European Sovereign Risk: The Knock-on Effects of Default Risk across the Public and Financial Sectors*

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Abstract

The European financial situation is so serious that it is reminiscent of the so-called “Lehman Shock” (the downturn that followed the bankruptcy of the Lehman Brothers) in 2008. Member countries of the Europe may be more susceptible to ripple effects triggered by outbreak of a credit crisis in one part of the region because of the following reasons. Europe has the dominant share of financial transactions within in the region, and regional sovereign risk may spread to neighboring countries through securities investment and lending. There is also concern that financial system instability may harm the fiscal health of those countries as a result of tax revenue reduction due to economic slowdown caused by credit crunch, public fund injection into financial institutions, and so on. The foundation of the European Financial Stabilization Mechanism meant the creation of an additional route through which a fiscal crisis breaking out in one country in the region might spread to the entire European region.

In this paper, we take into consideration the mutual interdependence among the countries, as well as between the financial and public sectors, and examine the features of the knock-on effects of crisis within the European region. Since the foundation of the European Financial Stabilization Mechanism, the knock-on effects among the Eurozone’s core countries have been dramatically heightened, and our research suggests that these knock-on effects have been amplified through concerns about the instability of the financial system. On the other hand, we cannot detect knock-on effects from the Greek sovereign CDS, or Credit Default Swap, which showed an extraordinary rise, which we attribute to shrinking market liquidity against the background of tighter regulations on CDS transactions and confusion regarding the certification of credit events. Even among the core countries, the knock-on effects of the sovereign risk on the CDS of German financial institutions were light, and we may attribute this to the “flight-to-quality” phenomenon having an impact of lowering the German sovereign CDS premiums.

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I. Introduction

The European financial situation is so serious that it is reminiscent of the so-called "Lehman Shock" in 2008. The effect of the financial market turmoil has not been limited to within the GIIPS countries (Greece, Ireland, Italy, Portugal and Spain) but has diffused throughout the whole area of the Eurozone.

The European nations are characterized as being closely interdependent, and the impact of an economic crisis occurring in a country of the region is highly likely to spread throughout the whole area via international trade and financial transactions. In particular, the introduction of the euro, due to the disappearance of exchange risk, has stimulated financial institutions to diversify their portfolio investments and lending across the member states, including the Southern European nations. During the global financial crisis starting from 2007, the sovereign nations in this region were presumably regarded as a safe haven and attracted investments and lending from financial institutions in the core nations. The default risk of the GIIPS countries has been highlighted since the detection of the Greek window-dressing fiscal deficit in October 2009, and as a result of this, the default risk of the core nations’ financial institutions which have great exposure to the GIIPS countries has been significantly recognized. The further aggravation of the creditworthiness of the GIIPS countries might increase the default risk of the core nations, because the instability of the financial system in the core nations is expected to worsen their fiscal deficits. In this matter, the default risk of the public and banking sectors are mutually dependent.

The Eurozone nations have completed the unification of their monetary policies, although they have not coordinated their fiscal policies. The unification of fiscal policies might be essential for them without the exchange rate adjustments to solve the external imbalances. The European Financial Stability Facility (EFSF), created in May 2010, is interpreted as a part of this fiscal policy coordination and might contribute to calming down the excess turmoil in the European financial markets. On the other hand, it might intensify the default risk diffusion across the region.

Since the creation of the EFSF, there has been no sign of the sovereign CDS premiums of the Eurozone nations stabilizing, and even those of the core nations have shown a prominent tendency toward an upward trend. It is meaningful to explore whether the financial bailout scheme has contributed to putting an end to the diffusion of default risk throughout the region.

This paper investigates the knock-on effects of default risk across the Eurozone nations by focusing on the interdependence across the public and banking sectors of those countries. Specifically, a structural VAR model is applied to represent the interdependence of the public and banking sectors of each country and to identify an idiosyncratic shock in the sovereign and banking CDS premiums, to examine these impacts.

This paper uses CDS as an indicator of default risk of a reference entity. Under the simplest case, a CDS premium is determined as equating the expected gain and the expected cost of a loss and reflects the probability of bankruptcy. If market participants’
perceptions for future macroeconomic conditions and their risk aversion changes and they require an additional guarantee fee, however, CDS premiums would presumably increase. During periods when financial markets become stressful, we have observed uniform and sharp increases in CDS premiums. This study adopts an indicator of risk appetite as a common factor of CDS premiums to confirm its impact on them.

The remainder of this paper is organized as follows. Section 2 presents an overview of the European sovereign risk crisis and confirms the cross-border financial transactions throughout the Eurozone region. Section 3 explains the mechanism of the co-movement of CDS premiums across the region, by summarizing related previous studies. The data and the econometric methodology used for the analysis are presented in Section 4. The empirical results are reported afterward. Finally, the major findings are summarized and the implications and future research are presented.

II. The European Sovereign Crisis: An Overview

The European sovereign crisis began after the discovery of the Greek window-dressing budget deficit in November 2009. Member countries of the Eurozone are obliged to restrict the ratio of their annual government deficit to below 3% of GDP. On October 21, 2009, however, it was detected that Greece had incurred a ratio of budget deficit of 12.5%, which substantially exceeded the previously released deficit of 3.7%. On April 22, 2010, the figure was revised upward to 13.6%. Although the Greek government declared a program of fiscal reform, such as spending cuts and increased taxes, credit rating companies decided to downgrade the sovereign rate, which spurred the selling of Greek government bonds, leading to a soar in government bond yields.

On May 2, 2011, the IMF and EU declared a financial bailout package. On May 9, the member states of the Eurozone decided to establish the EFSF and to provide the first financial bailout of 110 billion euro on the condition of rigorous austerity measures. At the same time, the ECB conducted an open market operation of purchasing the government bonds of Greece, Spain and Portugal.

Although the market seemed to regain stability, the European government bond yield resurfaced in the latter part of 2010. The government of Ireland, which suffered heavily from the crash of the real estate markets, decided to guarantee all of its financial institutions’ debts, including not only deposits of small depositors but also deposits held by counterparties in the interbank market, bonds, senior debt and dated subordinated debt. Therefore, Ireland’s budget deficit relative to GDP exceeded 30% relative to GDP. As a result, the price of the Ireland government bonds crashed and the bond yield sharply increased to 9.26% on November 11, from 6.61% on October 1. On November 22, Ireland, following Greece, required financial support from the EU and the IMF.

On May 5, 2011, Portugal, which was depressed because of its budget deficit and the economic slowdown, became the third country to receive a financial bailout from the EFSF. In July, the member states began negotiations with Greece and private investors for an
increase in the bailout funds held by the EFSF and a write-off of Greek sovereign debt held by banks, in accordance with the recognition that Greece will need further financial aid. In August, Italy and Spain fell into an emergency situation where they needed the open market operations of the ECB. Under these situations, the government bond yields and the sovereign CDS spreads of the Eurozone countries including the core members such as Germany and France uniformly increased (Figure 1).

Figure 1  Sovereign CDS Premium of Eurozone Countries

Some of the European countries heavily depend on fundraising from foreign countries. In Greece, for example, the percentage of the issued government bonds held by non-resident investors reached 94.2% in 2010 (IMF, 2010). In other countries such as Austria, Belgium, France, Ireland, Italy and Portugal, the percentage of bonds held by non-residents also exceeded 50%. Though the Japanese public debt ratio has been extraordinary high, its percentage is 11.5% and the Japanese government bond prices have remained stable, for the reason of the purchase by domestic financial institutions absorbing enormous amounts of domestic savings.

The intensified knock-on effect of sovereign risk across the Eurozone can partly be explained by the disappearance of foreign exchange risk, due to the introduction of the single currency, which has stimulated the expansion of portfolio investments and lending by financial institutions in the core countries. After the global financial crisis, in particular, financial institutions chose investments in the public sectors of southern European
countries as a safe haven, leading to the further increase of investments.

Figure 2-1 shows the external debt of the banking sectors of GIIPS owed to 24 major credit countries, from the Bank of International Settlement’s (BIS) Consolidate Banking Statistics. Lending to the Italian banking sector slowed down in 2007 and drastically declined after the Lehman Shock. Although the credit to the banking sectors of the other four countries continued to increase until the beginning of 2008, it sharply decreased after the autumn of 2008.

![Figure 2-1 External Debt held by Financial Sector of GIIPS](image)

The external debts of the public sectors of GIIPS reported in Figure 2-2 show a tendency to increase during the period from 2007 to the beginning of the Greek sovereign risk. This phenomenon can be interpreted as “flight-to-quality,” caused by subprime loan shocks. That is, it is presumed that the international financial institutions shifted to investments in the public sector, whose default risk was believed to be relatively low. The lending to the Italian public sector prominently increased from the latter part of 2007, which offset the decrease in lending to the Italian banking sector. Though the lending to the public sectors of GIIPS dropped off after the Lehman Shock, it resurged in 2009.

1 Data collected from BIS is shown in Figure 2-1 and Figure 2-2, reflecting changes in exposure adjusted by hedging.
Major creditors of GIIPS countries are the international financial institutions of the core countries including France, Germany, Belgium and the Netherlands, as well as non-Eurozone countries such as the UK and the US. These financial institutions, which had been heavily damaged by the global financial crisis, may have been expanding their portfolio investments and lending to the public sectors to avoid the increased default risk of the financial sectors. As a result, an increase in the sovereign risk of GIIPS further aggravated the default risk of those international financial institutions in the core countries, which diffused default risk across the whole Eurozone.

The increase in the default risk of financial institutions may worsen the creditworthiness of the public sector, as is suggested by the Irish case. If some of the GIIPS went into bankruptcy, the impact of this would reach not only the financial institutions lending to and investing in GIIPS, but also the public sectors suffering from financial system instability.

III. Mechanisms of Asset Price Co-movement

This paper investigates the transmission effects of default risk across the Eurozone by using CDS premium. In this section, we classify the mechanism bringing about asset price co-movements.

First is the impact of common factors. One of examples included in this category can
be the change in the market averaged risk aversion, affecting the co-movement of asset prices. Frank, et.al. (2008), Eichengreen, et.al. (2009), and Ohno (2010) investigate the impact of common factors on CDS premiums during the period of global financial crisis triggered by the subprime loan shocks. Eichengreen, et.al. (2009) conducted principal component analysis for CDS premium for the period around the Lehman Shock, and implied that the impact of global liquidity squeeze was a common factor. Frank, et. al. (2008) applied DCC-GARCH model to examine the relationship between the conditional coefficient of CDS spreads and global liquidity indicators. Ohno (2010) used the structural VAR model to focus on the impact of global liquidity and uncertainty of global macroeconomic conditions as common factors on CDS premiums of major financial institutions, as a reference. Sgherri and Zoli (2009), Caceres et.al. (2010) and Shino and Takahashi (2010), which investigated the government bond yield spreads of members of the Eurozone during the period including the global financial crisis and the European sovereign crisis, reported that while the impact of common factors were prominent during the global financial crisis, the impact of idiosyncratic factors became dominant after 2009. They concluded that the European sovereign crisis was a phenomenon of a region-wide crisis triggered by the aggravation of creditworthiness due to the budget deficit expansion of some member countries.

Second is the interdependence of asset prices. European countries are closely and mutually related with each other via various cross-border economic activities, such as trade and financial transactions. Regarding the cross-border financial transactions, not only the private sector but also the public sector largely depend on fundraising in the regional financial markets.

Mutual dependence exists not only in inter-country relationships but also relationships between the private sector and the public sector. Many of the European countries decided to provide rescue packages for financial institutions during the global financial crisis, which indicates the pass-through of the default risk of the financial sector to the public sector. Suppose that it is decided to inject public money into the financial sectors to avoid financial instability from leading to economic stagnation in one country. If this worsens the creditworthiness of the public sector of the country, the default risk of creditors located in neighboring countries as well as in the public sector of those countries might be also aggravated. Market participants’ forecasts of those knock-on effects of sovereign risk might lead to a uniform increase in government bond yields and sovereign CDS premiums in the region.

Mody (2009) reported that the financial support to a major investment bank, Bear Sterns, in March 2008 was a turning point, after which default risk of financial sectors have been reflected in the government bond yield. Ohno (2011) applied SUR to investigate the CDS premium of European countries and reported that vulnerability of the financial sector produced a soar in the Irish sovereign CDS premium after the latter part of 2009. Reinhart and Rogoff (2008) demonstrated that the phenomenon of a financial crisis triggering a fiscal crisis has been observed in countries ranging from developed countries
to emerging countries for several hundred years.

The EFSF, established in 2010, is funded by tax-payers burden by EU member countries. If more member countries demand financial support from the EFSF, the rest of the countries are required to provide funds, bringing about the spillover of sovereign risk to neighboring countries which maintain fiscal soundness.

Although the introduction of the single currency has been evaluated as a contributor to integrated bond markets which attract internal and external investors, the unification of the European bond markets might also aggravate fiscal discipline. Bernoth et.al. (2004) and Codogno et al. (2003) reported the positive relation between the amount of debts and bond yield spread, and implied that existence of a yield spread differential might contribute to discipline policymakers in the member countries. However, the rescue plan provided by the EU is interpreted as being that the burden of the fiscal crisis should be transferred to the surrounding countries, which makes the government bond yield of the member countries move uniformly.

Third is the contagion effect. The co-movement of government bond yield and sovereign CDS premiums in the Eurozone can be intensified by non-fundamentals such as investors’ overreactions and psychological factors. There is a literature on contagion including Forbes and Rigobon (2002), Rigobon (2002, 2003) and Dungey et.al. (2004). This paper does not emphasize on the contagion effect and focuses on the first and second mechanisms of asset price co-movements.

IV. Empirical Methodology

This paper employs the structural VAR model to investigate spillover effects of default risk across the public and banking sectors of the Eurozone countries. Particularly, this paper focuses on the impact of common factors and the interdependence among the public and banking sectors of the member states. In this section, we explain the default risk indicators and the common factors of the European CDS premiums, and then, demonstrate the empirical model applied in this paper.

IV-1. Data

There are several candidates for sovereign risk indicators, including government bond yield spreads and sovereign CDS premiums, although we have not reached a consensus on which indicator is superior. Jorion and Zhang (2007) and Zue (2006) point out that CDS premiums are more appropriate because bond yield spreads can reflect other factors that are not related to default risk, such as tax treatments and issuing conditions like the coupon rate and maturity. They also argue that CDS premiums are preferable because they provide a direct measure of credit risk for the underlying reference entity from a very liquid market.

In a case where the issuing entity is a sovereign nation, CDS markets are not
necessarily more liquid than bond markets; thus, it is too sweeping to say that CDS markets are more liquid. Take the U.S. as an example. The outstanding government bond amount was less than $7.6 trillion while the gross notional of sovereign CDS was only $11 billion in 2009 (Bank of Japan (2010)). Shino and Takahashi (2010), on the other hand, demonstrate that the amount outstanding of sovereign CDS of European middle-income countries and emerging countries were relatively large, which can be seen as grounds for the possibility of CDS premiums reflecting the credit risk of those countries. In addition, it is presumed that the government bond yields of GIIPS are determined artificially, caused by the Securities Markets Program (SMP) adopted by ECB. This paper, therefore, chooses sovereign CDS premiums as an indicator of sovereign risk.

CDS premiums can be also used for measuring default risk of banking sectors in this empirical study. Mody (2009) measured the fragility of banking sectors by adopting the financial sector’s stock price index of a country relative to its composite stock price index. This paper uses CDS premiums of financial institutions as a reference entity for a direct indicator of credit risk of banking sector, and calculates an index by averaging the CDS premiums which can be collected among major financial institutions.

As for the common factor of CDS premiums, the CFE-VIX index, the implied volatility of S&P500 index listed on CBOE, is chosen. This paper uses VIX as an indicator of risk appetite in the international financial markets, and investigates whether the common factor represented by VIX had some impact on the uniform increase in CDS premiums.

The CDS premium is determined by reflecting expected loss and risk premiums which guarantors require to bear the burden of credit risk. Gai and Vause (2006) argue that risk premiums must depend not only on the riskiness of assets but also on the risk appetite, which is determined by the degree to which investors accept uncertainty (risk aversion) and the level of uncertainty itself (uncertainty about macroeconomic prospects). Guarantors of CDS may require higher payment for bearing default risk in the situation

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2 When analyzing the European sovereign bonds, results might be sensitive to the choice of benchmark. Since yield spreads can be affected by not only default risk but also market liquidity risk, a bond which is chosen as a benchmark should be what is regarded as the safest bond according to the two types of risk. The government bond of Germany, which is the largest economic power in the Europe, has often been used as a benchmark of the other European government bonds because it has been believed to be the least risky bond in terms of default risk. But it is not necessarily regarded to be the safest bond in terms of market liquidity risk. The amount outstanding of the Italian government bond had been the largest in the European sovereign bond market until the midst of 2000s, not that of Germany, which has been careful against issuing bonds for anti-inflation purposes.

3 Financial institutions whose CDS premium are used are as follows: Belgium (Dexia, KBC Bank); France (BNP Paribas, Credit Agricole, Societe Generale, Credit Lyonnais); Germany (Commerzbank, Deutsche Bank, DZ Bank, Landesbank); Italy (Banca MDP di Siena, Mediobanca, Banco Popolare, UBI Banca, UniCredit, Intesa Sanpaolo); Ireland (Bank of Ireland, Allied Irish Bank, Anglo Irish Bank); Spain (BBVA, Banco Santander, Banco Popolar Espanoir, Banco Sabadell, Banco Pastor); Portugal (Banco Commercial Portugal, Banco Espirito Santo, Banco BPI, Caixa Geral de Depositos); Greece (National Bank of Greece, Alpha Bank, EFG Eurobank Ergasias).
where pessimistic perspective of future macroeconomic environments prevails. Or, if the market-averaged risk tolerance becomes less because guarantors, like hedge funds who are likely to be more risk tolerant with less equity capital, are forced to exit from markets facing a serious liquidity squeeze, higher guarantee fees might be required. That is, the uncertainty of future macroeconomic conditions and the increase in the market-averaged risk aversion result in the worsening of risk appetite, leading to a soar in CDS premiums.

Data of CDS premiums are collected from Markit. Data of VIX is collected from Datastream by Thomson Reuters. The sample period ranges from July 2, 2007 through October 3, 2011.

IV-2 Empirical Model

This paper presumes that sovereign and banking CDS of the European nations depend on VIX as a common factor and that they are mutually dependent. As an example, suppose that CDS premiums of Greece, Germany and Belgium are represented with the following structural VAR model.4

\[
AX_t = B_0 + B_1 X_{t-1} + B_2 X_{t-2} + \cdots + B_k X_{t-k} + u_t
\]

\[
X_t = \begin{bmatrix}
VIX_t \\
GREECE_t \\
GERMANY_t \\
BELGIUM_t \\
BANKGREECE_t \\
BANKGERMANY_t \\
BANKBELGIUM_t \\
\end{bmatrix}, \quad u_t = \begin{bmatrix}
u_{VIX,t} \\
u_{GREECE,t} \\
u_{GERMANY,t} \\
u_{BELGIUM,t} \\
u_{BANKGREECE,t} \\
u_{BANKGERMANY,t} \\
u_{BANKBELGIUM,t} \\
\end{bmatrix}
\]

Therein, \(VIX\) specifies VIX as a common factor. \(GREECE\), \(GERMANY\) and \(BELGIUM\) respectively represent sovereign CDS premiums of Greece, Germany and Belgium. \(BANKGREECE\), \(BANKGERMANY\) and \(BANKBELGIUM\) also represent banking sector’s CDS premium for Greece, Germany and Belgium, respectively. Matrix \(A\) describes the contemporaneous relationship among VIX and CDS premiums of countries to be considered. Vector \(u\) consists of structural shock of VIX and each CDS premium with variance-covariance matrix \(E[u_t u_t']=I\). According to equation (1), idiosyncratic shock of a specific CDS premium is defined as that which is shock in the CDS premium extracted

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4 Though it is preferable to include all of the Eurozone member countries to be considered in the model, the estimation cannot be conducted. Thus, this paper limits the number of variables included in vector \(X\) to 7.
with impact of the common factor and the other CDS premiums defined to be interdependent. Therefore, idiosyncratic shock of each CDS premium can be regarded as default risk of the reference entity, from which the additionally charged guarantee fee due to the aggravation of risk appetite is excluded.

The empirical study of this paper attempts to investigate transmission of default risk across the public and banking sectors of the Eurozone member states, by conducting estimation of impulse response functions after identifying idiosyncratic shock of VIX and each CDS premium. For the purpose, matrix $A$ is specified as following two cases. The first case of matrix $A$ is as follows.

$$
A_1 = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 \\
-a_{21} & 1 & -a_{23} & -a_{24} & 0 & 0 & 0 \\
-a_{31} & -a_{32} & 1 & -a_{34} & 0 & 0 & 0 \\
-a_{41} & -a_{42} & -a_{43} & 1 & 0 & 0 & 0 \\
-a_{51} & -a_{52} & 0 & 0 & 1 & 0 & 0 \\
-a_{61} & -a_{62} & -a_{63} & -a_{64} & 0 & 1 & -a_{67} \\
-a_{71} & -a_{72} & -a_{73} & -a_{74} & 0 & -a_{76} & 1 \\
\end{bmatrix}
$$

(2)

Here, it is presumed that VIX contemporaneously affects all of the CDS premiums, and the impact of any of the premiums does not spill contemporaneously, but reaches with lags to VIX. Since the increase in VIX caused by the aggravation of risk appetite is believed to result in higher guarantee fees required by protection sellers, coefficients $a_{21}$, $a_{31}$, $a_{41}$, $a_{51}$, $a_{61}$ and $a_{71}$ are expected to show a positive sign.

Matrix $A_1$ also describes the mutually interdependent relationships across CDS premiums via lending in the interbank markets, via portfolio investments and lending toward the public sectors by financial institutions, and via closely related economic partnerships. Coefficients including $a_{52}$, $a_{62}$ through $a_{67}$, and $a_{72}$ through $a_{76}$ are presumed to be positive because the worsened creditworthiness of debtors is believe to transfer to the creditors’ default risk. Coefficients including $a_{23}$, $a_{24}$, $a_{32}$, $a_{34}$, $a_{42}$ and $a_{43}$ are presumed to be positive, reflecting closely related economic relationships among the Eurozone member countries. As an example, the economic slowdown in one of the areas may decrease demands toward imported goods from neighboring countries, which might produce reductions in tax revenue across the states. The establishment of a financial bailout scheme

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5 The estimation applying different combinations of zero restrictions showed similar results.

6 According to matrix $A_1$, an idiosyncratic shock of the banking sectors of Germany and Belgium is defined as being a shock in CDS premiums of those reference entities extracted with effects of exposures in investments and lending toward the public sectors and those in the interbank markets. Therefore, the worsening of the creditworthiness of German and Belgium banks is caused by factors such as loss in domestic lending.
also implies the existence of the transmission roots of sovereign risk.\(^7\)

The second specification of matrix \( A \) is represented with following identification restrictions.

\[
A_2 = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 \\
-a_{21} & 1 & 0 & 0 & -a_{25} & 0 & 0 \\
-a_{31} & -a_{32} & 1 & -a_{44} & 0 & -a_{36} & 0 \\
-a_{41} & -a_{42} & -a_{43} & 1 & 0 & 0 & -a_{37} \\
-a_{51} & -a_{52} & 0 & 0 & 1 & 0 & 0 \\
-a_{61} & -a_{62} & -a_{63} & 0 & 0 & 1 & -a_{67} \\
-a_{71} & -a_{72} & 0 & -a_{74} & 0 & -a_{76} & 1
\end{bmatrix}
\]

\( (3) \)

Matrix \( A_2 \) represents the structure of creditworthiness of banks depending on the default risk of debtors, the interdependence across the European sovereign nations, as well as the transmission mechanism from the default risk of the banking sector to the public sector. The occurrence of a financial crisis can bring about a fiscal crisis, through reduction of tax revenue and injection of public funds to insolvent financial institutions, which implies coefficients including \( a_{25}, a_{36} \) and \( a_{47} \) as being positive. Under the specifications of matrix \( A_2 \), an idiosyncratic shock of sovereign risk of a country is defined as a default risk triggered by factors except for domestic financial system instability.

V. Empirical Results

The sample period is divided into four parts. The first period (Period 1) is defined as the period from September 2, 2007, until September 12, 2008, immediately before the Lehman Brothers’ bankruptcy. The second period (Period 2) represents the period of financial crisis triggered by the Lehman Shock, which is specified as being from September 15, 2008, until April 30, 2009. The third period (Period 3) is defined as the period until May 1, 2010, immediately before the agreement of the financial bailout program for Greece supported by EU and IMF. The fourth period (Period 4) ranges from May 2, 2010, through October 3, 2011, and the part of the fourth period from February 1, 2011, until October 3, 2011 is defined as Period 4-2, which represents the period when the sovereign crisis spread through the whole area of the Eurozone.

This paper conducted an Augmented Dickey Fuller (ADF) test for the daily differences in the logarithmic VIX and the daily differences of CDS premiums and confirmed the rejection of unit root for all variables. Therefore, the first order difference of CDS premiums

\(^7\) In order for matrix \( A_1 \) to be just-identified, it is presumed that contemporaneous transmissions from sovereign risk of the core member states to default risk of the Greek banking sector and those between the Greek banking sector and that of the core member states do not exist.
premiums and logarithmic VIX are employed for estimation of the structural VAR model represented by equation (1). Lag order of the VAR is determined according to BIC criterion.

The next section reports the results of impulse response functions estimated for each period. The resulting estimated impulse response is accumulated to show the impact of each structural shock on the level of CDS premium.

\textbf{V-1. Impact of common factors}

In this sub-section, the impact of common factors on the CDS premiums of the public and banking sectors of the Eurozone countries is reported. This paper adopts VIX as an indicator of risk appetite and confirms whether the co-movements of CDS premiums can be explained by factors such as the pessimistic forecast of market participants for future macroeconomic perspective and the increase in market-averaged risk aversion. Since VIX can be related to the availability of fund raising, VIX might soar in a situation where the part of market participants with less risk aversion and with less equity capital are forced to exit from an international market experiencing a liquidity squeeze.\(^8\)

Figure 3 presents the impulse response functions of sovereign CDS premiums of each country to a shock in VIX. We confirm no reaction to a change in VIX during Period 1. During this period, the sovereign CDS premiums remained stable at a low level, even though the perspective on the world economic activities had become aggravated and liquidity had become tighter since the Paribas Shock in August 2007. These results infer that the change in risk appetite did not affect the sovereign CDS of the Eurozone countries whose default risk was believed to be near to zero.

During Period 2, the reaction to VIX is revealed to increase for all states. During a period of severe financial market dysfunction and abrupt economic slowdown across the world, guarantors might require higher risk premiums for taking credit risk of states with preferable credit rating. We can also see that the differences in reaction to VIX across countries are relatively small. Ireland, which decided to inject an enormous amount of public funds into its banking sector in September 2008, presents the highest reaction, with its accumulated impulse response of 0.00073 at the date after three weeks, while Germany reveals the lowest reaction of 0.0002.

\(^8\) Brunermeier (2009) examined how the international market became dysfunctional in the autumn of 2008 by emphasizing the relationship between funding liquidity and market liquidity. Ohno (2010) inferred that funding liquidity risk had a prominent impact on the CDS premium of major international financial institutions as a reference entity. It should be noted that there can be two channels for funding liquidity to influence CDS premiums: via a channel where tightened liquidity aggravates the market-averaged risk aversion, and via a channel where financial institutions are on the verge of bankruptcy because of a liquidity squeeze.
Figure 3  Impact of Common Factor on Sovereign CDS Premium of Eurozone Countries

Impulse Responses of Sovereign CDS premiums to shocks in VIX

Note: Impulse responses of sovereign CDS premium of Greece, Spain and Portugal are those which are estimated from the VAR model applying sovereign CDS and banks’ CDS of those countries. Impulse responses of sovereign CDS premium of France and Italy and those of Germany and Belgium are estimates calculated from the VAR model with CDS premiums of Greece, France and Italy and those with CDS premiums of Greece, Germany and Belgium, respectively. Similarly, impulse responses of Ireland are those obtained from the combination of CDS of Greece, Ireland and Portugal.
The responses to VIX declined for all countries in Period 3. The estimated impulse responses for some of countries including France and Spain become insignificant, though the impulse responses showed statistical significance for all countries in Period 2. This result is consistent with Sgherri and Zoli (2009), Caceres et.al. (2010) and Shino and Takahashi (2010). The aggravation of risk appetite was likely to ignite the hike in CDS premiums in Period 2, and a local or a regional factor such as budget deficit, not a global factor might be the driving force of CDS premiums.

In Period 4, the impulse responses to shock in VIX resurge and all of them reveal statistical significance, but the degree of responses diverge across countries. Greece shows the highest response to VIX which is 0.0036, while the impulse response of Germany, which reveals the lowest response, is 0.000072. In a case when the sample period is limited from February 1, 2011 (Period 4-2), the gap of the responses across countries is widened. Other countries which show higher responses corresponding with that of Greece include Ireland and Portugal, receiving the financial bailout from EU and IMF.

According to the empirical results mentioned above, it is supposed that the European fiscal crisis triggered by the discovery of the Greek window-dressing fiscal deficit stirred uncertainty in the world economic activities and made guarantors of CDS pessimistic, resulting in higher guarantee charges.

Figure 4 reports the estimated impulse response functions of CDS premiums of the banking sectors to a shock in VIX. The CDS premiums of the banking sectors began increasing the responses to VIX in Period 1. Among them, the response of the Irish banking sector, which already faced the problem of non-performing loans caused by the collapse of real estate markets, was exceptionally high. The response of the Irish sovereign CDS, on the other hand, was small in this period, when the public fund infection has not been determined.

The impulse responses of all countries became higher in Period 2. The banking sectors of Greece and Ireland show prominently high responses and that of Italy follows them. In Period 3, the responses decline for all countries, similar to those of the sovereign CDS.

The responses to VIX prominently increase for all countries in Period 4. Although the Period 2 long-term response (the accumulated impulse response at two weeks after the date generating the shock) exceeds that of Period 4 for the CDS premiums of the banking sectors of Ireland and Italy, the magnitude of response at one week later in Period 4 is exceptionally large, implying that the CDS premiums of the financial institutions of those countries were immediately raised due to the aggravation of risk appetite. The CDS premium of the Greek banking sector shows the largest response to VIX, and the banking sectors of the other states including Spain, Portugal, Belgium and France present large responses, whose magnitude significantly exceeds those for the Lehman Shock in Period 2.

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9 Due to lack of space, the confidence bands are omitted.
Figure 4  Impact of Common Factor on Bank CDS Premium of Eurozone Countries

Note: Impulse responses of BANKGREECE, BANKSPAIN and BANKPORTUGAL are those estimated from the VAR model applying sovereign CDS and banks' CDS of Greece, Spain and Portugal. Impulse responses of BANKFRANCE and BANKITALY and those of BANKGERMANY and BANKBELGIUM are estimates calculated from the VAR model with CDS premiums of Greece, France and Italy and those from Greece, Germany and Belgium. Similarly, impulse responses of BANKIRELAND are those obtained from the combination of CDS premium of Greece, Ireland and Portugal.
We can see that the CDS premiums of not only the banking sectors of nations facing the fiscal debt crisis and receiving financial bailouts, but also their creditors in the surrounding nations experienced sharp increase, influenced by the hike in VIX. These results may infer that guarantors required higher guarantee payments as a result of the worsened risk appetite. Another interpretation is that these hikes might reflect the aggravated creditworthiness of financial institutions falling into liquidity squeeze problems in the European interbank market.\(^\text{10}\)

\textit{V-2. The Knock-on Effects of Default Risk to Peripheral Countries from Countries receiving Bailout Funds}

In this sub-section, the knock-on effects to surrounding nations from nations falling into fiscal crisis and receiving financial bailouts are examined. On May 2, 2010, the financial bailout scheme supported by the EU and IMF was established to provide financial backing to Greece. Subsequently, financial support to Ireland was decided on November 22, 2010, and support to Portugal was determined on May 5, 2011. Furthermore, a second bailout scheme for Greece was decided upon on July 21, 2011. We attempt to find out the difference in the transmission effects of CDS premiums between Period 4, during which the financial bailout plans were determined one after another, and the other sub periods.

The Eurozone nations are closely related with each other via international trade and financial transactions. For example, economic stagnation in one of the Eurozone nations, which might reduce its imports from the other nations, might bring about a slowdown of their economies. Since the economic slowdown is highly likely to reduce tax revenues, the expansion of the fiscal deficit of the nation may lead to the worsened fiscal conditions of the surrounding nations. After Period 4, in addition, the EU established a financial bailout scheme for the member countries, in which transmission channels for sovereign risk are inherent because the resources for the financial support of nations in fiscal crisis comes from taxpayers’ payments in the supporting nations. Therefore, it can be presumed that the magnitude of the transmission effects of default risk is amplified in Period 4, caused by the establishment of the bailout scheme, coupled with economic interdependence among the nations.

Figure 5 presents the impulse response functions of the sovereign CDS premiums of Ireland and Portugal to a shock in the Greek sovereign CDS premium and those of the sovereign CDS premiums of Portugal to a shock in the Irish sovereign CDS premium. Figure 6 reports the impulse response functions of the sovereign CDS premiums of the other countries except for Ireland and Portugal to a shock in the Greek sovereign CDS premium.

\(^{10}\) It is also confirmed in the analysis of variance decomposition that the contribution of VIX increases in Period 2, declines in Period 3 and resurges in Period 4 for all of the sovereign and banking CDS premiums, although the results are not reported due to lack of space.
Figure 5  Knock-on Effect of Sovereign Risk across Countries Receiving Bailout Funds

<table>
<thead>
<tr>
<th>Country</th>
<th>Period 1</th>
<th>Period 2</th>
<th>Period 3+</th>
<th>Period 4</th>
<th>Period 4-2</th>
</tr>
</thead>
</table>

Note: Impulse responses of PORTUGAL to shocks in GREECE are those which are estimated from the VAR model applying sovereign and bank CDS of Greece, Spain and Portugal. Similarly, impulse responses of IRELAND to shocks in GREECE and those of PORTUGAL to shocks in IRELAND are estimates calculated from the VAR model applying the combination of CDS premiums of Greece, Ireland and Portugal.

In Period 4, during which the Greek sovereign CDS experienced an extraordinarily sharp increase, the Irish sovereign CDS premium reveals the largest reaction to the Greek sovereign CDS premium. The response of the Portuguese sovereign CDS to the Irish sovereign CDS is exceptionally high. The Portuguese sovereign CDS premium also shows a relatively large response to a shock in the Greek CDS premium, though its highest reaction is found in Period 3 which includes the sub-period of the prevalence of fear of fiscal crisis, fostered as a result of the detection of the window-dressing Greek fiscal deficit. In Period 4, which starts the day after the establishment of the financial bailout scheme, on the contrary, the responses of the other nations’ sovereign CDS to the Greek sovereign CDS drop drastically, and some of them show negative reactions. They reveal higher responses in Period 3 or Period 2, when sovereign nations were believed to be a qualified debtor.
Figure 6  Knock-on Effect of Sovereign Risk from Greece to Peripheral Countries

Impulse Responses of Sovereign CDS of Neighboring Countries to Shocks in Greek Sovereign CDS

Note: Impulse responses of SPAIN are those estimated from the VAR model applying sovereign and bank CDS premiums of Greece, Spain and Portugal. Similarly, impulse responses of FRANCE and ITALY and those of GERMANY and BELGIUM are estimates calculated from the VAR model applying the combination of CDS premiums of Greece, France and Italy and those from Greece, Germany and Belgium, respectively.

Figure 7 presents the impulse response functions of the banking sectors of Greece and France to a shock in the Greek sovereign CDS. While both of them are major creditors to the Greek government, the reaction of the Greek banks increases over time and the reaction of the French banks significantly declines in Period 4.

The prominent increases in the transmission effects across Greece, Ireland and Portugal and the transmission effect from the public sector to the banking sector in the Greek domestic region might be interpreted as the knock-on effects of default risk. That is, guarantors might require higher guarantee fee for the sovereign CDS of Ireland and Portugal and the Greek banks after the Greek fiscal crisis might be immediately associated
with the emergency of countries facing huge fiscal deficit similar to Greece, and might be associated with the bankruptcy of financial institutions holding huge amount of credit to the Greek government. However, this supposition does not explain why the other nations except for Ireland and Portugal reveal larger reaction to the Greek sovereign CDS in Period 2, rather than in Period 3 and Period 4 when the Greek fiscal problem emerged, and why some of the nations experienced negative reaction to the shock in the Greek sovereign CDS in Period 4.

Figure 7  Transmission of Default Risk from Greece to Major Creditors

<table>
<thead>
<tr>
<th>Impulse Responses of Banking CDS of Greece and France to Shocks in Greek Sovereign CDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GREECE→BANKGREECE</strong></td>
</tr>
<tr>
<td><strong>GREECE→BANKFRANCE</strong></td>
</tr>
</tbody>
</table>

Note: Impulse responses of BANKGREECE and BANKFRANCE are those estimated from the VAR model applying sovereign and banking CDS of Greece, France and Italy.

One of the causes of the bipolarization shown in those impulse response functions can be the decrease in market liquidity in CDS markets. Market liquidity infers the ease with which an asset is traded, and is related to the scale of its purchase and sale. As presented in Figure 1, the sovereign CDS premiums of the nations receiving financial support experienced an extraordinarily sharp increase. While the Greek sovereign CDS premium remained at 48.78 basis point on July 1, 2008, it increased to 726.44 basis point on May 2, 2010, just after the determination of the first financial fund provision for Greece. It resurged to 2327.115 basis point on July 21, 2011, determining the second financial support for Greece by EU, and reached to 6986.28 basis point on September 30, 2011. The sovereign CDS premiums of Ireland and Portugal also experienced the upward trends after the announcement of the financial support provision. The tremendous increases in those sovereign CDS premiums can be attributed to the decline in market liquidity of those markets, as well as the increased uncertainty about the fiscal conditions of those nations.11

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11 Shirasu and Yonezawa (2008) reported that the expansion of corporate bond yield spreads during the period of the Japanese financial system instability could be attributed to not only the anxiety about insolvency of issuers but also the increased market liquidity risk in the corporate bond markets. Ohno (2010) showed that, during the financial crisis period starting from the emergence of the subprime loans problems, there was no transmissions of CDS premiums from monoline companies which were on the verge of bankruptcy because of huge losses in the financial insurance
Figure 8 shows the gross notional of sovereign CDS of eight Eurozone states. The market scales of Germany, France, Italy, Spain and Belgium have been expanding, while those of Greece, Ireland and Portugal have been diminishing.

The declining trend of the gross notional of those three countries can be explained by the introduction of the ban on naked CDSs of a sovereign nation as a reference entity. Critics of naked CDSs have accused naked CDS buyers of making the crisis worse because they allow speculators to bear raid companies or countries. On May 19, 2010, Germany prohibited investors from buying CDS on sovereign debt unless they owned the underlying bonds. On December 1, 2011, the European Parliament announced the Eurozone-wide ban on naked CDSs on the debt of sovereign nations.

The regulation is aimed at abusive use of sovereign CDS by financial institutions to bet against countries’ debts. But there are various forms of proxy hedging, including a strategy of buying CDS for the debt of countries other than the one where the institution’s exposure lies (so-called ‘cross-border hedging’). A primary condition a sovereign CDS must meet if it is not to be deemed to be naked is “a consistent significant positive correlation between the value of the asset/liability being hedged and the value of the referenced sovereign business to financial institutions receiving guarantees from monoline companies, which may be attributable to the reduced market liquidity of the CDS on monolines’ debts.
debt.” However, there is possibility that proxy hedging strategies, including hedging across the European Union’s internal borders, fail the correlation test, and so would be excluded from the exemptions in the regulation.\(^\text{12}\) If cross-border hedging is excluded from the exemptions, a purchase of Greek sovereign CDS partly to hedge against exposure to French banks holding plenty of Greek debt might be viewed as a use of CDS for the purpose of speculation and might not be permitted. Nakazora (2012) argues that the reduction of market liquidity in CDS markets as a result of the ban on naked CDSs circumscribes financial institutions’ effective credit risk management of cover transactions related to customers, as well as proprietary trading, causing transfer increased costs to CDS premiums.

Under a debt restructuring deal for the Greek debt during the period from mid-2011 through to the spring of 2012, the controversies over the determination of credit events might also become a cause of market liquidity reduction. On October 26, 2011, leaders of seventeen Eurozone countries agreed on a 50% write-off of Greek sovereign debt held by banks, more than the earlier agreed 21% hair-cut. The policymakers insisted upon voluntary participation because traders, if compensated from insurance contracts, would be encouraged to be against indebted nations and worsen the crisis.

“Restructuring” is one of the cases defined as a credit event, and reductions in the rate of interest or amount of principal payable are also listed as restructuring credit events. What matters is that the CDS definitions do not refer to a distinction between voluntary and mandatory events.\(^\text{13}\) An important element of the definition of “restructuring” is that the event has to occur in a form that binds all holders of the restructured debt. As such, it does not appear to be likely that the Eurozone deal with regard to Greece will trigger payments under existing CDS contracts.

On March 9, 2012, finally, the International Swaps and Derivatives Association (ISDA) issued a communiqué calling the debt restructuring deal with its private sector involvement (PSI) a “Restructuring Credit Event,” which will trigger payment of credit default swaps. While this might be evaluated as a reasonable decision, because it might contribute to avoid loss of market faith in the product’s ability to provide a hedge against sovereign risk, the wrangle over the Greek debt undoubtedly had an impact on the trade volume of sovereign CDSs.

If CDSs cannot be effectively used as a hedging instrument in spite of the increased uncertainty about default risk, the scale of the CDS market for reference entities with higher probability of bankruptcy is expected to shrink. As shown in Figure 5 and Figure 7, the impulse responses of sovereign CDS premiums of Ireland and Portugal and that of CDS premiums of the Greek banking sector to the shock in the sovereign CDS of Greece presented a prominent increase in Period 4. These results are likely to be interpreted as the

\(^{12}\) This is cited from the website of Reuters, “Short-selling and CDS regulation in EU: Less to nakedness than meets the eye, funds and firms argue,” released on March 5, 2012.

\(^{13}\) This is based on, “Greek Sovereign Debt Q&A,” released on the ISDA’s webpage.
knock-on effects of the dry-up of market liquidity coupled with the chain reaction associated with default risk under many disputes over whether the Eurozone deal for the indebted nation qualified as a credit event.

It can be said that default risk is closely related with market liquidity. Cossin and Jung (2005) explored the CDS markets around the Russian and the Latin American crises by using an original dataset of transactions and quotes, and disclosed that there was a significant “flight to quality” that was accompanied by a drastic increase in purchase of protection relative to sale, creating an imbalance in the markets. This excess demand does not translate into more transactions but significantly larger bid-ask spreads, which cannot be explainable with only rating quality.

V-3. Transmission of Default Risk across Core Countries

In this last sub-section, the transmission effects of CDS premiums across the core nations of the Eurozone are confirmed. During the period from the discovery of the window-dressing fiscal deficit of Greece until the summer of 2011, the upward trend of the sovereign CDS premiums of Italy and Spain, the third and fourth economic powers in the Eurozone respectively, has been becoming highlighted, although the sovereign CDS premiums of core nations such as Germany and France remained at low level. Since the summer of 2011, however, the sovereign CDS premiums of France and Germany have started increasing.

Figure 9 reports the impulse response functions of the sovereign CDS premiums of France and Germany to a shock in the sovereign CDS premiums of Italy and Spain. We can see that the response of France to Spain and Italy increases in Period 4. Compared with the results of France, the responses of Germany to both Spain and Italy are estimated to be small for any of the sub-periods. Moreover, its response to Spain estimated for Period 4, albeit statistically significant, is smaller than that for Period 2. These results are consistent with the upward tendency of the sovereign CDS of France relative to Germany, as shown in Figure 1. France reveals more vulnerability to the influence of Spain and Italy than Germany, and the gap has been widened between them in Period 4.

Figure 10 portrays the impulse response functions of the CDS premiums of the French and German banking sectors to a shock in the sovereign CDS premiums of Italy and Spain. Similar to the results shown in Figure 9, the French banking sector reveals a larger response to the increase in the sovereign CDS premiums of Italy and Spain than the German banking sector, and the gap has become substantially large in Period 4.

During Period 4, the government deficit problems of not only nations to be rescued from the bankruptcy but also of the other nations including Spain and Italy have been severely highlighted. If Spain and Italy fell into emergency and needed to receive a financial bailout from the EFSF, the remaining member countries would bear the huge amount of budget required to rescue these large nations. The results shown in Figure 9 might be partly attributed to the amplified default risk transmission though the established
financial bailout scheme. Nevertheless, the impact of Spain and Italy on Germany has not become substantial in Period 4.

Figure 9  Transmission of Sovereign Risk across Core Countries in the Eurozone

The gap between the French and German financial institutions is not likely to be explained by the difference in credit risk exposures to the Italian and Spanish public sectors. France is the largest credit country for Italy. The averaged percentage of the gross direct loan exposures to the Italian sovereign nation held by the three major French banks including BNP Paribas, Societe Generale and Credit Agricole is 17.51%.\textsuperscript{14} The averaged percentage of the direct loan exposures to it held by the four major German banks including DeutscheBank, Commerzbank, Landesbank and DZ Bank is 10.70% in gross terms, and 9.92% in net terms. On the other hand, the averaged percentage of the exposures to the Spanish sovereign nation hardly differs between them (5.02% for France and 5.19% for Germany in gross terms).

\textsuperscript{14} The information on exposures is collected from the EU-Wide Stress Test released by European Banking Authority in 2011. The averaged exposure is calculated without using the exposure information of Credit Lyonnais because of a lack of data. The averaged percentage of the net direct positions which is calculated by subtracting cash short position of sovereign debt to other counterparties from the gross exposures is 17.63%.
One of the causes for the difference may be demonstrated by the “flight to quality” to Germany, although further examinations should be conducted. That is, protection sellers might rush into the CDS on the German sovereign debt which is the safest in the European CDS markets, offsetting the upward pressure resulting from the default risk transmissions.

Coefficient $a_{34}$ of matrix $A_1$, which represents the contemporaneous impact from ITALY to FRANCE, is estimated to be 0.3025 and is statistically significant at the significant level of 1% for Period 4. The coefficient representing the contemporaneous impact from ITALY to GERMANY is estimated to be, albeit statistically significant at the significant level of 1%, 0.126. Similarly, the corresponding coefficients representing the impact from SPAIN to FRANCE and that from SPAIN to GERMANY, both of which are also statistically significant at the significant level of 1%, are estimated to be 0.2626 and 0.1282, respectively.

Damage to the soundness of the financial system is liable to aggravate the creditworthiness of public sectors via a reduction of tax revenue due to economic slowdowns and via the injection of public funds. An idiosyncratic shock of a sovereign CDS premium estimated by using the identification restrictions specified with matrix $A_1$ is considered to reflect a change in default risk of the public sector caused by the instability
of the financial system as well as a change in its default risk caused by other factors. To exclude the impact of default risk of the domestic financial sector from the idiosyncratic shock of a sovereign CDS premium, the structural shocks are identified by imposing restrictions represented with matrix $A_2$ and impulse response functions are estimated.

Figure 11 portrays the impulse response functions of the French and German sovereign CDS premiums of a shock in the Italian sovereign CDS premium estimated based on the specification of matrix $A_1$ and those based on the specification of matrix $A_2$. As seen in Figure 9, Figure 11 reveals that the French CDS premium presents a larger reaction to the soar in the Italian CDS premium than that of Germany. We can also confirm that the responses of the CDS premiums of both countries estimated by adopting matrix $A_2$ are smaller than those by employing matrix $A_1$, and the difference between them becomes prominent in Period 4. These results are interpreted as the increase in the Italian sovereign CDS premium amplified by the instability of its financial system, spilling over into the French and German sovereign CDS premiums.

**Figure 11  Impact of Financial Instability on Sovereign CDS**

<table>
<thead>
<tr>
<th>Impulse Responses of Sovereign CDS of France and Germany to Shocks in Italian Sovereign CDS</th>
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<tbody>
<tr>
<td><strong>ITALY→FRANCE</strong></td>
</tr>
<tr>
<td><strong>ITALY→GERMANY</strong></td>
</tr>
</tbody>
</table>

Note 1: Case1 and Case2 are those where matrix $A_1$ and $A_2$ is applied to equation (1), respectively.  
Note 2: Impulse responses of sovereign CDS of country A to shocks in sovereign CDS of country B are those estimated from the VAR model applying sovereign and banking CDS of Greece as well as country A and country B.
VI. Conclusion

The effects of the Greek crisis, triggered by the window-dressing fiscal deficit, were not limited to within the nations facing fiscal crisis, and have been proliferating over the whole Eurozone. This paper explores the knock-on effects of default risk across the public and banking sectors of these Eurozone member states by using CDS premiums as an indicator of default risk and VIX as an indicator of risk appetite in the international market. This paper particularly stresses the interdependence between these two sectors and mutual dependence across the member nations. The following describes the conclusions of the empirical analysis of this study.

We can see that, in Period 1, as a period with greater strains in the international financial market due to the subprime loan problems initiated by so-called Paribas Shock, the aggravated risk appetite promoted an increase in the CDS of the European banking sectors, but it hardly affected the CDS premium on debts of the public sectors whose default risk were believed to be zero. During Period 2, starting the date of Lehman Brothers bankruptcy, the CDS premiums of both public and banking sectors across the European countries soared, a part of which can be explainable by the adverse shock in risk appetite. While its impact is particularly significant in the CDS premium of Ireland severely hit by the serious decline in real estate prices, the differences in the magnitude of the impact of VIX among countries were relatively small. In Period 3, when the global financial market had been recovering from the severe dysfunction when uncertainty about the Greek government fiscal conditions emerged, the impact of VIX dropped, and the European sovereign crisis looked like a regional turmoil caused by factors such as the budget deficits of the member states, not a phenomenon driven by global factors. In Period 4, however, VIX again becomes an influential factor for the European CDS premiums. It should be noted that the gap in the responses to VIX widened across countries in the last sub-period, and the CDS premium of a nation facing a serious fiscal situation is likely to show a larger reaction to VIX.

Risk appetite depends on investors’ perception of future global economic conditions, as well as the averaged investors’ risk aversion, which might be linked to availability of funding liquidity in the global financial markets. In addition, bankruptcy scenarios include two types: insolvency because of excessive debt and bankruptcy caused by fundraising difficulties. Therefore, there might be two channels for funding liquidity to affect CDS premiums: via a channel where liquidity tightening makes the averaged protection seller more risk averse, resulting in higher guarantee charge for risk burden, and via a channel where market participants change their assessments of the probability of bankruptcy of a reference entity facing fundraising difficulties, raising higher risk premiums. The examination by employing a direct indicator representing funding liquidity risk in the European interbank market might demonstrate the impact of liquidity squeeze on the CDS premiums of the Eurozone member states.

The Greek sovereign CDS premium presented an extraordinarily sharp hike and the
soar of the Irish and Portuguese premiums was also extremely high. Although the emergency measures established by EU in May 2010 can be interpreted as mechanisms proliferating the effect of default risk of one member state throughout the whole area of the Eurozone, we can observe the bipolar tendency of the transmission effects, and countries except for those receiving the bailout showed little or negative reactions to the hike in the Greek sovereign CDS premium. One of the possible causes may be the reduction of market liquidity of CDS on debts of nations with high probability of bankruptcy, accompanied by the ban on naked CDS and the controversy regarding the determination of credit event. If CDS cannot be used as an effective instrument of credit risk hedging, the market liquidity of CDS on debt of a reference entity with higher probability of bankruptcy might be reduced. In fact, the CDS transactions of the nations facing fiscal problems were reduced, contrary to the increase in the trading volume of CDS of the core nations of the Eurozone. The transmission effects among the nations falling into fiscal crisis might have been amplified due to the knock-on effect of default risk, coupled with the linkages of market liquidity reduction, which should be examined rigorously in the future. If this bipolarization might also be as a result of the establishment of rescue packages determined by EU, a series of measures should be evaluated to contribute as a firewall for the spillover of crisis through the whole area of Eurozone. It should be confirmed whether the transmission from the crisis countries to the surrounding countries was amplified by identifying the effect of market liquidity spillovers.

The transmissions effects across the CDS premiums of the core nations in the Eurozone prominently increased in Period 4. Nevertheless, the transmissions to Germany were relatively small. Although the major German banks also had large exposure to the Italian and Spanish sovereign debts, their CDS premiums revealed smaller responses to the shock in the CDS premiums of the neighboring nations compared with those of the major French banks. These results can be interpreted as a result of “flight to quality.” That is, protection sellers were unwilling to bear default risk of nations with large fiscal deficits and were inclined to shift to the German sovereign market as a safe haven, producing downward pressures on the guarantee charge for the German sovereign risk. Lastly, this paper suggests that the transmission effects among the sovereign CDS premiums of the core nations in the Eurozone were intensified by the growing recognition of the worsened sovereign risk associated with the financial system instability.

The following presents remaining issues for this study. The impact of default risk on CDS premiums should be distinguished from those of market liquidity and funding liquidity. As Gonzalez-Hermosillo (2008) pointed out, credit risk, market liquidity risk and funding liquidity risk are mutually and closely related. When a liquidity squeeze happens and risk-tolerant guarantors with less equity capital are forced to exit from markets, the remaining guarantors are more risk averse players. In a case in which sellers of protection evaporate due to the extreme liquidity tightening, an imbalance in markets presumably promotes a sharp hike in CDS spreads. Consequently, an increase in funding liquidity risk might lead to an increase in market liquidity risk. In addition, a change in guarantors’
recognition of default risk of a reference entity might create a drastic decline in sales of protection, shrinking market liquidity of the credit derivative market. In the case of the European sovereign risk crisis, the controversies over the credit events related to the Greek sovereign debts might spur a reduction in the market liquidity of CDSs in nations falling into fiscal crisis. If an indicator of market liquidity such as bid-ask spreads is available, the effect of market liquidity on CDS premiums can be explored.

This paper investigates the knock-on effects among eight member nations of the Eurozone, but the expansion of countries to be considered could produce informative results. The GIIPS countries have depended on non-Eurozone nations such as the U.K., the U.S. and Switzerland for their fundraising. In addition, the GIIPS countries have lent a considerable amount to countries in Central and Eastern Europe and in Central and South America. Accordingly, the sovereign risk of the GIIPS countries has presumably spilled over into non-Eurozone areas. Sovereign risk can be transmitted within the Eurozone via investments and lending, as well as via linkages through monetary and fiscal policies (including financial support schemes in crisis periods), but there are no linkages through the monetary and fiscal policies between Eurozone and non-Eurozone areas. The comparison of the transmission effects within the Eurozone area and those between two zones may contribute to the accumulation of new knowledge.

This paper uses CDS premium data on the European major banks as an indicator of banking sector vulnerability. In some countries in particular, like Spain, medium-scale and small-scale banks might suffer from a serious non-performing loan problem rather than major banks. Further examination of linkages between the public and banking sectors through investments and lending is necessary to determine the knock-on effects across these sectors in the region.
The reduced form of equation (1) is represented as follows.

$$X_t = C_0 + C_1 X_{t-1} + C_2 X_{t-2} + \cdots + C_k X_{t-k} + \epsilon_t$$  \hfill (A-1)

$$C_k = A^{-1} B_k \quad \quad \epsilon_t = A^{-1} u_t \quad \quad E[\epsilon_t \epsilon_t'] = \Sigma$$

When each element of vector $X$ satisfies stationarity, the VAR model should be invertible and equation (A-1) should be rewritten as a following reduced-form VMA.

$$X_t = \epsilon_t + D_1 \epsilon_{t-1} + D_2 \epsilon_{t-2} + \cdots + D_k \epsilon_{t-k} + \cdots$$

$$= D(L) \epsilon_t$$  \hfill (A-2)

$$D(L) = I + D_1 L + D_2 L^2 + \cdots + D_k L^k + \cdots$$

Equation (A-2) should be further rewritten as a following structural VMA.

$$X_t = D(L) \epsilon_t$$

$$= D(L) A^{-1} A \epsilon_t$$  \hfill (A-3)

$$= F(L) u_t$$

Because $\epsilon_t$ is represented as $\epsilon_t = A_0^{-1} u_t$, the variance covariance matrix of $\epsilon_t$ is implied as follows.

$$\Sigma = E[\epsilon_t \epsilon_t'] = E\left[ A^{-1} u_t u_t' \left( A^{-1} \right)' \right] = A^{-1} \left( A^{-1} \right)'$$  \hfill (A-4)

To identify the structural model from an estimated VAR, it is necessary to impose 21 restrictions on the structural model. This paper imposes 21 zero restrictions specified with matrix $A_1$ or matrix $A_2$. 
References


