CAUSALITY IN PERIPHERAL EMU PULIC DEBT MARKETS: A DYNAMIC APPROACH*

Marta Gómez-Puig[a] and Simón Sosvilla-Rivero[b]

April 2012

Abstract

Our research aims to analyze the causal relationships in the behavior of public debt issued by peripheral member countries of the European Economic and Monetary Union (EMU), with special emphasis on the recent episodes of crisis triggered in the eurozone sovereign debt markets since 2009. With this goal in mind, we make use of a database of daily frequency of yields on 10-year government bonds issued by five EMU countries (Greece, Ireland, Italy, Portugal and Spain), covering the entire history of the EMU from its inception on 1 January 1999 until 31 December 2010. In the first step, we explore the pair-wise causal relationship between yields, both for the whole sample and for changing subsamples of the data, in order to capture the possible time-varying causal relationship. This approach allows us to detect episodes of significant increase in causality between yields on bonds issued by different countries. In the second step, we study the determinants of these episodes, analyzing the role played by different factors, paying special attention to instruments that capture the total national debt (domestic and foreign) in each country.

JEL Classification Codes: E44, F36, G15

Keywords: Sovereign bond yields, causality, transmission, time-varying approach, euro area, peripheral EMU countries.

---

* [a]Marta Gómez-Puig: University of Barcelona & RFA-IREA.[b]Simón Sosvilla-Rivero: Universidad Complutense de Madrid. This paper is based upon work supported by the Government of Spain and FEDER under grant number ECO2010-21787-C03-01, and ECO2008-05565. Marta Gómez-Puig wants to thank the Instituto de Estudios Fisccales for financial support and Simón Sosvilla-Rivero thanks the University of Barcelona & RFA-IREA for their hospitality. The authors also wish to thank Javier Llordén from the Euro Area Accounts and Economic Data Division of the European Central Bank for his valuable advice and help in the construction of the dataset on private debt-to-GDP by sector in each country, and Analistas Financieros Internacionales for kindly providing the credit rating dataset. They are also grateful to the participants at the XXIV Symposium Moneda y Crédito in Madrid and EC^2 Conference in Florence for their insightful comments on previous versions of the paper. All remaining errors are solely the authors' responsibility. Corresponding author: Marta Gómez-Puig, Department of Economic Theory, University of Barcelona. Av. Diagonal 690. Barcelona 08034. Spain. T: 34-934.021.933. E-mail: marta.gomezpuig@ub.edu

1. Introduction

After ten years of stability, the financial and economic crisis that followed the US subprime crisis and Lehman Brothers collapse highlighted the imbalances within the European Economic and Monetary Union (EMU) countries. These imbalances had probably been undervalued during the stability period when markets seemed to underestimate the possibility that governments might default. Nevertheless, from August 2007 onwards, in parallel with the rise in global financial instability that led to a "flight-to-quality", yield spreads of euro area issues with respect to Germany spiraled (see Figure 1). Moreover, since 2010, Greece has been bailed out twice and the Republic of Ireland and Portugal also needed bailouts to stay afloat. These events brought to light the fact that the origin of sovereign debt crises in Europe could even go beyond the imbalances in public finances.

Indeed, the main causes of the debt crises in Europe vary according to the country and reflect an important interconnexion between public and private debt. In Ireland, the crisis was mainly due to the private sector, particularly a domestic housing boom which was financed by foreign borrowers who did not require a risk premium related to the probability of default (see Lane, 2011). In Spain, since absorption exceeded production, the external debt grew and the real exchange rate appreciated, implying a loss of competitiveness for the economy. Unlike previous expansions, the resort to financing was not led by the public sector but by private households and firms. In contrast to Ireland and Spain, the origin of the debt crisis in Greece and Portugal was the structural deficit in the government sector. If the crisis spreads to Italy, this structural deficit would be the possible cause. Greece and Italy's large fiscal deficit and huge public debt are the cumulative result of chronic macroeconomic imbalances[1]. However, the case of Portugal illustrates the importance of external debt[2] (specifically, that of its private sector: banks and enterprises).

[1] As pointed out in Gómez-Puig (2006 and 2008), in the past, Italy may have benefited from the fact that "size matters for liquidity" and thus for the success of a sovereign debt market since at the end of 2010 its market was the biggest in the euro area.

[2] The current account deficit over GDP was 9.86% in December 2010.

Some studies have already found a strong relationship between risk premium and a wide range of vulnerability indicators that go beyond the fiscal position. The IMF (2010) and Barrios *et al.* (2009) present empirical evidence of the strong relationship between current account deficits and foreign debt and the behavior of sovereign risk premium. Moreover, Gros (2011) contends that foreign debt is more important than public debt, and that this may have a number of implications for the ongoing eurozone crisis[3].

Other authors (Bolton and Jeanne (2011) and Allen *et al.* (2011)), have focused on the study of cross-border banking system linkages to the government sector. Although, cross-border banking effect on risk diversification is a key benefit, foreign capital is likely to be more mobile than domestic capital and, in a crisis situation, foreign banks may simply decide to "cut and run". In addition, in an integrated banking system, financial or sovereign crisis in a country can quickly spill over to other countries. In this context, it is important to note that the European Union and, especially the euro area, witnessed a significant increase in cross-border financial activity over the 10 years before the global crisis (see Barnes, Lane and Radziwill, 2010). Both the elimination of currency risk and regulatory convergence[4] can explain this important increase (see Kalemli-Ozcan, Papaioannou and Peydró-Alcalde, 2009). Spiegel (2009a and 2009b) shows that the effect of the monetary union has been even stronger for some of the peripheral EMU countries. In particular, the sources of external financing for Portuguese and Greek banks radically shifted on joining the euro; traditionally reliant on dollar debt, these banks were subsequently able to raise funds from their counterparts elsewhere in the EMU.

Therefore, in this scenario of increased cross-border financial activity in the euro area, Gray *et al.* (2008) point out the importance of identifying the channels that connect the banking and the sovereign sectors, not only within a country but across countries as well. On the one hand, a

[3] This author points out that the importance of external debt is due to the fact that euro area governments retain full sovereignty over the taxation of their citizens, but they are bound by existing treaties and international norms and do not have a free hand in taxing non-citizens. Therefore, euro countries can always service their domestic debt, even without access to the printing press, but not their external debt.

[4] The introduction of the Single Banking License in 1989 through the Second Banking Directive was a decisive step towards a unified European financial market, which subsequently led to a convergence in financial legislation and regulation across member countries.

systemic banking crisis can induce a contraction of the entire economy, weakening public finances and thus transferring the distress to the government. This effect is amplified when the financial sector has state guarantees. As a feedback effect, risk is further transmitted to holders of sovereign debt. On the other hand, macroeconomic imbalances in a specific country lead to rising sovereign spreads and a devaluation of the government debt that is mirrored in banks' balance sheets. Moreover, as the recent European sovereign debt crisis has stressed, transmission of the crisis in one country to others through the banking system can be a major issue.

The recent literature on sovereign debt has not studied these linkages in depth. Only a handful of recent papers have addressed the interaction between sovereign default and the stability of the domestic financial system. The analyses by Mody (2009), Ejsing and Lemke (2009), Gennaioli, Martin and Rossi (2010) and Broner, Martin and Ventura (2010), are among them[5]. The papers most closely related to our analysis are the studies by Bolton and Jeanne (2011) and Andenmatten and Brill (2011). Bolton and Jeanne's (2011) central issue is the analysis of the international contagion caused by the banks' exposure to the sovereign risk of foreign countries. To that end, they use data from the 2010 European stress test and show that financial integration without fiscal integration results in an inefficient equilibrium supply of government debt[6]. Andenmatten and Brill (2011) perform a bivariate test for contagion that is based on an approach proposed by Forbes and Rigobon (2002) to examine whether the co-movement of sovereign CDS premium increased significantly after the beginning of the Greek debt crisis in October 2009. Unlike Forbes and Rigobon, they conclude that in European countries "both contagion and interdependence" occurred.

However, an important constraint in the above-mentioned empirical evidence is the fact that it ignores the dynamic component of the degree of interconnexion of public debt markets. In this

[5] Beakert *et al.* (2011) analyze the transmission of crises to country-industry equity portfolios in 55 countries, using the 2007-2009 financial crisis as a laboratory.

[6] The same conclusion is reached by Gros and Mayer (2011) who say that "The EU resembles a group of highly interdependent companies with large cross-holdings of equity stakes. However, the formal structure of the group is very light. There is no central authority that can give orders to individual members of the group". They conclude that the euro area can no longer avoid a stark choice: "either it sticks to the limited liability character of EMU (but in this case sovereign default becomes likely), or it moves towards a fiscal union with a mutual guarantee for the public debt of all member countries".

regard, Abad, Chuliá and Gómez-Puig (2010 and 2012) examine the European government bond market integration from a dynamic perspective, applying an asset pricing model to a dataset spanning the years 2004 to 2009[7]. Nonetheless, the evolution of the time-varying degree of causality of EMU sovereign debt yields behavior (and the factors behind it, especially the role played by private debt and cross-border banking linkages) has not yet been analyzed in sufficient depth by the literature. This paper aims to carry out an analysis of this kind.

Thus, the main objectives of this paper are: (1) to test for the existence of possible causal relationships between the evolution of the yield of bonds issued by peripheral EMU countries, (2) to examine the time-varying nature of these causal relationships and to detect episodes of significant increase in causality between them, and (3) to analyze the determinants of those events considering not only macroeconomic imbalances, but also the role played by private debt, cross-border banking linkages and indicators of investor sentiment. This paper also makes three main contributions to the existing literature. First, it presents a dynamic approach to the analysis of the evolution of the degree of causality of EMU sovereign debt yields behavior. Second, it makes use of a unique dataset on private debt-to-GDP by sector (households, banks and non-financial corporations) in each EMU country and on cross-border banking linkages. Private debt dataset has been built up by the authors using the Monetary Financial Institutions (MFI) balance sheet statistics provided for each euro country by the European Central Bank, whilst cross border banking linkages are measured using the consolidated claims on an immediate borrower basis of Bank for International Settlements reporting banks (in the public, the banking and the non-financial private sectors). Third, it focuses the analysis on peripheral EMU countries (Greece, Ireland, Italy, Portugal and Spain), since these are the countries which have come under market pressure since 2009, reflecting investors' perceptions of risks, and which to a large extent have been the origin of the current sovereign debt crisis in the whole eurozone.

---

[7] Their results suggest that, from the beginning of the financial market tensions in August 2007, markets moved towards higher segmentation, and the differentiation of country risk factors increased substantially across countries. Although the levels were very low, the persistence of positive yield spreads against Germany detected before the beginning of the crisis (see Gómez-Puig, 2009a and 2009b) was still a reflection of incomplete integration in EMU bond markets.

The most important results of the analysis can be summarized as follows. Firstly, they provide empirical evidence of the existence of sub-periods of Granger causality in all pair-wise relationships. Secondly, they also present empirical evidence which indicates that the causality relationships between peripheral EMU yields have significantly increased during the recent crises in sovereign debt markets from 2009. Thirdly, the results of the probit models estimated to analyze the determinants of the episodes of causality intensification show that in all cases the variable that captures cross-border banking linkages is statistically significant. This finding might suggest that, not only macroeconomic imbalances may be key determinants of the probability of occurrence of those episodes, but in a scenario of increased international financial activity in the euro area, transmission of the crisis in one country to other countries through the banking system can be a major issue. Lastly, the results support the important role played by private debt, especially in the cases of Spain and Italy.

The rest of the paper is organized as follows. Section 2 presents the causality analysis and our approach for the detection of episodes of causality's increase. In Section 3 we carry out the exploration of the determinants of these episodes. Finally, Section 4 summarizes the findings and offers some concluding remarks.

2. Causality analysis

2. 1. Econometric methodology

The concept of Granger causality was introduced by Granger (1969) and Sims (1972) and is widely used to ascertain the importance of the interaction between two series. The central notion is one of predictability (Hoover, 2001): one variable Granger-causes some other variable, given an information set, if past information about the former can improve the forecast of the latter based only in its own past information. Therefore, the knowledge of one series evolution reduces the forecast errors of the other, suggesting that the latter does not evolve independently of the former.

Testing Granger causality typically employs the same lags for all variables. This presents a potential problem, since causality tests are sensitive to lag length. Therefore, it is important that the lengths selected should be the right ones to avoid inconsistently estimating the model and drawing misleading inferences (see, Thornton and Batten, 1985). In determining the optimal lag structure for each variable, we follow Hsiao's (1981) sequential method to test for causality, which combines Akaike's final predictive error (FPE, from now on) and the definition of Granger causality[8]. Essentially, the FPE criterion trades off bias that arises from under-parameterization of a model against a loss in efficiency resulting from over-parameterization of the model, removing us from the ambiguities of the conventional procedure.

Consider the following models,

$$X_{\mathrm{t}} = \alpha_0 + \sum_{i=1}^{m} \delta_i X_{t-i} + \varepsilon_t \tag{1}$$

$$X_t = \alpha_0 + \sum_{i=1}^{m} \delta_i X_{t-i} + \sum_{j=1}^{n} \gamma_j Y_{t-j} + \varepsilon_t \tag{2}$$

where X_t and Y_t are stationary variables [i.e., they are I(0) variables]. The following steps are used to apply Hsiao's procedure for testing causality:

i) Treat X_t as a one-dimensional autoregressive process (1), and compute its FPE with the order of lags *m* varying from 1 to *m*[9]. Choose the order which yields the smallest FPE, say *m*, and denote the corresponding FPE as FPE_X (m, 0).

ii) Treat X_t as a controlled variable with *m* number of lags, and treat Y_t as a manipulated variable as in (2). Compute again the FPE of (2) by varying the order of lags of Y_t from 1 to *n*, and determine the order which gives the smallest FPE, say *n*, and denote the corresponding FPE as FPE_X (m,n)[10].

---

[8] Thornton and Batten (1985) show that the Akaike's FPE criterion performs well relative to other statistical techniques.

[9] FPE_X(m,0) is computed using the formula: $FPE_X(m,0) = \frac{T+m+1}{T-m-1} \cdot \frac{SSR}{T}$, where T is the total number of observations and SSR is the sum of squared residuals of OLS regression (1)

[10] FPE_X(m,n) is computed using the formula: $FPE_X(m,n) = \frac{T+m+n+1}{T-m-n-1} \cdot \frac{SSR}{T}$, where T is the total number of observations and SSR is the sum of squared residuals of OLS regression (2)

iii) Compare FPE_X (m, 0) with FPE_X (m,n) [i.e., compare the smallest FPE in step (i) with the smallest FPE in step (ii)]. If FPE_X (m,0) > FPE_X (m,n), then Y_t is said to cause X_t. If FPE_X (m,0) < FPE_X (m,n), then X_t is an independent process.

iv) Repeat steps i) to iii) for the Y_t variable, treating X_t as the manipulated variable.

When X_t and Y_t are not stationary variables, but are first-difference stationary [i.e., they are I(1) variables] and cointegrated (see Dolado *et* al., 1990), it is possible to investigate the causal relationships from ΔX_t to ΔY_t and from ΔY_t to ΔX_t, using the following error correction models:

$$\Delta X_t = \alpha_0 + \sum_{i=1}^{m} \delta_i \Delta X_{t-i} + \varepsilon_t \qquad (3)$$

$$\Delta X_t = \alpha_0 + \beta Z_{t-1} + \sum_{i=1}^{m} \delta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + \varepsilon_t \qquad (4)$$

where Z_t is the OLS residual of the cointegrating regression ($X_t = \mu + \lambda Y_t$), known as the error-correction term. Note that, if X_t and Y_t are I (1) variables, but they are not cointegrated, then β in (4) is assumed to be equal to zero.

In both cases [i.e., X_t and Y_t are I(1) variables, and they are or are not cointegrated], we can use Hsiao's sequential procedure substituting X_t with ΔX_t and Y_t with ΔY_t in steps i) to iv), as well as substituting expressions (1) and (2) with equations (3) and (4). Proceeding in this way, we ensure efficiency since the system is congruent and encompassing **(**Hendry and Mizon, 1999).

2. 2. Data

We use daily data of 10-year bond yields from 1 January 1999 to 31 December 2010 collected from Thomson Reuters Datastream for EMU peripheral countries: Greece, Ireland, Italy, Portugal and Spain. Figures 1a and 1b plot the evolution of daily 10-year sovereign bond yields and their spread against the bund for each country in our sample. A simple look at these figures indicates the differences in the yields behavior before and after the financial crisis of 2008.

[Insert Figures 1a and 1b here]

Specifically, it is remarkable that after the introduction of the euro in January 1999 and until the subprime crisis in global financial markets in August 2007, spreads on bonds of EMU peripheral countries moved in a narrow range with only slight differentiation across countries. In fact, the stability and convergence of spreads was considered a hallmark of successful financial integration inside the euro area. Nevertheless, after the subprime crisis in 2007, severe tensions emerged in financial markets worldwide, including the EMU bond market. Moreover, following the collapse of the US financial institution Lehman Brothers on 15 September 2008, the financial turmoil turned into a global financial crisis which began to spread to the real sector.

Therefore, the financial crisis highlighted the imbalances within the euro area and yield spreads between government bond issues of participating countries, which had reached levels close to zero between 2003 and 2007 (the average value of the 10-year yield spread against the German bund moved between -4 and 20 basis points, in the case of Ireland and Greece, respectively), reemerged. Indeed, the risk premium on EMU government bonds increased strongly in 2008, reflecting investor perceptions of upcoming risks. Concretely, figure 1b displays that by the end of December 2010 it reached levels of 952 basis points in Greece, 580 in Ireland, 380 in Portugal, 255 in Spain and 182 in Italy.

[Insert Table 1 here]

Table 1 presents descriptive statistics for the levels and differences of the 10-year government's yield in peripheral EMU countries during the sample period (1999-2010). As can be seen, the mean is not significantly different from zero for the first differences. Normality is tested with the Jarque-Bera test (which is distributed as $\chi^2(2)$ under the null) and strongly rejected for both the levels and first differences. Since rejection could be due to either excess of kurtosis or skewness, we report these statistics separately in Table 1. Given that the kurtosis of the normal distribution is 3, our results suggest that the distribution of the yields of Greece and Ireland, as well as all the first differences, are peaked relative to the normal, while the distribution of the yields in the cases of Italy, Portugal and Spain are flat relative to the normal. Finally, regarding the asymmetry of the distribution of the series around their mean, we find positive skewness for all the variables in levels and for the first difference in the case of Italy, suggesting that their distributions have long right tails, whilst in the cases of the first differences of yields for Greece, Ireland, Portugal and Spain there is evidence of negative skewness and therefore of distributions with long left tails.

2.3. Preliminary results

As a first step, we tested for the order of integration of the 10-year bond yields by means of the Augmented Dickey-Fuller (ADF) tests. The results, shown in Table 2, decisively reject the null hypothesis of non stationarity, suggesting that both variables can be treated as first-difference stationary[11].

[Insert Table 2 here]

Following Carrion-i-Silvestre *et al.* (2001)'s suggestion, we confirm this result using the Kwiatkowski *et al.* (1992) (KPSS) tests, where the null is a stationary process against the alternative of a unit root. As can be seen in Table 3, the results fail to reject the null hypothesis of stationarity in first differences, but strongly reject it in levels.

[Insert Table 3 here]

As a second step, we tested for cointegration between each of the 10 pair combinations[12] of peripheral EMU yields using Johansen (1991, 1995)'s approach. An important decision in this approach is whether to include deterministic terms in the cointegrating Vector Autoregressive (VAR) model. Deterministic terms, such as the intercept, linear trend, and indicator variables, play a

---

[11] These results were confirmed using Phillips-Perron (1998) tests. These additional results are not shown here to save space, but they are available from the authors upon request.

[12] Recall that the number of possible pairs between our sample of five peripheral EMU yields is given by the following formula $\frac{n!}{r!(n-r)!} = \frac{5!}{2!(5-2)!} = 10.$

crucial role in both data behavior and limiting distributions of estimators and tests in integrated processes. Banerjee *et al.* (1993), Johansen (1994) and Nielsen and Rahbek (2000) show that the statistical properties of the commonly used test procedure are affected, indicating that in some cases its size cannot be controlled, and in others there is substantial power loss. Depending on their presence or absence, the system may manifest drift, linear trends in cointegration vectors, or even quadratic trends. In practical work, there seem to be only two relevant model representations for the analysis of cointegration amongst most economic time series variables:

i. the level data have no deterministic trend and the cointegrating equations have intercepts; and

ii. the level and the cointegrating equations have linear trends.

Table 1 shows that the hypothesis of the expected values of the first differences of the series is equal to zero can not be rejected; hence, there is no evidence of linear deterministic trends in the data. The graphs in Figure 1a support this finding. Therefore, we conclude that the cointegrated VAR model should be formulated according to i), with the constant term restricted to the cointegration space, and no deterministic trend terms. This implies that some equilibrium means are different from zero.

As can be seen in Table 4, only for the Greece-Ireland and Greece-Portugal cases does the trace test indicate the existence of one cointegrating equation at (at least) the 0.05 level. Therefore, for these two pairs we test for Granger-causality in first differences of the variables, with an error-correction term added [i. e., equations (3) and (4)], whereas for the remaining cases, we test for Granger-causality in first differences of the variables, with no error-correction term added [i. e., equations (3) and (4) with $\beta=0$]

[Insert Table 4 here]

2.4. Empirical results

The resulting FPE statistics for the whole sample are reported in Table 5.[13]

[Insert Table 5 here]

As can be seen, in most of the cases our results suggest bidirectional Granger causality. We do not find unidirectional Granger causality relationships running from Greece to Spain or from Portugal to Ireland.

Note that, even though the results of the cointegration tests reject (with only two exceptions) a long-run relationship between them, we find evidence of strong causal linkages between peripheral EMU yields. Therefore, each yield series contains useful information that is not present in the others which can help to explain the others' short-run evolution. This finding may indicate that peripheral EMU countries are considered by market participants as a group, confirming earlier evidence of market segmentation between core and peripheral EMU countries (see, e.g., Sosvilla-Rivero and Morales-Zumaquero, 2012).

In order to gain further insights into the dynamic causality between the 10 possible relationships in peripheral EMU yields, we carry out 33,486 rolling regressions using a window of 200 observations[14]. In each estimation, we apply Hsiao (1981)'s sequential procedure outlined above to determine the optimum FPE (m, 0) and FPE (m, n) statistics in each case.

A graphic presentation of the evolution of the difference between FPE (m, 0) and FPE (m, n) statistics in each case is shown in Figure 2. These graphs provide us with a view of the dynamic influence of each EMU peripheral yield over the other four and constitute our indicator of time-

[13] These results were confirmed using both Wald statistics to test the joint hypothesis $\hat{\gamma}_1 = \hat{\gamma}_2 = ... = \hat{\gamma}_n = 0$ in equation (4) and Williams-Kloot test for forecasting accuracy (Williams, 1959). These additional results are not shown here to save space, but they are available from the authors upon request.

[14] To the best of our knowledge, there is no statistical method to set the optimal window size. The chosen value of 200 observations is representative of the one used in practice and seems appropriate for our empirical application since it represents 6.36% of the sample.

varying causality. Adopting a forward-looking framework, we assign the computed indicator to the first date used in the rolling regressions. Therefore, the sample covers the period 1 January 1999 to 26 March 2010 in all cases, except in those pairs where Greece is present, in which case the sample runs from 1 January 2001 to 26 March 2010. Note that if the difference is positive in the case XX → YY, this indicates the existence of a statistically significant Granger causality relationship running from country XX towards country YY.

As can be seen, we find sub-periods of Granger causality in all pair-wise relationships, including those running from Greece to Spain and from Portugal to Ireland, even though these relationships were rejected in the whole sample tests. In other words, we detect, in all cases, sub-periods where the yields on bonds issued by one peripheral EMU country carries relevant and useful information about the future behaviour of the yields on bonds issued by other peripheral EMU country.

We proceed further by identifying sub-periods of significant increase in causality in order to be able to analyze which factors may have been behind them. To that aim, we identify episodes of causality intensification as those in which the time-varying causality indicator is greater than its average plus two standard errors[15]. Therefore, we look for episodes where there is evidence of an enlargement in the information content of the yield series to significantly improve the explanatory power of future evolution of the other yield series, suggesting a strengthening of their interdependence.

The graphs in Figure 2 suggest that these episodes are concentrated around the first year of the existence of the EMU in 1999, the introduction of euro coins and banknotes in 2002, and the global financial crisis of the late-2000s. As can be seen, the graphs also indicate that the causality relationships between peripheral EMU yields increased significantly during the recent crises in sovereign debt markets since 2009, providing evidence of a reinforcement of the interconnexion between them.

[15] We perform formal tests to evaluate whether the series have the same mean during the detected episodes and the rest of the observations. The results of these tests (not shown here, but available from the authors upon request) strongly reject the null hypothesis of equal mean across sub-samples, and provide additional support for the presence of increased causality.

[Insert Figure 2 here]

3. Determinants of episodes of causality intensification

3.1. Econometric methodology

Once the episodes of causality intensification have been detected, we use probit models to analyze their determinants. In our case, we define a new dependent variable (y) that takes the value one if we have detected such episode and zero otherwise. The goal is to quantify the relationship between a set of instruments (X) characterizing the country issuing a given bond and the probability of an episode of increased causality (y).

To this end, we adopt a specification designed to handle the particular requirements of binary dependent variables. Suppose that we model the probability of observing a value of one as:

$$\Pr(y = 1 \mid X, \beta) = 1 - \Phi(-X'\beta) = \Phi(X'\beta) \qquad (5)$$

where Φ is the cumulative distribution function of the standard normal distribution. As can be seen, we adopt the standard simplifying convention of assuming that the index specification is linear in the parameters so that it takes the form $X'\beta$.

3.2. Instruments to model the causality intensification

According to Dornbusch, Park, and Claessens (2000), reasons that may explain the evolution of yield's causality between countries can be divided into two groups: fundamental-based reasons on the one hand, and investor behavior-based reasons on the other. While fundamental-based transmission works through real and financial linkages across countries, behavior-based is more sentiment-driven. Therefore, in our analysis we will use instruments that capture both of them. Following the literature, in order to measure fundamental reasons we not only use instruments that gauge the country's fiscal position but also instruments that assess the foreign debt, the country's potential rate of growth, the loss of competitiveness, the private sector indebtedness and, specially the cross-border banking system linkages.

Concretely, the variables used to measure the country's fiscal position are the government debt-to-GDP (GOVDEB) and the government deficit-to-GDP (DEF). These two variables have been widely used in the literature by other authors (see, e.g., Bayoumi *et al.*, 1995) and present the advantage over the credit rating that they cannot be considered *ex post* measures of fiscal sustainability. They are compiled from Eurostat, and monthly data are linearly interpolated from quarterly observations. Besides, the current-account-balance-to-GDP ratio (CAC) is the instrument used as a proxy of the foreign debt and the net position of the country towards the rest of the world. The importance of this variable has been underlined by the IMF (2010) and Barrios *et al.* (2009). This variable is drawn from the OECD and monthly data are linearly interpolated from quarterly observations. In view of Mody (2009)'s argument that countries' sensitivity to the financial crisis is more pronounced the greater the loss of growth potential and competitiveness, we include instruments that measure these features. The unemployment rate (U), which has been collected from Eurostat, is the variable used to capture the country's growth potential, whilst the Harmonized Index of Consumer Prices monthly rate of growth (which has also been drawn from Eurostat) is the inflation rate measure (INF) we use as a proxy of the appreciation of the real exchange rate and, thus, the country's loss of competitiveness.

To assess the interconnection between the public and private debt and the role of the latter in the euro area sovereign debt crisis, we also incorporate instruments that capture the level of indebtedness of each country's private sector in the analysis. To that end, we make use of a unique dataset on private debt-to-GDP by sector (households, banks and non-financial corporations) in each EMU country. In particular, we use three variables: Banks' debt-to-GDP (BANDEB), non-financial corporations' debt-to-GDP (NFIDEB), and households' debt-to-GDP (HOUDEB), which have been constructed from data obtained from the European Central Bank Statistics. A summary of their evolution is presented in Table 6. Concretely, we have used the statistics corresponding to the Monetary Financial Institutions (MFI) balance sheets in each euro country. Thus, household debt corresponds to the total loans to households from MFIs. To isolate it from the intermediation effect that would inflate debt ratios, banks' debt is constructed by subtracting M3, banks' remaining liabilities and banks' capital and reserves from total MFI liabilities[16]. And non-financial corporation debt is built up by adding non-financial corporation securities to total loans to non-financial corporations from MFIs[17].

[Insert Table 6 here]

Table 6 clearly shows the importance of private debt in the ongoing crisis. Concretely, after the subprime crisis in August 2007, not only does the government level of indebtedness increase in the euro area (the ratio over the GDP achieves levels of 143%, 119%, 96%, 93% and 60% at the end of December 2010 in Greece, Italy, Ireland, Portugal and Spain, respectively) but private borrowing also registers a sizeable increase. In particular, as can be observed, at the end of 2010, banks' debt-to-GDP is huge in Ireland (729%), but is also high in Portugal, Spain and Greece (182%, 159% and 98%). On the other hand, households' debt-to-GDP surpasses the 80% threshold in Ireland, Portugal and Spain, whilst non-financial corporations' debt-to-GDP is close to 90% in Portugal and Spain and around 70% in Ireland. Thus, during the period 2007-2010, whereas the government debt-to-GDP ratio registers the highest increases compared to the period 2002-2006 in Ireland, Portugal and Greece (39%, 15% and 9%), there is a much steeper rise in the banks' debt-to-GDP ratio which is higher than 150% in Greece, close to 70% in Ireland, around 64% in Spain and close to 40% in Portugal. Besides, households' debt-to-GDP ratio registers an increase close to 30% in Greece, close to 20% in Ireland and Spain and around 15% in Italy, whilst non-financial corporations' debt-to-GDP ratio rises close to 30%, 25% and 20% in Ireland, Spain and Greece respectively.

As it has already been mentioned, some authors (Bolton and Jeanne (2011) and Allen *et al.* (2011) among them) outline that, in an scenario of increased international financial activity in the euro

[16] The banks' debt variable we have constructed avoids the effects of intermediation, even though it can only be considered as an approximation of its real value, and some caveats are in order: specifically, some deposits will appear as debt (those not included in M3) and some debt securities will not be considered debt (those included in M3).

[17] Non-financial corporations' (NFCs) debt should also include "net equity of households" (liabilities of NFCs from direct pension commitments to their employees). Nevertheless, we have ignored this variable since it was not available for all the countries in the sample.

area, not only public finances imbalances are key determinants of the probability that the sovereign debt crisis could spill over from one country to another, but that transmission of the crisis through the banking system can also be a major issue. Therefore, in our analysis we also include variables that capture the important cross-border banking system linkages in euro area countries. These linkages are measured using the consolidated claims on an immediate borrower basis of Bank for International Settlements (BIS) reporting banks in the public, banking and non-financial private sectors as a proportion of GDP (monthly data are linearly interpolated from quarterly observations). In particular, we include foreign bank claims on government debt-to-GDP (PUB), on bank debt-to-GDP (BAN) and on non-financial private sector debt-to-GDP (PRI). The evolution of these variables is summarized in Table 7.

[Insert Table 7 here]

The figures in Table 7 underline the fact that, as it was mentioned in the Introduction, the causes of the debt crises that led to subsequent rescues in Europe varied substantially according to country. Greek fiscal deficit and public debt to GDP were close to 15% and 130% at the end of 2009 as a result of chronic macroeconomic imbalances. Besides, on average, foreign banks' claims on its public sector debt represented around 30% of its GDP during the period 2005-2010. Conversely, in Ireland, the crisis was mainly due to the private sector, particularly the domestic housing boom which was financed by foreign borrowing. In particular, the amount of bank and non-financial enterprise debt claimed by foreign banks is huge during the period 2005-2010 (102% and 216% of its GDP, on average). Finally, in Portugal, markets were mostly worried about the country's high external debt, specifically, that of its non-financial corporations. During the 2005-2010 period, foreign banks' claims on Portuguese enterprises surpassed 40% of the country's GDP.

Moreover, we also explore the role of consolidated claims on an immediate borrower basis provided by BIS by nationality of reporting banks as a proportion of total foreign claims on each country. This variable is denoted as XXYYBAN, meaning the percentage of country XX's foreign claims held by country YY's banks (again, monthly data have been linearly interpolated from quarterly observations).

[Insert Table 8 here]

This information is displayed in Table 8 and is very useful for understanding the channels of transmission of debt crises through the banking system. It can be observed that at the end of 2010 French and German banks were the most exposed to foreign Greek debt, holding 39.6% and 23.7% of total foreign Greek claims respectively. In the case of Ireland, the maximum risk was borne by British banks (29.9%) followed by the Germans (26.13%). A Portuguese default would be especially harmful for Spanish banks which hold 41.9% of Portuguese banks' total claims. Finally, around 45% and close to 65% of Spanish and Italian foreign claims, respectively, are held by French and German banks.

Finally, as mentioned, we also introduce an instrument that might capture investor behavior-based reasons of crisis's transmission. We use the credit rating as a proxy of the default risk (RAT). Standard &Poor's, Moody's and Fitch ratings for each government's debt are compiled from Bloomberg. Following Blanco (2001), we build up a scale to gauge the effect of investor sentiment based on the rating offered by the three agencies[18].

3.3. Empirical results

Given that the instruments used as independent variables have been constructed on a monthly frequency, we need also to compute the dependent variable in the probit models on a monthly basis. To do so, we first assign a value of 1 to the daily observation if the time-varying causality indicator is greater than its average plus two standard errors. In the second step, we compute the monthly data by averaging the daily observation and assigning a value of 1 if the resulting monthly

[18] By construction, the higher the scale, the worse the rating categories.

average is greater than 0.5 (i. e., if at least for half of the month there is evidence of causality intensification).

In Table 9 we report the results of the probit models estimated by maximum likelihood for the sample period March 2005 to March 2010[19,20]. The z-statistics in that table are based on robust standard errors computed using the Huber-White quasi-maximum likelihood method.

[Insert Table 9 here]

The analysis of the coefficient values is complicated by the fact that coefficients estimated from a binary model cannot be interpreted as the marginal effect on the dependent variable. Nevertheless, the direction of the effect of a change in any instrument depends only on the sign of the coefficient estimated: positive values imply that an increase in a given instrument will raise the probability of contagion, while negative values indicate the opposite.

As expected, our results indicate that the variables used to measure the country's fiscal position (GOVDEB and DEF) are important determinants of the probability of an episode of causality's increase. However, our results also indicate that other factors beyond the fiscal position explain those episodes, too. Interestingly, the variable XXYYBAN is statistically significant in all cases; suggesting that, in a scenario of increased cross-border financial activity in the euro area, transmission of the crisis in one country to other countries through the banking system can really be a major issue.

---

[19] Note that even though we could be dealing with a binary choice model with I(1) regressors, Park and Phillips (2000) have proved that the coefficient estimated by maximum likelihood are still consistent, converging at a rate $T^{3/4}$ along its principal component, having a slower rate of T^{314} convergence in all other directions. Moreover, this authors showed that the limit distribution of the maximum likelihood estimator was mixed normal with mixing variates being dependent upon Brownian local time as well as Brownian motion, so the usual inference methods are still valid Grabowski (2007) have added that when among the regressors include variables with different orders of integration, the rate of convergence of the estimate of the coefficients depend of such order: T^{314} for stationary regressors and T^{314} for I(1) or I(2) regressors.

[20] The reduction in the sample period is imposed by the availability of data regarding the consolidated claims of Bank for International Settlements' reporting banks on each sector.

Moreover, the instruments used to gauge both the level of competitiveness (INF) and the net position towards the rest of the world (CAC) are statistically significant with the expected sign. In particular, they are extremely useful when explaining the causality from Greece, Spain and Portugal. In relation to the variables used to capture the country's growth potential, we find a positive influence for U which suggests that the weaker the economy, the higher the probability of sovereign debt crisis transmission. This conclusion is particularly relevant in the case of Greece, Italy and Portugal.

With regard to the role of private debt, we find empirical evidence supporting its importance in the cases of Spain and Italy. Interestingly, this variable is not significant in the case of Ireland, even though some authors have claimed that it was the main cause of the debt crisis in this country. Nevertheless, we detect a major effect of foreign bank claims on banking and non-financial private sector debt-to-GDP on the probability of an episode of causality's increase from Ireland. This finding seems to underline the dependence of Ireland's domestic expansion on foreign borrowing.

Finally, as regards the impact of investor sentiment, the credit rating scale seems to be an important determinant in six out of the 20 cases considered.

In Table 9 we report the McFadden R-squared as a measure of goodness of the fit. As can be seen, it ranges from 0.5595 to 0.8474, suggesting the relative success of the probit regression models in predicting the values of the dependent variable within the sample[21]. As a further test to evaluate how well our estimated probit models fit the observations, we compute the fitted probability both within-sample and out-of-sample. Recall that when generating our indicator, we left out nine observations (April to December 2010) that were not used in the estimation. This allows us to evaluate the out-of-sample performance of the estimated probit models based on the actual evolution of the instrumental variables. Figure 3 reports the results.

[21]The same conclusion is reached when performing the Pearson-type test of goodness-of-fit proposed by Hosmer and Lemeshow (2000.)

[Insert Figure 3 here]

As can be seen, the fitted probabilities closely track the evolution of the observed within-sample probabilities. Regarding the out-of-sample probabilities, our results suggest the occurrence of an additional episode of significant increase of causality in the last months of 2010 coinciding with a period of renewed turbulence in European debt markets.

4. Concluding remarks

In the current context of uncertainty in European sovereign debt markets, the analysis presented in this paper deals with a subject that has not been addressed in sufficient depth by the literature and is of particular relevance both to academics and to policy-makers.

Concretely, this paper presents a dynamic approach to the analysis of the evolution of the degree of causality between peripheral EMU sovereign yields behavior (Greece, Ireland, Italy, Portugal and Spain). To this end, we have (1) tested for the existence of possible causal relationships between the evolution of these countries 10-year yields, (2) examined the time-varying nature of these causal relationships to detect episodes of significant increase of causality between them, and (3) analyzed the determinants of these episodes.

Since it seems increasingly clear that the origin of sovereign debt crisis in Europe has gone beyond the imbalances in public finances and that there is an obvious interconnection between public and private debt, we have analyzed the role of the latter in the episodes of causality intensification by using a unique dataset on private debt-to-GDP by sector (households, banks and non-financial corporations) in each peripheral EMU country. Besides, since the reasons that may explain transmission of sovereign debt crisis from one country to another can be fundamental-based or investor behavior-based, we have included instruments that capture both types. In addition, we have borne in mind that fundamental-based contagion works not only through real linkages, but also through financial linkages across countries. Specifically, in the current scenario of increased cross-border financial activity in the euro area, special attention has been paid to the impact of the degree of integration of the banking system on the speed at which a sovereign crisis in a country can spill over to others. This channel of transmission has generally been ignored by the recent literature, but its relevance is crucial.

The main results of our analysis can be summarized as follows. Firstly, the results of the rolling analysis we apply in order to explore the dynamic causality between peripheral EMU yields suggest that there exist sub-periods of Granger causality in all pair-wise relationships. Secondly, our empirical evidence suggests that the episodes with significant causality increase are concentrated around the first year of the launch of the EMU in 1999, the introduction of euro coins and banknotes in 2002 and the global financial crisis in the late-2000s. Therefore, our results indicate that the causality relationships between peripheral EMU yields have been significantly reinforced during the recent crises in sovereign debt markets since 2009. Thirdly, the results of the probit models estimated to analyze the determinants of the previously detected episodes indicate that in all cases the variable that captures cross-border banking linkages is statistically significant. This finding suggests that, in a scenario of increased international financial activity in the euro area, transmission of the crisis in one country to other countries through the banking system may be an important issue. It is important to recall that macroeconomic imbalances in a specific country (the instruments we have used to capture them also indicate that they are key determinants of the probability of occurrence of an episode of causality's increase) lead to rising sovereign spreads and a devaluation of the government debt that is mirrored in banks' balance sheets. Lastly, regarding the role of private debt, we find evidence of its importance in the cases of Spain and Italy. However, we detect a major effect of foreign bank claims on private sector debt in the case of Ireland, which seems to underline the dependence of Ireland's domestic boom on foreign borrowing.

References

Abad, P.; H. Chuliá and M. Gómez-Puig (2010). "EMU and European Government Bond Market Integration", *Journal of Banking and Finance,* Vol. 34, pp. 2851–2860.

Abad, P.; H. Chuliá and M. Gómez-Puig (2012). "Time-varying integration in European government bond markets". *European Financial Management*, fortchoming

Andenmatten, S. and F. Brill (2011). "Measuring Co-Movements of CDS Premia during the Greek Debt Crisis". Discussion Papers 11-04, Department of Economics , University of Bern.

Allen, F.; T. Beck; E. Carletti; P.L. Lane; D. Schoenmaker and W. Wagner (2011). *Cross-Border Banking in Europe: Implications for Financial Stability and Macroeconomic Policies*. London: Centre for Economic Policy Research Editions.

Akaike, H. (1974). "A New Look at the Statistical Model Identification", *IEEE Transactions on Automatic Control*, Vol. 19, pp. 716–723

Banerjee, A., Dolado, J., Galbraith, J. and Hendry, D. (1993): *Cointegration, Error Correction and the Econometric Analysis of Nonstationary Series*. Oxford: Oxford University Press.

Bank for International Settlements (2011). "International Banking and Financial Market Developments", *BIS Quarterly Review*, June.

Bayoumi, T., Goldstein, M., Woglom, G. (1995). "Do credit markets discipline sovereign borrowers? Evidence from the US States". *Journal of Money Credit and Banking*, Vol. 27, pp. 1046-1059.

Bekaert, G.; M. Ehrmann; M. Fratzscher and A. Mehl (2011). "Global crises and equity market contagion". Discussion Paper 8438, Centre for Economic Policy Research.

Barnes, S, Lane, P R and Radziwill A (2010), "Minimising Risks from Imbalances in European Banking". Working Paper 828, Economics Department, Organization for Economomic Cooperation and Development.

Barrios, S.; P. Iversen.; M. Lewandowska and R. Setze (2009). "Determinants of intra-euro area government bond spreads during the financial crisis". Economic Paper 388, European Commission.

Blanco, R. (2001). "The euro-area government securities markets. Recent developments and implications for market functioning". Documento de Trabajo 0120, Banco de España.

Bolton, P. and O. Jeanne (2011). "Sovereign default risk and bank fragility in financially integrated economies". Discussion Paper 8368, Centre for Economic Policy Research.

Broner, Fernando,and Jaume Ventura (2011). "Globalization and Risk Sharing". *Review of Economic Studies*, Vol. 78, pp. 49-82.

Carrión-i-Silvestre, J. L., Sansó-i-Roselló, A. and Ortuño, M. A. (2001). "Unit root and stationarity tests' wedding". *Economics Letters*, Vol. 70, pp. 1–8.

Dolado, J. J., Jenkinson, T. and Sosvilla-Rivero, S. (1990): "Cointegration and Unit Roots". *Journal of Economic Surveys*, Vol. 4, pp. 149-173.

Dornbusch, R., Park, Y. C., & Claessens, S. (2000). "Contagion: Understanding how it spreads". *The World Bank Research Observer*, Vol. 15, pp. 177-198.

Ejsing, J. and W. Lemke (2009). "The Janus-headed salvation: sovereign and bank credit risk premia during 2008-09". Working Paper 1127, European Central Bank.

Forbes, K., & Rigobon, R. (2002). "No contagion, only interdependence: Measuring stock market comovements". *Journal of Finance*, Vol. 57, pp. 2223-2261.

Gennaioli, N.; A. Martin and S. Rossi (2011). "Sovereign Default, Domestic Banks and Financial Institutions". *NBER Meetings in International Finance and Macroeconomics*.

Gómez-Puig, M. (2006). "Size Matters for Liquidity: Evidence from EMU Sovereign Yield Spreads", *Economics Letters*, Vol. 90, pp. 156-162.

Gómez-Puig, M. (2008). "Monetary Integration and the Cost of Borrowing", *Journal of International Money and Finance,* Vol. 27, pp. 455-479.

Gómez-Puig M. (2009a). "The Immediate Effect of Monetary Union over UE-15's Sovereign Debt Yield Spreads", *Applied Economics*, Vol. 41, pp. 929-939.

Gómez-Puig, M. (2009b) "Systemic and Idiosyncratic Risk in UE-15 Sovereign Yield Spreads After Seven Years of Monetary Union", *European Financial Management*, Vol. 15, pp. 971–1000.

Granger, C. W. J. (1969) "Investigating Causal Relations by Econometric Models and Cross-spectral Methods", *Econometrica*, Vol. 37, pp. 24-36.

Grabowsky, W. (2007): "Integrated time series in binary choice models", in A. Welfe and W. Welfe (eds.) *33rd International Conference MACROMODELS'06*, pp. 215-233.

Gray, D. F. (2009). "Modeling Financial Crises and Sovereign Risks," *Annual Review of Financial Economics,* Vol. 1, pp.117–144.

Gros, D. (2011). "External versus domestic debt in the euro crisis". Policy Brief 243, Centre for European Policy Studies.

Gros, D. and T. Mayer (2011). "Debt reduction without default?". Policy Brief 233, Centre for European Policy Studies.

Hendry, D. F. and Mizon, G. E. (1999): "The Pervasiveness of Granger Causality in Econometrics", in R. F. Engle and H. White (eds.) *Cointegration, Causality, and Forecasting. A Festsschrift in Honour of Clive W. J. Granger*, pp. 102-134. Oxford: Oxford University Press.

Hoover, K. D. (2001): *Causality in Macroeconomics*. Cambridge: Cambridge University Press.

Hosmer, D.W. and Lemeshow, S. (2000): *Applied Logistic Regression*. New York, John Wiley and Sons.

Hsiao, C. (1981). "Autoregressive Modelling and Money-income Causality Detection", *Journal of Monetary Economics*, Vol. 7, pp. 85–106.

International Monetary Fund (2010). "Global Financial Stability Report", *April.*

Johansen, S. (1991): "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, Vol. 59, pp. 1551-1580.

Johansen, S. (1994): "The Role of the Constant and Linear Terms in Cointegration Analysis of Nonstationary Variables", *Econometric Reviews*, Vol. 13, pp. 205-229.

Johansen, S. (1995): *Likelihood-based Inference in Cointegrated Vector Autoregressive Models*. Oxford: Oxford University Press.

Kalemi-Ozcan, S.; E. Papaioannou and J.-L. Peydró-Alcalde (2010): "What Lies Beneath the Euro's Effect on Financial Integration? Currency Risk, Legal Harmonization, or Trade? *Journal of International Economics*, Vol. 81, pp. 75-88.

Lane, P.R. (2011). "The Irish Crisis". Discussion Paper 8287, Centre for Economic Policy Research.

MacKinnon, J. G., Haug, A. A. and Michelis, L. (1999): "Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration", *Journal of Applied Econometrics*, Vol.14, pp. 563-577.

Mody, A. (2009). "From Bear Sterns to Anglo Irish: How Eurozone sovereign spreads related to financial sector vulnerability". Working Paper 09/108, International Monetary Fund.

Nielsen, B. and Rahbek, A. (2000). Similarity Issues in Cointegration Analysis". *Oxford Bulletin of Economics and Statistics*, Vol. 62, pp. 5-22.

Park, J. Y. and Phillips, P. C. B. (2000): "Nonstationary binary choice", *Econometrica*, Vol 68, pp.1249-1280.

Phillips, P. C. B. and Perron, P. (1988): "Testing for a Unit Root in Times Series Regression", *Biometrika*, Vol. 75, pp. 335-346.

Sims, C. A. (1972): "Money, Income, and Causality", *American Economic Review*, Vol. 62, pp. 540-552.

Sosvilla-Rivero, S. and Morales-Zumaquero, A. (2012): "Volatility in EMU Sovereign Bond Yields: Permanent and Transitory Components", *Applied Financial Economics*, Vol. 22, pp. 1453-1464.

Spiegel, M (2009a). "Monetary and Financial Integration in the EMU: Push or Pull?". *Review of International Economics*, Vol. 17, pp. 751-776.

Spiegel, M (2009b). "Monetary and Financial Integration: Evidence from the EMU". *Journal of the Japanese and International Economies*, Vol. 23, pp. 114-130.

Thornton, D. L., and Batten, D. S. (1985). "Lag-length Selection and Tests of Granger Causality between Money and Income", *Journal of Money, Credit, and Banking*, Vol. 27, pp. 164-178.

Williams, E.J. (1959): *Regression analysis,* Wiley, New York.

Figure 1a. Daily 10-year sovereign yields in peripheral EMU countries: 1999-2010

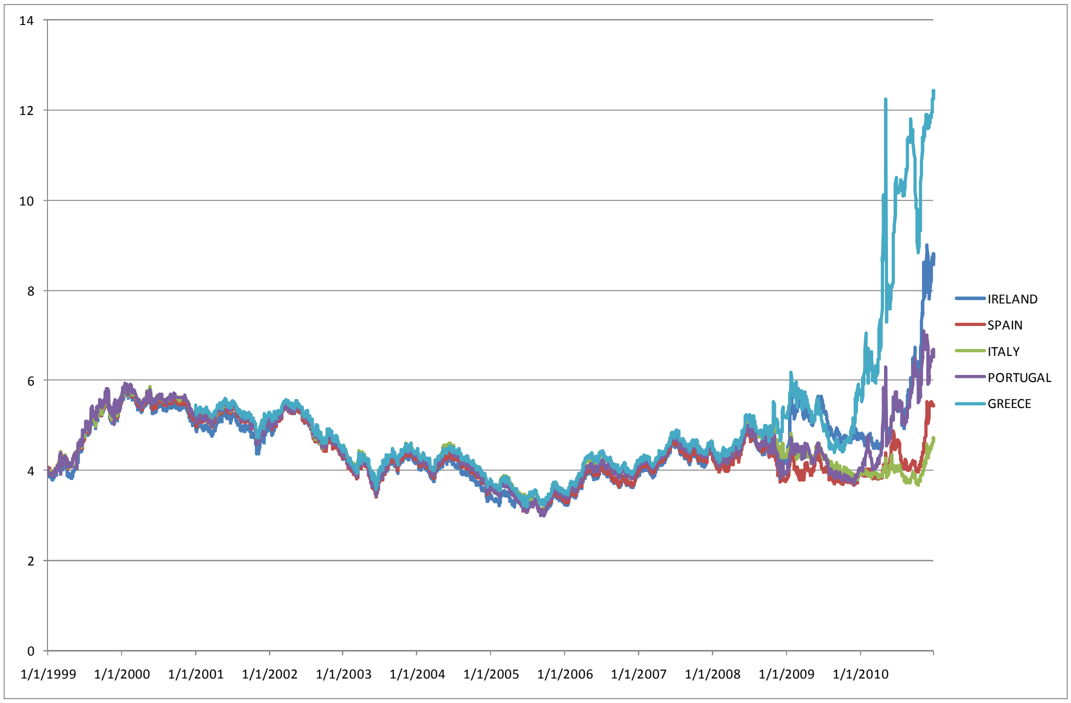


Figure 1b. Daily 10-year sovereign yield spreads over Germany: 1999-2010

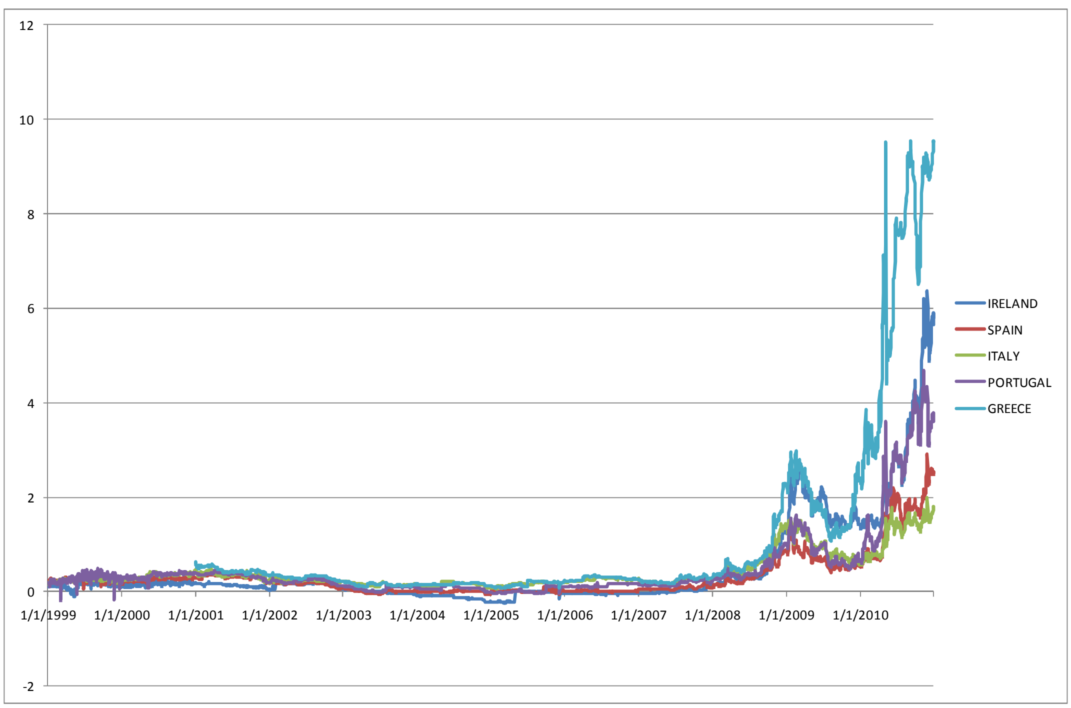
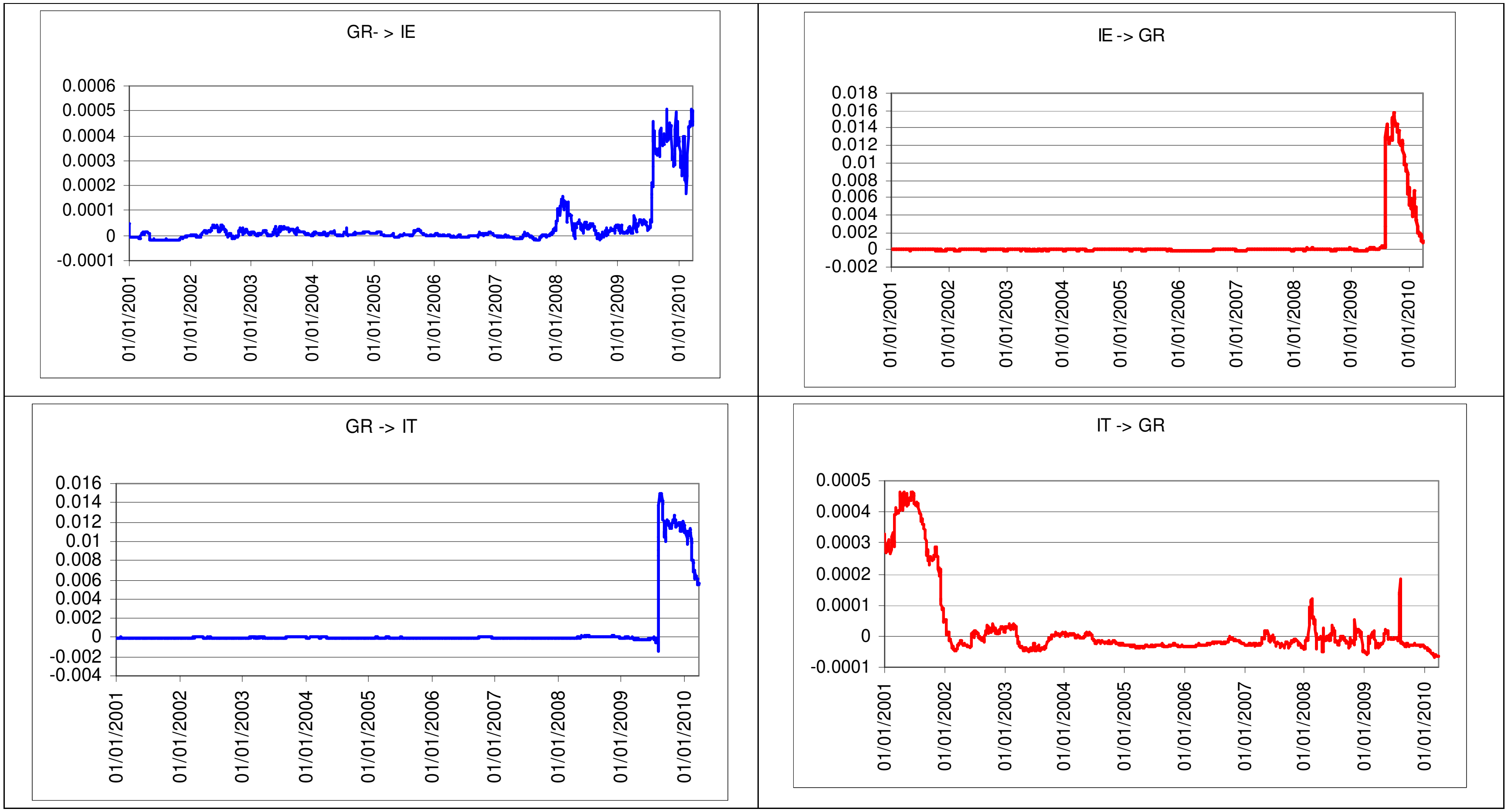
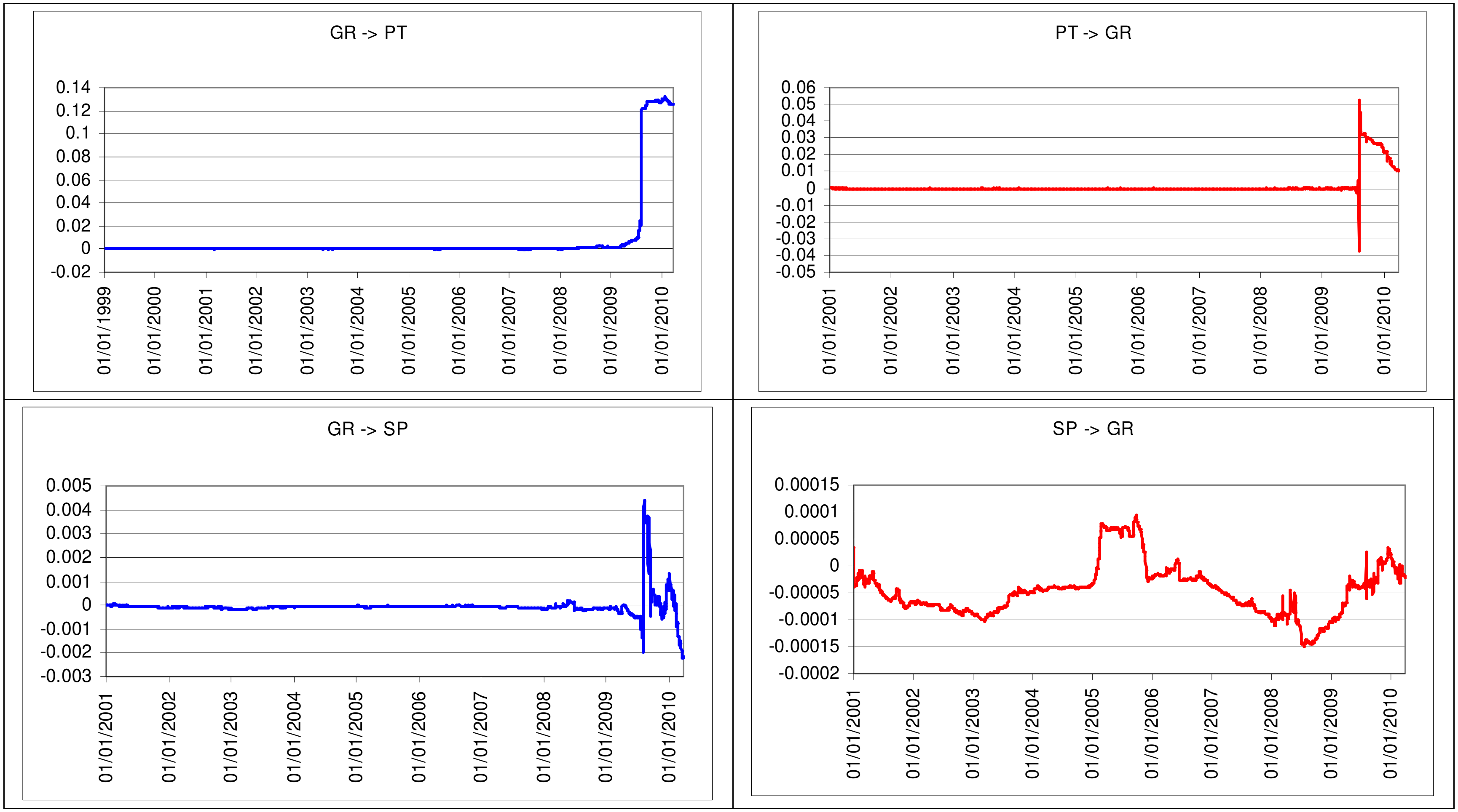
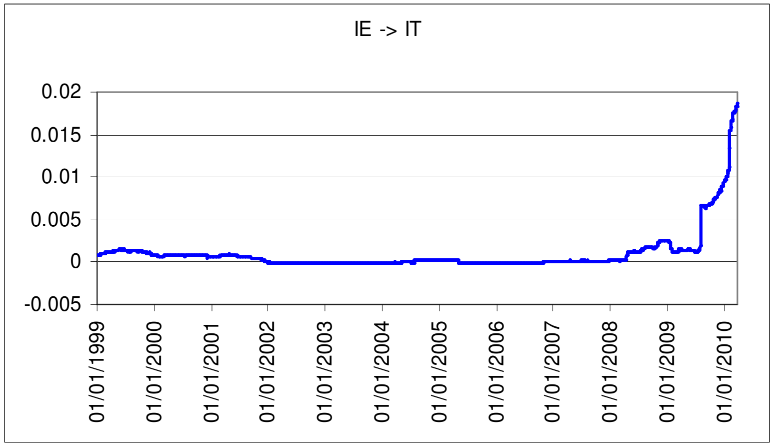
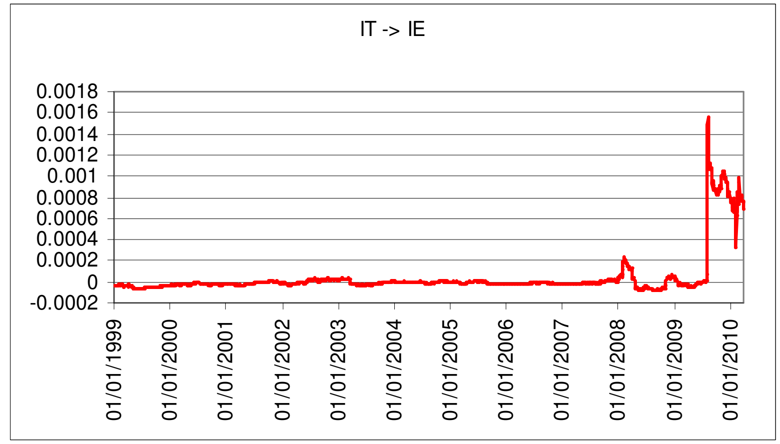


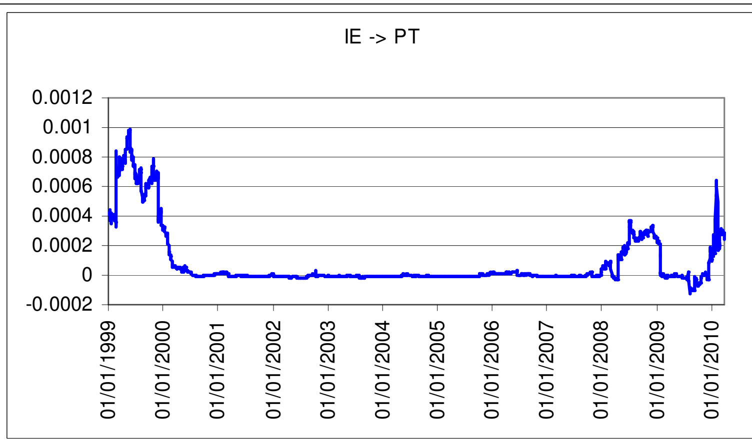
Figure 2: FPE sequence from rolling regressions

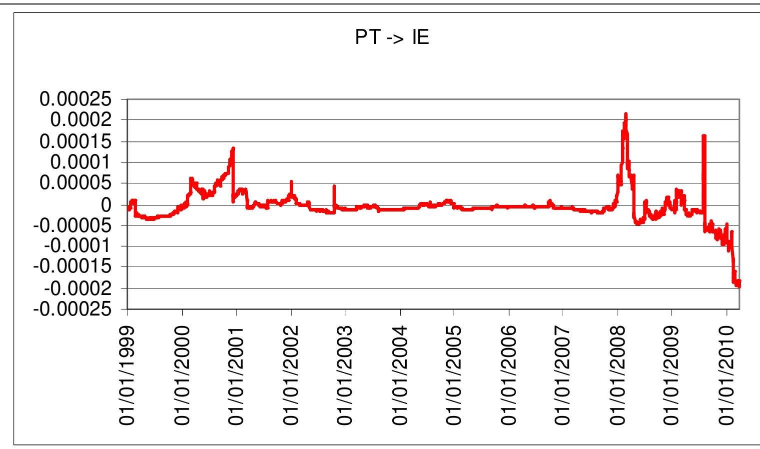


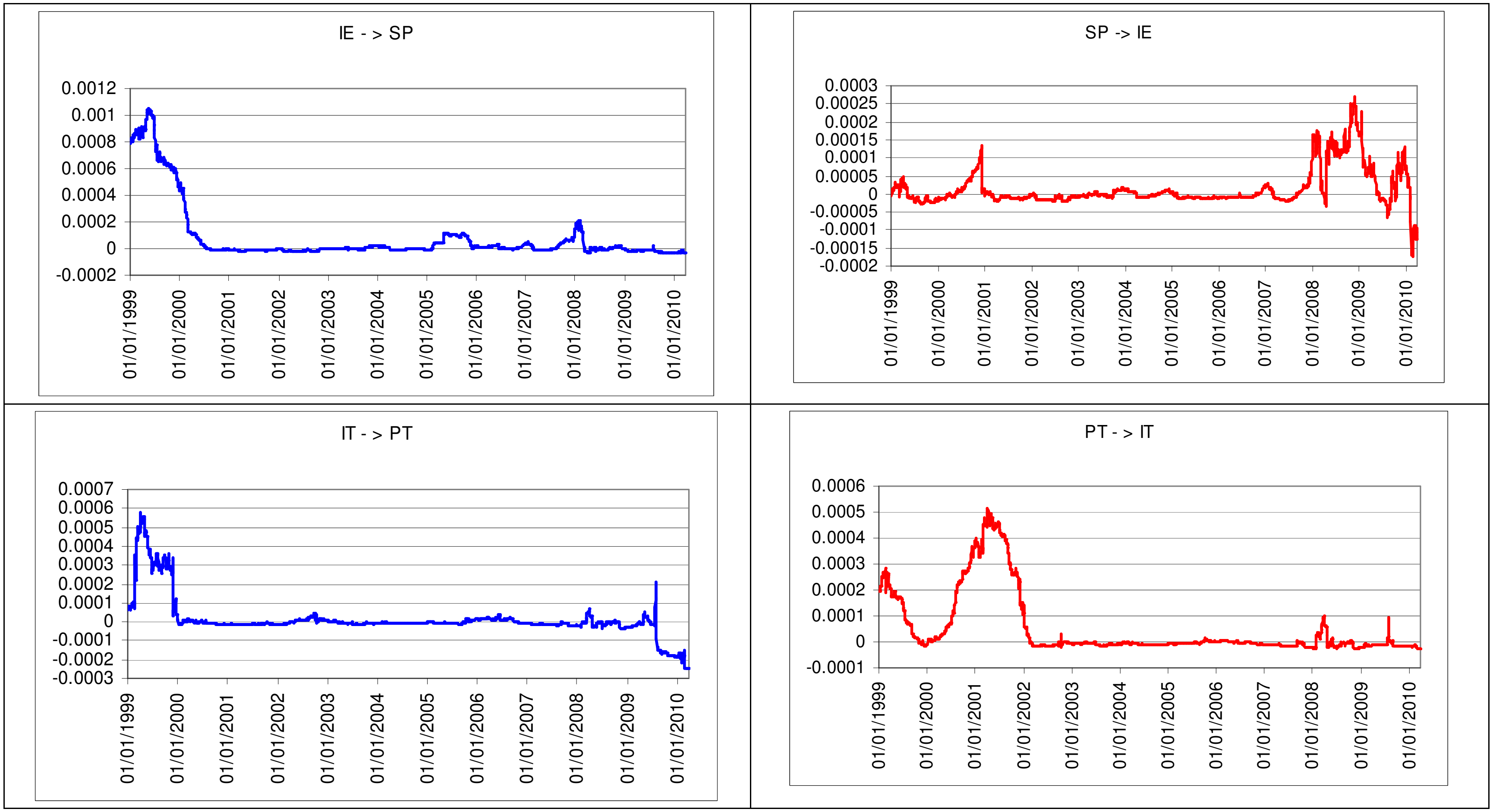

GR -> PT
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
PT -> GR
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
GR -> SP
0.005
0.004
0.003
0.002
0.001
0
-0.001
-0.002
-0.003
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
SP -> GR
0.00015
0.0001
0.00005
0
-0.00005
-0.0001
-0.00015
-0.0002
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010


IE -> IT
0.02
0.015
0.01
0.005
0
-0.005
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010


IT -> IE
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
-0.0002
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010


IE -> PT
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
-0.0002
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010


PT -> IE
0.00025
0.0002
0.00015
0.0001
0.00005
0
-0.00005
-0.0001
-0.00015
-0.0002
-0.00025
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010


IE - > SP
SP -> IE
IT - > PT
PT - > IT
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010

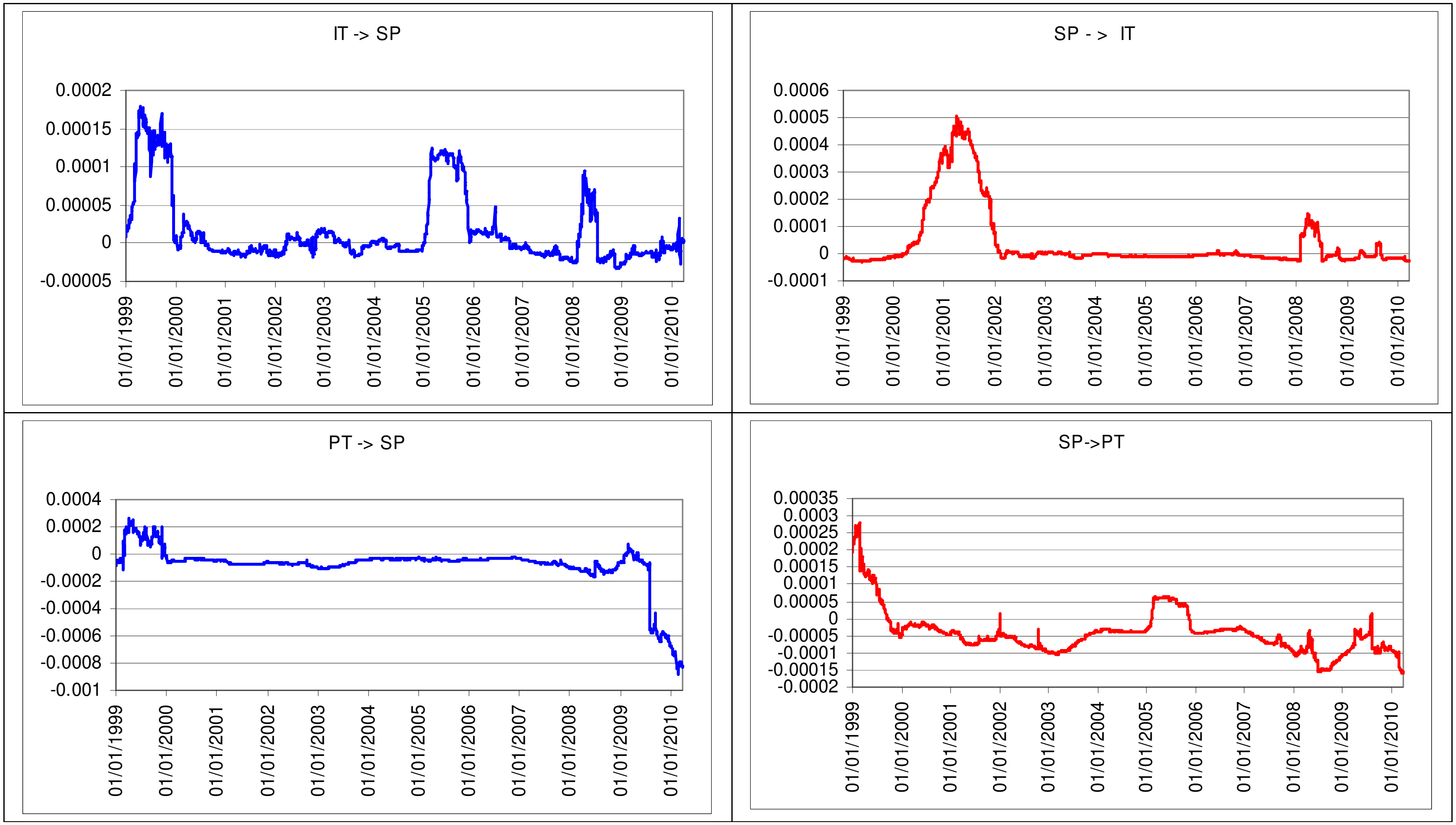
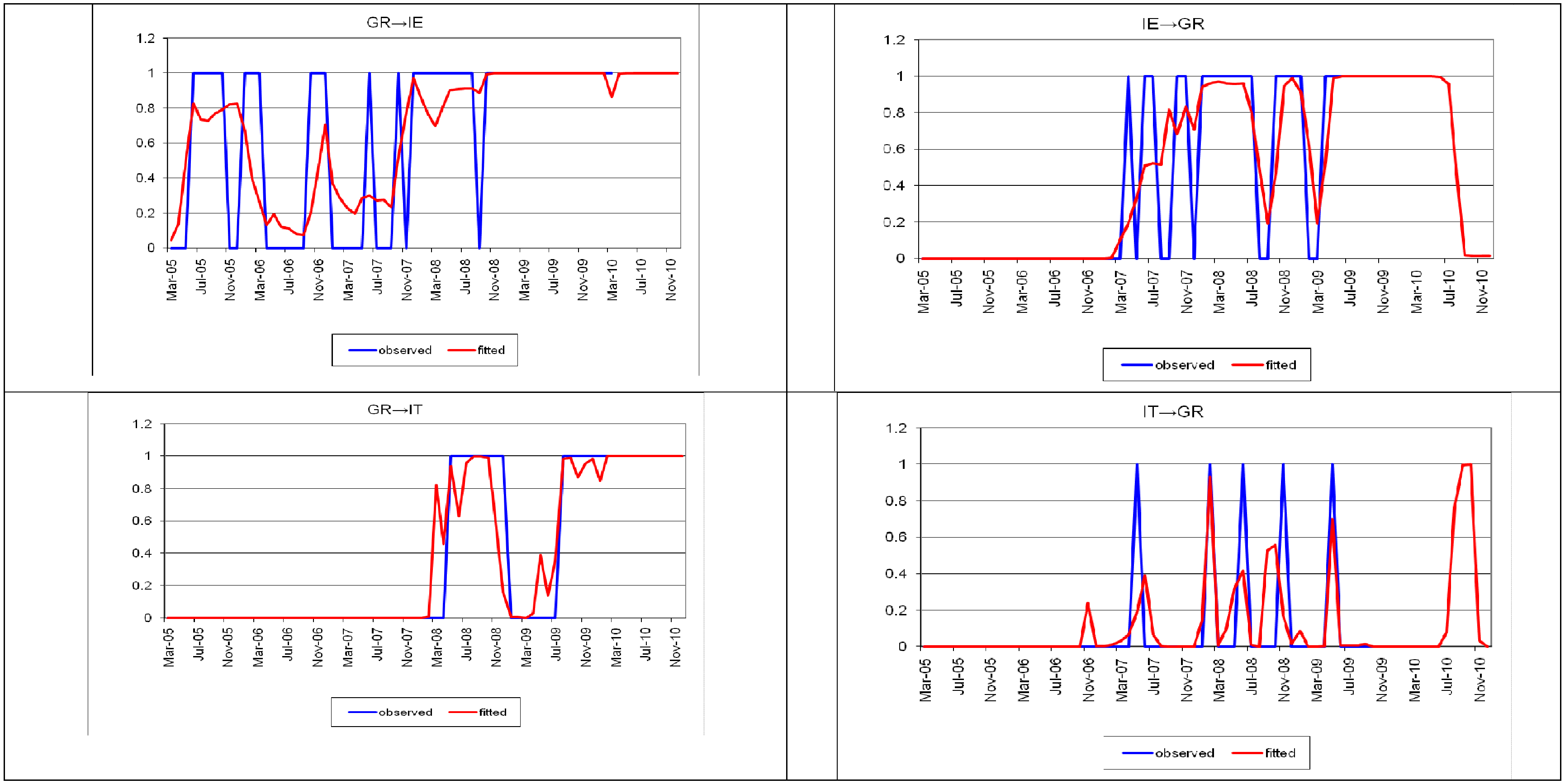
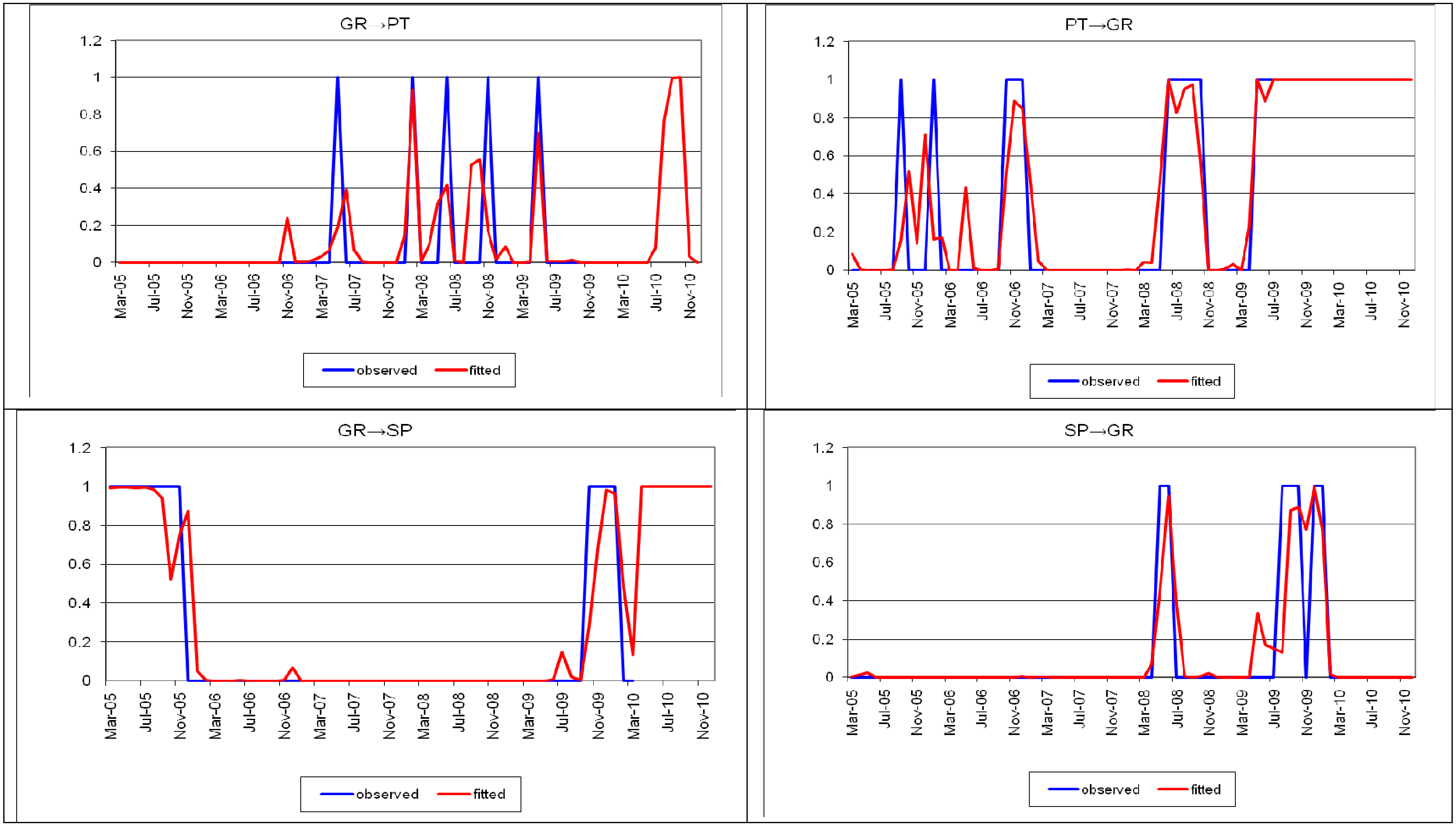
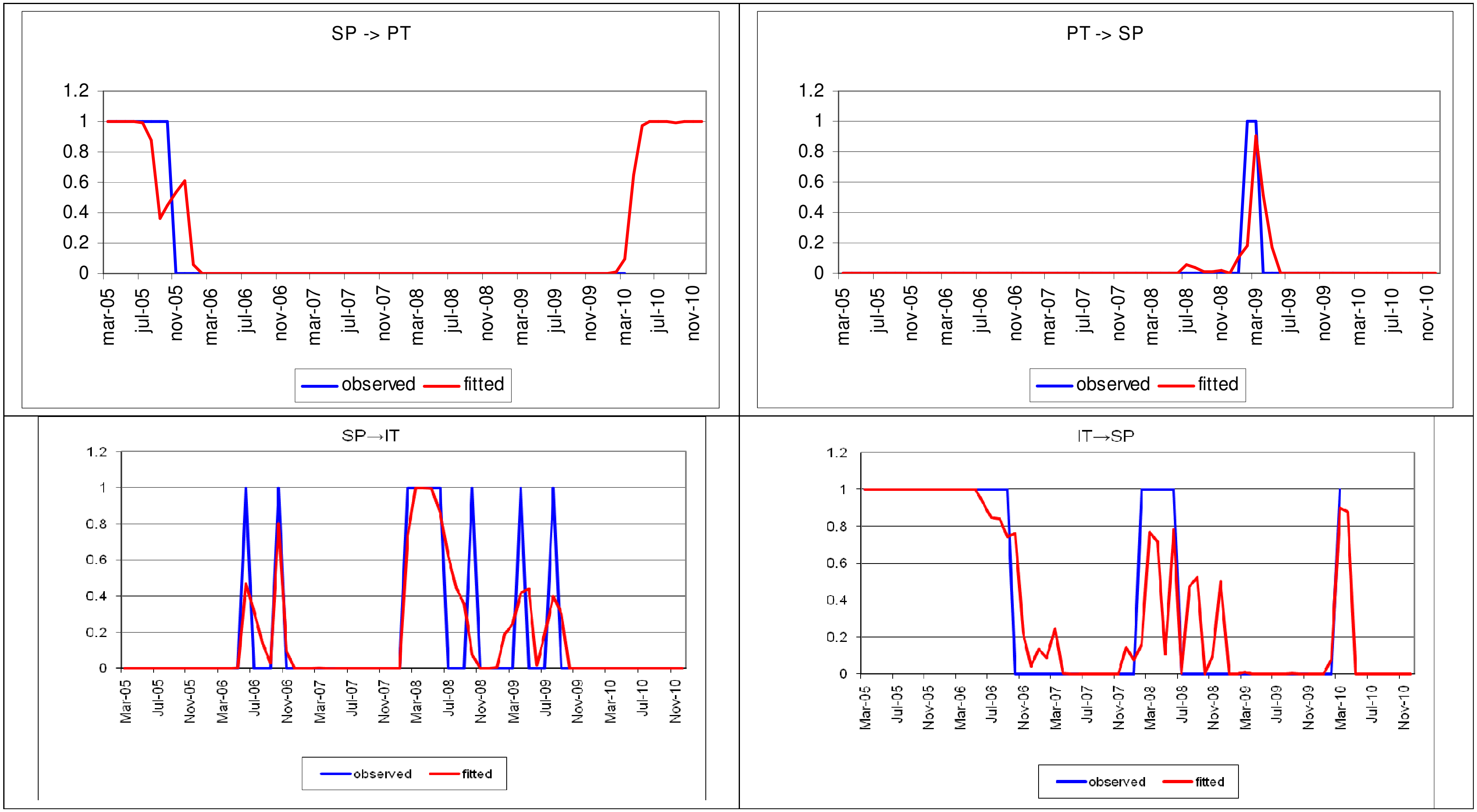
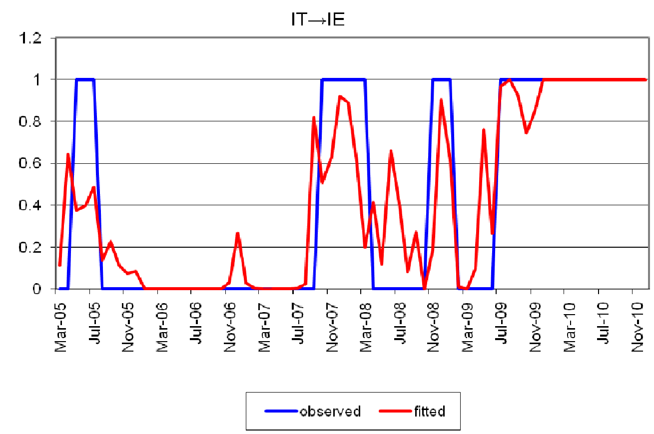

IT -> SP
0.0002
0.00015
0.0001
0.00005
0
-0.00005
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
SP - > IT
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
-0.0001
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
PT -> SP
0.0004
0.0002
0
-0.0002
-0.0004
-0.0006
-0.0008
-0.001
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
SP->PT
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
-0.00005
-0.0001
-0.00015
-0.0002
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010

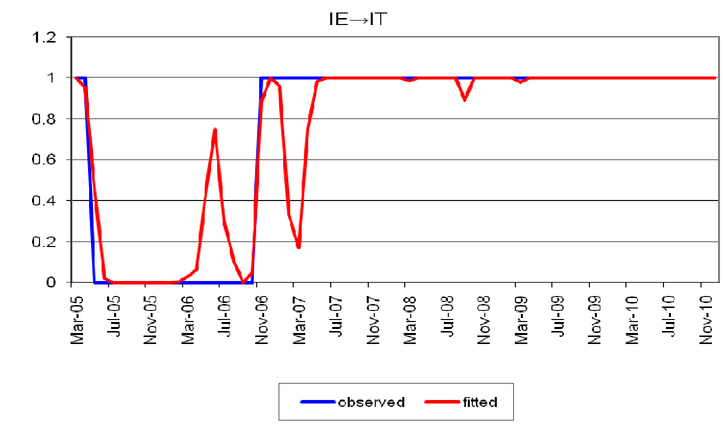
Figure 3: Probit results

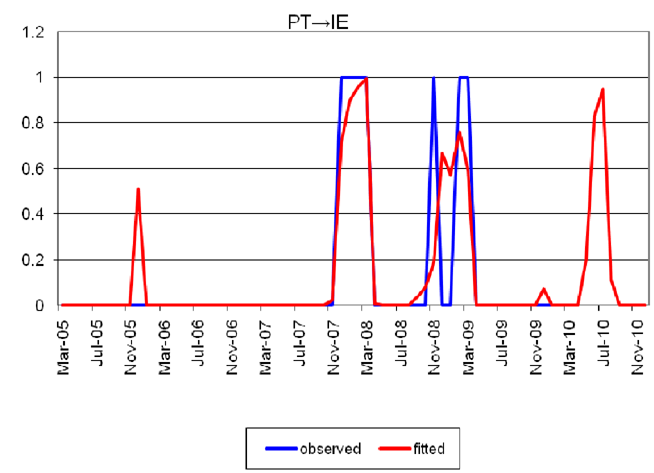


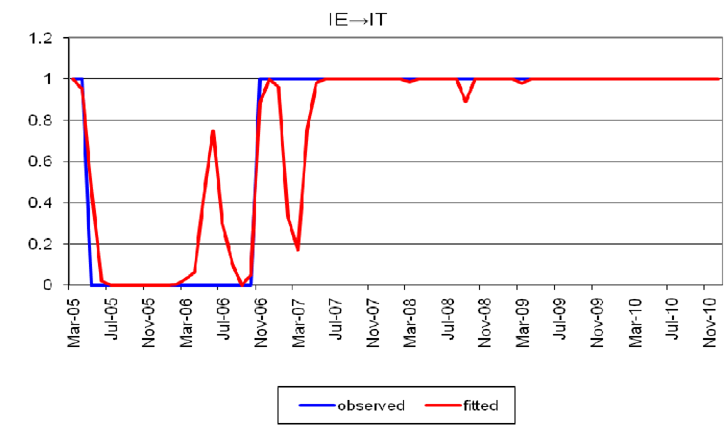

GR→PT
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted
PT→GR
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted
GR→SP
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted
SP→GR
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted


SP -> PT
PT -> SP
SP→IT
IT→SP
observed
fitted
1.2
1
0.8
0.6
0.4
0.2
0
mar-05
jul-05
nov-05
mar-06
jul-06
nov-06
mar-07
jul-07
nov-07
mar-08
jul-08
nov-08
mar-09
jul-09
nov-09
mar-10
jul-10
nov-10


IT→IE
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted


IE→IT
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted


PT→IE
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted


IE→IT
1.2
1
0.8
0.6
0.4
0.2
0
Mar-05
Jul-05
Nov-05
Mar-06
Jul-06
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
observed
fitted

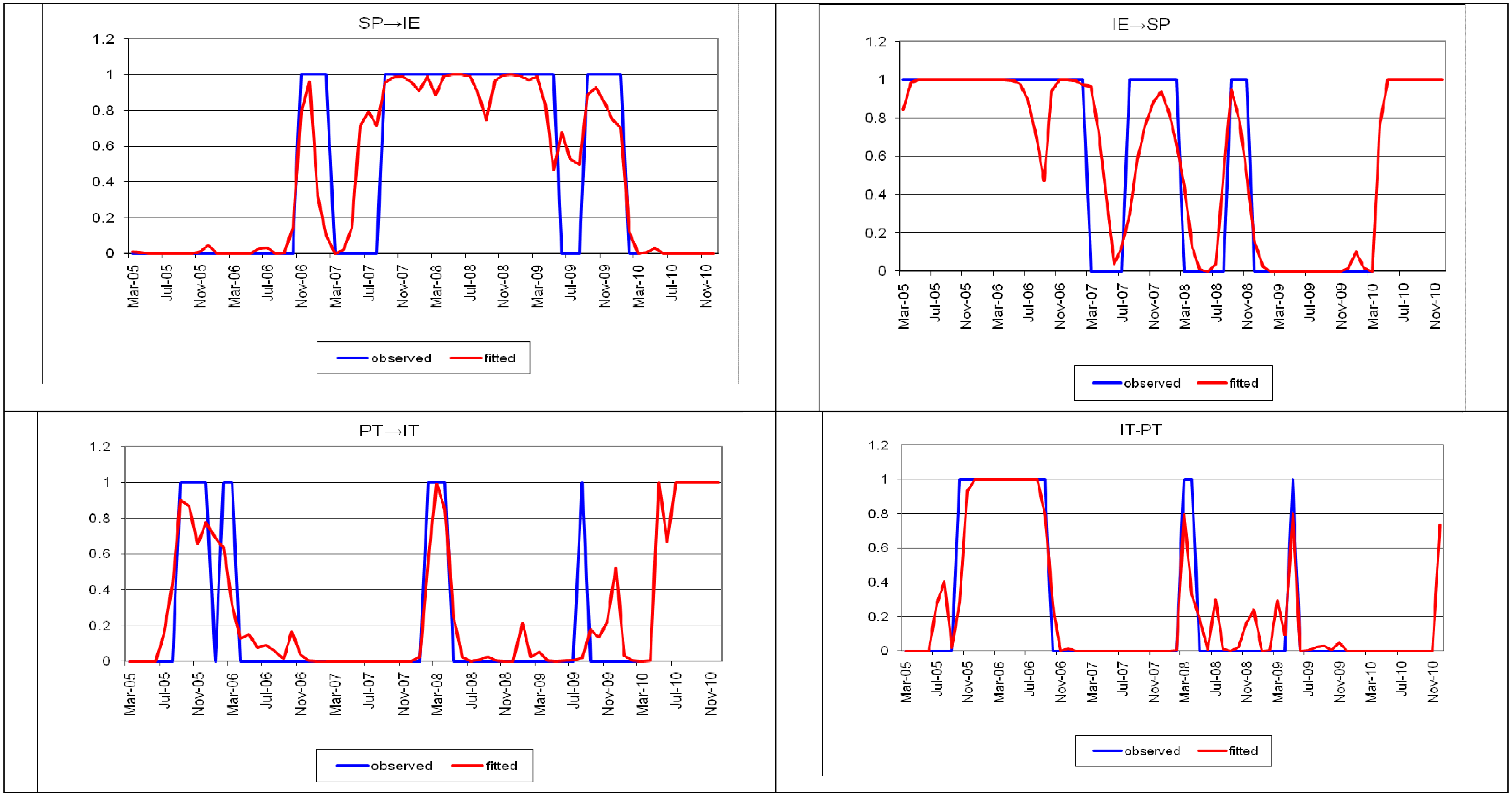

SP→IE
IE→SP
PT→IT
IT-PT
observed
fitted

Table 1. Descriptive statistics

Panel A: Levels					
	GR	**IE**	**IT**	**PT**	**SP**
Mean	4.995	4.543	4.491	4.541	4.379
Median	4.544	4.459	4.374	4.405	4.232
Maximum	12.440	9.012	5.879	7.104	5.870
Minimum	3.206	3.038	3.215	2.997	3.025
Std. Dev.	1.637	0.828	0.615	0.722	0.650
Skewness	2.714	1.236	0.343	0.423	0.376
Kurtosis	10.589	7.304	2.268	2.793	2.230
Jarque-Bera	9468.5	3213.9	131.5	99.0	151.2
Observations	2610	3131	3131	3131	3131
Panel B: First differences					
	DGR	**DIE**	**DIT**	**DPT**	**DSP**
Mean	0.003	0.002	0.000	0.001	0.000
Median	0.000	0.000	0.000	0.000	0.000
Maximum	1.304	0.682	0.213	0.546	0.253
Minimum	-4.323	-1.028	-0.319	-1.470	-0.441
Std. Dev.	0.117	0.058	0.041	0.062	0.044
Skewness	-17.879	-1.162	0.181	-4.230	-0.077
Kurtosis	720.496	48.784	5.562	113.490	7.960
Jarque-Bera	56102048.0	274076.8	873.0	1601451.0	3211.0
Observations	2609	3130	3130	3130	3130

Note:
In all tables GR, IE, IT, PT and SP stand for Greece, Ireland, Italy, Portugal and Spain respectively.

Table 2. Augmented Dickey- Fuller tests for unit roots.

Panel A: I (2) versus I (1)			
	τ_T	τ_μ	τ
DGR	-17.8072*	-17.6380*	-17.5929*
DIE	-47.7382*	-47.7020*	-47.6802*
DIT	-52.3394*	-52.3468*	-52.3535*
DPT	-31.6051*	-31.5955*	-31.5838*
DSP	-51.8722*	-51.8773*	-51.8802*
Panel B: I (1) versus I (0)			
	τ_T	τ_μ	τ
GR	0.2766	1.2043	1.5440
IE	0.3425	0.3400	1.3145
IT	-2.6923	-2.0867	0.0225
PT	-1.0206	-1.2202	0.6855
SP	-1.8358	-1.7678	0.2859

Notes:
The ADF statistic is a test for the null hypothesis of a unit root.
τ_τ, τ_μ and τ denote the ADF statistics with drift and trend, with drift, and without drift, respectively.
* denotes significance at the 1% level. Critical values based on MacKinnon (1996)

Table 3. KPSS tests for stationarity

Panel A: I (2) versus I (1)		
	τ_T	τ_μ
DGR	0.1052	0.2574
DIE	0.0877	0.3287
DIT	0.1083	0.1072
DPT	0.1103	0.1868
DSP	0.0975	0.1551
Panel B: I (1) versus I (0)		
	τ_T	τ_μ
GR	0.9832*	1.8948*
IE	1.1606*	1.1528*
IT	0.6825*	2.9237*
PT	0.9373*	1.6140*
SP	0.8374*	3.0079*

Notes:
The KPSS statistic is a test for the null hypothesis of stationarity.
τ_τ and τ_μ denote the KPSS statistics with drift and trend, and with drift, respectively.
* denotes significance at the 1% level. Asymptotic critical values based on Kwiatkowski *et al.* (1992. Table 1)

Table 4. Cointegration tests

	Hypothesized numbers of cointegrating relations	Trace statistic[a]	p-value[b]
GR. IE	None At most one	20.3839** 1.0135	0.0481 0.9498
GR. IT	None At most one	16.5832 3.0084	0.1488 0.5791
GR. PT	None At most one	21.0916** 2.8721	0.0384 0.6049
GR. SP	None At most one	14.7411 2.6170	0.2416 0.6544
IE. IT	None At most one	12.6781 1.2744	0.3901 0.9118
IE. PT	None At most one	10.2764 1.7622	0.6127 0.8244
IE. SP	None At most one	9.67O6 1.0393	0.6721 0.9464
IT. PT	None At most one	9.2582 1.8854	0.7119 0.8004
IT. SP	None At most one	13.5751 2.7382	0.3197 0.6307
PT. SP	None At most one	15.5181 2.9255	0.1981 0.5947

Notes: [a] * and ** denote rejection of the hypothesis at the 1% and 5% level, respectively.
[b] MacKinnon *et al.* (1999)'s p-values.

Table 5. FPE statistics for the whole sample

	FPE(m.0)x10^{-3}	FPE(m.n) x10^{-3}	Causality
GR → IE	3.4311 (1.0)	3.3972 (1.1)	Yes
IE → GR	13.1864 (4.0)	12.8586 (4.4)	Yes
GR → IT	1.6707 (1.0)	1.6695 (1.1)	Yes
IT → GR	13.1864 (4.0)	13.0770 (4.1)	Yes
GR → PT	3.5423 (4.0)	3.5096 (4.1)	Yes
PT → GR	13.1864 (4.0)	12.6075 (4.4)	Yes
GR → SP	1.9055 (4.0)	1.9063 (4.1)	No
SP → GR	13.1864 (4.0)	13.1102 (4.4)	Yes
IE → IT	1.6910 (1.0)	1.6586 (1.1)	Yes
IT → IE	3.2584 (1.0)	3.2596 (1.1)	Yes
IE → PT	3.8007 (4.0)	3.6855 (4.1)	Yes
PT → IE	3.2584 (1.0)	3.2602 (1.1)	No
IE → SP	1.9248 (4.0)	1.8941 (4.1)	Yes
SP → IE	3.2584 (1.0)	1.9248 (1.4)	Yes
IT → PT	3.8007 (4.0)	3.7989 (4.1)	Yes
PT → IT	1.6910 (1.0)	1.6812 (1.1)	Yes
IT → SP	1.9248 (4.0)	1.9214 (4.1)	Yes
SP → IT	1.6910 (1.0)	1.6878 (1.1)	Yes
PT → SP	1.9248 (4.0)	1.9183 (4.1)	Yes
SP → PT	3.8007 (4.0)	3.7832 (4.11)	Yes

Note: The figures in brackets are the optimum order of lags in each pair of countries

Table 6. Debt-to-GDP by sector.

GREECE	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2002-06 (I)	Average 2007-10 (II)	% (II)/(I)
Banks	24.6	26.0	25.5	28.4	33.7	48.4	63.2	68.5	97.6	**27.6**	**69.4**	**151%**
Households	19.5	22.6	27.0	32.6	37.0	40.4	40.8	41.5	59.9	**35.7**	**45.6**	**28%**
Non-financial corporations	32.6	33.2	34.0	37.5	39.0	43.1	50.9	48.0	53.0	**41.3**	**48.8**	**18%**
General Government	101.7	97.4	98.9	109.0	106.4	105.4	110.7	127.1	142.8	**111.0**	**121.5**	**9%**
IRELAND	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average 2002-06 (I)**	**Average 2007-10 (II)**	**% (II)/(I)**
Banks	287.1	329.0	399.3	491.9	579.6	609.7	726.1	753.6	729.1	**417.4**	**704.6**	**69%**
Households	43.9	48.5	60.9	70.9	77.8	81.2	84.8	92.3	89.5	**72.2**	**86.9**	**20%**
Non-financial corporations	40.2	44.0	55.4	63.6	79.9	91.3	105.9	107.2	72.0	**73.3**	**94.1**	**28%**
General Government	30.7	31.0	29.5	27.4	24.8	25.0	44.4	65.6	96.2	**41.6**	**57.8**	**39%**
ITALY	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average 2002-06 (I)**	**Average 2007-10 (II)**	**% (II)/(I)**
Banks	65.5	69.4	71.9	77.1	85.6	94.1	104.1	105.9	104.3	**73.9**	**102.1**	**38%**
Households	21.5	23.0	25.1	27.0	28.5	29.8	30.3	32.7	38.1	**28.4**	**32.7**	**15%**
Non-financial corporations	44.4	46.4	47.4	48.0	51.7	56.8	60.9	61.7	62.3	**53.3**	**60.4**	**13%**
General Government	105.7	104.4	103.9	105.9	106.6	103.6	106.3	116.1	119.0	**107.9**	**111.3**	**3%**
PORTUGAL	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average 2002-06 (I)**	**Average 2007-10 (II)**	**% (II)/(I)**
Banks	106.3	113.3	101.6	103.8	115.3	126.4	136.6	156.3	182.5	**108.1**	**150.4**	**39%**
Households	59.3	58.6	60.4	64.5	70.7	74.5	78.3	81.7	82.3	**70.0**	**79.2**	**13%**
Non-financial corporations	68.2	67.9	67.2	70.8	72.7	78.7	90.8	93.0	90.6	**77.8**	**88.3**	**14%**
General Government	53.8	55.9	57.6	62.8	69.5	68.3	71.6	83.0	93.0	**68.4**	**79.0**	**15%**
SPAIN	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average 2002-06 (I)**	**Average 2007-10 (II)**	**% (II)/(I)**
Banks	72.4	78.5	84.7	107.3	116.9	133.7	150.1	161.4	159.2	**92.0**	**151.1**	**64%**
Households	47.5	51.1	55.8	66.4	74.2	78.3	81.9	83.5	82.1	**69.0**	**81.4**	**18%**
Non-financial corporations	47.1	49.6	53.8	63.0	76.3	85.5	91.2	90.4	87.0	**71.6**	**88.5**	**24%**
General Government	52.5	48.7	46.2	43.0	39.6	36.1	39.8	53.3	60.1	**46.6**	**47.3**	**2%**

Note: Debt-to-GDP at the end of each year.
Source: Eurostat, Monetary Financial Institutions (MFIs) balance sheets obtained from the European Central Bank and authors' estimates.

Table 7. Foreign banks' claims on individual countries-to-GDP by sector.

Foreign banks' claims on public sector debt/GDP							
	2005	2006	2007	2008	2009	2010	Average
GREECE	30.79	33.64	36.07	30.56	29.93	17.64	29.77
IRELAND	4.78	6.19	7.56	8.37	15.19	11.69	8.96
ITALY	20.59	21.55	23.24	21.45	24.05	13.07	20.66
PORTUGAL	19.47	22.03	20.61	20.60	24.00	12.68	19.90
SPAIN	8.46	8.86	8.16	7.50	9.21	6.73	8.15
Foreign banks' claims on banks debt/GDP							
	2005	2006	2007	2008	2009	2010	Average
GREECE	6.23	7.02	10.04	12.17	10.33	3.55	8.23
IRELAND	103.93	120.21	140.62	100.51	92.71	51.09	101.51
ITALY	10.85	12.87	14.97	11.03	9.46	7.38	11.09
PORTUGAL	15.77	19.14	23.58	19.71	21.08	15.88	19.19
SPAIN	16.72	20.78	26.61	23.51	23.03	14.91	20.93
Foreign banks' claims on non-financial private sector debt/GDP							
	2005	2006	2007	2008	2009	2010	Average
GREECE	16.73	27.42	35.73	36.01	26.07	26.22	28.03
IRELAND	133.91	177.50	251.16	269.12	252.07	213.98	216.29
ITALY	11.60	20.67	28.28	23.07	24.97	22.83	21.90
PORTUGAL	32.12	38.35	46.84	46.22	49.83	45.57	43.15
SPAIN	17.38	25.38	33.61	29.83	30.52	25.09	26.97

Note: Reliance on foreign bank financing is measured by the consolidated claims on an immediate borrower basis of Bank for International Settlements (BIS) reporting banks on each sector (public, banks and non-financial corporations as a proportion of GDP). Data correspond to the end of each year.
Source: This table has been constructed from data collected from Table 9C of BIS Quarterly Review: June 2011 and the OECD.

Table 8. Claims by nationality of reporting banks as a proportion of total foreign claims.

GREECE	2005	2006	2007	2008	2009	2010	Average
Austrian banks	3.3	2.8	2.4	2.1	2.2	2.3	2.5
Belgian banks	8.7	5.6	5.7	3.8	2.0	1.3	4.5
Finnish banks	0.0	0.0	0.0	0.0	0.0	0.0	0.0
French banks	9.4	19.1	24.4	28.4	36.7	39.6	26.2
German banks	22.0	18.1	15.9	14.5	20.9	23.7	19.2
Irish banks	0.0	5.6	3.6	3.2	4.0	0.6	2.8
Italian banks	2.2	0.0	4.3	3.6	3.2	2.9	2.7
Dutch banks	11.3	8.8	7.9	4.9	5.7	3.5	7.0
Portuguese banks	1.9	2.3	2.5	2.4	4.6	7.2	3.5
Spanish banks	0.6	0.3	0.4	0.4	0.6	0.7	0.5
British banks	5.4	4.6	5.5	4.8	7.1	9.8	6.2
US banks	5.0	4.1	3.4	2.6	7.7	5.1	4.6
Others	30.3	28.7	24.0	29.3	5.4	3.3	20.2
IRELAND	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average**
Austrian banks	1.22	1.39	1.16	0.76	1.27	0.64	1.1
Belgian banks	8.82	10.52	8.42	6.75	5.68	5.62	7.6
Finnish banks	0.00	0.00	0.00	0.00	0.00	0.16	0.0
French banks	7.30	9.06	12.02	10.10	8.47	6.55	8.9
German banks	25.78	23.95	25.90	29.97	29.88	26.13	26.9
Greek banks	0.22	0.12	0.07	0.05	0.10	0.11	0.1
Italian banks	3.71	2.96	3.43	3.62	2.83	2.99	3.3
Dutch banks	9.92	7.49	5.69	5.25	4.58	3.70	6.1
Portuguese banks	0.52	0.75	0.40	0.56	0.76	1.14	0.7
Spanish banks	3.11	3.81	3.04	2.20	2.38	2.22	2.8
British banks	26.49	26.91	26.21	28.22	27.12	29.91	27.5
US banks	3.15	3.97	4.51	4.89	9.28	11.27	6.2
Others	9.77	9.07	9.15	7.63	7.67	9.57	8.8
PORTUGAL	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average**
Austrian banks	1.39	1.31	1.09	1.11	1.15	0.81	1.1
Belgian banks	5.14	6.65	4.77	5.28	2.33	1.75	4.3
Finnish banks	0.00	0.00	0.00	0.00	0.00	0.19	0.0
French banks	10.28	10.55	13.79	13.11	17.83	13.33	13.1
German banks	20.64	19.27	20.05	19.50	18.79	18.03	19.4
Greek banks	0.02	0.01	0.02	0.02	0.05	0.04	0.0
Irish banks	0.00	4.30	3.62	2.78	2.16	1.35	2.4
Italian banks	3.18	3.83	3.39	2.72	2.66	2.01	3.0
Dutch banks	7.45	6.66	7.39	6.07	5.61	3.24	6.1
Spanish banks	35.12	31.99	32.23	33.93	33.71	41.89	34.8
British banks	11.17	8.68	8.55	9.62	10.20	12.05	10.0
US banks	1.64	2.26	1.51	0.81	1.85	2.61	1.8
Others	3.98	4.50	3.60	5.05	3.66	2.70	3.9
SPAIN	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average**
Austrian banks	0.86	0.87	0.82	0.87	0.96	0.95	0.9
Belgian banks	4.22	4.52	4.44	4.82	2.46	3.06	3.9
Finnish banks	0.00	0.00	0.00	0.00	0.00	0.22	0.0
French banks	18.25	14.94	18.92	19.35	22.97	20.01	19.1
German banks	26.51	30.07	29.23	27.83	25.89	25.88	27.6
Greek banks	0.06	0.01	0.01	0.03	0.04	0.05	0.0
Irish banks	0.00	3.86	3.84	3.70	3.45	2.13	2.8
Italian banks	2.49	2.34	2.70	3.12	3.39	4.22	3.0
Dutch banks	16.87	13.95	13.36	13.69	13.02	10.94	13.6
Portugal banks	2.61	2.84	2.77	3.14	3.14	3.80	3.0
British banks	15.23	13.84	12.55	13.66	11.98	15.25	13.8
US banks	4.55	4.72	4.12	3.67	6.31	6.72	5.0
Others	8.35	8.02	7.25	6.12	6.37	6.78	7.1
ITALY	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average**
Austrian banks	2.64	2.19	2.04	1.61	2.23	2.58	2.2
Belgian banks	10.85	8.09	4.38	4.74	2.83	2.99	5.6
Finnish banks	0.00	0.00	0.00	0.00	0.00	0.08	0.0
French banks	18.94	27.45	37.66	42.79	44.44	45.53	36.1
German banks	25.26	20.10	19.41	18.91	16.60	18.82	19.9
Greek banks	0.15	0.07	0.02	0.03	0.06	0.07	0.1
Irish banks	0.00	5.20	3.94	4.25	3.99	1.53	3.2
Dutch banks	10.84	13.82	11.65	6.11	6.04	5.26	9.0
Portuguese banks	0.76	0.75	0.41	0.32	0.47	0.35	0.5
Spanish banks	4.44	2.99	2.82	4.44	4.13	3.62	3.7
British banks	9.22	7.02	7.09	6.83	6.71	7.70	7.4
US banks	5.78	3.25	2.79	2.33	4.66	4.26	3.8
Others	11.12	9.08	7.78	7.65	7.84	7.21	8.4

Note: Table 8 displays the consolidated claims on an immediate borrower basis of Bank for International Settlements (BIS) by nationality of reporting banks as a proportion of total foreign claims on each country. Data correspond to the end of each year.

Source: This table has been constructed from data collected from Table 9D of BIS Quarterly Review: June 2011.

Table 9: Probit models

Greece → Ireland

	Coefficient	z-Statistic
GRIEBAN	16.2492	2.7521
GRGOVDEB	-0.0521	-2.2643
UGR	0.7388	2.1374
DEFIE	0.1064	2.0586
IEBAN	-0.0325	-2.2617
IEPRI	0.0211	2.1911
GRBANDEB	0.1257	2.3125
McFadden R-squared	0.7413	

Ireland → Greece

	Coefficient	z-Statistic
Constant	-2.8012	-2.0634
IEGRBAN	91.6240	2.9967
IEPUB	1.2065	2.9655
DEFIE	0.0926	2.2747
McFadden R-squared	0.7198	

Greece → Italy

	Coefficient	z-Statistic
Constant	14.0900	2.2549
GRITBAN	0.21393	2.2850
INFGR	0.4900	2.1984
UGR	2.0301	3.3365
RATGR	1.9055	2.1252
GRGOVDEB	0.2932	2.2038
McFadden R-squared	0.8105	

Italy → Greece

	Coefficient	z-Statistic
Constant	22.3885	2.8110
ITGRBAN	0.8811	2.5241
DEFIT	0.6796	3.9229
ITBANDEB	0.1942	3.2798
URIT	4.0351	3.7468
RATGRE	1.1494	2.8010
ITPUB	0.0494	2.6652
ITHOUDEB	1.7672	2.9852
McFadden R-squared	0.7365	

Greece → Portugal

	Coefficient	z-Statistic
Contant	-3.1133	-2.1357
GRPTBAN	53.5999	2.5940
INFGR	2.3869	2.1412
UGR	7.7531	2.7749
GRGOVDEB	0.8771	3.4462
VARRATPT	5.8638	3.9751
GRNFIDEB	1.1808	3.9503
GRPUB	1.6704	2.6380
GRPRI	0.8294	3.4910
McFadden R-squared	0.8474	

Portugal → Greece

	Coefficient	z-Statistic
Constant	-96.3741	-4.2545
PTGRBAN	5.9734	3.3352
INFPT	3.2890	3.9156
UPT	8.1793	4.2537
DEFPT	0.3027	2.3217
PTNFIDEB	1.3158	2.7293
PTPUB	0.5964	2.3633
PTBANDEB	0.9296	2.6373
McFadden R-squared	0.7386	

Greece → Spain

	Coefficient	z-Statistic
Constant	-6.2095	-1.4073
GRSPBAN	7.2864	2.4876
UGR	4.1365	5.5873
GRGOVDEB	0.3101	4.3304
DEFSP	0.2693	2.5897
McFadden R-squared	0.8125	

Spain → Greece

	Coefficient	z-Statistic
Constant	-99.4167	-4.1675
SPGRBAN	33.1269	3.9718
SPBANDEB	0.3791	2.5198
SPANFIDEB	0.1302	2.4135
RATGR	1.3577	2.6305
RATSP	5.6458	2.6104
CACSP	1.1596	2.4870
SPPUB	10.1523	3.2375
McFadden R-squared	0.7093	

Spain → Portugal

	Coefficient	z-Statistic
Constant	-40.6506	-2.8468
SPPTBAN	6.9212	2.1449
SPNFIDEB	2.6210	3.2914
UPOR	3.1901	2.7406
McFadden R-squared	0.6611	

Portugal → Spain

	Coefficient	z-Statistic
PTSPBAN	12.1144	2.5430
DEFPT	0.3725	2.1648
GROPT	-13.9959	-2.6106
INFPT	-6.6052	-2.3755
VARRATPT	0.2782	2.2489
GROSP	12.8877	2.6820
SPGOVDEB	-1.1445	-2.5831
McFadden R-squared	0.8088	

Spain → Italy

	Coefficient	z-Statistic
Constant	-11.8675	2.1670
SPITBAN	0.2741	2.6442
DEFSP	0.1581	2.7266
USP	0.2012	2.1985
SPGOVDEB	0.1813	2.3653
CACSP	-0.1115	-2.3400
UIT	0.1168	2.1243
ITPUB	0.6969	3.3779
RATIT	0.3399	2.5867
McFadden R-squared	0.6246	

Italy → Spain

	Coefficient	z-Statistic
Constant	-36.0502	-2.3662
ITSPBAN	3.1718	2.1135
DEFIT	0.5437	2.8247
ITBANDEB	0.2590	2.8595
RATSP	17.8700	3.0272
ITGOVDEB	0.1312	2.5231
UIT	8.0025	2.8793
McFadden R-squared	0.7496	

Italy → Ireland

	Coefficient	z-Statistic
Constant	21.7423	2.3740
ITIEBAN	3.0855	3.5476
DEFIT	0.0392	2.3489
ITBANDEB	0.0343	2.8695
UIT	1.9383	3.9144
RATIE	0.5681	4.2812
ITHOUDEB	0.7421	2.8408
ITGOVDEB	0.4103	3.6599
McFadden R-squared	0.6470	

Ireland → Italy

	Coefficient	z-Statistic
Constant	-34.7139	-3.7590
IEITBAN	0.0110	2.0619
IEPUB	4.9328	3.8503
DEFIE	0.3727	3.0778
INFIE	1.6927	3.5820
McFadden R-squared	0.8173	

Portugal → Ireland

	Coefficient	z-Statistic
Constant	-52.0783	-3.5789
PTIEBAN	1.0286	3.8186
DEFPT	0.4460	5.0346
UPT	5.5694	4.1245
INFPT	1.6688	2.2816
RATPT	0.8951	2.6585
UIE	0.3554	2.6639
IEGOVDEB	0.0715	2.8254
McFadden R-squared	0.7412	

Ireland → Portugal

	Coefficient	z-Statistic
Constant	-53.9995	-4.7011
IEPTBAN	0.9309	2.8166
IEPUB	0.2234	2.3844
DEFIE	0.4235	4.3270
UIE	5.4868	4.1534
IEBAN	0.0030	2.1760
IEGOVDEB	1.4048	3.4880
UPT	0.1068	2.1824
CACPT	-3.3297	-4.5435
McFadden R-squared	0.8257	

Spain → Ireland

	Coefficient	z-Statistic
Constant	-30.2923	-2.5886
SPIEBAN	6.5169	2.3238
DEFSP	0.0716	2.8099
USP	3.0126	3.2156
SPBAN	0.3619	2.5362
SPGOVDEB	0.6502	3.0083
CACSP	-1.2045	-2.4112
UIE	0.7980	3.4112
SPBANDEB	0.0729	2.5343
McFadden R-squared	0.7002	

Ireland → Spain

	Coefficient	z-Statistic
Constant	-4.4028	-2.6272
IESPBAN	0.3133	2.6764
IEPUB	1.7950	3.1077
DEFIE	0.4638	3.2044
IEBAN	0.0749	3.1281
IEGOVDEB	1.0637	3.1027
USP	2.2242	2.9601
McFadden R-squared	0.7045	

Portugal → Italy

	Coefficient	z-Statistic
Constant	-59.3698	-4.0692
PTITBAN	4.8112	2.4425
DEFPT	0.4549	2.2626
UPT	2.5365	2.1736
RATPT	7.2804	3.9456
UIT	2.5939	3.0013
PTPUB	1.8024	4.2752
RATIT	1.0716	2.6486
PTGOVDEB	0.7401	3.3067
McFadden R-squared	0.5595	

Italy → Portugal

	Coefficient	z-Statistic
Constant	28.0712	2.0045
ITPTBAN	6.8975	3.3487
DEFIT	0.6021	2.5329
UIT	3.5979	2.8359
UPT	5.7698	2.7683
ITHOUDEB	2.7336	3.2757
RATIT	1.3327	2.1908
ITGOVDEB	1.3677	3.2470
McFadden R-squared	0.7383	

Note:
CACXX = Current-account-balance-to-GDP of country XX
UXX = Unemployment rate of country XX
INFXX = Inflation rate of country XX
RATXX = Credit rating scale of country XX.
DEFXX = Government deficit-to-GDP of country XX.
XXGOVDEB = Government debt-to-GDP of country XX.
XXBANDEB = Bank debt-to-GDP of country XX
XXNFIDEB = Non-financial corporations debt-to-GDP of country XX
XXHOUDEB = Households debt-to-GDP of country XX
XXBAN = Foreign bank claims on banks debt-to-GDP of country XX
XXPUB = Foreign bank claims on government debt-to-GDP of country XX
XXPRI = Foreign bank claims on non-financial private debt-to-GDP of country XX
XXYYBAN = Percentage of country XX's foreign claims held by country YY's banks