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# Default Risk Transfer between the Eurozone Sovereign and Financial Sectors under the Effect of EFSF

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*We construct a dynamic model that examines the interdependencies between the default risk of several Eurozone members and their financial institutions during the European sovereign debt crisis. The rescue package issued by the EFSF on 9 May 2010 has significant impacts on the default risk of the Eurozone sovereign and financial sectors. The main findings of this research indicate that, in the period before the first bailout issued by the EFSF, the systemic financial crisis has a "two-way feedback" effect on both the sovereign and financial sectors; after the bailout, a shock from the sovereign default risk has stronger impacts on the financial sectors, however, the impacts of a shock from the financial sector on the sovereign default risk become negative or less significant. This suggests that the EFSF bailout relieves the financial crisis for the moment, but further increases the government debt burdens in the future.*

## 1. Introduction

The European sovereign debt crisis developed from early 2010 in some European states. The Eurozone countries have fewer monetary controls than other countries that have free exchange rate, thus the sovereign debt crisis has more severe impacts on the Eurozone for both non-financial and financial sectors. On 9 May 2010, the European Financial Stability Facility (EFSF) issued the first bailout package worth €750 billion to ensure the financial stability of the Eurozone countries, and more measures were taken thereafter by the governments to prevent the collapse of the financial system across Europe. However, the complicated relationship between the sovereign and financial sectors and the risk transmission after the bailouts are rarely known, which increases the uncertainty of the intervention outcome by the governments.

Recent studies have found that there exists a two-way feedback effect between the public and private sectors, and the default risk might transfer between the government and financial sectors after certain financial events during the financial crisis (Acharya, Drechsler and Schnabl (2011); Alter and Schüler (2012); Dieckmann and Plank (2012 )). These studies have analysed the risk changes in the sovereign and financial default risk during previous financial crisis from 2007-2010, and the Lehman Brothers' event has been used as a break point to compare the risk transfer in the sub-periods. However, few have analysed different characters of the European sovereign debt crisis since 2010 and the impacts of the largest bailout package issued by the EFSF.

This research focuses on the interdependence of default risk of sovereign and financial sectors among the Eurozone countries, and investigates the risk transmission due to the EFSF bailout issued in May 2010. We use daily CDS spreads as a proxy of default risk, and analyse the default risk transfer among ten

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Eurozone countries (Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain) and their domestic financial sectors from Nov 2007 to Feb 2012. Methodologically, we follow the research by Alter and Schüler ((2012 )) to examine the dynamic short- and long-run interdependencies of the sovereign and financial institution CDS series, using bivariate vector autoregressive (VAR) and bivariate vector error correction (VEC) models. We also include impulse response functions (IRFs) to capture the dynamic relationship between the two sectors.

The main findings suggest that, in the period prior to the EFSF bailout, positive interdependencies exist between the sovereign and financial institutions' default risk; after the bailout program, changes in the sovereign default risk have stronger impacts on their domestic financial institutions, but not vice versa. The results indicate that the risk transfer occurs based on the current financial situations of the governments and their domestic financial sectors, and the relieved default risk of the financial institutions after the bailout might increase the debt burdens of the government and further weaken the private sector in the long term.

The remaining part of this paper is organized as follows. Section 2 reviews the related literature and identifies the gaps in the literature. Section 3 is the research methodology including hypotheses, data description and empirical models. Section 4 analyses the results, and Section 5 concludes.

## 2. Literature Review

This study contributes to several aspects of literature. Sovereign debt crisis may reduce foreign credit to the domestic private sectors via a decline in supply and cause a decrease in aggregate demand of credit as investors' perceptions to the country default risk increase (Dooley and Verma (2001); Drudi and Giordano (2000); Tomz and Wright (2008 )). Kim and Wu ((2008 )) analyse the impacts of sovereign credit ratings on financial market developments, and the results indicate that the rating events stimulate the developments of domestic stock and banking sectors. On the other hand, the performance of financial sector may reflect the outlook of economic growth and influence the public finances. An increase in the default risk of a financial institution augments the probability that it cannot fulfil its payments to other financial counterparties, thus a systemic financial crisis might arises. Acharya et al. ((2011 )) use data of CDS spreads of the Eurozone countries for 2007-2010 and provide evidence that there exists "two-way feedback" interdependencies between the sovereign and financial default risks.

Recent studies have been focused on the financial crisis before 2010, but few have analysed different characters of the European sovereign debt crisis and the impacts of the largest bailout package issued by the EFSF. The European Financial Stability Facility (EFSF) is a company supported by 17 Eurozone countries, and the first EFSF rescue package has been issued on 9 May 2010 for up to €750 billion in accordance with the share of the guarantee countries in the paid-up capital of the European Central Bank. The difference between the on-going European sovereign debt crisis and other former financial crises is that, the capital injection into a country in crisis is from the EFSF which is supported by the 17 guarantees, rather than from the bailouts issued by the domestic governments. This indicates that bailouts from the EFSF directly increase the domestic government debt burdens. Dieckmann

((2012 )) uses event study to analyse the market reaction to the EFSF bailouts, and the results show that the sovereign CDS spreads increase significantly in the Eurozone countries suffering the crisis. In this research, we further study the default risk transfer between the governments and domestic financial sectors under the introduction of the EFSF bailouts.

Furthermore, we use CDS spreads as an indicator of credit default risk of an institution. Studies have shown that CDS spreads can measure investors' risk preference. According to Hull, Predescu et al. ((2004 )), both changes and levels of CDS spread contain significant information in estimating the probability of rating events. Ismailescu and Kazemi ((2010 )) analyse the relationship between sovereign CDS spreads and sovereign credit ratings further, and they indicate that investors can make decisions according to the same public information that would lead to the changes in CDS spreads prior to a rating announcement. On the other hand, Düllmann and Sosinska ((2007 )) analyse the CDS spreads of banks, and their empirical analysis exhibits significant results that banks' CDS spreads indicate banking credit risk from three risk sources including idiosyncratic risk, systematic risk and liquidity risk.

## 3. Methodology

### 3.1 Hypotheses

Based on the literature reviewed, in this section, we propose the hypotheses to be estimated. First, we explain the contagion channels linking the two sectors.

When a country is facing distress, e.g. heavy debt burdens, the sovereign default risk of this country is raising because of the devaluation of the sovereign debt. In the short run, (i) for the domestic financial institutions, the cost of holding the sovereign debt is higher, which changes the balance sheet of the financial institutions; (ii) for other governments which support the distressed country, e.g. provide bailout packages, the sovereign and financial sectors of the supporting governments are also facing higher default risk for holding the devaluated sovereign debt or issuing funding to the distressed country. In the long run, sovereign debt crises are followed with a decline in foreign capital inflows as investors' perceptions to the sovereign default risk increase, and the domestic credit market becomes competitive, which deteriorate the production in the private sector and future economic growth. Deteriorating the solvency of the private sector can raise the probability of funding or liquidity issues for the domestic financial sector and increase the default risk of the financial institutions.

When a financial institution is facing distress, the default risk of the financial institution is higher. This increases the probability that it cannot pay the obligations to other financial counterparties, thus the financial counterparties could face funding difficulties, and their default risk is higher. Thereafter, a systemic financial crisis might arise and hamper the whole economy, which also deteriorate public finances, thus the sovereign default risk is higher.

Before the bailout packages are issued, as the "two-way feedback" effect (Acharya, Drechsler and Schnabl (2011 )), we argue that there exists positive interdependencies between the sovereign default risk and financial institutions'

default risk.

***Hypothesis 1:*** *Prior to the bailout programs, changes in the sovereign default risk affect the credit default risk of the domestic financial institutions, and vice versa.*

After the government interventions, as government guarantees for the financial sector increases, changes in the sovereign default risk have direct impacts on the perceived default risk of the financial sector. The financial institutions might receive rescue capital from their governments, thus the financial sector are more sensitive to the credit health of their governments, and the sensitivity of the financial institutions' default risk to the sovereign default risk is expected to increase.

***Hypothesis 2(a):*** *After the bailout programs, changes in the sovereign default risk affect the credit default risk of the domestic financial institutions stronger than before.*

***Hypothesis 2(b):*** *After the bailout programs, an increase/decrease in the sovereign default risk affects the credit default risk of the domestic financial institutions in the same directions.*

After the government interventions, the default risk transfers from the financial sector to the government sector, as the government has heavier debt burdens. Although in the long run, a decline in the default risk of the financial sector might transfer into healthier economy and public finances, in the short run, the relieved default risk of the financial institutions indicates larger probability of government support in the future. Thus, changes in the default risk of the financial sector have negative impacts on the short-run sovereign default risk, which also weaken the sensitivity of sovereign default risk to the financial sector default risk.

***Hypothesis 3(a):*** *After the bailout programs, changes in the credit default risk of the domestic financial institutions affect the sovereign default risk weaker than before.*

***Hypothesis 3(b):*** *After the bailout programs, an increase/decrease in the credit default risk of the domestic financial institutions affects the sovereign default risk in the opposite directions.*

The last hypothesis tests the outcome of bailouts in different countries. For the countries being rescued, such as Greece, Ireland, Italy, Portugal and Spain, their feedback effects after the bailouts might be more significant than the results from the countries providing bailouts, because the private-to-public risk transfer, i.e. direct capital injection to the financial sector and larger debt burdens of the governments, are more likely to happen in the former countries. Thus, we argue that the outcome of the bailouts is heterogeneous among the European countries.

***Hypothesis 4:*** *After the bailout programs, the heterogeneity of the rescue packages across the Eurozone countries translates into the asymmetric interdependent relationship between the sovereign default risk and the credit default risk of the domestic financial institutions.*

### 3.2 Data Description

The selection of financial institution and sovereign CDS series was restricted by data availability. 10 Eurozone guarantees of the EFSF are included in our data set, i.e. Austria (AT), Belgium (BE), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT), and Spain (ES) (see Table 1a), together with their domestic financial institutions (40 financial institutions in total, see Table 1b). The CDS series of the financial institutions are chosen according to the SIC (Standard Industrial Classification) code of the institutions (major groups 60-67, including Finance, Insurance, and Real Estates), respectively. Most of the financial sector constituents of the iTraxx Europe index (13 out of 25) are covered by our data set, which indicates that the financial institutions chosen are representative of the financial sectors of these Eurozone countries.

We choose senior five-year CDS, since it is the largest and the most liquid constitute of the CDS markets. Our data set starts from 13 November 2007 to 17 February 2012, including 1114 observations of daily data for each CDS series. Prior to the empirical analysis, we take the logarithms of the CDS spread levels. We investigate the interdependence of the sovereign and the financial institution CDS series in two sub-periods. The first stage starts from 13 November 2007 to 7 May 2010 and contains 649 observations for each CDS series. On 9 May 2010, the EFSF set out the first bailout worth €750 billion aimed at rescuing financial stability across the European countries. The second stage starts from 10 May 2010 after the first rescue package set out, and it ends on 17 February 2012 before the second bailout by the EFSF.

**Table 1a: List of CDS Series of Financial Institutions**

| No | Market | Code | Name |
|---|---|---|---|
| 1 | Austria | at | REPUBLIC OF AUSTRIA |
| 2 | Belgium | be | KINGDOM OF BELGIUM |
| 3 | France | fr | FRENCH REPUBLIC |
| 4 | Germany | de | FEDERAL REP GERMANY |
| 5 | Greece | gr | HELLENIC REPUBLIC |
| 6 | Ireland | ie | IRELAND |
| 7 | Italy | it | REPUBLIC OF ITALY |
| 8 | Netherlands | nl | KINGDOM OF NETHERLANDS |
| 9 | Portugal | pt | REPUBLIC OF PORTUGAL |
| 10 | Spain | es | KINGDOM OF SPAIN |

**Table 1b: List of CDS Series of Financial Institutions**

| No | Market | Code | Name |
|---|---|---|---|
| 1 | Austria | rzb | RAIF. ZNTRLBK. OSTER AG |
| 2 | Austria | ers | ERSTE GROUP BANK AG |
| 3 | Belgium | kbc | KBC GROUP NV |
| **4** | **France** | **bnp** | **BNP PARIBAS** |
| **5** | **France** | **car** | **CREDIT AGRICOLE SA** |
| **6** | **France** | **sge** | **SOCIETE GENERALE SA** |
| 7 | France | cnt | NATIXIS |
| 8 | France | axa | AXA |
| 9 | France | sco | SCOR SA |
| 10 | France | gfc | GECINA SA |
| 11 | France | wed | WENDEL INVESTI |
| **12** | **Germany** | **ikb** | **ALLIANZ SE** |
| **13** | **Germany** | **dbk** | **COMMERZBANK AG** |
| **14** | **Germany** | **cbg** | **DEUTSCHE BANK AG** |
| **15** | **Germany** | **muv** | **HANNOVER RUCK.AG** |
| 16 | Germany | alv | IKB DT.INDUSTR.BANK AG |
| 17 | Germany | hnr | MUNICH REINSURANCE CO |
| 18 | Greece | aca | ALPHA BANK A.E. |
| 19 | Ireland | aib | ALLIED IRISH BANKS |
| 20 | Ireland | bki | BANK OF IRELAND |
| 21 | Ireland | ipm | IRISH LIFE & PERM |
| **22** | **Italy** | **bci** | **INTESA SANPAOLO SPA** |
| 23 | Italy | mdb | MEDIOBANCA SPA |
| **24** | **Italy** | **bmp** | **BANCA MDP DI SIENA SPA** |
| 25 | Italy | pii | BCA PPO MILANO SOCO ARL |
| **26** | **Italy** | **uni** | **UNICREDITO ITALIANO SPA** |
| 27 | Italy | ubi | UNIONE DI BANCHE |
| 28 | Italy | gas | ASSIC GENI - SO PER AZN |
| 29 | Netherlands | abn | ABN AMRO BANK NV |
| **30** | **Netherlands** | **aen** | **AEGON NV** |
| 31 | Netherlands | ina | ING VERZEKERINGEN NV |
| 32 | Netherlands | inb | ING BANK NV |
| 33 | Netherlands | sns | SNS BANK |
| 34 | Portugal | bcp | BANCO COMR.PORTUGUES |
| 35 | Portugal | bes | BANCO ESPIRITO SANTO SA |
| **36** | **Spain** | **bbv** | **BANCO BILBAO VIZCAYA ARG** |
| 37 | Spain | bkt | BANKINTER SA |
| 38 | Spain | pop | BANCO POPOLAR ESPN. SA |
| 39 | Spain | sab | BANCO SABADELL SA |
| **40** | **Spain** | **san** | **BANCO STDR.CTL.HISP. SA** |

Note: The CDS series in bold are constituents of the iTraxx Europe index.

### 3.3 Empirical Models

In order to examine the dynamic short- and long-run interdependency of the sovereign and financial institution CDS series, we follow the methodology of Alter and Schüler ((2012 )) to construct a bivariate vector autoregressive (VAR) and bivariate vector error correction (VEC) model. Except for the cointegration analysis, we also include impulse response functions (IRFs) to capture the dynamic relationship between the CDS spreads.

We carry out the empirical analysis in two sub-periods: before and after the bailout (May 2010). Prior to the VAR and VEC model analysis, we test the unit roots of the

log-level CDS spreads and the first differences of the log levels using the augmented Dickey-Fuller (ADF) tests for the two sub-samples, respectively. If the variable in log-levels is I(1), we carry out the cointegration and the VEC framework for the variable; if the variable in log-levels is stationary/I(0), we do not apply a VEC but use a VAR model for the log-level variable, as it cannot be cointegrated with another stationary or non-stationary variable.

To test the cointegration of the I(1) variables for each bivariate model, we use Johansen's trace tests except for the ADF tests. If the variables in log-levels can be cointegrated, i.e. reject maximum rank at 0 or 1, we proceed to estimate the VEC model. We determine the optimal lag order *p* in the VAR and VEC models by minimizing the common information criteria in the underlying VAR model of the log-levels. We estimate the VEC models via Johansen's maximum likelihood method and the VAR models via ordinary least squares.

We estimate the following VAR and VEC models with a sovereign CDS spreads (in short '*Sov*') and a domestic financial institution CDS spreads (in short '*Fi*'):

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t \quad , \tag{1}$$

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{pmatrix} \alpha_{Sov} \\ \alpha_{Fi} \end{pmatrix} \left( \beta_{Sov} cds_{Sov,t-1} + \beta_{Fi} cds_{Fi,t-1} + \beta_0 \right) + \sum_{i=1}^{p-1} \begin{bmatrix} \gamma_{SovSov,i} & \gamma_{SovFi,i} \\ \gamma_{FiSov,i} & \gamma_{FiFi,i} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_t \, . \tag{2}$$

where $cds_{j,t}$ with $j \in (Sov, Fi)$ is CDS spreads in log-levels of institution *j* at day *t*, i.e. the logarithmized CDS spreads of the government or financial institution. $\Delta cds_{j,t}$ refers to the first differences of $cds_{j,t}$. *v* is a vector of constants.

Noted that a VEC model with (*p*-1) lags can be represented as a VAR structure with *p* lags, we employ impulse response functions (IRFs) of VAR models using CDS spreads in log-levels.

## 4. Analysis

The dataset has been separated into Group A and Group B. Group A includes the countries that have requested for the bailout funding from the EFSF or have been facing severe default risk, i.e., Greece, Ireland, Italy, Portugal and Spain. Group B is constituted of the other guarantees of the EFSF that have contributed most to the bailouts, i.e., Austria, Belgium, France, Germany and Netherlands.

Table 2a and Table 2b exhibit the cointegration analysis results of Group A before and after the bailout issued by the EFSF, respectively. According to the VEC model, $\beta_{Sov}$ and $\beta_{Fi}$ reveal the long-term relationship between the sovereign and the financial institution's default risks as Equation (3).

$$cds_{Sov,t} = -\frac{\beta_{Fi}}{\beta_{Sov}} cds_{Fi,t} + \beta_0 \tag{3}$$

Since $\beta_{Sov}$ is set as 1, then a negative $\beta_{Fi}$ indicates that the relationship between the two sectors is positive, and from Table 2a and 2b, in both periods before and after the EFSF bailout, all the $\beta_{Fi}$ coefficients are significantly negative except the pair of ES and SAB before the bailout. The coefficients $\alpha_{Sov}$ and $\alpha_{Fi}$ measure the speed of adjustment towards the long-term relationship. When the $\alpha$ coefficients are significant and have opposite signs to their respective $\beta$ coefficients, the variables are taking part in the error correction mechanism, which means the CDS series are attracted back to the long-run equilibrium. Comparing Table 2a and Table 2b, we have noticed that some $\alpha$ coefficients have changed from insignificant to significant after the EFSF bailout, i.e., the financial institutions MDB from Italy and BKT, POP and SAB from Spain, which indicates that the CDS series of the financial institutions are more attracted back to the long-run equilibrium. This provide some evidence to *Hypothesis 2(a)* and *Hypothesis 3(a)* that, compared with the period before the bailout, the risk has transferred from the financial sector to the government after the bailout, and the default risk of the financial institutions are more influenced by the sovereign default risk.

**Table 2a: Cointegration Analysis of Group A before Bailout**

| Country | Sov | Fi | α_Sov | α_Fi | β_Sov | β_Fi | Constant |
|---|---|---|---|---|---|---|---|
| Greece | gr | aca | -0.004 | **0.015** | 1.000 | **-0.828** | -0.238 |
| | | | (-0.953) | **(2.105)** | - | **(-4.650)** | - |
| Ireland | ie | aib | - | - | - | - | - |
| | | | - | - | - | - | - |
| | ie | bki | 0.004 | **0.005** | 1.000 | **-3.300** | 13.813 |
| | | | (1.537) | **(2.862)** | - | **(-5.100)** | - |
| | ie | ipm | **0.001** | **0.001** | 1.000 | **-10.030** | 51.933 |
| | | | **(1.866)** | **(2.016)** | - | **(-3.250)** | - |
| Italy | it | bci | - | - | - | - | - |
| | | | - | - | - | - | - |
| | it | mdb | **-0.009** | 0.004 | 1.000 | **-0.888** | -0.791 |
| | | | **(-2.039)** | (0.963) | - | **(-2.030)** | - |
| | it | bmp | - | - | - | - | - |
| | | | - | - | - | - | - |
| | it | pii | **0.001** | **0.001** | 1.000 | **-21.980** | 96.598 |
| | | | **(2.512)** | **(2.108)** | - | **(-3.040)** | - |
| | it | uni | - | - | - | - | - |
| | | | - | - | - | - | - |
| | it | ubi | - | - | - | - | - |
| | | | - | - | - | - | - |
| | it | gas | - | - | - | - | - |
| | | | - | - | - | - | - |
| Portugal | pt | bcp | 0.000 | **0.017** | 1.000 | **-1.406** | 2.450 |
| | | | (0.034) | **(2.910)** | - | **(-4.690)** | - |
| | pt | bes | 0.003 | **0.014** | 1.000 | **-1.561** | 3.471 |
| | | | (0.609) | **(2.913)** | - | **(-4.020)** | - |
| Spain | es | bbv | - | - | - | - | - |
| | | | - | - | - | - | - |
| | es | bkt | **-0.026** | 0.020 | 1.000 | **-0.422** | -6.250 |
| | | | **(-3.688)** | (1.559) | - | **(-2.304)** | - |
| | es | pop | **-0.015** | 0.000 | 1.000 | **-0.292** | -1.990 |
| | | | **(-2.972)** | (0.026) | - | **(-3.113)** | - |
| | es | sab | **-0.004** | -0.001 | 1.000 | **3.586** | -24.481 |
| | | | **(-2.807)** | (-0.923) | - | **(2.070)** | - |
| | es | san | - | - | - | - | - |
| | | | - | - | - | - | - |

**Table 2b: Cointegration Analysis of Group A after Bailout**

| Country | Sov | Fi | α_Sov | α_Fi | β_Sov | β_Fi | Constant |
|---|---|---|---|---|---|---|---|
| Greece | gr | aca | -0.015 | **0.012** | 1.000 | **-2.077** | 7.130 |
| | | | (-1.169) | **(1.889)** | - | **(-12.020)** | - |
| Ireland | ie | aib | 0.006 | **0.017** | 1.000 | **-1.301** | 2.831 |
| | | | (1.047) | **(3.023)** | - | **(-6.410)** | - |
| | ie | bki | - | - | - | - | - |
| | | | - | - | - | - | - |
| | ie | ipm | - | - | - | - | - |
| | | | - | - | - | - | - |
| Italy | it | bci | -0.010 | **0.025** | 1.000 | **-0.845** | -0.986 |
| | | | (-0.658) | **(1.718)** | - | **(-8.770)** | - |
| | it | mdb | -0.012 | **0.043** | 1.000 | **-0.904** | -0.658 |
| | | | (-0.720) | **(3.467)** | - | **(-14.510)** | - |
| | it | bmp | 0.004 | **0.021** | 1.000 | **-1.129** | 0.972 |
| | | | (0.320) | **(2.109)** | - | **(-6.970)** | - |
| | it | pii | **-0.034** | -0.008 | 1.000 | **-0.682** | -1.830 |
| | | | **(-2.765)** | (-0.804) | - | **(-6.790)** | - |
| | it | uni | -0.015 | 0.012 | 1.000 | **-0.924** | -0.500 |
| | | | (-1.012) | (0.952) | - | **(-7.760)** | - |
| | it | ubi | **-0.025** | 0.019 | 1.000 | **-0.950** | -0.285 |
| | | | **(-1.901)** | (1.575) | - | **(-8.750)** | - |
| | it | gas | 0.001 | **0.023** | 1.000 | **-1.084** | 0.246 |
| | | | (0.094) | **(2.030)** | - | **(-7.940)** | - |
| Portugal | pt | bcp | -0.004 | **0.018** | 1.000 | **-1.049** | 0.628 |
| | | | (-0.344) | **(2.020)** | - | **(-7.320)** | - |
| | pt | bes | **0.009** | **0.010** | 1.000 | **-1.991** | 6.842 |
| | | | **(1.699)** | **(2.549)** | - | **(-5.600)** | - |
| Spain | es | bbv | - | - | - | - | - |
| | | | - | - | - | - | - |
| | es | bkt | **-0.041** | **0.045** | 1.000 | **-0.577** | -2.176 |
| | | | **(-2.620)** | **(3.141)** | - | **(-7.960)** | - |
| | es | pop | **-0.059** | **0.052** | 1.000 | **-0.585** | -2.099 |
| | | | **(-2.946)** | **(4.175)** | - | **(-15.260)** | - |
| | es | sab | -0.033 | **0.026** | 1.000 | **-0.609** | -1.983 |
| | | | (-1.450) | **(1.783)** | - | **(-8.310)** | - |
| | es | san | - | - | - | - | - |
| | | | - | - | - | - | - |

Note: *t*-statistics are reported in brackets. Table 2a and Table 2b only present the cointegration analysis for the bi-variables that are tested to be cointegrated in the Johansen's trace tests.

Table 3a and Table 3b provide the results of cointegration analysis for Group B before and after the EFSF bailout, and the situation of Group B is similar to Group A that most of the $\beta_{Fi}$ coefficients are significantly negative, suggesting a positive relationship between the sovereign and financial sectors in the long run.

**Table 3a: Cointegration Analysis of Group B before Bailout**

| Country | Sov | Fi | α_Sov | α_Fi | β_Sov | β_Fi | Constant |
|---|---|---|---|---|---|---|---|
| Austria | at | rzb | -0.000 | **0.009** | 1.000 | **-2.831** | 10.841 |
| | | | (-0.103) | **(3.213)** | - | **(-5.800)** | - |
| | at | ers | **0.001** | **0.003** | 1.000 | **-6.911** | 31.667 |
| | | | **(1.989)** | **(2.900)** | - | **(-4.070)** | - |
| Belgium | be | kbc | -0.001 | **0.014** | 1.000 | **-1.267** | 2.542 |
| | | | (-0.264) | **(2.517)** | - | **(-4.060)** | - |
| France | fr | bnp | - | - | - | - | - |
| | | | - | - | - | - | - |
| | fr | car | **0.002** | **0.002** | 1.000 | **-14.517** | 62.954 |
| | | | **(2.641)** | **(2.589)** | - | **(-3.540)** | - |
| | fr | sge | 0.003 | **0.005** | 1.000 | **-5.005** | 19.578 |
| | | | (1.644) | **(3.015)** | - | **(-4.160)** | - |
| | fr | cnt | 0.001 | **0.001** | 1.000 | **-7.471** | 36.780 |
| | | | (1.362) | **(1.852)** | - | **(-2.390)** | - |
| | fr | axa | -0.001 | **-0.001** | 1.000 | **7.021** | -37.674 |
| | | | (-1.501) | **(-2.129)** | - | **(1.970)** | - |
| | fr | sco | **-0.002** | -0.001 | 1.000 | **5.262** | -27.998 |
| | | | **(-2.127)** | (-1.394) | - | **(1.840)** | - |
| | fr | gfc | **-0.004** | -0.001 | 1.000 | 0.899 | -9.695 |
| | | | **(-1.897)** | (-0.555) | - | (0.890) | - |
| | fr | wed | **0.004** | **0.005** | 1.000 | **-3.017** | 15.920 |
| | | | **(2.608)** | **(3.149)** | - | **(-4.990)** | - |
| Germany | de | ikb | -0.001 | **-0.003** | 1.000 | **1.902** | -15.636 |
| | | | (-1.418) | **(-2.451)** | - | **(1.780)** | - |
| | de | dbk | 0.001 | **0.009** | 1.000 | **-3.944** | 14.990 |
| | | | (0.269) | **(3.367)** | - | **(-4.870)** | - |
| | de | cbg | **0.001** | **0.001** | 1.000 | **-21.422** | 93.451 |
| | | | **(2.238)** | **(2.827)** | - | **(-3.360)** | - |
| | de | muv | -0.000 | **0.000** | 1.000 | **935.406** | -3753.748 |
| | | | (-1.104) | **(-2.760)** | - | **(2.780)** | - |
| | de | alv | 0.002 | **0.004** | 1.000 | **-7.213** | 28.654 |
| | | | (1.450) | **(3.130)** | - | **(-3.770)** | - |
| | de | hnr | 0.000 | **0.002** | 1.000 | **-13.216** | 53.218 |
| | | | (0.909) | **(2.809)** | - | **(-2.960)** | - |
| Netherlands | nl | abn | -0.000 | **0.002** | 1.000 | **-12.405** | 52.816 |
| | | | (-0.156) | **(2.934)** | - | **(-3.110)** | - |
| | nl | aen | **-0.006** | -0.003 | 1.000 | 0.159 | -4.689 |
| | | | **(-1.750)** | (-1.621) | - | (0.190) | - |
| | nl | ina | 0.001 | **0.005** | 1.000 | **-3.572** | 14.304 |
| | | | (0.845) | **(3.256)** | - | **(-4.120)** | - |
| | nl | inb | -0.000 | **0.002** | 1.000 | **-9.539** | 39.084 |
| | | | (-0.399) | **(2.761)** | - | **(-3.230)** | - |
| | nl | sns | -0.000 | **0.010** | 1.000 | **-2.201** | 8.655 |
| | | | (-0.040) | **(4.202)** | - | **(-6.720)** | - |

**Table 3b: Cointegration Analysis of Group B after Bailout**

| Country | Sov | Fi | α_Sov | α_Fi | β_Sov | β_Fi | Constant |
|---|---|---|---|---|---|---|---|
| Austria | at | rzb | 0.001 | **0.029** | 1.000 | **-1.521** | 3.437 |
| | | | (0.049) | **(3.069)** | - | **(-11.970)** | - |
| | at | ers | -0.031 | **0.036** | 1.000 | **-1.053** | 0.900 |
| | | | (-1.481) | **(2.436)** | - | **(-19.200)** | - |
| Belgium | be | kbc | 0.005 | **0.041** | 1.000 | **-0.818** | -0.730 |
| | | | (0.338) | **(3.686)** | - | **(-9.790)** | - |
| France | fr | bnp | **-0.042** | 0.003 | 1.000 | **-0.830** | -0.318 |
| | | | **(-2.134)** | (0.148) | - | **(-7.630)** | - |
| | fr | car | -0.024 | **0.030** | 1.000 | **-1.238** | 1.981 |
| | | | (-1.190) | **(1.756)** | - | **(-10.210)** | - |
| | fr | sge | **-0.052** | 0.011 | 1.000 | **-0.801** | -0.250 |
| | | | **(-2.251)** | (0.582) | - | **(-10.400)** | - |
| | fr | cnt | -0.014 | **0.037** | 1.000 | **-1.467** | 3.260 |
| | | | (-0.793) | **(4.084)** | - | **(-12.140)** | - |
| | fr | axa | **-0.039** | 0.014 | 1.000 | **-0.877** | 0.142 |
| | | | **(-2.225)** | (1.378) | - | **(-9.560)** | - |
| | fr | sco | **-0.031** | 0.011 | 1.000 | **-1.052** | 0.705 |
| | | | **(-2.147)** | (1.497) | - | **(-6.270)** | - |
| | fr | gfc | -0.012 | 0.006 | 1.000 | -0.463 | -1.979 |
| | | | (-1.521) | (1.422) | - | (-1.290) | - |
| | fr | wed | **-0.020** | 0.001 | 1.000 | **-0.752** | 0.103 |
| | | | **(-1.943)** | (0.255) | - | **(-2.280)** | - |
| Germany | de | ikb | -0.004 | **0.013** | 1.000 | **-4.425** | 22.622 |
| | | | (-0.557) | **(3.581)** | - | **(-6.290)** | - |
| | de | dbk | 0.001 | **0.017** | 1.000 | **-1.500** | 3.260 |
| | | | (0.158) | **(2.361)** | - | **(-4.740)** | - |
| | de | cbg | -0.015 | **0.021** | 1.000 | **-1.095** | 1.563 |
| | | | (-1.299) | **(1.683)** | - | **(-7.130)** | - |
| | de | muv | 0.001 | **0.008** | 1.000 | **-3.940** | 12.816 |
| | | | (0.376) | **(2.488)** | - | **(-3.410)** | - |
| | de | alv | 0.005 | **0.032** | 1.000 | **-1.718** | 3.732 |
| | | | (0.460) | **(3.045)** | - | **(-7.670)** | - |
| | de | hnr | 0.000 | **0.001** | 1.000 | **-30.310** | 139.550 |
| | | | (0.154) | **(2.480)** | - | **(-3.000)** | - |
| Netherlands | nl | abn | 0.001 | **0.001** | 1.000 | **-27.555** | 134.414 |
| | | | (0.809) | **(3.258)** | - | **(-3.410)** | - |
| | nl | aen | -0.002 | **0.012** | 1.000 | **-2.984** | 11.751 |
| | | | (-0.427) | **(2.943)** | - | **(-6.600)** | - |
| | nl | ina | -0.005 | **-0.007** | 1.000 | **2.566** | -17.709 |
| | | | (-1.482) | **(-3.123)** | - | **(2.380)** | - |
| | nl | inb | **-0.019** | 0.013 | 1.000 | **-1.605** | 3.823 |
| | | | **(-1.916)** | (1.397) | - | **(-8.980)** | - |
| | nl | sns | -0.018 | **0.041** | 1.000 | **-2.118** | 7.601 |
| | | | (-1.548) | **(4.258)** | - | **(-13.580)** | - |

Note: *t*-statistics are reported in brackets. Table 3a and Table 3b only present the cointegration analysis for the bi-variables that are tested to be cointegrated in the Johansen's trace tests.

Then we analyse the results of impulse responses. Table 4 shows the impulse responses of Group A in both periods before and after the EFSF bailout. The responses after 1, 2 and 5 days represent the short-term effects, and the responses after 22 days show the long-run effects. Before the bailout, a two-way feedback effect exists between the two sectors, as most of the responses of financial institutions to the sovereign CDS shocks are significantly positive, and vice versa. The results support *Hypothesis 1*, that prior to the bailout programs, changes in the

sovereign default risk affect the credit default risk of the domestic financial institutions, and vice versa.

**Table 4: Impulse Responses of Group A**

| Country | Impulse | Reponse | Before Bailout | | | | After Bailout | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 5 | 22 | 1 | 2 | 5 | 22 |
| Greece | gr | aca | 0.094 | 0.126 | **0.176** | **0.390** | **0.081** | **0.072** | **0.099** | **0.192** |
| | aca | gr | 0.008 | 0.012 | 0.020 | 0.055 | **-0.213** | -0.126 | -0.056 | 0.294 |
| Ireland | ie | aib | -0.036 * | -0.069 * | -0.058 * | 0.122 * | 0.012 | 0.116 | 0.168 | **0.403** |
| | aib | ie | **0.157** * | **0.186** * | **0.264** * | -0.152 * | 0.060 | 0.046 | 0.191 | 0.018 |
| | ie | bki | **0.049** | **0.060** | **0.082** | **0.170** | **0.275** * | **0.316** * | **0.459** * | **0.819** * |
| | bki | ie | **0.144** | **0.145** | **0.116** | -0.048 | 0.031 * | 0.033 * | 0.043 * | 0.065 * |
| | ie | ipm | **0.075** | **0.070** | **0.080** | **0.118** | **0.248** * | **0.330** * | **0.528** * | **1.010** * |
| | ipm | ie | **0.171** | **0.142** | **0.116** | -0.023 | 0.025 * | 0.031 * | 0.042 * | 0.067 * |
| Italy | it | bci | **0.153** * | **0.154** * | **0.183** * | **0.268** * | **0.376** | **0.472** | **0.533** | **0.680** |
| | bci | it | **0.192** * | **0.168** * | **0.136** * | -0.018 * | **-0.111** | **-0.130** | -0.113 | -0.019 |
| | it | mdb | **0.145** | **0.151** | **0.165** | **0.199** | **0.222** | **0.348** | **0.413** | **0.650** |
| | mdb | it | **0.185** | **0.184** | **0.177** | 0.110 | **-0.128** | **-0.241** | -0.178 | 0.018 |
| | it | bmp | 0.014 | 0.027 | 0.063 | **0.183** | **0.252** | **0.355** | **0.395** | **0.532** |
| | bmp | it | **0.161** | **0.160** | 0.096 | -0.158 | **-0.164** | **-0.345** | **-0.374** | -0.278 |
| | it | pii | **0.066** | **0.073** | **0.090** | **0.154** | **0.229** | **0.389** | **0.298** | 0.073 |
| | pii | it | **0.196** | **0.189** | **0.149** | -0.053 | -0.008 | -0.100 | -0.020 | **0.313** |
| | it | uni | -0.046 * | -0.044 * | 0.033 * | **0.313** * | **0.215** | **0.332** | **0.343** | 0.377 |
| | uni | it | **0.180** * | **0.132** * | **0.111** * | -0.043 * | -0.072 | -0.130 | -0.089 | 0.119 |
| | it | ubi | **0.019** * | **0.036** * | **0.083** * | **0.238** * | **0.224** | **0.407** | **0.405** | **0.395** |
| | ubi | it | -0.002 * | -0.004 * | -0.010 * | -0.029 * | -0.041 | **-0.186** | -0.108 | 0.246 |
| | it | gas | **0.076** * | **0.090** * | **0.112** * | **0.184** * | **0.246** | **0.403** | **0.449** | **0.595** |
| | gas | it | **0.149** * | **0.146** * | **0.099** * | -0.117 * | **-0.165** | **-0.296** | **-0.298** | -0.237 |
| Portugal | pt | bcp | **0.238** | **0.318** | **0.385** | **0.525** | **0.245** | **0.347** | **0.322** | **0.448** |
| | bcp | pt | **0.114** | **0.137** | 0.107 | -0.088 | 0.064 | -0.072 | -0.022 | 0.012 |
| | pt | bes | **0.217** | **0.296** | **0.359** | **0.485** | **0.197** | **0.254** | **0.186** | **0.339** |
| | bes | pt | **0.095** | **0.113** | 0.071 | -0.179 | 0.113 | -0.001 | -0.123 | -0.389 |
| Spain | es | bbv | **0.171** * | **0.183** * | **0.211** * | **0.258** * | **0.351** * | **0.416** * | **0.418** * | **0.619** * |
| | bbv | es | **0.214** * | **0.200** * | **0.150** * | -0.080 * | 0.055 * | -0.072 * | -0.192 * | **-0.449** * |
| | es | bkt | **0.021** | **0.042** | **0.098** | **0.310** | **0.192** | **0.243** | **0.332** | **0.526** |
| | bkt | es | **0.010** | **0.019** | **0.044** | **0.140** | **-0.086** | -0.072 | -0.006 | 0.169 |
| | es | pop | 0.005 | 0.010 | 0.024 | 0.089 | **0.098** | **0.181** | **0.350** | **0.610** |
| | pop | es | 0.004 | 0.008 | 0.020 | 0.072 | -0.041 | -0.027 | 0.087 | **0.312** |
| | es | sab | **0.091** | **0.098** | **0.115** | **0.180** | **0.148** | **0.226** | **0.335** | **0.464** |
| | sab | es | **0.168** | **0.157** | **0.119** | -0.081 | 0.055 | 0.003 | -0.107 | 0.142 |
| | es | san | **0.160** * | **0.163** * | **0.186** * | **0.229** * | **0.246** * | **0.422** * | **0.339** * | **0.547** * |
| | san | es | **0.184** * | **0.162** * | **0.114** * | -0.090 * | **0.133** * | -0.001 * | -0.074 * | -0.069 * |

Note: A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. Results in bold indicate significance at a 0.1 level. * indicates the bi-variables are not tested to be cointegrated, but the IRF results of them are presented for comparisons.

In the period after the bailout, we can observe the significant effect of default risk transfer that, in both the short and long run, the responses of the financial institutions to the sovereign CDS shocks are significantly positive, and the responses are even larger than before. This provides evidence to *Hypotheses 2(a)* and *2(b)* that the domestic financial institutions are affected stronger by the shocks in sovereign default risk after the bailout.

On the other hand, the responses of the sovereign CDS to the domestic financial institutions become either insignificant or significantly negative for most variables

after the bailout. This indicates that the default risk transfers from the financial sector to the government after the EFSF interventions, and the relieved default risk of the financial institutions becomes heavier debt burdens to the government instead. This supports *Hypotheses 3(a)* and *3(b)* that changes in the default risk of the financial institutions have negative impacts on the sovereign default risk.

Table 5 is the results of impulse responses for Group B countries, which have contributed the most of the bailout package towards the Group A countries. Before the bailout, the two-way feedback effect is not significant for some countries such as France and Germany, and after the bailout, the responses of the financial sector to the sovereign default risk are still in the same direction. This indicates that the governments and their domestic financial sectors are not facing severe debt crisis, so the governments do not have to take over the default risk from the financial sector. The different results of Group A and Group B provide evidence to *Hypotheses 4* that the heterogeneity of the rescue packages across the countries translates into the asymmetric interdependent relationship between the default risk of the sovereign and financial sectors.

The empirical results indicate that the default risk transfer might occur based on the current financial situations of the governments and their domestic financial sectors, and the capital injection directly to the financial sector might not relieve the sovereign debt crisis, but further magnify the impacts of sovereign default risk on the financial sector through increasing the government debt burdens.

**Table 5: Impulse Responses of Group B**

| Country | Impulse | Reponse | Before Bailout | | | | After Bailout | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 5 | 22 | 1 | 2 | 5 | 22 |
| Austria | at | rzb | **0.178** | **0.202** | **0.115** | **0.208** | **0.110** | **0.195** | **0.249** | **0.442** |
| | rzb | at | **0.230** | **0.309** | **0.325** | 0.171 | **0.171** | 0.008 | -0.173 | -0.148 |
| | at | ers | **0.141** | **0.167** | **0.410** | **0.351** | 0.063 | **0.219** | **0.258** | **0.468** |
| | ers | at | **0.083** | -0.018 | **0.103** | -0.010 | **0.181** | 0.181 | -0.027 | 0.336 |
| Belgium | be | kbc | -0.014 | -0.055 | -0.039 | **0.312** | **0.144** | **0.273** | **0.353** | **0.673** |
| | kbc | be | 0.076 | **0.104** | **0.234** | 0.151 | **0.146** | 0.039 | **-0.227** | -0.233 |
| France | fr | bnp | 0.059 * | 0.083 * | **0.114** * | **0.201** * | **0.092** | **0.205** | 0.093 | 0.086 |
| | bnp | fr | **0.094** * | **0.107** * | 0.057 * | -0.168 * | **0.283** | **0.363** | 0.196 | **0.411** |
| | fr | car | 0.027 | 0.039 | 0.056 | **0.118** | **0.109** | **0.189** | 0.096 | 0.286 |
| | car | fr | 0.052 | 0.044 | -0.034 | **-0.373** | **0.327** | **0.422** | **0.305** | 0.315 |
| | fr | sge | **0.061** | **0.084** | **0.109** | **0.181** | **0.086** | **0.194** | 0.106 | 0.177 |
| | sge | fr | **0.178** | **0.215** | **0.164** | -0.136 | **0.316** | **0.435** | **0.326** | **0.487** |
| | fr | cnt | 0.027 | 0.033 | 0.045 | 0.100 | **0.094** | **0.145** | **0.244** | **0.460** |
| | cnt | fr | **0.099** | **0.104** | **0.092** | 0.031 | 0.120 | 0.146 | 0.139 | 0.087 |
| | fr | axa | **0.073** | **0.186** | **0.217** | **0.163** | **0.066** | **0.095** | **0.135** | 0.237 |
| | axa | fr | 0.026 | 0.013 | -0.002 | -0.054 | **0.202** | **0.278** | **0.352** | **0.507** |
| | fr | sco | **0.092** | **0.104** | **0.108** | **0.116** | **0.050** | **0.073** | **0.108** | 0.209 |
| | sco | fr | 0.003 | -0.004 | -0.029 | -0.155 | 0.145 | **0.205** | **0.277** | **0.470** |
| | fr | gfc | 0.035 | 0.044 | 0.049 | 0.062 | **0.064** | **0.085** | **0.108** | **0.191** |
| | gfc | fr | 0.061 | 0.073 | 0.064 | -0.003 | 0.046 | 0.051 | 0.028 | -0.089 |
| | fr | wed | 0.007 | 0.082 | 0.141 | **0.266** | **0.104** | **0.130** | **0.135** | 0.119 |
| | wed | fr | 0.021 | 0.049 | -0.019 | **-0.238** | 0.075 | 0.101 | 0.133 | 0.242 |
| Germany | de | ikb | 0.059 | 0.070 | 0.065 | 0.026 | **0.073** | **0.066** | **0.088** | **0.148** |
| | ikb | de | 0.005 | 0.007 | 0.007 | 0.008 | 0.045 | 0.050 | 0.083 | 0.183 |
| | de | dbk | **0.082** | **0.115** | **0.142** | **0.195** | 0.065 | 0.092 | **0.139** | **0.307** |
| | dbk | de | **0.070** | **0.089** | 0.074 | -0.018 | 0.055 | 0.065 | 0.056 | 0.003 |
| | de | cbg | 0.038 | 0.053 | 0.066 | 0.100 | **0.144** | **0.172** | **0.205** | 0.306 |
| | cbg | de | **0.099** | **0.113** | 0.053 | -0.246 | **0.083** | **0.106** | **0.147** | 0.286 |
| | de | muv | **0.120** | **0.162** | **0.167** | 0.105 | 0.093 | **0.229** | 0.091 | 0.129 |
| | muv | de | 0.044 | 0.053 | 0.029 | -0.106 | 0.050 | 0.045 | -0.140 | -0.103 |
| | de | alv | **0.102** | **0.138** | **0.153** | **0.161** | 0.061 | **0.210** | 0.090 | **0.360** |
| | alv | de | 0.030 | 0.030 | -0.005 | -0.165 | **0.090** | 0.108 | 0.004 | -0.073 |
| | de | hnr | 0.065 | 0.012 | -0.006 | 0.030 | -0.001 | 0.037 | -0.151 | -0.104 |
| | hnr | de | 0.029 | 0.019 | -0.001 | -0.100 | **0.176** | 0.137 | 0.013 | 0.026 |
| Netherlands | nl | abn | 0.042 | 0.043 | 0.043 | 0.042 | **0.073** | **0.099** | **0.102** | 0.069 |
| | abn | nl | **0.089** | **0.092** | 0.095 | 0.101 | 0.125 | 0.154 | 0.095 | -0.212 |
| | nl | aen | 0.006 | 0.007 | 0.006 | 0.004 | **0.044** | **0.067** | **0.102** | **0.201** |
| | aen | nl | **0.138** | **0.168** | **0.200** | **0.314** | **0.248** | **0.336** | **0.364** | 0.317 |
| | nl | ina | **0.108** | **0.104** | **0.116** | **0.161** | **0.178** | **0.203** | **0.172** | -0.015 |
| | ina | nl | **0.091** | **0.083** | **0.080** | 0.059 | 0.037 | 0.032 | -0.010 | -0.209 |
| | nl | inb | **0.062** | **0.063** | **0.061** | 0.045 | **0.155** | **0.199** | **0.211** | 0.195 |
| | inb | nl | **0.163** | **0.176** | **0.197** | 0.267 | 0.092 | **0.146** | **0.259** | **0.639** |
| | nl | sns | 0.014 | -0.030 | 0.006 | 0.110 | 0.053 | **0.093** | **0.190** | **0.400** |
| | sns | nl | **0.086** | **0.115** | **0.252** | **0.228** | **0.226** | **0.262** | **0.309** | **0.384** |

Note: A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. Results in bold indicate significance at a 0.1 level. * indicates the bi-variables are not tested to be cointegrated, but the IRF results of them are presented for comparisons.

## 5. Conclusion

We analyse the risk transfer between sovereign and financial institutions' CDS series during the European sovereign debt crisis in 2010. The empirical results suggest that before the EFSF bailout in May 2010, there is a two-way feedback effect between

the two sectors in both short and long run; after the bailout, the sovereign default risk has stronger impacts on the financial sector, but not vice versa. We conclude that the risk transfer might happen based on the current financial situations of the public and private sectors, and the bailouts directly to the financial system might not relieve the sovereign debt crisis but further increase the debt burdens of the government and weaken the private sector in the long term.

In this paper, we use the date of the first bailout package from the EFSF as the breakpoint of the sub-periods for all the countries. In the future, we might consider the two-way feedback effect in individual countries, which have received or requested for the bailouts, and the secondary market intervention in February 2012 will also be included.

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