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Analysis of Sovereign CDSs in the PIIGS Countries – Co-movement and Transmission during the Eurozone Crisis Period

Takayasu Ito
Meiji University, School of Commerce, Tokyo Japan
Note☆

Abstract

This paper analyzes the co-movement and transmission of sovereign credit default swaps (CDSs) in the PIIGS (Portugal, Italy, Ireland, Greece and Spain) countries during the period of the Eurozone sovereign crisis. Sovereign CDSs among the five PIIGS countries moved together during the period. Greece propelled the sovereign CDS market of the other four PIIGGS countries. On the other hand, no influence on Greece from other PIIGS countries was found. From the empirical analysis, it can be concluded that the financial contagion existed among sovereign CDS markets of PIIGS countries. Greece, which was in the state of severe fiscal crisis, was a driving force in the financial contagion of the Eurozone.

Keywords: Sovereign CDS, PIIGS Countries, Eurozone Crisis, Financial Contagion

1.Introduction

This paper focuses on the financial contagion caused by the sovereign credit default swaps (CDSs) of the PIIGS (Portugal, Italy, Ireland, Greece and Spain) countries during the Eurozone sovereign crisis. Originally, the CDS was introduced to serve as a sort of insurance insofar as it is a financial swap agreement whereby the seller will compensate the buyer if there is a credit event. The buyer of the CDS makes a series of payments to the seller and, in exchange, receives a compensation payoff if there is a default, whereupon the seller retakes possession of the defaulting bond or loan.

As the Eurozone sovereign crisis deepened around the middle of 2010, massive sell-offs were observed, especially in Greek bonds, whose CDS premium rose dramatically. This triggered a rise in government bond yields and CDS premiums in other countries such as Ireland, Italy, Spain and Portugal.

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This paper analyzes the co-movement and transmission of sovereign CDSs in the PIIGS countries during the Eurozone sovereign crisis. It investigates this from two points of view. Firstly, it looks at the co-movement of sovereign CDSs in the PIIGGS countries. Secondly, it investigates the transmission of CDSs among PIIGS countries. The contribution of this paper to the literature is that informs us as to whether the credit crisis was shared in these countries and which country was a driving factor of Eurozone sovereign crisis, especially in the five PIIGS countries.

Many of the CDS related studies, such as Alter and Beyer (2014), Beirne and Fratzscher (2013), Calice et al(2013), Gorea and Radev(2014), Grammatikos and Vermeulen (2012), and Kalbaska and Gatkowskib (2012), focus on financial contagion. Alter and Beyer (2014) quantify spillovers between sovereign credit markets and banks in the euro area. Spillovers are estimated recursively from the VAR (Vector Autoregressive) model of daily changes in CDS spreads with exogenous common factors. Beirne and Fratzscher (2013) analyze the drivers of sovereign risk for 31 advanced and emerging economies during the European sovereign debt crisis. Their study shows that deterioration in fundamentals of countries and sharp rise in the sensitivity of financial markets to fundamentals were the main explanations for the rise in sovereign yield spreads and CDS spreads.

The major finding of Calice et al.'s(2013) study is that, for several countries, including Greece, Ireland and Portugal, the liquidity of the sovereign CDS market has a substantial time varying influence on sovereign bond credit spreads. Gorea and Radev (2014) examine the determinants of the joint default risk of euro area countries during 2007 to 2011and recover joint default probabilities from individual CDS contracts. In contrast to earlier theoretical studies, they find that financial linkages are an active contagion of transmission channel only in the case of the troubled periphery euro area economies.

Grammatikos and Vermeulen (2012) show that financials became significantly more dependent on changes in the difference between the Greek and German CDS spreads after Lehman's collapse, compared with the pre-Lehman sub period. Kalbaskaa and Gatkowski (2012) confirm that Greece and the other PIIGS countries (even Spain and Italy) had a lower capacity to trigger contagion than core EU countries. In addition, Portugal was the most vulnerable country, whereas the UK was the most immune to shocks.

The remainder of this paper is organized as follows: Section 2 describes the data and provides summary statistics; Section 3 discusses the methodology; Section 4 presents the results; and Section 5 concludes the paper.

2. Data

The CDS market is liquid only in the maturity of five years. The data of the CDSs with a maturity of five years are used in this analysis. The sample period runs from January 29, 2009 to September 16, 2011. The five PIIGS (Portugal, Italy, Ireland, Greece and Spain) countries are chosen for this study. Data are provided by Bloomberg on a daily basis. CDS is quoted by basis point and percentage in the market. The movement of CDSs is shown in Figures 1. The descriptive statistics of the dataset are shown in Table1.

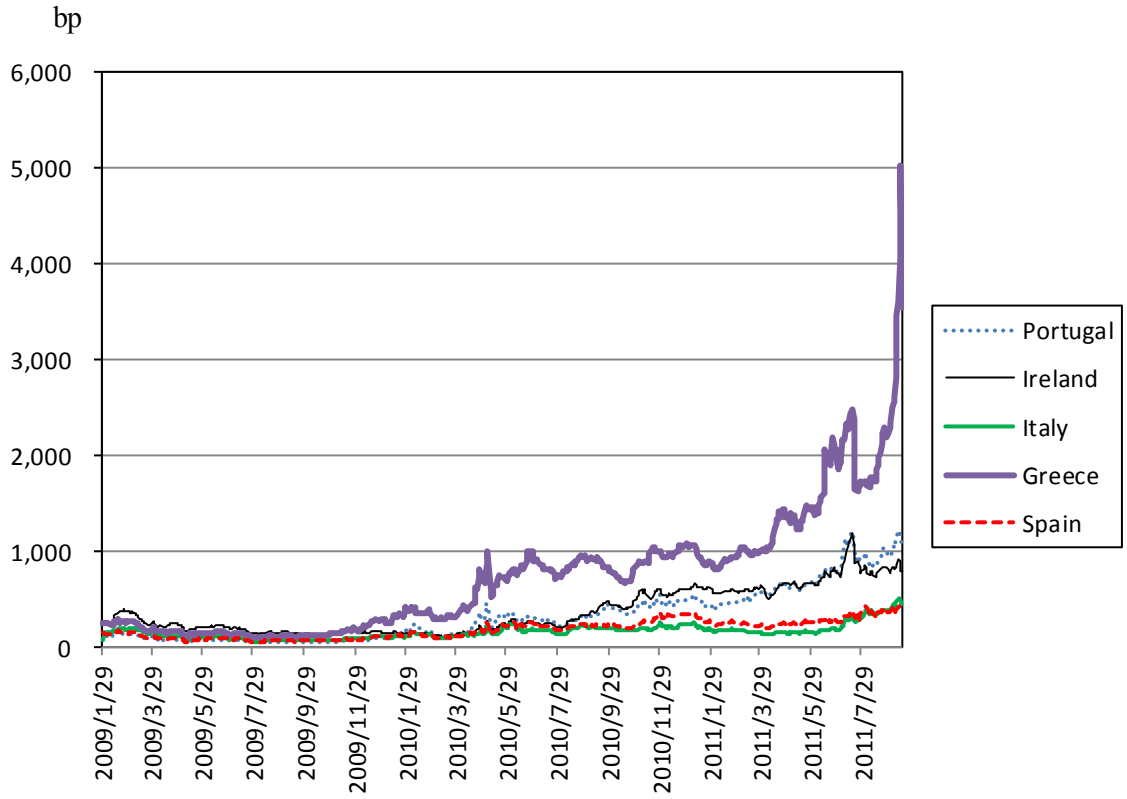

Figure 1 Movement of CDS

Notes : CDS prices of PIIGS (Portugal, Ireland, Italy, Greece, and Spain) are shown.
The sample period is from January 29, 2009 to September 16, 2011.
The data source is Bloomberg.

Table 1 Descriptive statistics

Variable	Average	SD	Min	Max	Median
Portugal	327.278	280.621	43.134	1214.856	274.575
Ireland	371.393	238.748	110.297	1180.500	257.302
Italy	159.395	76.074	57.718	504.000	154.888
Greece	736.511	662.711	100.500	5034.450	720.662
Spain	185.455	94.848	53.233	429.652	197.010

Note: The sample period is from January 29, 2009 tp September 16, 2011.

About two weeks before the sample period began, on January 14, 2009. Standard and Poor's (S&P) downgraded the rating of Greek government bonds to A− on the basis that the country's fiscal deficit would worsen within the downward trend of the global economy. Moody's Investors Service also downgraded Greece's local- and foreign-currency bond ratings to Ca from Caa1 on July 25, 2011, about two months before the end of the sample period.

According to Moody's Investor Service (2013), obligations rated Ca are highly speculative and are likely to be in default or very close to it, with some prospect of recovering the principal and interest. Although the International Swaps and Derivatives Association (ISDA) announced that the Greek case was not a credit event on October 31, 2011, the last day when price information of CDS price information was updated on the information vendor was September 16, 2011.

3. Methodology

3.1. Unit Root Test

Because empirical analyses of the period from the mid-1980's to the mid-1990's show that data such as interest rates, foreign exchange and stocks are non-stationary, it is firstly necessary to check whether the data used in this paper contain unit roots. ADF (Augmented Dickey/Fuller) and PP (Phillips/Perron) tests are conducted[1]. Both the ADF and PP tests define the null hypothesis as 'unit roots exist' and the alternative hypothesis as 'unit roots do not exist'. Fuller (1976) provides the tables for the ADF and PP tests. Firstly, the original data are checked to see whether they contain a unit root. Then, the data with first differences are analyzed to see whether they have a unit root in order to confirm that the data represent *I* (1) variables.

3.2 Cointegration Test

Generally speaking, the ordinary least squares (OLS) method is used to analyze the relationships among variables. However when non-stationary variables are included, ordinary hypothesis testing tends to produce erroneous results because the coefficient of determination and t-statistics do not follow a simple distribution.

Granger and Newbold (1974) call this problem 'spurious regression'. Phillips (1986) points out two things about the analysis of non-stationary data: (1) the coefficient of determination tends not to measure the relationships among variables, and (2) the estimated equation with a low Durbin-Watson ratio can be subject to the problem of spurious regression.

A non-stationary time series model is necessary to cope with these problems. There are two main types of cointegration test; (1) Johansen (1988), (2) Engle and Granger (1987). The most difficult part of a cointegration analysis starting from a VAR model is deciding on the number of cointegration relationships. For example, when three variables are analyzed, the number of cointegration relationships may be one or two. The method proposed by Engle and Granger cannot cope with this problem, but Johansen's approach does provide a means to decide the number of cointegration relationships[2].

In this paper, the cointegration analysis is applied as described below to investigate the co-movement of distress after it is confirmed that the data are non-stationary *I* (1) variables. Johansen suggests an analysis using the *k* order VAR model. Here, the VAR model is presented with *k* order against vector X_t with p variables.

[1] See Dickey and Fuller (1979), Dickey and Fuller (1981), and Phillips and Perron (1988) .
[2] For more details, see Engle and Granger (1987) and Johansen (1988).

$$X_t = \Pi_1 X_{t-1} + \ldots + \Pi_k X_{t-k} + \lambda + u_t \qquad (1)$$

All the p elements of X_t are considered to be I (1) variables. u_t is an error term with zero mean and λ is a constant term. The Johansen cointegration test is applied to the CDSs in the PIIGS countries. Maximal eigen value and trace tests are conducted to investigate the cointegration relationship. When such cointegration relationship is found, it may be concluded that the CDS markets in the PIIGS countries move in the long-run equilibrium. In other words, the CDSs in PIIGGS countries co- move.

3.3 Granger Causality Test

Granger causality tests are applied to investigate the causalities among CDS prices in the five stated countries and hence to identify the transmission of contagion. The original data are usually transformed into the change ratio to avoid the problem of spurious regression, but using these data is considered to cause an error. Toda and Yamamoto (1995) developed the Granger causality test in which non-stationary data are used directly.

According to their method, the null hypothesis is tested by adding trend term t and p + 1 (original lag plus one) for the estimation of the four equations mentioned below. As outlined below, these four equations are used to test the CDSs in the PIIGS countries: for example, equation (3) checks if the CDS of Italy, Ireland, Greece, Spain and Portugal Granger-cause the CDSs of Portugal. The Schwarz's Bayesian information criterion (BIC) standard is used for the original number of lags.

$$Portugal_t = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i Italy_{t-i} + \sum_{i=1}^{p+1} \beta_i Ireland_{t-i} + \sum_{i=1}^{p+1} \chi_i Greece_{t-1} + \sum_{i=1}^{p+1} \delta_i Sapin_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i Portugal_{t-1} + u_t \quad (3)$$

$$Italy_t = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i Italy_{t-i} + \sum_{i=1}^{p+1} \beta_i Ireland_{t-i} + \sum_{i=1}^{p+1} \chi_i Greece_{t-1} + \sum_{i=1}^{p+1} \delta_i Sapin_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i Portugal_{t-1} + u_t \quad (4)$$

$$Irelandy_t = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i Italy_{t-i} + \sum_{i=1}^{p+1} \beta_i Ireland_{t-i} + \sum_{i=1}^{p+1} \chi_i Greece_{t-1} + \sum_{i=1}^{p+1} \delta_i Sapin_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i Portugal_{t-1} + u_t \quad (5)$$

$$Greece_t = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i Italy_{t-i} + \sum_{i=1}^{p+1} \beta_i Ireland_{t-i} + \sum_{i=1}^{p+1} \chi_i Greece_{t-1} + \sum_{i=1}^{p+1} \delta_i Sapin_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i Portugal_{t-1} + u_t \quad (6)$$

$$Spain_t = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i Italy_{t-i} + \sum_{i=1}^{p+1} \beta_i Ireland_{t-i} + \sum_{i=1}^{p+1} \chi_i Greece_{t-1} + \sum_{i=1}^{p+1} \delta_i Sapin_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i Portugal_{t-1} + u_t \quad (7)$$

4.Results

4.1 Unit Root Test

Firstly, ADF and PP tests are conducted for the original series both with and without time trends. The results are shown in Tables 2 and 3.The BIC standard is used for the determination of lag length in the ADF test. The critical point of 5% for the t type of T = ∞ is –2.86(without trend) and –3.41(with trend) as reported in Fuller (1976). It is apparent that all the variables are non-stationary.

Table 2 ADF test - original series

Variable	Without Trend	With Trend
Portugal	1.867	-1.937
Ireland	0.287	-3.018
Italy	1.217	-1.209
Greece	2.489	-0.219
Spain	0.584	-3.113

Notes: * indicates significance at 5 % level.
5% critical values are −2.88 (without trend), −3.43 (with trend).

Table 3 PP test - original series

Variable	Without Trend	With Trend
Portugal	0.767	-1.781
Ireland	-0.216	-2.065
Italy	0.184	-0.932
Greece	0.903	-1.221
Spain	-0.904	-3.533

Notes: * indicates significance at 5 % level.
5% critical values are −2.88 (without trend), −3.43 (with trend).

Next, the data with first difference from the original data are analyzed using the ADF and PP tests. These results are shown in Tables 4 and 5. It is possible to conclude that all the variables are $I(1)$.

Table 4 ADF test - first differenced series

Variable	Without Trend	With Trend
⊿Portugal	-11.588*	-11.849*
⊿Ireland	-18.271*	-18.408*
⊿Italy	-20.698*	-19.229*
⊿Greece	-10.798*	-11.151*
⊿Spain	-18.135*	-18.147*

Notes: * indicates significance at 5 % level.
5% critical values are −2.88 (without trend), −3.43 (with trend).

Table 5 PP test - first differenced series

Variable	Without Trend	With Trend
⊿Portugal	-11.588*	-11.849*
⊿Ireland	-18.271*	-18.408*
⊿Italy	-20.698*	-19.229*
⊿Greece	-10.798*	-11.151*
⊿Spain	-18.135*	-18.147*

Notes: * indicates significance at 5 % level.
5% critical values are −2.88 (without trend), −3.43 (with trend).

4.2 Johansen Cointegration Test

The Johansen cointegration test is conducted for five variables. The results are shown in Table 6. Two cointegration relationships are found using the maximal eigenvalue test and one is found using the trace test. Thus it is proper to judge that one cointegration relationship exists among the sovereign CDSs of the five PIIGS countries. These sovereign CDSs are considered to shift during the long- term equilibrium during the period of Eurozone crisis. In other words, sovereign CDS among the five PIIGS countries moved together in the period from January 29, 2009 to September 16, 2011.

4.3 Granger Causality Test

The Granger causality tests developed by Toda and Yamamoto (1995) are conducted. The results are shown in Table 7. Causalities from Greece to the other four countries (Portugal, Ireland, Italy, and Spain) are found, but not the other way. Causalities from Portugal to Ireland, Italy, and Spain are found, as are causalities from Ireland to Spain, from Italy to Portugal, and from Spain to Italy.

Table 6 Johansen cointegration test

Null	Alternative	Test Statistics	5% Critical Value	Test Statistics	5% Critical Value
		Maximal Eigenvalue Test		Trace Test	
r = 0	r = 1	34.808*	34.400	85.129*	76.070
r ≦ 1	r = 2	29.376*	28.140	50.321	53.120
r ≦ 2	r = 3	9.888	22.000	20.945	34.910
r ≦ 3	r = 4	8.957	15.670	11.057	19.960
r ≦ 4	r = 5	2.101	9.240	2.101	9.240

Notes: * indicates significance at 5 % level.
Critical values are from Osterwald-Lenum (1992).

Table 7 Granger causality test

Variables	Test Statistics	Variables	Test Statistics
Portugal→Ireland	2.581*	Portugal→Greece	1.649
Portugal→Italy	2.259*	Portugal→Spian	2.864*
Ireland→Portugal	0.858	Ireland→Greece	0.866
Ireland→Italy	1.349	Ireland→Spain	3.750*
Italy→Portugal	4.029*	Italy→Greece	1.763
Italy→Ireland	1.437	Italy→Spain	2.167
Greece→Portugal	2.840*	Greece→Ireland	2.847*
Greece→Italy	4.627*	Greece→Spain	13.181*
Spain→Portugal	2.207	Spain→Ireland	0.888
Spain→Italy	3.075*	Spain→Greece	1.283

Notes: *,** indicates significance at 5 % level and 10 % level.
As for the number of lags, one is added to BIC selection.

5. Conclusion

This paper analyzes the co-movement and transmission of sovereign CDSs in the PIIGS countries during the Eurozone sovereign crisis. It investigates this from two points of view for the period from January 29, 2009 to September 16, 2011. Firstly, it looks at the co-movement of sovereign CDSs in PIGGS countries. Secondly, it investigates the transmission of CDSs among PIIGS countries. This makes us to know whether credit crisis was shared in these countries and which country was a driving factor of the sovereign crisis of Eurozone, especially in the PIIGS countries.

Sovereign CDSs among the five PIIGS countries moved together during the period of the Eurozone sovereign crisis. Greece propelled the sovereign CDS market. On the other hand, no influence on Greece from the other PIIGS countries was found. From the empirical analysis, it can be concluded that financial contagion existed among the sovereign CDS markets of the PIIGS countries. Greece, which was in a state of severe fiscal crisis, was a driving force in the financial contagion of the Eurozone.

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