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Contagion effects during financial crisis: Evidence from the Greek sovereign bonds market

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ABSTRACT

In this study, we test for the possible contagion effects of the 10-year Greek government bond yield. We first employ the well-documented adjusted correlation coefficient of Forbes and Rigobon (2002) and then we estimate an exponential generalized autoregressive conditional heteroskedasticity model extended for volatility spillovers. Finally, we propose an extension of the corrected Dynamic Conditional Correlation (cDCC) model, which allows for structural breaks in the correlation dynamics. The suggested cDCC specification provides a natural testing framework for the correlation contagion hypothesis. Compared with other similar approaches, the proposed structural break cDCC approach allows for consistent inferences. The results do not confirm any contagious effects stemming from the 10-year Greek sovereign bond.

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1. Introduction

Since the inception of the common currency, European Monetary Union (EMU) countries have experienced a convergence of their long-term interest rates. The establishment of the EMU created expectations among peripheral countries (such as Greece, Portugal, and Ireland) for sustainable economic growth due to the political and financial stability that the EMU introduced. The single currency implied a common monetary policy with very low interest rates set by the European Central Bank (ECB) that would be based initially on low German inflation rates. Thus, the countries with high inflation rates at that time (Greece, Portugal, and others) gained credibility from this. However, this loose monetary policy prevented the inflation rates of these countries from converging with the EU average inflation rate over time (Gibson et al., 2014). This situation created problems such as a lack of competitiveness and the deterioration of their fiscal balances.

In 2007, after the bursting of the subprime mortgage bubble, the world long-term interest rates increased. As some authors (see Gartner et al., 2011; Chionis et al., 2014) claim, the fundamental macroeconomics of each country were the primary reason for this increase. On the other hand, many authors (such as Gamez-Puig and Sosvilla-Riverob, 2014) argue that the increased volatility of the European government bond yields was a result of a contagious effect from the Greek crisis. This was hypothesized because Greece was the first country that claimed financial support from the EU and the IMF, in May 2010 (see Table 1). Greece's twin deficits, macroeconomic imbalance, and its unsustainable debt path were the main concerns of the international financial community due to a possible contagion to other European countries.

There are various definitions of contagion in the literature as well as various econometric methods of estimating it.[1] In this study we define contagion as the structural break in the linear transmission mechanism of financial shocks (Corsetti et al., 2005) and the consequent possibility of a significant increase in the cross-market linkage between two countries (Forbes and Rigobon, 2002). In doing so, we initially estimate the adjusted correlation coefficient (Forbes and Rigobon, 2002) of the 10-year sovereign bond returns between seven European countries. The test is designed to

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[1] For a more detailed discussion on the definitions of contagion please refer to the next section.

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Table 1
A timeline of the major events during the European Economic crisis period.

23/5/2009 Greece seeks financial support	21/11/2010 Ireland seeks financial support	6/4/2011 Portugal requests activation of the aid mechanism	21/2/2012 Eurogroup agrees on second financial aid package for Greece	27/6/2012 Spain seeks financial support	27/6/2012 Cyprus requests financial support

Source: European Central Bank (ECB).

prevent false signals of contagion effects caused by the bias induced by the presence of heteroskedasticity. We compute the adjusted correlation coefficient from the variance/covariance matrix of the residuals of a regression model of the return series. In the adjusted correlation method, problems of omitted variables and endogeneity may bias the results in favour of a rejection or an acceptance of the contagion hypothesis (Forbes and Rigobon, 2002; Dungey et al., 2005).

In accordance with Baur (2003), we then implement an exponential generalized autoregressive conditional heteroskedasticity (EGARCH) specification, including a dummy variable as a variance regressor, in order to test for the presence of volatility spillovers from the Greek 10-year bond market to the rest of the examined European markets.

The last approach adopted in the study is based on the estimation of the correlation procedure modelled as a dynamic process. In this line of research the presence of correlation contagion in a dynamic correlation framework is typically detected by graphical inspection of the correlation output. However, a major shortcoming of such an approach is that the contagion hypothesis cannot be explicitly tested. Many authors employ the estimated correlation process as a proxy of the unobserved correlation process by assuming a constant path with structural breaks (Chiang et al., 2007; Syllignakis and Kouretas, 2011; Ahmad et al., 2013; Mighri and Mansouri, 2013).

The contagion hypothesis was then tested from the estimation output of a regression of the proxy variable on dummy variables that control for the crisis periods (*correlation regression method*, or CRM from now on). A significant difference between the estimated coefficients of the two dummy variables provides evidence of different correlation regimes in the corresponding subsamples.

Although the CRM approach seems simple and effective, it presents some statistical drawbacks that can cause bias in the estimations and inferences. Ignoring the breaks in the estimation of the correlation dynamics will lead to overestimated persistences that can affect the consistency of the estimated correlation regimes. More specifically, the smoother correlation dynamics due to the overestimated persistence result in a shrinkage bias of the estimated correlation regimes that can lead to a false rejection of the contagion hypothesis. Moreover, since the inferences on the correlation regimes are not adjusted for the estimation of the correlation dynamics, the standard errors of the estimated correlation regimes can be inconsistent.

A different approach is adopted by Celik (2012), who estimates the correlation process separately in the crisis and pre-crisis periods and tests the difference between the mean of the estimated correlation processes in the two subsamples by a standard t-test. As in the CRM approach, since the estimated rather than the true dynamic correlations are used as the input of the t-stat the asymptotic size of the test is likely to be different from the nominal size. Furthermore, the estimation of the standard errors of the correlation processes entering the t-stat would require a heteroskedasticity and autocorrelation robust estimator (Newey and West, 1987).

The main contribution of this study is the introduction of a new method for testing the correlation contagion hypothesis that solves the inconsistency problems of the two approaches mentioned above. Following Cappiello et al. (2006), we tested for the possibility of structural breaks in the correlation dynamics by modeling this as a corrected dynamic conditional correlation (cDCC) process (Aielli, 2013).[2] To further support our methodology, a simulation study is included where we show the superiority of the accuracy of the proposed method in terms of the estimation and inferences with respect to the CRM method. Specifically, the coverage probability of the confidence intervals of the proposed method is close to the nominal values whereas this seems largely biased in the CRM method.

To the best of our knowledge, the hypothesis of the existence of a contagion mechanism in the European bonds market stemming from Greece's debt crisis has never been tested under the aforementioned methods. Moreover, only one paper (Philippas and Siriopoulos, 2013) takes into account the whole sample period of the Greek crisis (from 2009 to 2012) as is done here.

However, we recognize that the rejection or acceptance of the contagion hypothesis is a very complicated task since there are several possible channels of contagion (Cipriani et al., 2013; Masson, 1998); we mainly concentrate on the part of the literature that tests the hypothesis of contagion in a correlation framework and try to correct some of the existing statistical issues.

The paper proceeds as follows: Section 2 reviews the relevant literature. Section 3 describes the data used. Section 4 analyses the proposed methodologies and presents the main findings. Finally, Section 5 presents our conclusions.

2. Literature review

According to the World Bank, contagion occurs when cross-country correlations increase during *crisis times* relative to correlations during *tranquil times*.[3] Dornbusch et al. (2000), state that "*contagion refers to the spread of market disturbances, mostly on the downside, from one country to the other, a process observed through comovements in exchange rates, stock prices, sovereign spreads, and capital flows*". Forbes and Rigobon (2002) define contagion as a significant increase in cross-market linkages after a shock to one country (or group of countries). They move a step further, pointing out that there may be *interdependence* among countries, which does not necessarily imply a contagion effect, if the comovement does not increase significantly. In Masson (1998), "pure contagion" exists when markets jump from a "good" to a "bad" equilibrium. With respect to the above definitions, Dungey et al. (2005) argue that differences in the definitions used to test

[2] With respect to Engle's DCC model, the cDCC model has known stationary properties. We also note that our extension differs from the asymmetric extension of the DCC model, which is also used in contagion analyses (see, among others, Yiu et al., 2010; Samitas and Tsakalos, 2013).

[3] This definition is also presented in Morales and Andreosso-O'Callaghan (2014, p. 111). For an extensive presentation of the related literature refer also to Pericoli and Sbracia (2003). Also, Claessens and Forbes (2001) present many theoretical models and country case studies in their book.

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