	3.34	50.74
GOLDMAN SACHS	25.67	1.88	14.41	0.93	57.11
MERRILL LYNCH	14.75	0.67	2.14	1.97	80.47
MORGAN STANLEY	13.44	2.63	26.69	1.01	56.23
EU Insurance Companies					
AEGON	35.39	2.02	17.71	1.80	43.09
AG	24.30	1.65	2.94	6.11	65.00
ALLIANZ	30.33	1.15	1.77	5.59	61.17
AVIVA	26.09	1.54	2.21	6.09	64.06
AXA	33.12	1.66	8.36	3.56	53.30
HANNOVER	18.94	1.04	2.53	6.42	71.08
ING	18.27	2.42	4.55	4.52	70.25
MUNICH RE.	23.02	0.58	2.18	4.49	69.73
PRUDENTIAL PLC.	25.22	1.55	1.64	3.74	67.84
SWISS RE.	25.59	1.83	4.89	4.79	62.90
ZURICH	19.68	1.67	2.25	6.07	70.33
EU Banks					
BARCLAYS	6.16	3.32	9.53	4.98	76.01
BANCO COM. PORT.	17.36	0.51	3.47	5.80	72.86
BANCO SANTANDER	22.09	0.28	1.13	5.97	70.54
CREDIT AGRICOLE	13.37	1.74	3.17	4.72	76.99
COMMERZBANK	8.85	2.73	2.77	7.28	78.36
CREDIT SUISSE	13.58	2.25	2.57	6.54	75.06
DEUTSHEBANK	9.09	5.85	3.04	0.20	81.81
FORTIS	15.47	7.33	11.94	0.61	64.66
HBOS	9.70	1.24	6.14	4.36	78.55
HSBC	17.22	3.30	2.97	6.32	70.19
LLOYDS TSB	11.68	1.29	7.38	5.03	74.62
BNP PARIBAS	19.34	3.65	2.30	6.16	68.55
RBS	8.87	2.27	13.98	6.59	68.30
SOCIETE GENERALE	14.92	4.26	3.08	3.29	74.46
STANDARD CHT. BANK	21.85	1.02	5.25	2.52	69.37
UBS	8.65	1.15	11.00	5.93	73.27
Japanese Financial Institutions					
DAIWA SECURITIES	8.49	6.06	5.60	0.97	78.88
NOMURA SECURITIES	15.85	4.70	6.25	4.38	68.82
MIZUHO CORP. BANK	13.97	1.49	4.63	4.10	75.81
MITSUBISHI UFJ	18.31	2.38	10.78	3.86	64.66
SUMITOMO MITSUI BKG.	16.72	2.82	5.85	3.96	70.65
MITSUI SUMITOMO INS.	20.81	2.03	4.11	2.78	70.26
SOMPO JAPAN	31.86	2.53	2.48	2.50	60.64
TOKIO MARINE NICHIDO	18.04	3.64	1.60	2.33	74.39
Average	18.35	2.43	5.20	4.41	69.61

Figure 1. CDS spreads of AIG and major monoline insurers

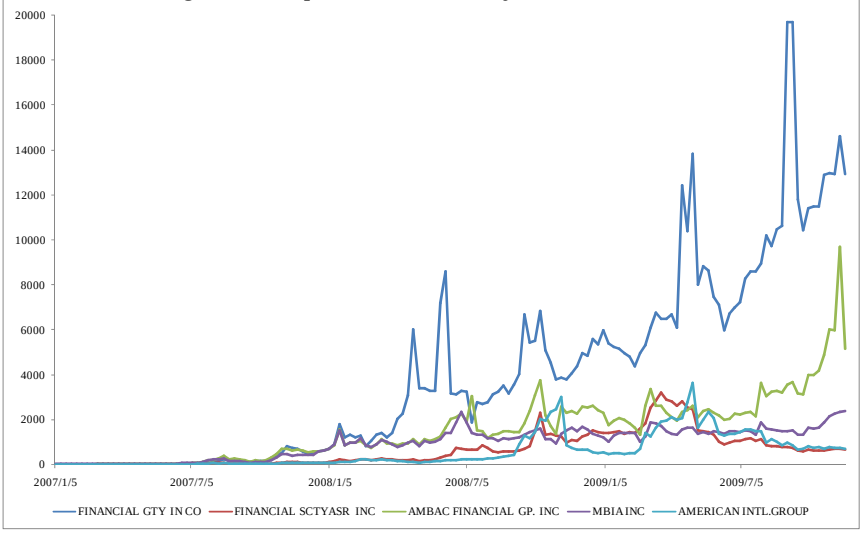


Figure 2-1. CDS spreads of US insurance companies

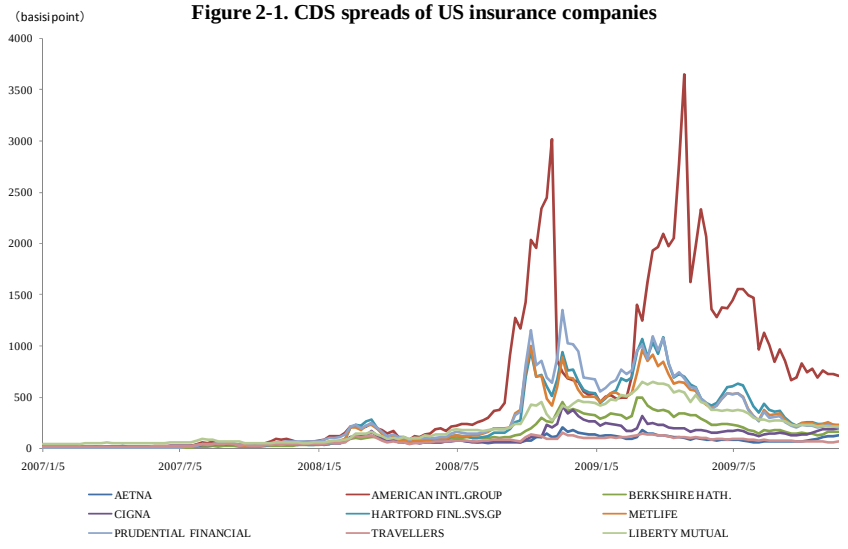
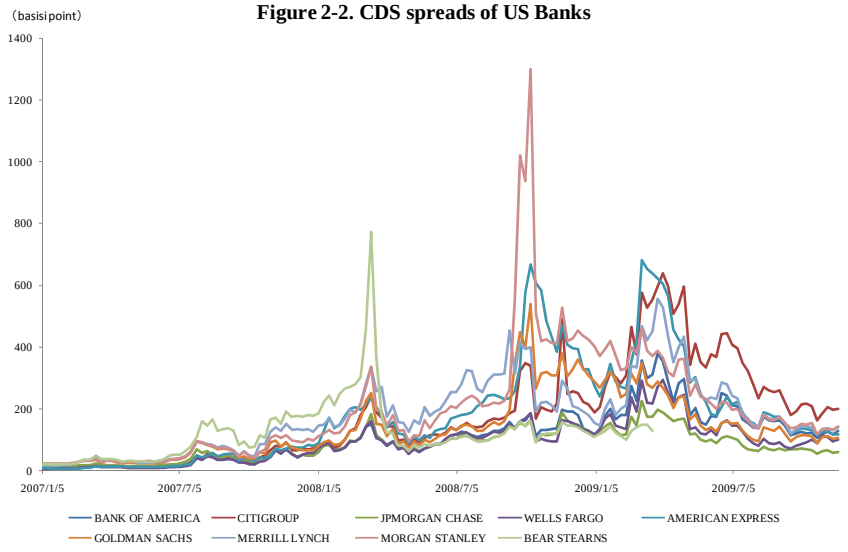
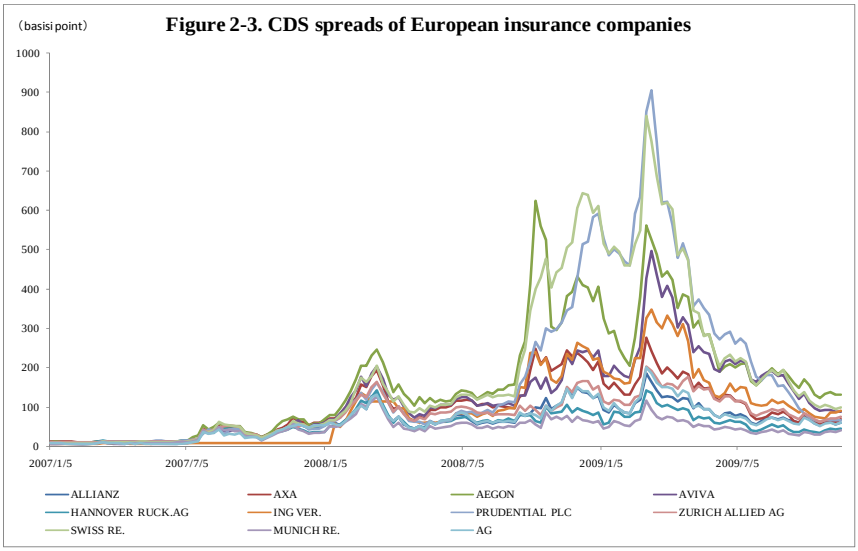
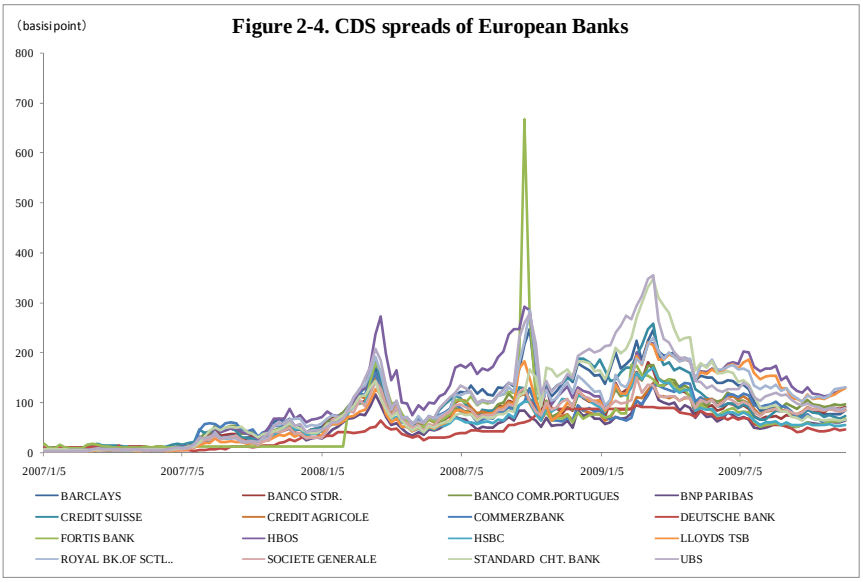


Figure 2-2. CDS spreads of US Banks




(basisi point)
Figure 2-3. CDS spreads of European insurance companies
1000
900
800
700
600
500
400
300
200
100
0
2007/1/5
2007/7/5
2008/1/5
2008/7/5
2009/1/5
2009/7/5
ALLIANZ
AXA
AEGON
AVIVA
HANNOVER RUCK.AG
ING VER.
PRUDENTIAL PLC
ZURICH ALLIED AG
SWISS RE.
MUNICH RE.
AG


(basisi point)
Figure 2-4. CDS spreads of European Banks
800
700
600
500
400
300
200
100
0
2007/1/5
2007/7/5
2008/1/5
2008/7/5
2009/1/5
2009/7/5
BARCLAYS
BANCO STDR.
BANCO COMR.PORTUGUES
BNP PARIBAS
CREDIT SUISSE
CREDIT AGRICOLE
COMMERZBANK
DEUTSCHE BANK
FORTIS BANK
HBOS
HSBC
LLOYDS TSB
ROYAL BK.OF SCTL..
SOCIETE GENERALE
STANDARD CHT. BANK
UBS

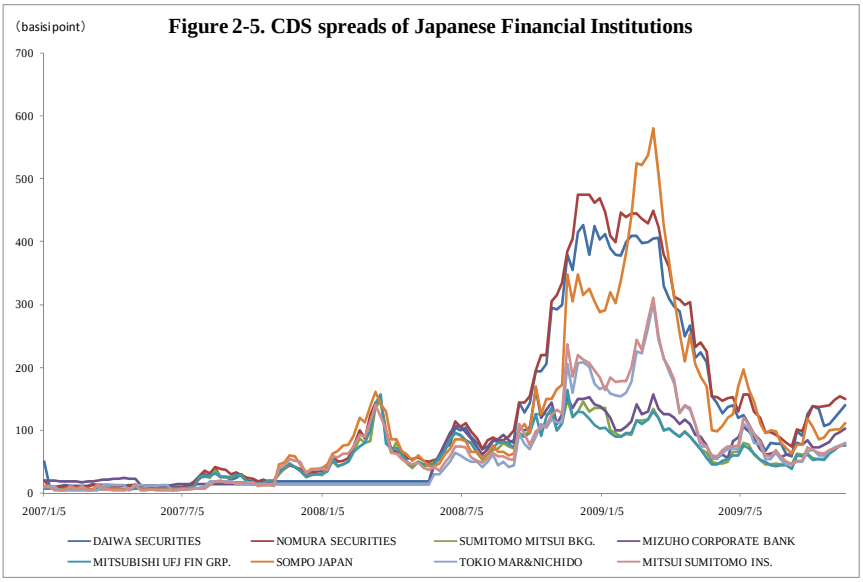

(basisi point)
Figure 2-5. CDS spreads of Japanese Financial Institutions
700
600
500
400
300
200
100
0
2007/1/5
2007/7/5
2008/1/5
2008/7/5
2009/1/5
2009/7/5
DAIWA SECURITIES
NOMURA SECURITIES
SUMITOMO MITSUI BKG.
MIZUHO CORPORATE BANK
MITSUBISHI UFJ FIN GRP.
SOMPO JAPAN
TOKIO MAR&NICHIDO
MITSUI SUMITOMO INS.

Figure 3. Indicators of future macroeconomic conditions

Figure 3. Indicators of future macroeconomic conditions (Continued)

Figure 4. Indicators of market liquidity

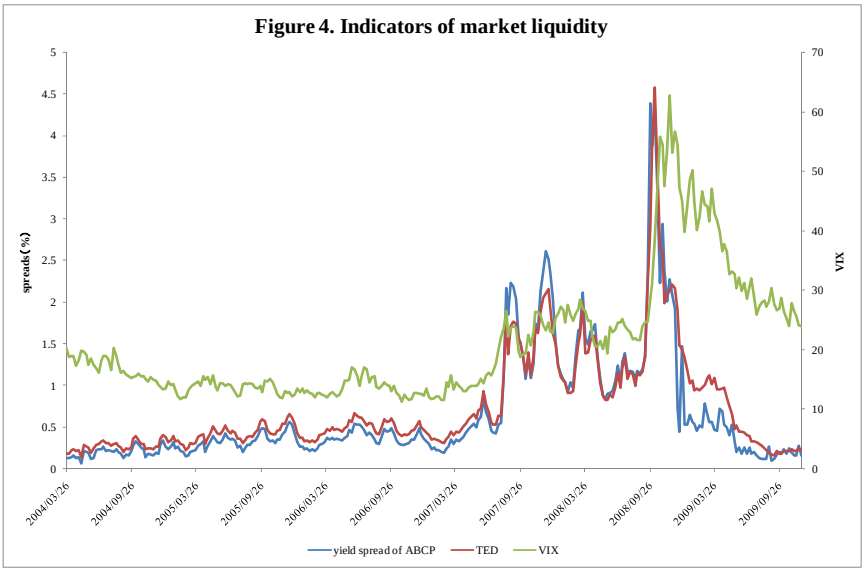


Figure 5-1. Impulse Response Functions

(AIG as a guarantor, Goldman Sachs as its counterparty)

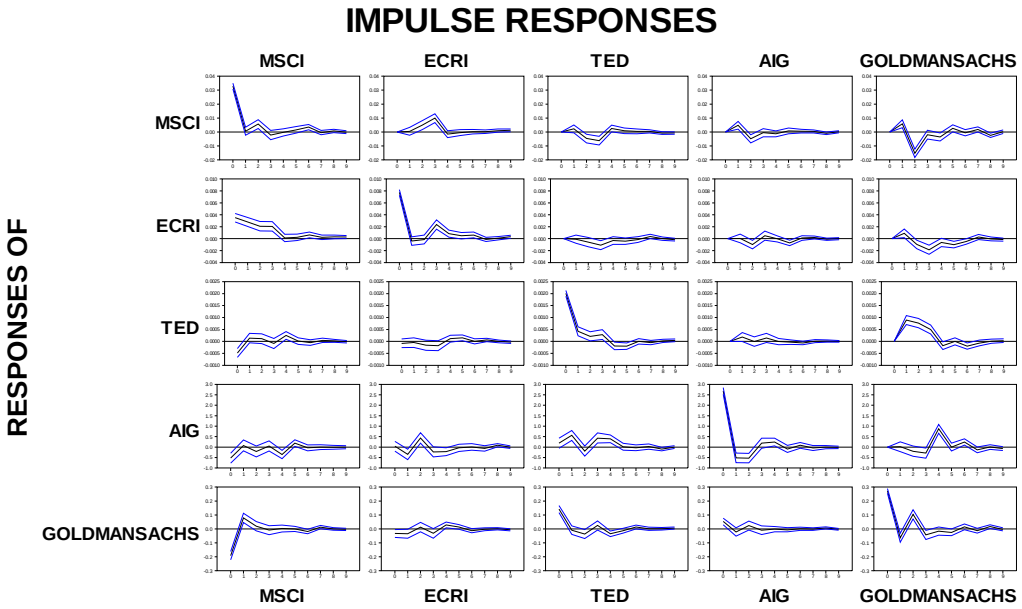


Figure 5-2. Impulse Response Functions

(AIG as a guarantor, Allianz as its counterparty)

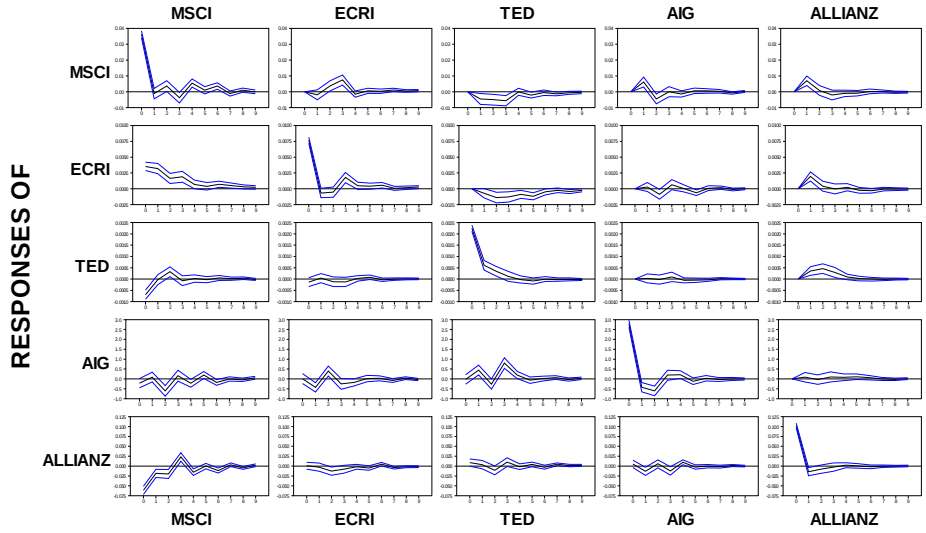


Figure 6-1. Impulse Reponses of CDS Spreads for US Insurance Companies to Shocks in MSCI World Index

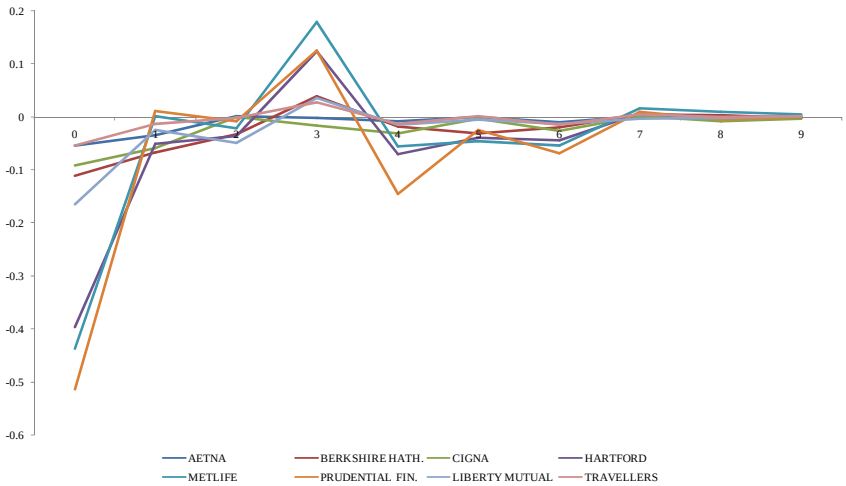


Figure 6-2. Impulse Reponses of CDS Spreads for US Banks to Shocks in MSCI World Index

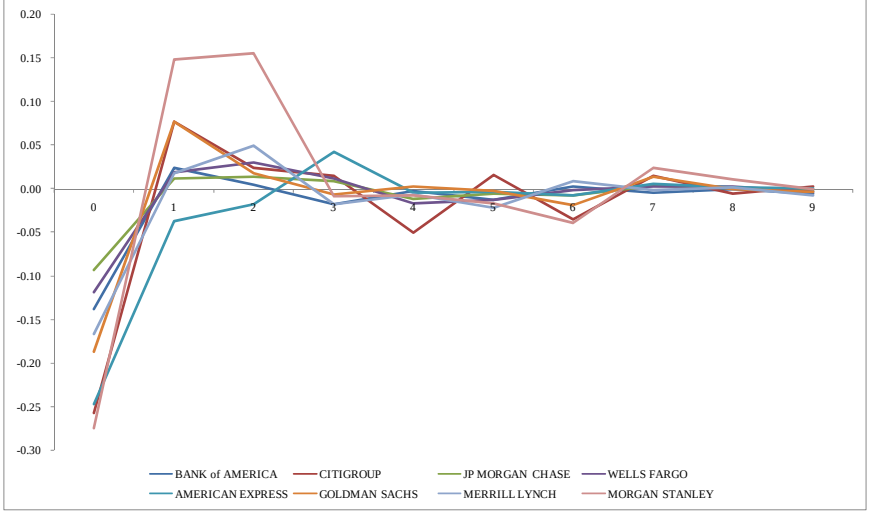


Figure 6-3. Impulse Reponses of CDS Spreads for European Insurance Companies to Shocks in MSCI World Index

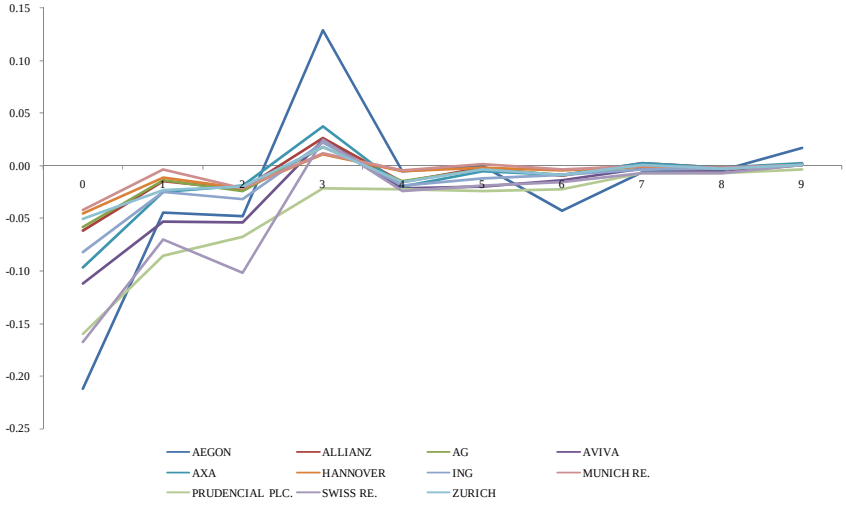


Figure 6-4. Impulse Reponses of CDS Spreads for European Banks to Shocks in MSCI World Index

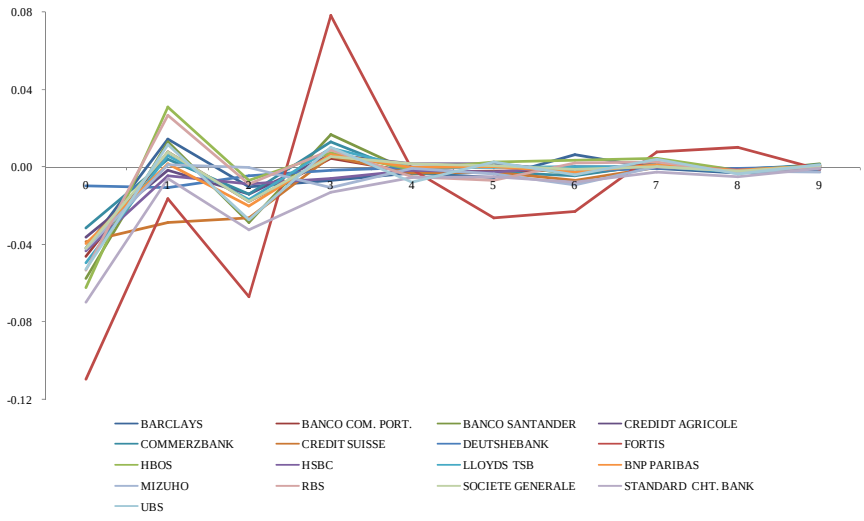


Figure 6-5. Impulse Reponses of CDS Spreads for Japanese Financial Institutions to Shocks in MSCI World Index

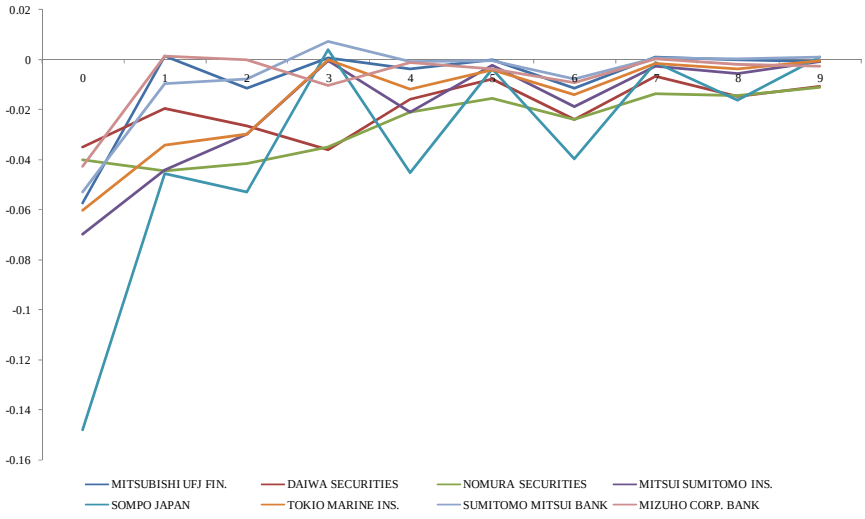


Figure 7-1. Impulse Responses of CDS Spreads for US Financial Institutions to Shocks in ECRI Leading Index

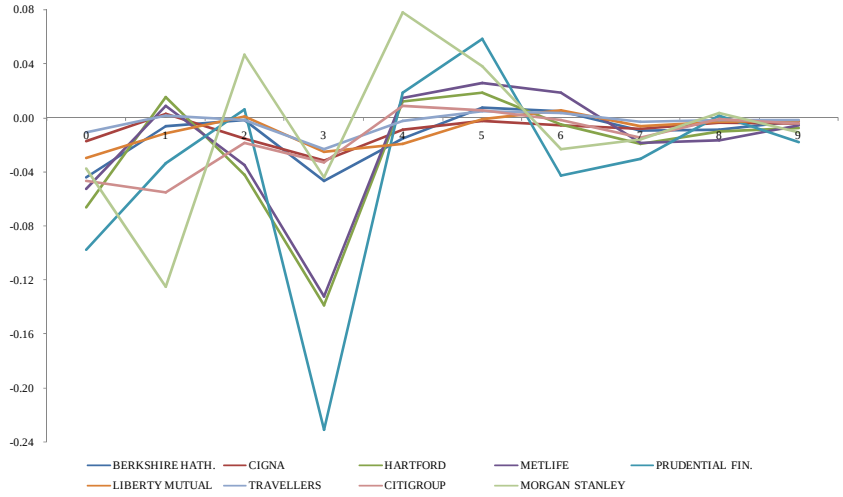


Figure 7-2. Impulse Responses of CDS Spreads for European Financial Institutions to Shocks in ECRI Leading Index

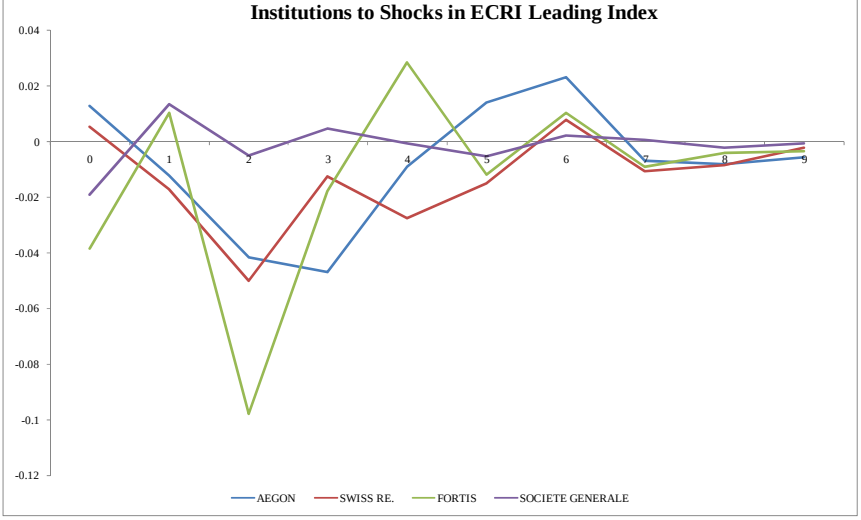


Figure 7-3. Impulse Responses of CDS Spreads for Japanese Financial Institutions to Shocks in ECRI Leading Index

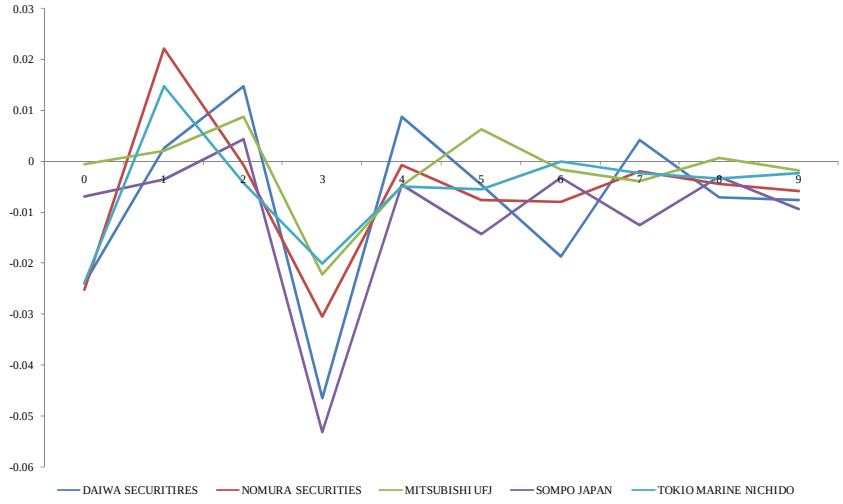


Figure 8-1. Impulse Responses of CDS Spreads for US Insurance Companies to Shocks in TED

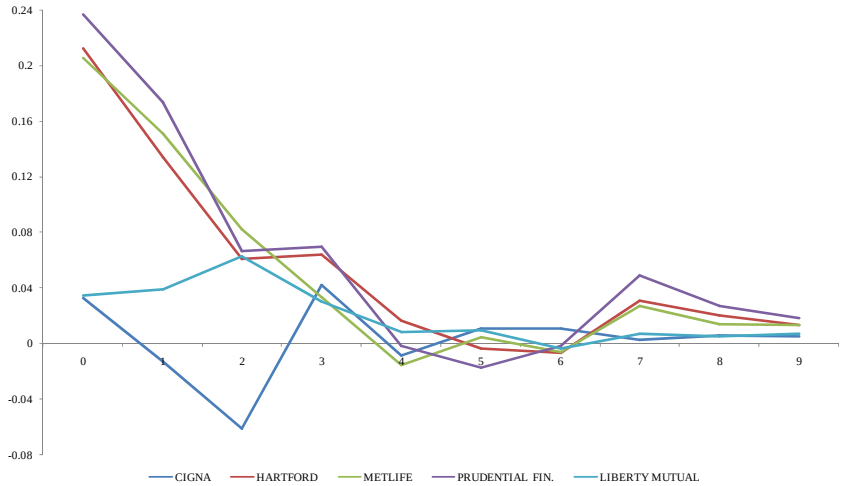


Figure 8-2. Impulse Responses of CDS Spreads for US Banks to Shocks in TED

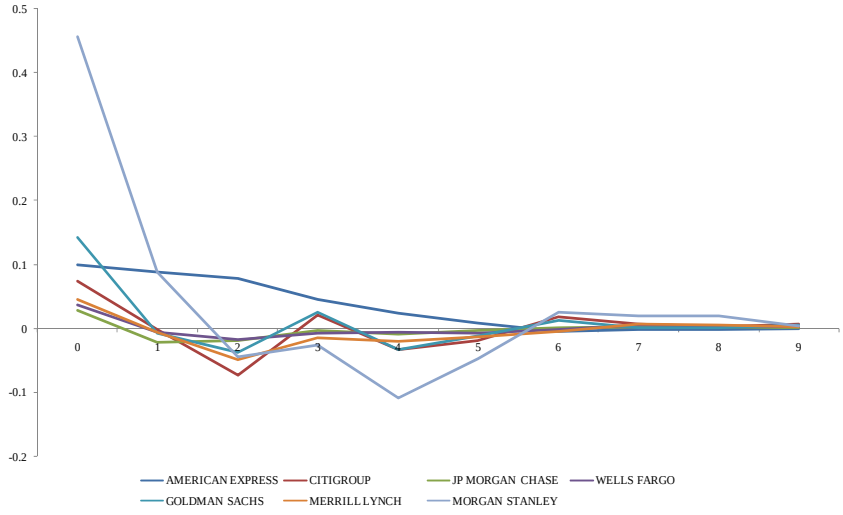


Figure 8-3. Impulse Responses of CDS Spreads for European Insurance Companies to Shocks in TED

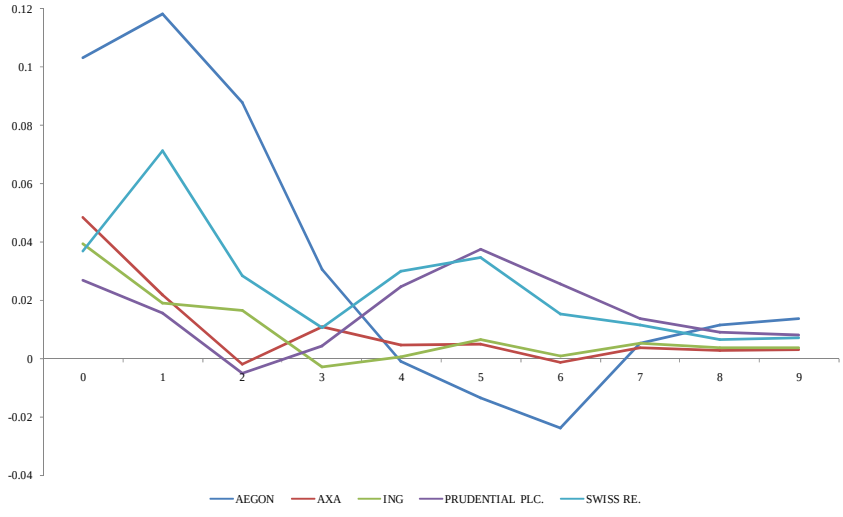


Figure 8-4. Impulse Responses of CDS Spreads for European Banks to Shocks in TED

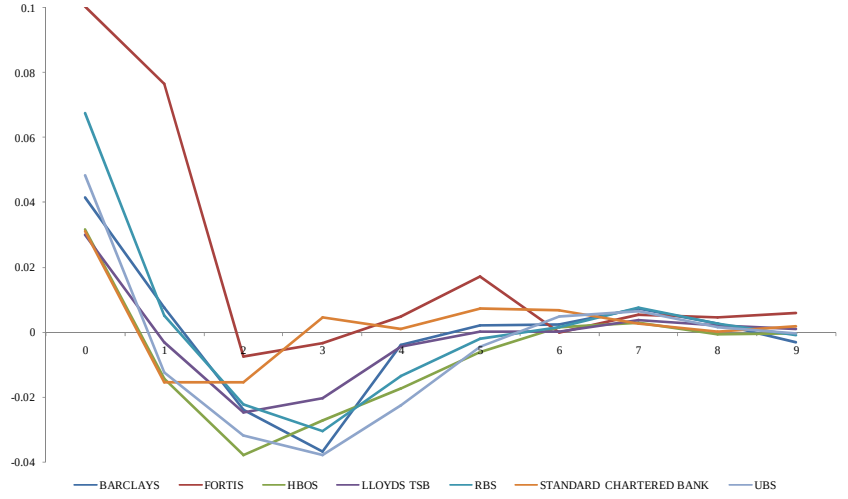


Figure 8-5. Impulse Responses of CDS Spreads for Japanese Financial Institutions to Shocks in TED

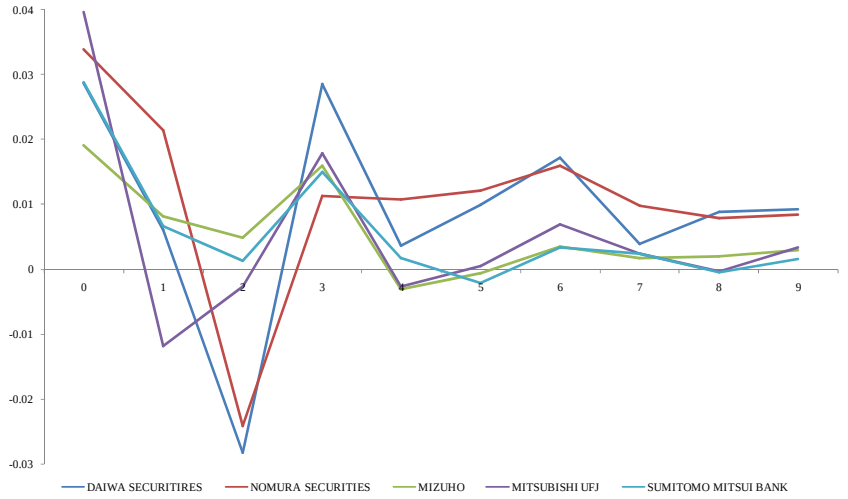


Figure 9-1. Impulse Responses of CDS Spreads for US Insurance Companies to Shocks in CDS Spread for MBIA

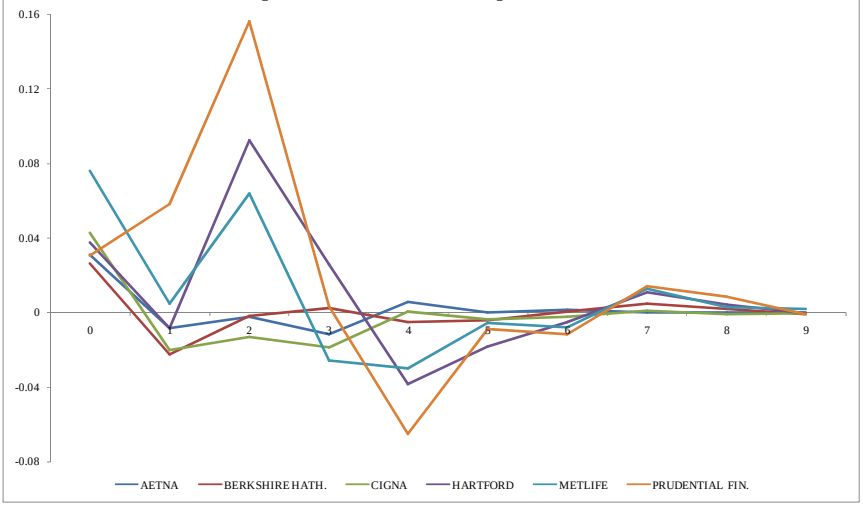


Figure 9-2. Impulse Responses of CDS Spreads for US Insurance Companies to Shocks in CDS Spread for AMBAC

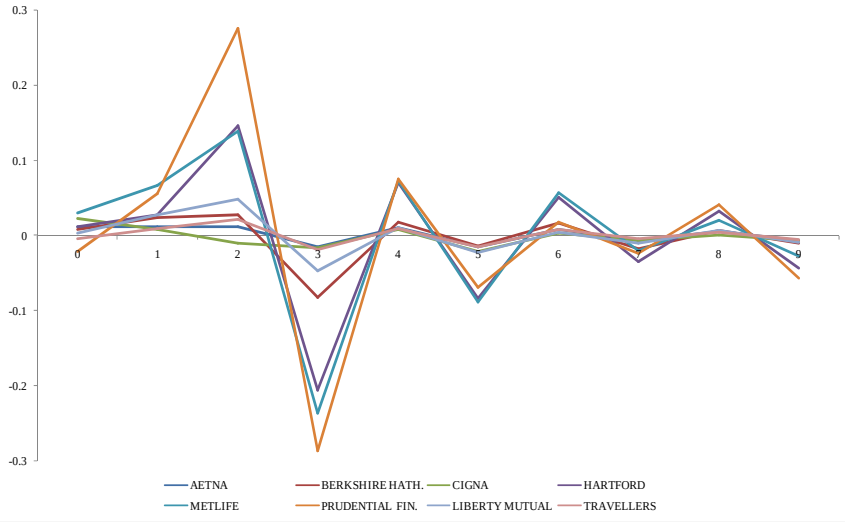


Figure 9-3. Impulse Responses of CDS Spreads for US Insurance Companies to Shocks in CDS Spread for AIG

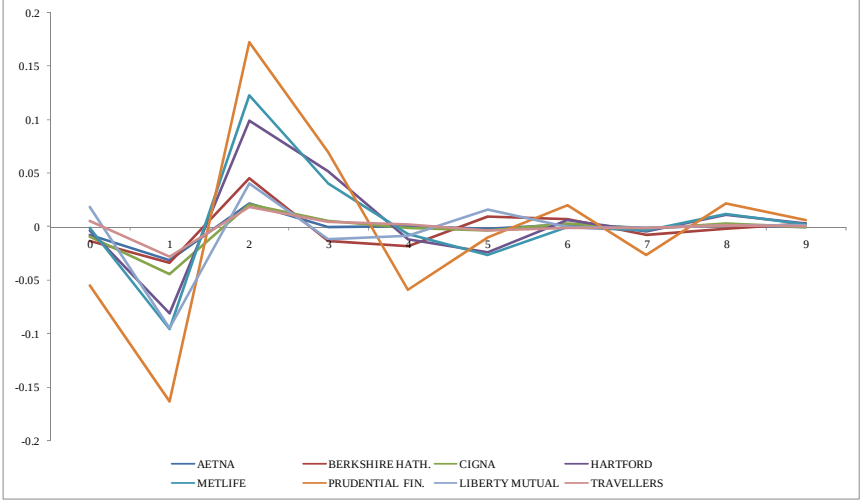


Figure 10-1. Impulse Responses of CDS Spreads for US Banks to Shocks in CDS Spread for MBIA

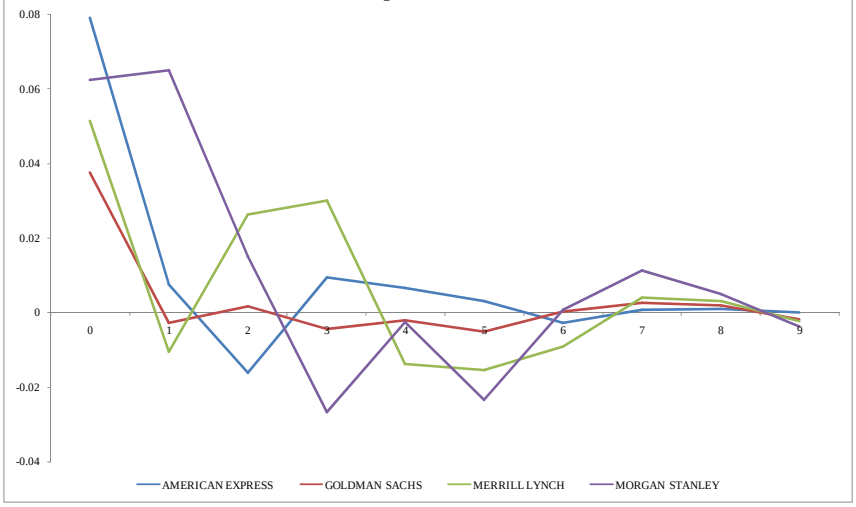


Figure 10-2. Impulse Responses of CDS Spreads for US Banks to Shocks in CDS Spread for AMBAC

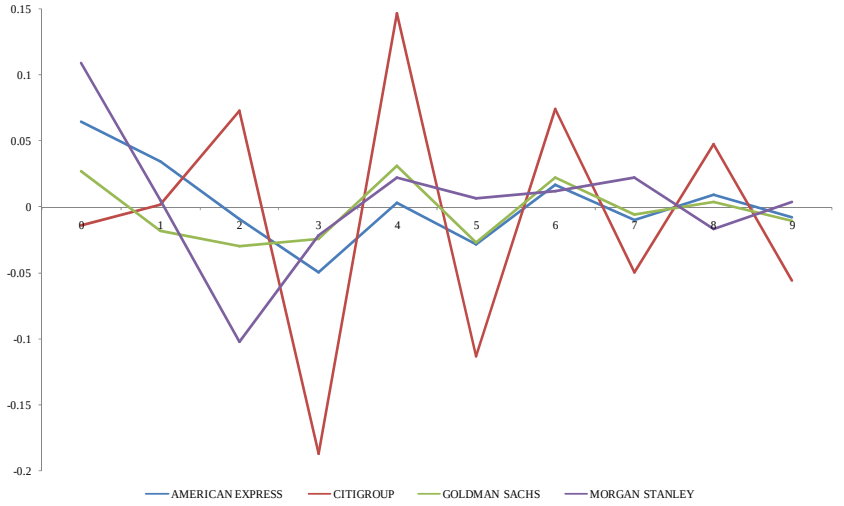


Figure 10-3. Impulse Responses of CDS Spreads for US Banks to Shocks in CDS Spread for AIG

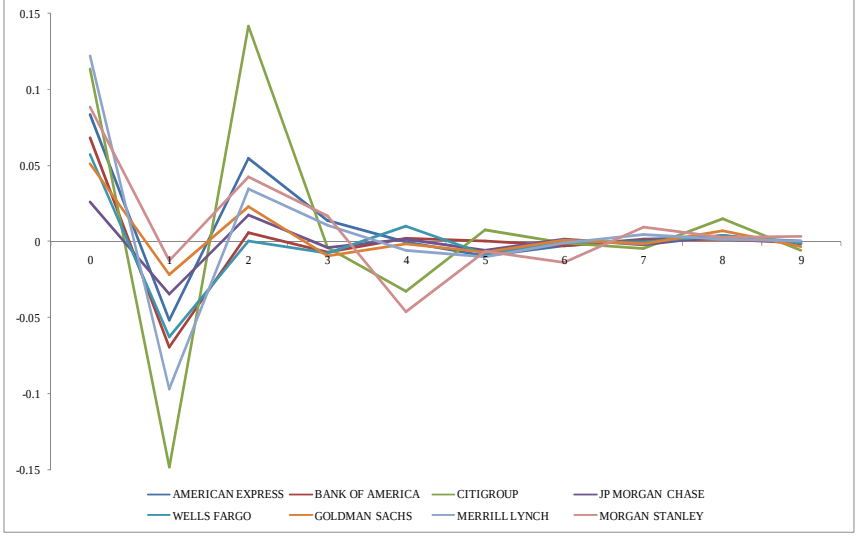


Figure 11-1. Impulse Responses of CDS Spreads for European Insusrance Companies to Shocks in CDS Spread for MBIA

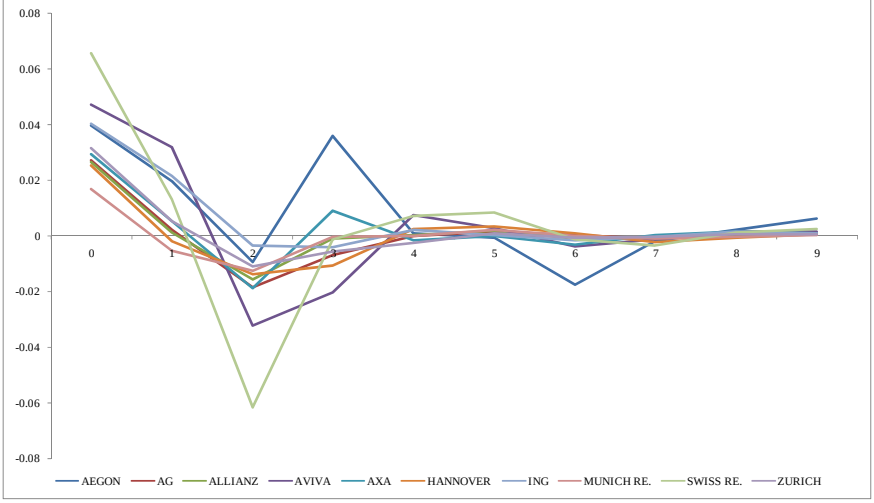


Figure 11-2. Impulse Responses of CDS Spreads for European Insusrance Companies to Shocks in CDS Spread for AMBAC

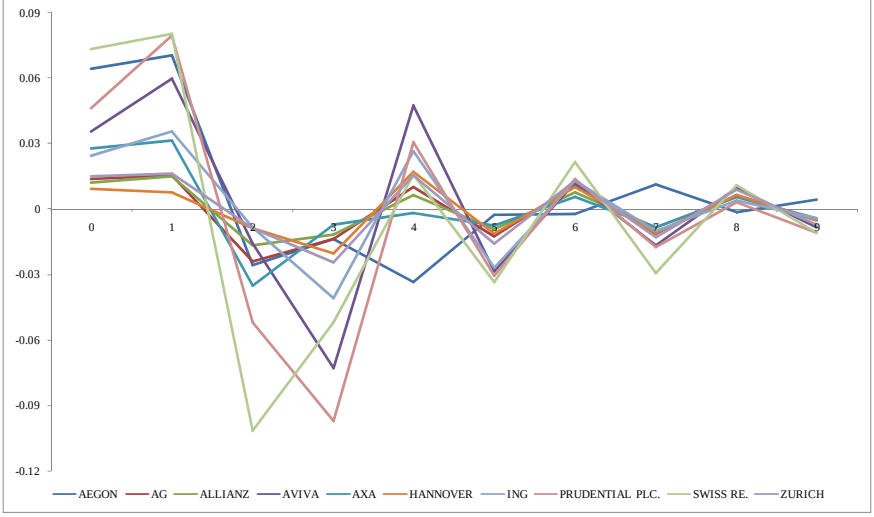


Figure 11-3. Impulse Responses of CDS Spreads for European Insusrance Companies to Shocks in CDS Spread for AIG

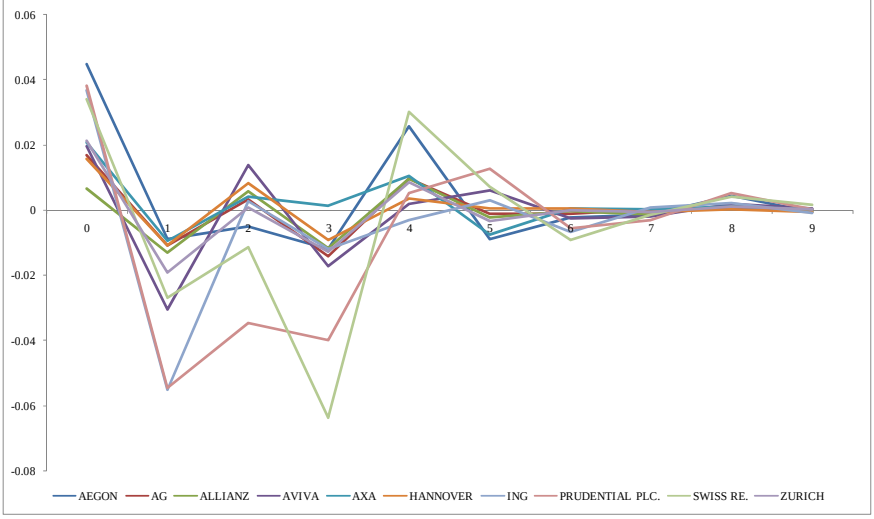


Figure 12-1. Impulse Responses of CDS spreads for European Banks to Shocks in CDS Spread for MBIA

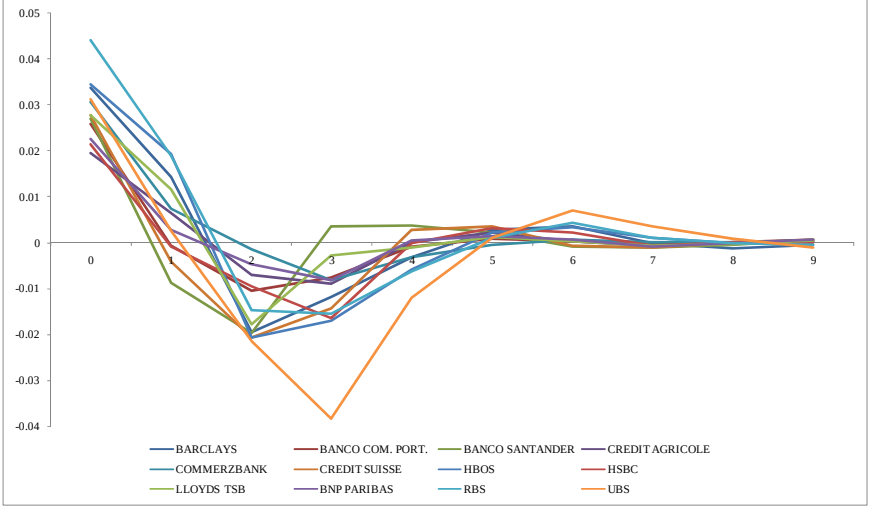


Figure 12-2. Impulse Responses of CDS spreads for European Banks to Shocks in CDS Spread for AMBAC

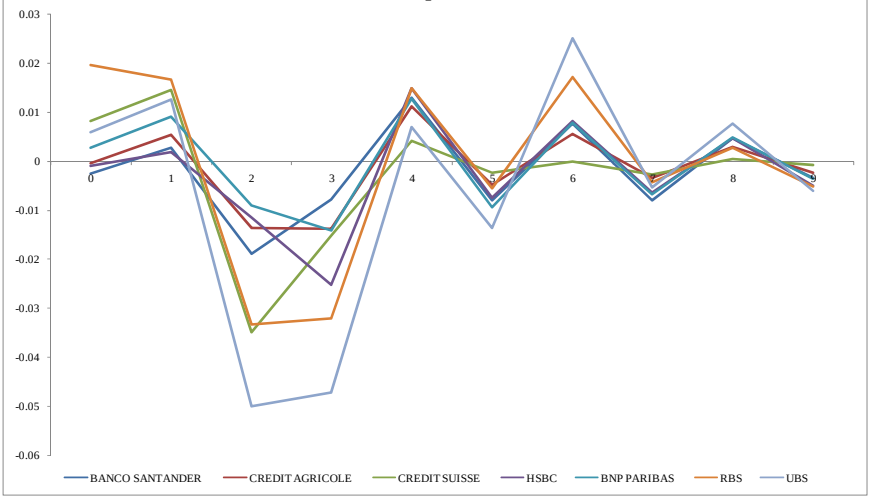


Figure 12-3. Impulse Responses of CDS spreads for European Banks to Shocks in CDS Spread for AIG

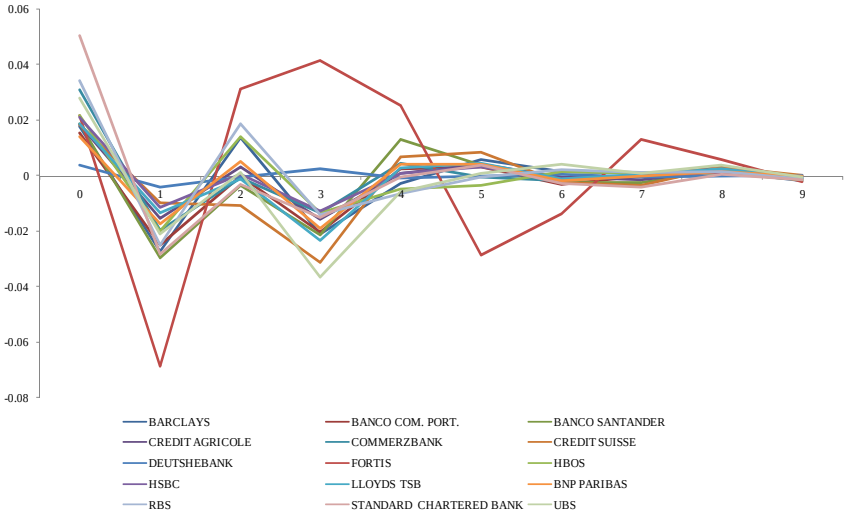


Figure 13-1. Impulse Responses of CDS spreads for Japanese Financial Institutions to Shocks in CDS Spread for MBIA

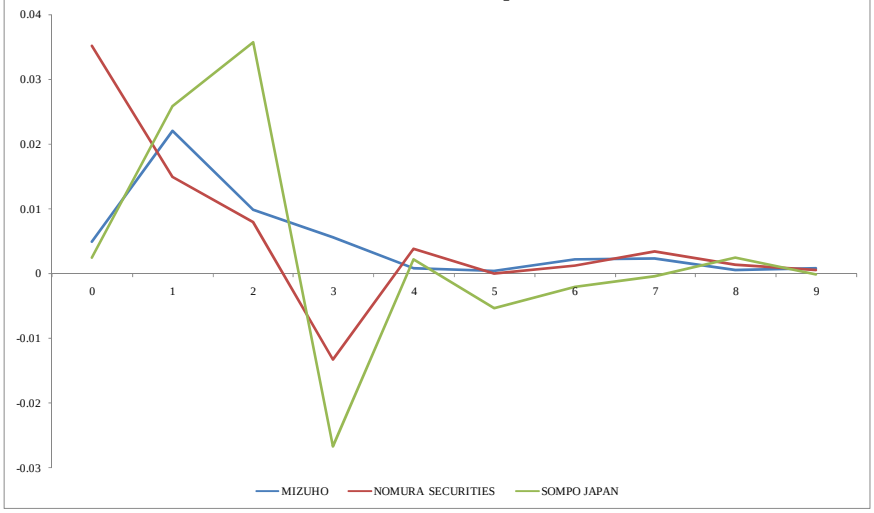


Figure 13-2. Impulse Responses of CDS spreads for Japanese Financial Institutions to Shocks in CDS Spread for AMBAC

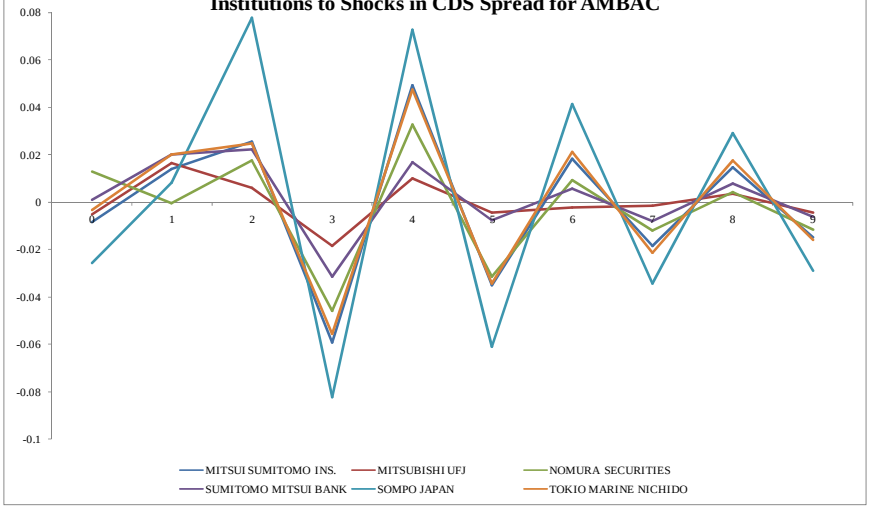


Figure 13-2. Impulse Responses of CDS spreads for Japanese Financial Institutions to Shocks in CDS Spread for AIG

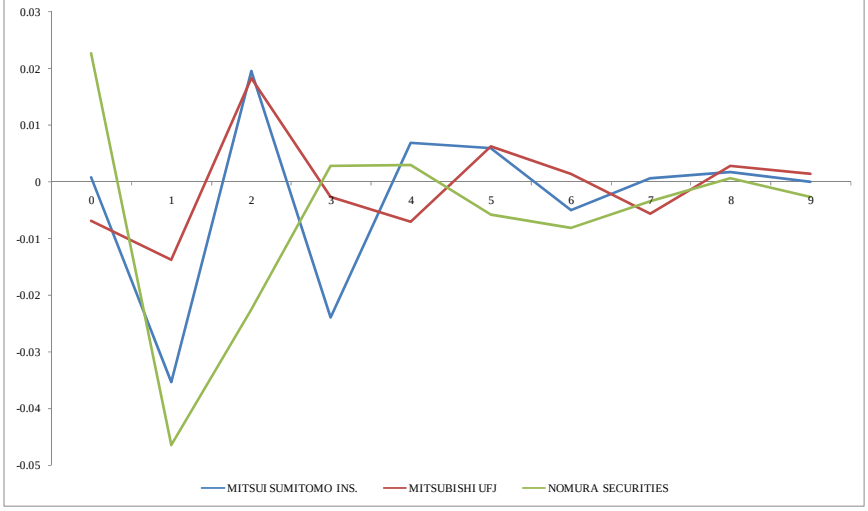


Figure 14-1. Historical Decomposition for CDS Spread of Goldman Sachs

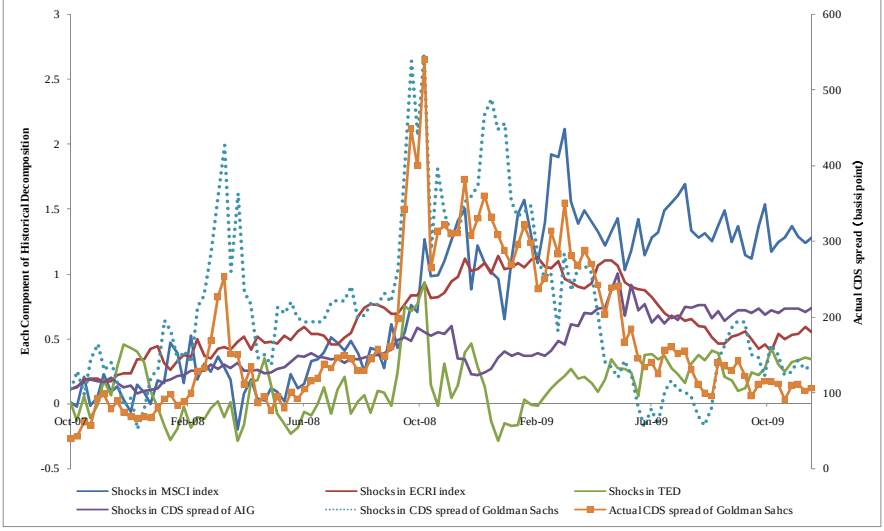


Figure 14-2. Historical Decomposition for CDS Spread of Morgan Stanley

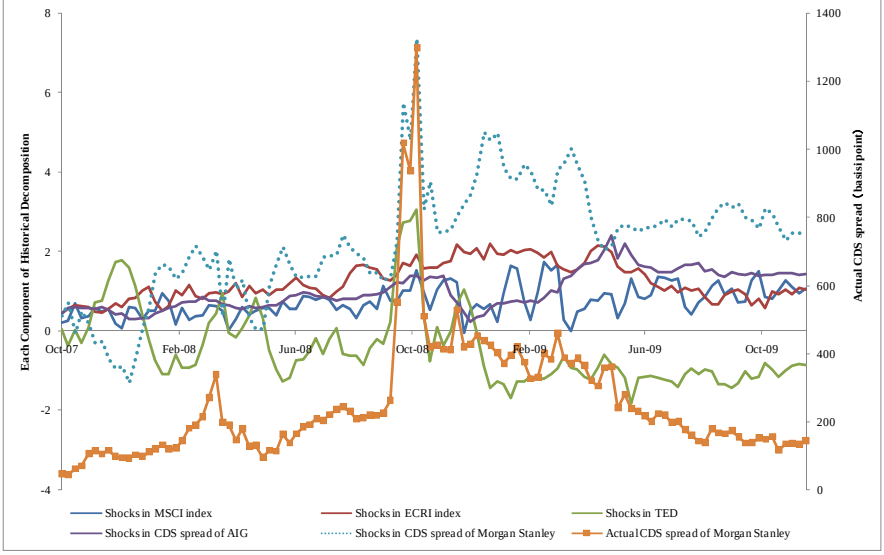


Figure 14-3. Historical Decomposition for CDS Spread of MetLife

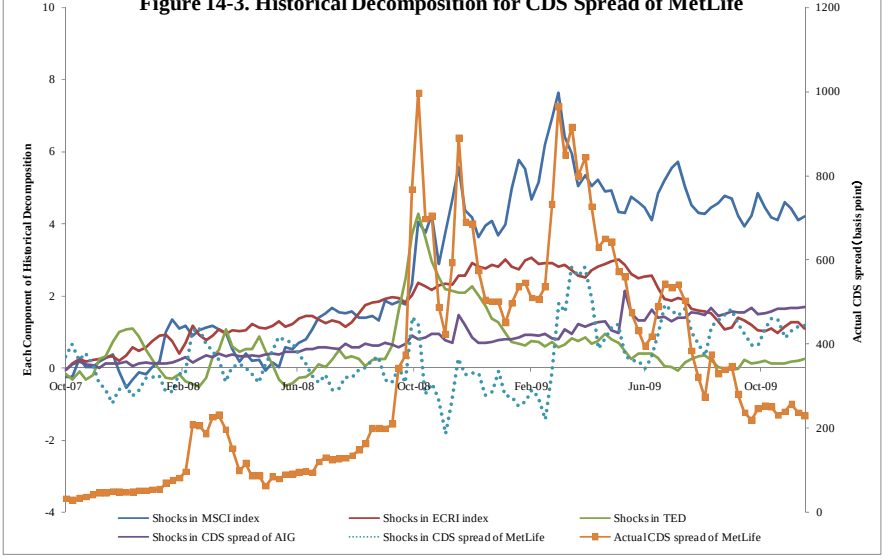


Figure 14-4. Historical Decomposition for CDS Spread of Aegon

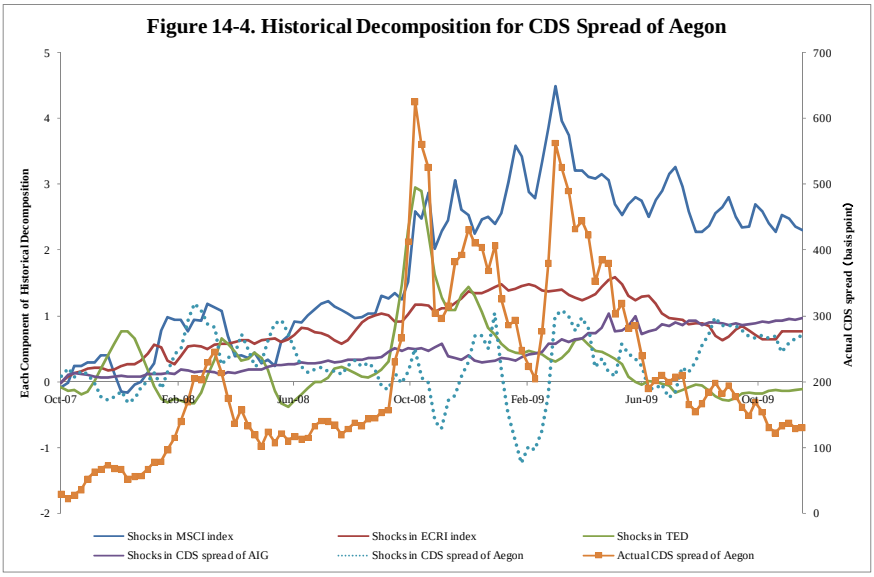


Figure 15. Historical Decomposition for CDS Spread of Merrill Lynch

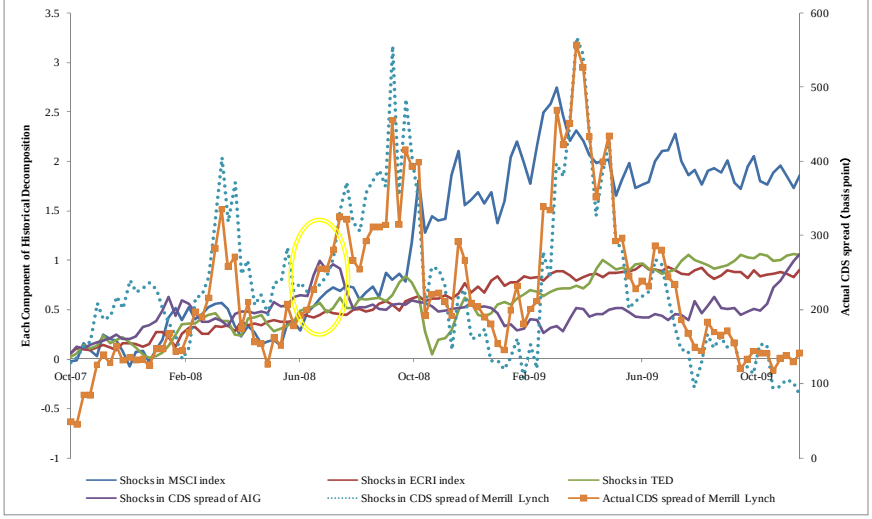


Figure 16. Historical Decomposition for TED
(Estimation by adopting AIG as a guarantor and Goldman Sachs as its coutnerparty)

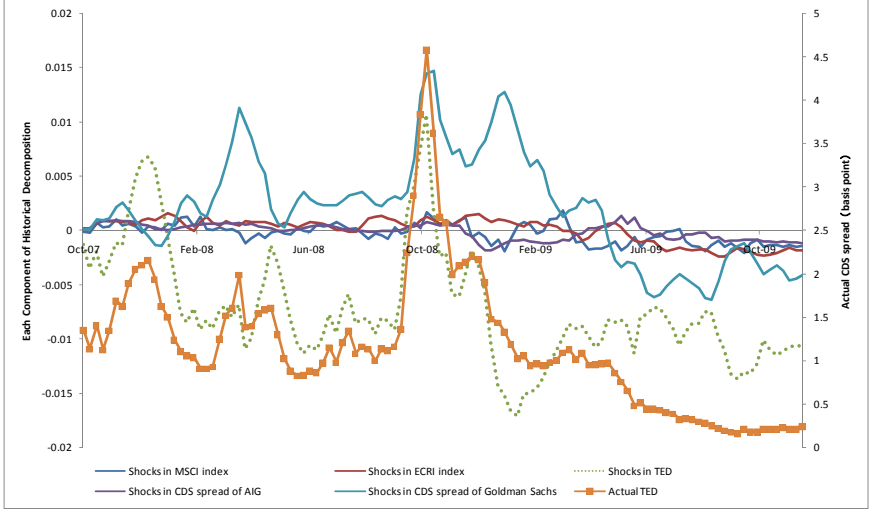


Figure 17. Historical Decomposition for CDS Spread of AIG
(Estimation by adopting Goldman Sachs as a counterparty)

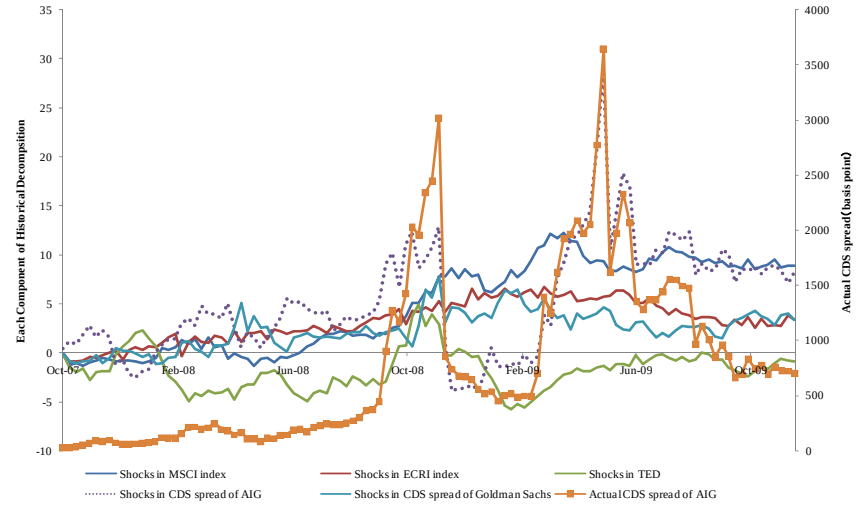


Figure 18-1. Bid-Offer Spread of CDS of Goldman Sachs and Historical Decomposition of Its Own Shock

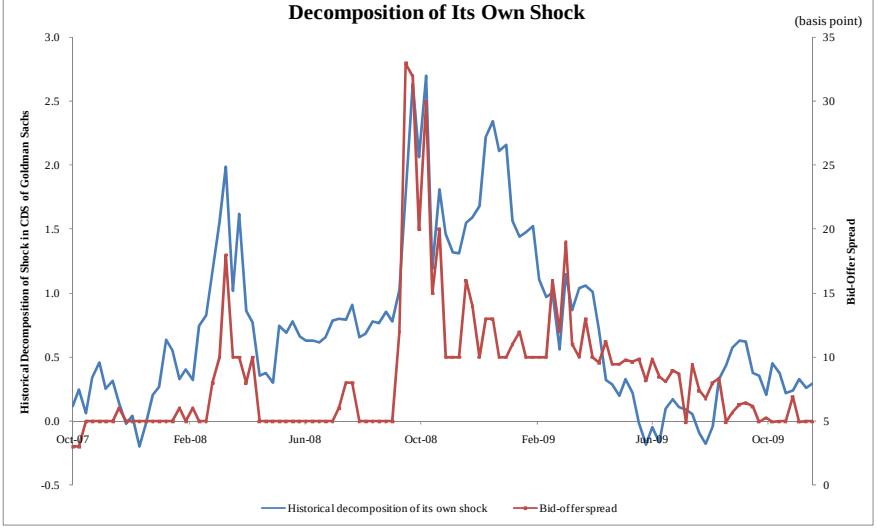


Figure 18-2. Bid-Offer Spread of CDS of AIG and Historical Decomposition of Its Own Shock