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A Fragmentation Indicator for Euro Area Sovereign Bond Markets

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Abstract

This *Letter* presents a simple indicator which can be used to monitor fragmentation in euro area sovereign bond markets. The indicator is a moving average cross-correlation of bond yield log returns between Germany and other euro area countries. We suggest that a lower correlation implies greater market fragmentation. We do not distinguish between fragmentation based on fundamentals and that based on market sentiment, although we expect sentiment to play a key role. We compare the simple indicator to a bivariate dynamic conditional correlation (DCC) GARCH estimate which accounts for heteroskedasticity. The estimates indicate that the core countries decouple from Germany and then re-attach, whereas the peripheral countries remain fragmented during the entire sample period.

1 Introduction

The euro area debt crisis has led to an increased focus on sovereign bond yield movements. Since the introduction of the euro up until the recent debt crisis, movements in sovereign bond yields had been highly synchronised across countries. However, the crisis triggered a divergence in sovereign bond yields owing to a re-pricing of credit risk and a loss of market confidence.

Since 2010 a growing literature has examined bond yields in euro area sovereign bond markets. Many papers investigate the factors which influence the widening of sovereign bond yield spreads (with the German yield serving as the benchmark yield). For example, Missio and Watzka (2011) suggest that contagion effects were present during the crisis and may have originated in Greece. In an examination of spill-over effects in euro area sovereign bond markets, Conefrey and Cronin (2013) find that the euro area sovereign bond crisis has moved from being driven by broadly-based systemic concerns to a focus on country-specific developments. De Grauwe and Ji (2012) present evidence that suggests that a significant part of the surge in sovereign spreads was due to negative market sentiment rather than fundamentals. Cronin (2014) applies a t-DCC-GARCH model and suggests that euro area policy has an influence on euro area sovereign bond markets' behaviour.

The aim of this *Economic Letter* is not to investigate the factors influencing euro area sovereign bond markets but rather to propose a simple indicator which can be used to monitor fragmentation in these markets. This fragmentation indicator complements the existing suite of indicators used to monitor euro area sovereign bond markets. For example, the European Securities

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and Markets Authority (ESMA) currently publish a number of monitoring indicators in their Risk Dashboard.[2]

Our proposed fragmentation indicator is a moving average cross-correlation of bond yield log returns between a number of euro area countries and Germany. We suggest that the indicator illustrates fragmentation from the German yield. The German yield is taken as a proxy for a euro-wide bond (as no such tradable bond existed during the time of the crisis). Comparing euro area bond yields to the German yield is a common practice amongst market participants when assessing relative credit risk and potential trading opportunities.

We note that before the crisis the yields moved together in a strong linear relationship (as is common practice in statistical analysis, we take a strong linear relationship to be one greater than 0.7). As the crisis develops the yields diverge from the German yield and the indicator falls (at different times for different countries). We do not distinguish between fragmentation which is based on market sentiment and that which is based on fundamentals. Considering the variability of the dynamic correlations, it is likely that sentiment plays a key role in the change. The indicator presents some interesting results in terms of the timing and the size of the impact of the crisis on individual countries and on the overall trend in the markets.

We employ a bivariate DCC-GARCH model to compare the unconditional and conditional correlation coefficient estimates. Forbes and Rigobon (2002) show that the unconditional correlation estimate can be upwardly biased because the estimate does not account for time-varying volatility. The DCC-GARCH estimate provides a more accurate estimate of time-varying correlations (Engle 2002). We note that the DCC-GARCH estimate does not alter our conclusions on general trends in market fragmentation. We propose the simple fragmentation indicator as it is relatively easy to reproduce and is thus accessible to all market participants. It can be useful for policymakers and market participants alike when monitoring the impact of events on the markets' view of fragmentation within the euro area. For those seeking a more accurate point estimate we would suggest the DCC-GARCH methodology.

The remainder of this *Letter* is structured as follows: Section 2 describes the data used in our analysis. Section 3 provides an overview of the methodology while Section 4 presents the results from our analysis. Section 5 concludes.

2 Data

In order to calculate the fragmentation indicator we use raw data on yields of seven euro area countries. These are Austria (AT), France (FR), Germany (DE), Ireland (IE), Italy (IT), Portugal (PT) and Spain (ES).[3] The daily 10 year sovereign bond yield data is taken from Thomson Reuters Datastream for the period 1 January 1999 to 30 May 2014.[4] The yields are transformed to log returns.[5]

In the absence of a tradable euro area benchmark sovereign bond, German yields are used as the reference rate for calculating the bilateral dynamic correlations.[6] As shown in Figure 1, sovereign bond yields diverge considerably during the euro area sovereign debt crisis. A significant increase in volatility in bond yield log returns is also evident for a number of countries (see Figure 2).

3 Methodology

By examining dynamic cross-correlations in euro area sovereign bond markets the question of fragmentation and how this changes over time can be studied. Our fragmentation indicator is a moving average cross-correlation of bond yield log returns between Germany and other euro area countries.[7]

[2] The Risk Dashboard is produced by the Committee for Economic and Market Analysis (CEMA) and published quarterly. See http://www.esma.europa.eu/page/Trends-risks-and-vulnerabilities-financial-markets. [Accessed: 16 September 2014].

[3] We conducted the analysis for a number of other euro area and European sovereign bond markets including Belgium, Finland, the Netherlands, Sweden and the United Kingdom. For brevity, we do not include the results in this *Letter*. The results for these countries are available upon request from the authors.

[4] The sample size of 1 January 2010 to 30 May 2014 is chosen for the DCC-GARCH estimate as it is the longest up-to-date period which meets the required stationarity constraints for all samples.

[5] The transformation to returns is conducted to remove any non-stationarity which may be present in the data while transforming to logs allows additivity.

[6] One caveat with this proxy of the risk-free rate is the impact of flight-to-quality effects on German yields. This may amplify the divergence effect underlying the correlation estimate.

[7] The indicator is based on Pearson's correlation coefficient.

This allows us to analyse the dynamical changes in the relationship.

When estimating a moving average correlation, an appropriate window size must be chosen which depends on the time period focus of the analysis. We selected a window size of 60 days which is consistent with the methodology used in the ESMA Risk Dashboard. Engle (2002) uses a similar approach with a window size of 100.

In order to account for changes in volatility we employ a bivariate DCC-GARCH model as proposed by Engle (2002). As noted by Forbes and Rigobon (2002), higher correlations can be driven by an increase in volatility in financial markets. If volatility increases, this may cause the correlation estimate to increase (even if fundamental cross-country linkages do not change). The DCC-GARCH model estimates the dynamic correlations correcting for heteroskedasticity in returns.

DCC-GARCH models have been employed in a number of studies in the literature (Central Bank of Ireland, 2012; Chiang et al, 2007; Missio and Watzka, 2011; Wang and Moore, 2012). In contrast to the constant conditional correlation (CCC) GARCH models, the DCC model allows for time-varying correlations and therefore would appear the most appropriate for our empirical analysis.

The bivariate DCC-GARCH model is applied to the sovereign bond yield log returns comparing Germany and six other euro area countries. As shown in Engle (2002), the DCC-GARCH model is estimated using a two-step approach to maximise the log-likelihood function.[8,9]

4 Results

Figure 2 shows the estimates of the fragmentation indicator from 2000 to mid-2014 for a number of selected countries. By measuring the strength of the correlation we are measuring the level of co-movement in euro area sovereign bond markets and how this changes over time (with the German bond yield as our benchmark). We are looking for the general trend rather than point estimates. We use 0.7 as a threshold indicating a rise in fragmentation (for correlation estimates falling below 0.7).[10]

Owing to the high degree of heterogeneity in our correlation estimates, we divide our sample of countries into two groups: core (Austria and France) and periphery (Ireland, Italy, Portugal and Spain). The correlation estimates for Austria and France are shown in Figures 3 and 4 respectively. The fragmentation indicator is represented by the blue line and the DCC-GARCH estimate is shown by the red line. A notable aspect is the steep decline in correlations for both countries in late 2011 through to mid-2012 and the subsequent recovery in late 2012. The sovereign bond yield correlations for these two countries are now back to levels observed before the euro area sovereign debt crisis of early 2010. For both countries, the simple indicator and the bivariate DCC-GARCH estimate are broadly in line, although the DCC-GARCH series is more volatile.[11]

In general the peripheral country estimates fall below the threshold of 0.7 during 2009 (see Figure 2). Figures 5 and 6 plot the correlation estimates for Ireland and Portugal while Figures 7 and 8 plot the correlation estimates for Italy and Spain respectively. We can see that for the four countries, the dynamic bond yield correlations with Germany remain below the threshold over the entire sample. This indicates that these peripheral countries remain fragmented from Germany. However, we note that a reduction in credit risk will not be immediately captured by our correlation estimate until the yield realigns with our benchmark yield. Therefore our estimate is a better early indicator of market fragmentation than cohesion. The simple indicator moves broadly in line with the bivariate DCC-GARCH estimates with some differences in point estimates.

[8] In the first step, the univariate GARCH equations are estimated. Using the standardised residuals obtained from the first step, the correlation parameters are estimated. For a detailed description of the DCC-GARCH estimation procedure, see among others, Engle (2002), Chiang et al. (2007), Missio and Watzka (2011), and Mighri and Mansouri (2013).

[9] The parameters must meet stationarity constraints which can limit the size of the estimation. The model satisfies the standard specification tests.

[10] The 0.7 threshold is commonly used by statisticians as a threshold indicating a strong linear relationship. For example, see Ratner (2011).

[11] The DCC-GARCH indicator is based on maximum likelihood estimation (Engle 2002). The estimated parameters are maximised over the entire sample. These parameters are then used to estimate the correlation at each time step.

5 Conclusion

In this *Letter* we present a simple indicator which can be used to monitor fragmentation in euro area sovereign bond markets. The indicator is a moving average cross-correlation of bond yield log returns between Germany and other euro area countries. A falling correlation (falling below 0.7) indicates increasing market fragmentation. We employ a bivariate DCC-GARCH model to account for heteroskedasticity in sovereign bond yield log returns. The simple indicator moves broadly in line with the DCC-GARCH estimate.

We find significant heterogeneity in correlation estimates for different country groups. For example, core (Austria and France) countries' correlations with Germany are overall much higher than the correlation estimates for peripheral (Ireland, Italy, Portugal and Spain) countries. Furthermore, the timing of the fragmentation differs: the correlation estimates for core countries decline substantially in late 2011 and recover in late 2012, whereas the peripheral countries are fragmented from Germany during the entire period. Going forward it would be interesting to monitor the peripheral countries' correlations to see if and when they realign with the German yield. This simple indicator can be updated regularly to provide market participants and policymakers with a timely indicator of the markets' view of fragmentation in euro area sovereign bond markets. For a more accurate point estimate we recommend the DCC-GARCH methodology.

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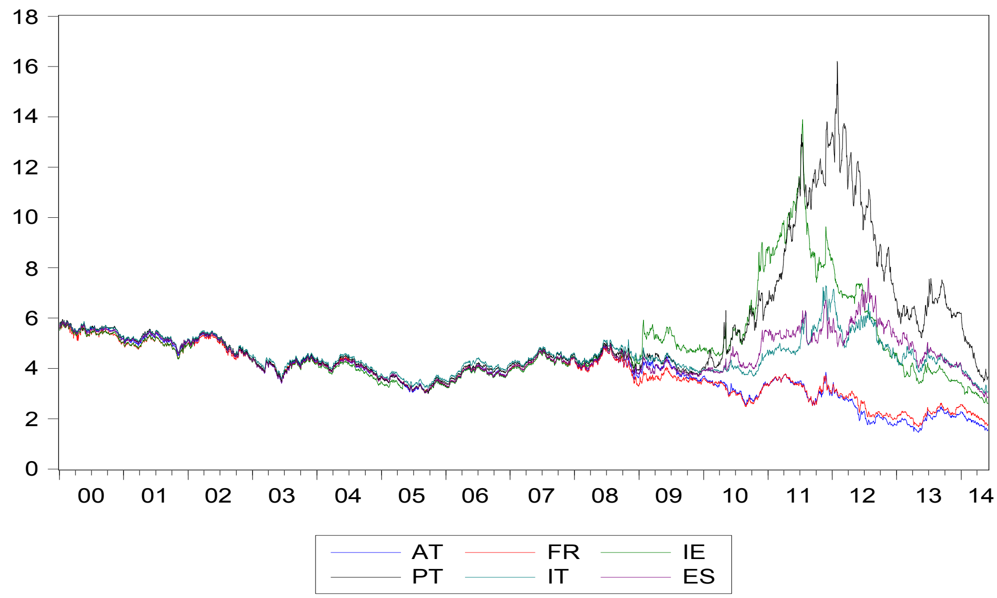
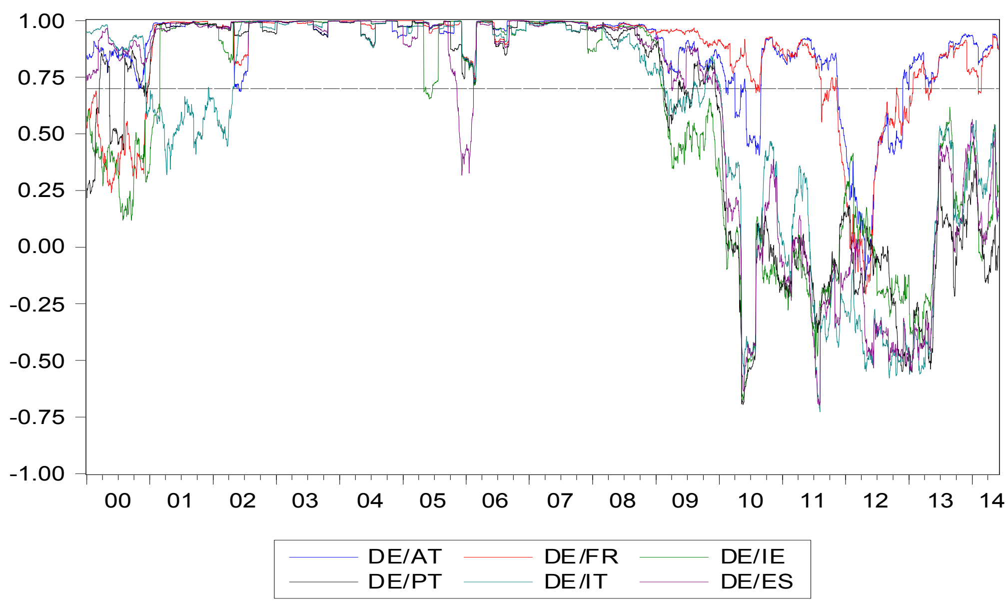
Figure 1: Selected Euro Area 10 Year Sovereign Bond Yields



Source: Thomson Reuters Datastream.

Figure 2: Selected Euro Area 10 Year Sovereign Bond Yield Log Returns (60 Days) Correlations with German Bunds (dashed line represents the threshold of 0.7)



Source: Thomson Reuters Datastream and authors' calculations.

Figure 3: Austria 10 Year Sovereign Bond Yield Log Returns Correlations with German Bunds (dashed line represents the threshold of 0.7)

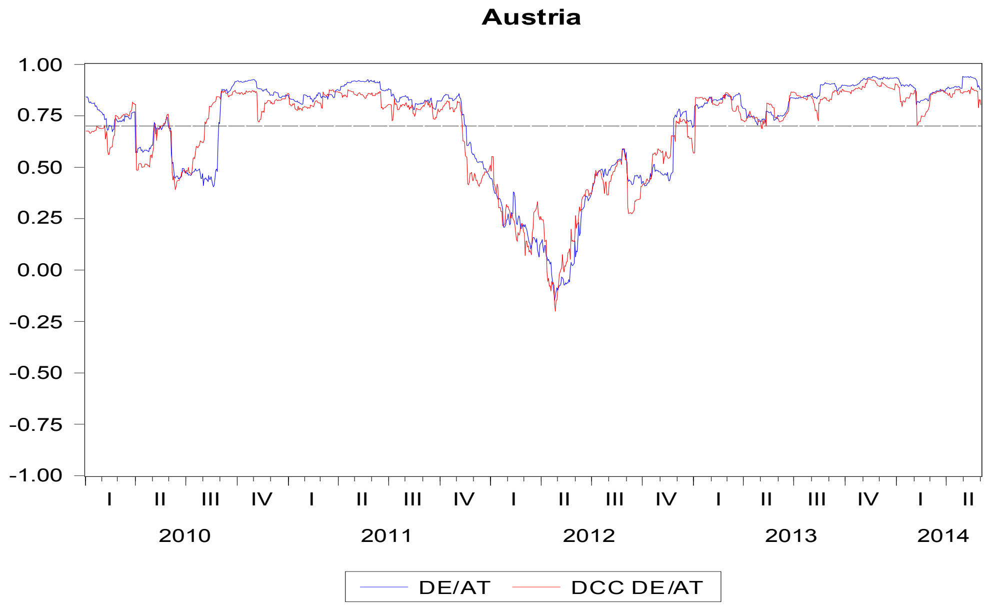


Figure 4: France 10 Year Sovereign Bond Yield Log Returns Correlations with German Bunds (dashed line represents the threshold of 0.7)

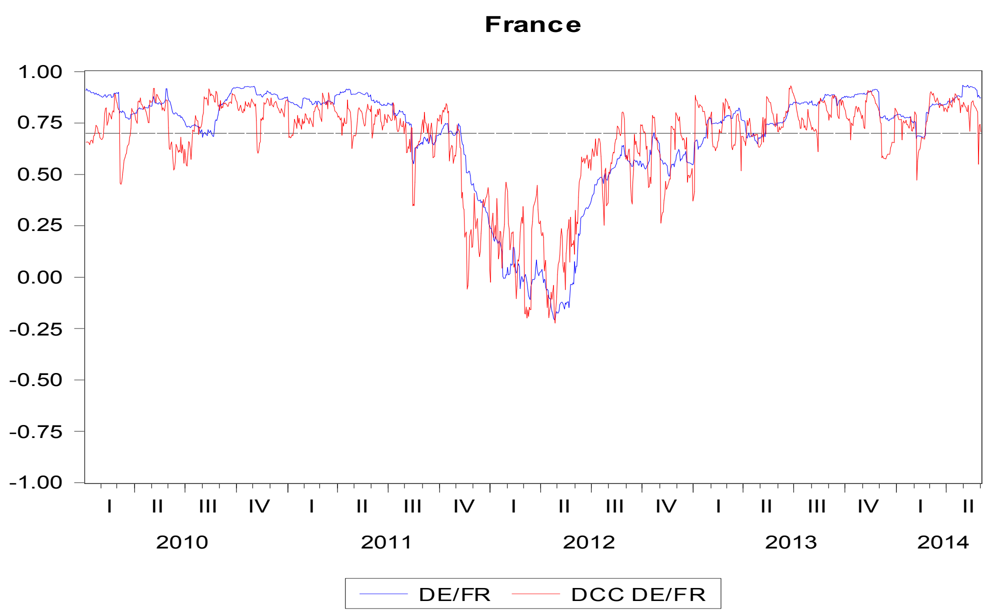


Figure 5: Ireland 10 Year Sovereign Bond Yield Log Returns Correlations with German Bunds (dashed line represents the threshold of 0.7)

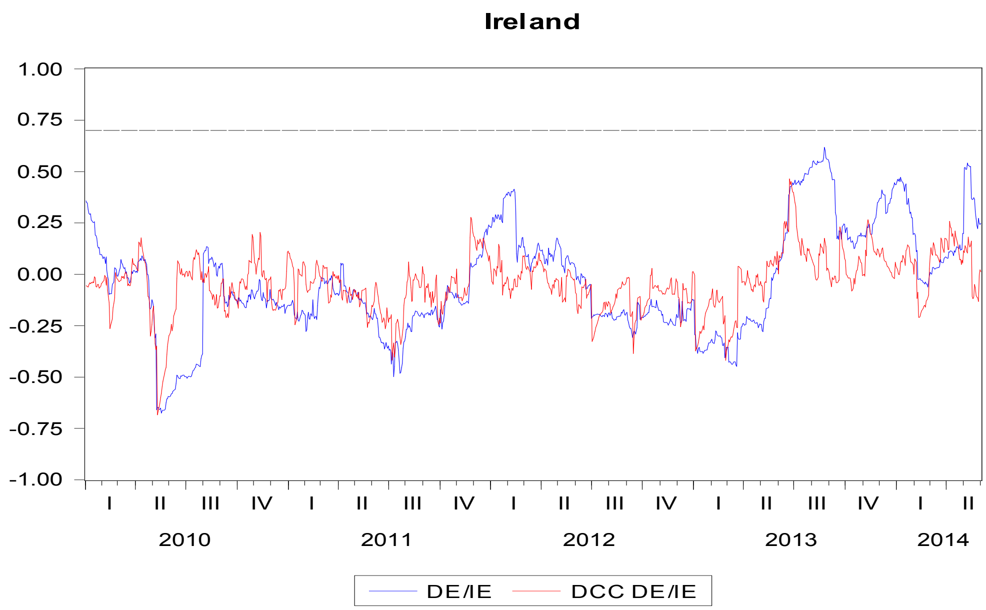


Figure 6: Portugal 10 Year Sovereign Bond Yield Log Returns Correlations with German Bunds (dashed line represents the threshold of 0.7)

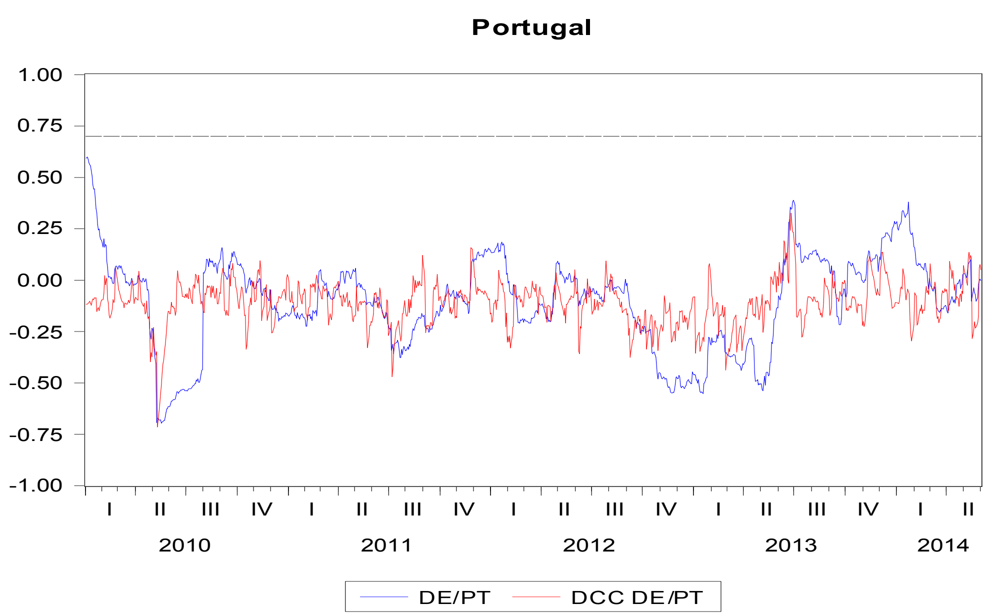


Figure 7: Italy 10 Year Sovereign Bond Yield Log Returns Correlations with German Bunds (dashed line represents the threshold of 0.7)

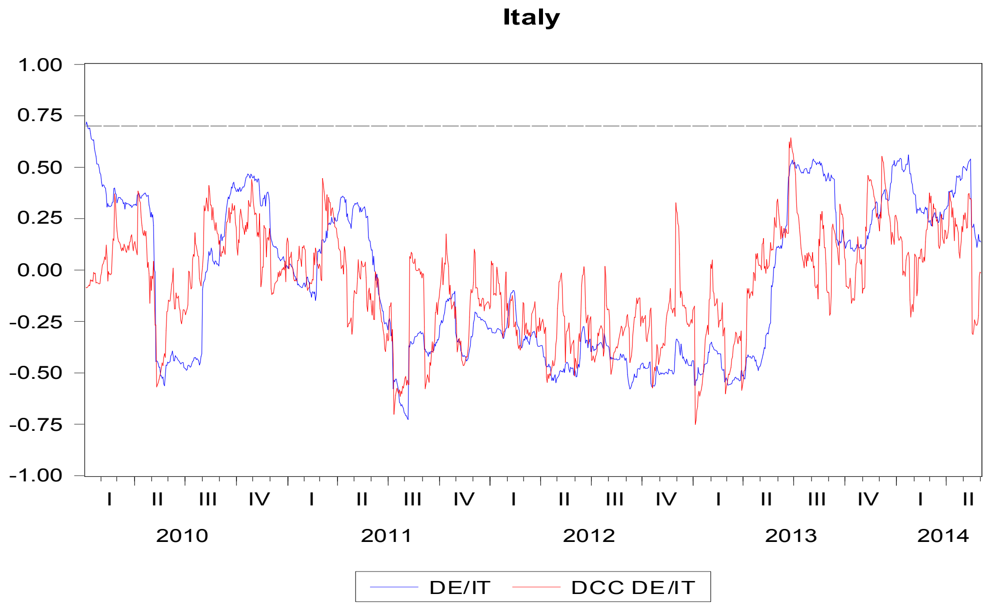


Figure 8: Spain 10 Year Sovereign Bond Yield Log Returns Correlations with German Bunds (dashed line represents the threshold of 0.7)