Sovereign CDS Contagion in the European Union: A Multivariate GARCH-in-Variables Analysis of Volatility Spill-Overs

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A GARCH-with-variables model is used to assess volatility contagion in the Eurozone Debt Crisis. Credit Default Swaps on sovereign debt with 3 years maturity are used as a reference financial instrument, covering the sample period from 2008-2013. Daily data on Credit Default Swaps is used. We conclude that there is strong statistical evidence of volatility contagion in CDS spreads from the Eurozone periphery to its core. However, the direction of contagion is contingent on the periphery and core countries being assessed. As such, German 3 year CDS on sovereign debt mean equation is to vulnerable to Portuguese and to Greek CDS volatility, whilst German sovereign CDS volatility is vulnerable to greek one day lagged sovereign volatility. Differently, France's sovereign debt Credit Default Swaps are only exposed to Spanish and Italian sovereign CDS in the mean equation. Exposure to greek lagged one day volatility exists as well.

Keywords: Eurozone debt crisis; Contagion; GARCH; Volatility; Credit Default Swaps

JEL Codes: C22; C58; E65;, G01 and H63

1. Introduction

A vivid debate has emerged with the 2008 financial crisis on the systemic risk posed by some complex financial derivatives. Over the counter (OTC) trading of credit derivatives, without tight regulation, is said by some to have led to wide speculation. In fact,, OTC trading of Credit Default Swaps, by investors that might not own the underlying asset, and hence were not following conventional hedging strategies, was perceived as an attempt to induce increased default probabilities. Indeed, Credit Default Swaps had been created (Veget et al, 2013) as a risk management tool. By 2008, they were far more than just that. The Euro Zone debt crisis has further enhanced such a debate, creating a dividing line between financial practitioners and some central banks, with the Banque de France at the forefront of the criticism of Credit Default Swap markets (e.g. Damette and Frouté, 2010).

The criticism of such financial instruments was further enhanced with the Euro Zone Debt Crisis. Sovereign CDS increased their relevance in worldwide trading by a significant amount, when compared to corporate CDS. Using data from the Bank of International Settlements (BIS, 2012), it is easy to observe that the weight of sovereign CDS has doubled between 2009 and 2011, and that when net notional value is considered, they weight of sovereign CDS has increased by 77%. Vogel et al (2013), among others, consider this to be related to the Euro Zone debt crisis.

This paper is organized as follows. The following section reviews the scarce existing literature on sovereign Credit Default Swaps, in particular in their relation to contagion effects in the Euro Zone. Section 3 discusses the methodology we shall use to assess

such contagion between CDS of different countries. The novelty of our approach is to use to a GARCH model where for the CDS spreads of a country, where the variance of CDS spreads of other countries is an explanatory variable both in the mean and in the variance equations. In this discussion we also present the data used for the econometric analysis. Section 4 presents and discusses the estimation results for the several cases considered. Section 5 concludes.

2. Literature Review

In spite of the evidence discussed above, pertaining the increasing relevance of sovereign CDS markets,, the literature on the topic is still is scarce. This is to a large extent understandable: Finland, for example, only has quoted sovereign CDS since July 2007. The Euro zone debt crisis, as can be seen, inter alia, in Beber et. al, (2009) and Manganelli and Wolsfwijk (2009), was firstly addressed in terms of bond spreads. Damette and Frouté (2010) is a path breaking paper in this field. The authors use panel unit root tests and panel Granger Causality to argue that movements in the government bonds market are due to movements in the Credit Default Swaps (CDS) market for sovereign debt. They claim that CDS markets are therefore speculative, since investors intend to induce higher bond yields.

A different conclusion is reached by Santos (2011). He claims that the usage of Granger Causality as a basis to assess speculation is dubious due to the *post hoc ergo propter hoc* fallacy. Using a cross section of OECD countries and ordered probit models, Santos (2011) concludes that there exists a relationship between the implied credit default probabilities in the CDS market for sovereign debt, and each country economic fundamentals. In particular, the savings rate plays a critical role in the CDS market: countries with higher credit default probabilities are also the ones with lower historical savings rates. Oliveira and Santos (2013), using a generalized random effects ordered probit further conclude that the level of external debt is also of relevance, in particular when dealing with countries in a higher risk class.

A different strand in the scarce sovereign CDS literature deals with contagion effects. A few noticeable exceptions are Manasse and Zavalloni (2013), who investigate this with a time varying parameters approach, regressing changes in sovereign risk spreads in a variety of factors: a global risk factor, a European risk factor and a financial intermediaries risk factor, concluding that exposure to Greek CDS risk was significant at the peaks of the Greek crisis, whilst core Euro Zone countries were less vulnerable to contagion after that, with changes in CDS spreads being explained to a large extent (54 to 80%) by economic fundamentals; Caporin et al. (2013), arguing with a pioneering use of Bayesian Quantile Regression that that the propagation mechanism of shocks in the Euro Area remained stable in the 2008-2011, when looking at the sovereign CDS markets; Broto and Perez-Quirós (2013), who assessed the contagion effect on peripheral Euro countries using a dynamic factor model; Kalbaska and Gatkowski (2013) use an exponentially weighted moving average correlation between Euro Zone CDS to show that this has exploded in the 2007-2010 period, and an impulse-response function to argue that Ireland had the biggest capacity to trigger distress in the Euro Zone, from all of the "PIIGS".

When looking at the literature on volatility contagion among sovereign CDS markets during the Euro debt crisis, Bucholz and Tonzer (2013) stand out as the most relevant reference. They use dynamic correlations obtained from a multivariate GARCH model to unfold the

existence of strong co-movements, especially between euro area countries and infer the existence of contagion effects. This approach can, in our view be improved, to the extent that nothing in Bucholz and Tonzer (2013) allows them to argue that what is being called contagion is more than an synchronization of sovereign CDS volatilities. Furthermore, their sample is not confined to the Euro Zone, which is our primary focus in this paper. Other papers, such as Afonso, Gomes and Taamouti (2014) focus on volatility contagion in the EU bond and equity markets, in response to ratings announcements, using an EGARCH approach. However, the authors do not focus on the contagion between CDS markets. Tamakoshi and Hamori (2013) assess the effect of the Greek CDS spread on the mean and variance of Credit Default Swaps for the Eurozone banking system. Hence, it is not an analysis of contagion between sovereign CDS, but from sovereign CDS to corporate (in this case banking) CDS. Hence their study is not to be confused with ours.

3. The Methodology and Model

In this paper we look at sovereign CDS volatilities in the Eurozone. We use 3 years-maturity CDS data on spreads, covering the sample period 4-11-2008 to 4-11-2013. This is a high frequency analysis, to the extent that we use daily data. Our choice of Credit Default Swaps with a maturity of 3 years is related to the high frequency analysis: day-to-day traders might be more worried with in the short run.

The sample period was chosen bearing in mind that it is our view that the Eurozone debt crisis did not stop yet. This approach is simply a pragmatic one: there are no strong evidences in the literature suggesting we should look at a shorter period, since the crisis would be over. In our view, most authors using a smaller sample, arbitrarily decide to look at the crisis period of their choice.

We use a GARCH model to look at sovereign CDS spreads. Our main concern are the spreads of Germany and France. Figure 1 shows these during the sample period.

Figure 1
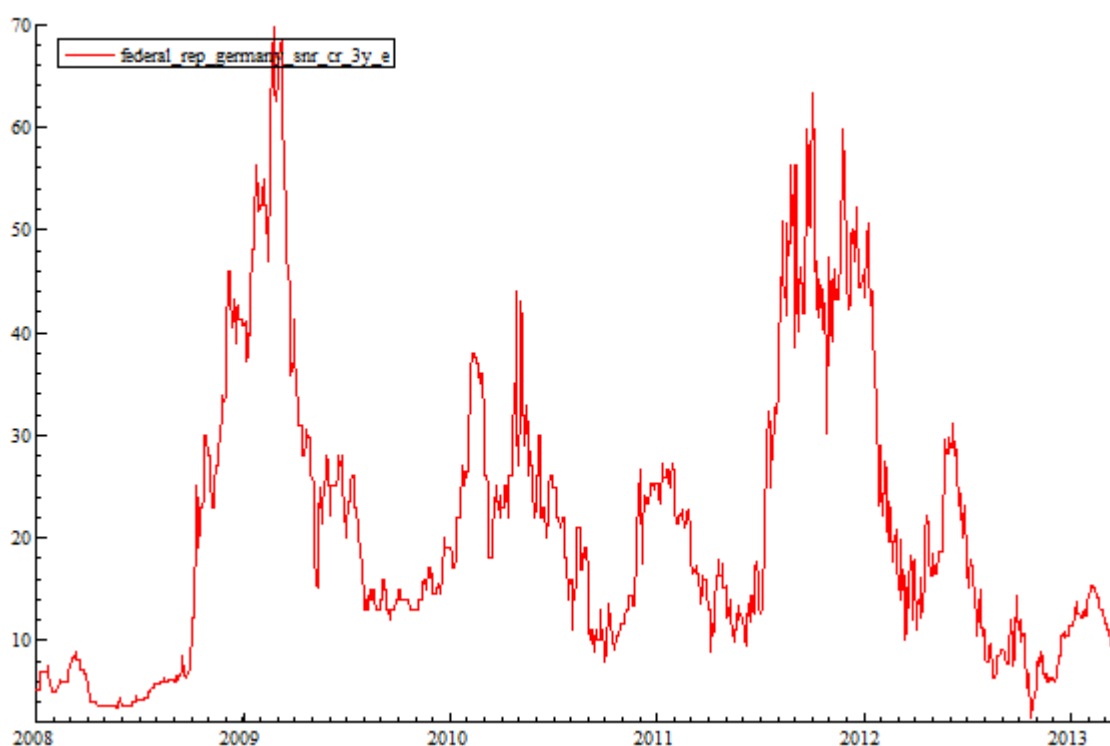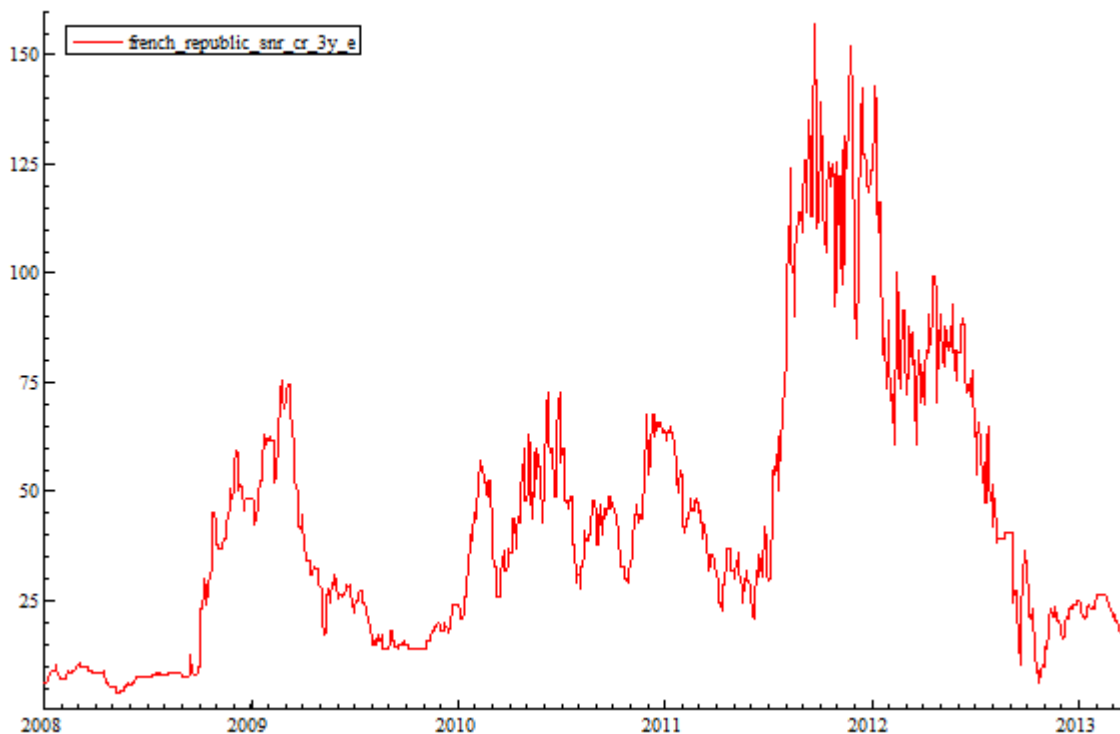
In order to check our hypothesis of contagion in the Eurozone, we use GARCH with variables models. In particular, we are interested in checking whether the volatility of sovereign CDS spreads, and/or log-returns of these (current and lagged), of so-called periphery countries affects the mean and variance of the spread of the core Eurozone countries (Germany and France). Therefore we computed daily log returns for Portugal, Spain, Ireland and Greece. For reasons to be discussed below, we have also computed the daily log-returns for Hungary (which is not a Euro Zone member country).

Hence, we estimated models of the type:

$$y_t = \mu + \boldsymbol{\pi}'\boldsymbol{x} + u_t \qquad\qquad \text{equation (1)}$$
$$h_t = \alpha_0 + \alpha_1.u_{t-1}^2 + \beta_1.h_{t-1} + \boldsymbol{\tau}'\boldsymbol{z} \qquad\qquad \text{equation (2)}$$

Clearly we are working with a GARCH (1,1) structure. Equation (1) is the mean equation, and equation (2), the variance equation. With $\boldsymbol{\pi}'\boldsymbol{x}$ we allow for different variables, and their lagged values, to influence the mean, and with (2) we allow for different variables (and their lagged values) to influence the variance. The dependent variable in the mean equation will be the spread of 3 years German CDS, in section 4.1, and the spread of 3 years French CDS spread in section 4.2. The explanatory variables will also change. In section 4 we only present the statistical significant models, although several others were tried.

One of the novelties in our analysis is that we have also computed the daily volatility of log returns for the periphery countries. In this way we could explicitly test whether, or not, the mean and variance of the core countries depended on such variables as the volatility of the periphery countries.

4. The Findings

We have tested for several specifications. The models we have ended up with are detailed below.

4.1 The German sovereign CDS market volatility

When estimating the GARCH-t(1,1) model for Germany, we obtained the results below:

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                     Coefficient Std.Error   robust-SE  t-value  t-prob
Constant        X      13.2611     0.1195      0.2179    60.8    0.000
varretcdsgrecia X      58.8049     13.28       20.77     2.83    0.005
varretcdsportugal X    23.7388     11.03       11.16     2.13    0.034
varretcdsgrecia_1 H    70.4802     39.11       34.18     2.06    0.039
alpha_0         H       0.537138    0.1473      0.2160    2.49    0.013
alpha_1         H       0.804252    0.05853     0.09273   8.67    0.000
beta_1          H       0.195746    0.05853     0.09273   2.11    0.035
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Non-normality was allowed for. The noticeable conclusions are the individual significance, at a 5% level, of all coefficients. Hence, the GARCH(1,1) model provides a good description of the data. More importantly, however, is that the volatility of the contemporaneous sovereign CDS returns for Greece and for Portugal is not only significant, but highly relevant for the perceived risk of German sovereign debt. In fact, an increase of 1 in the variance of the contemporaneous Greek CDS is estimated to augment the spread of German sovereign CDS by 58.81 basis points, on average. Portuguese CDS have a smaller impact, but still a significant one.
One day lagged volatility of greek CDS is also relevant in the volatility equation of German CDS, even at the 1% significance level. The estimated impact is of 70.1 on average, in the volatility equation.
German CDS spreads and their volatility are not dependent on Spanish, Irish or Italian CDS spreads or volatility.

4.2 The French sovereign CDS market volatility

When estimating the GARCH-t(1,1) model for France, we obtained the results below.

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                        Coefficient  Std.Error   robust-SE  t-value  t-prob
Constant        X         1.20339      0.1770      0.2490     4.83    0.000
spain_snr_cr_3y_e X       0.0637562    0.003380    0.005582   11.4    0.000
italy_snr_cr_3y_e X       0.267817     0.003082    0.003458   77.5    0.000
hellenic_snr_cr_3y_e_1 H  0.00310649   0.0005657   0.0006502   4.78   0.000
alpha_0         H         1.08043e-006   0.0002067 9.8e-07     1.10   0.273
alpha_1         H         0.870634     0.05526     0.05330    16.3    0.000
beta_1          H         0.129328     0.05518     0.05332     2.43   0.015
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Non-normality was allowed for. The noticeable conclusions are the individual significance, at a 5% level, of all coefficients. Hence, the GARCH(1,1) model provides a good description of the data. The noticeable differences with respect to the German case are that: the spreads of the periphery CDS are relevant, instead of their volatility; in the French case, it is Spain and Italy which matter for the mean equation; the spreads of Greek CDS are however relevant for the volatility equation (with a one day lag). As such, contagion through volatility also exists in the French CDS market.

5. Summary and Conclusions

Volatility in Eurozone core countries are subject to contagion from volatility and spreads level of the peripherical countries. However, not all core countries are exposed to the same PIIGS countries, and most importantly, they are no affected in the same way.

Our conclusions are relevant to the ongoing policy debate in the EU: if the cost of insuring German or French debt is inflated by the risk of other countries in the single currency, solutions have to be found in order to foster stability in the European Monetary Union.

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