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Sovereign Crisis, Contagion and Systemic Risk

In a recent working paper of the Norges Bank[1], I have investigated with Massimiliano Caporin, University of Padua, Francesco Ravazzolo, Norges Bank and Roberto Rigobon, MIT Sloan a series of questions about the contagion that the recent sovereign crisis in Europe could create. In particular we are interested in the following questions: How much contagion to countries in the European Monetary Union could be expected as a result of a possible credit event in Greece, Italy or Spain? How much France and Germany are going to be affected? How about countries outside the European Union? Through which channel is the shock going to be transmitted etc.? Clearly, these are important questions for economists, policy makers, and practitioners. However, the empirical challenges to address these questions are extraordinary.

The first challenge comes from the definition of contagion. What is exactly contagion? Is it the "normal" or "usual" propagation of shocks, or is it the transmission that takes place under unusual circumstances? Some literature tends to define contagion as the co-movement that takes place under extreme conditions – or tail events – while another sizeable proportion of the literature compares how different the propagation of shocks is after normal and rare events. The first definition concentrates on the measurement of the transmission after a bad shock takes place, while the second one measures how different the propagation is after a negative shock appears. It is impossible to solve this "semantic" problem in this paper, but our objective is to present convincing evidence of the amount of contagion that takes place according to the second definition. In other words, we are interested in understanding how much contagion exists within the sovereign debts in Europe, where contagion is defined as how different the propagation is after a large negative realization has taken place.

The second challenge is an empirical one. Contagion is an unobservable shock and therefore most empirical techniques have problems dealing with omitted variables and simultaneous equations. The problem is even more complicated because the data suffers from heteroskedasticity, which means that the econometric biases due to these problems shift in the sample, then the conditional volatility moves. In other words, if the correlation between two

variables is different in normal and crisis times, how can we be sure that this is the outcome of a shift in the propagation and not the result of the fact that correlations are not neutral to shifts in volatility? Crisis times are usually associated with higher volatility and simple correlations are unable to deal with this problem. Moreover, if a linear regression has been estimated across different regimes, again, how can the researcher be sure that the coefficients are different because the underlying parameters are shifting, as opposed to the fact that the omitted variable and simultaneous

[1] *http://ideas.repec.org/p/bno/worpap/2012_05.html. Retrieved on August 27, 2012.*

equation biases are not neutral to changes in the volatility?

Finally, the third challenge is that the channel of contagion is rarely understood before the crisis occurs. In other words, very few would have ever predicted that the channel of transmission of the Russian crisis in 1998 was going to be Long-Term Capital Management (LTCM). Furthermore, even though several economists anticipated the US 2008 crisis, none described the transmission from the subprime, to insurances, to AIG, and then to the rest of the world. The profession is extremely good at describing the channels through which shocks are transmitted internationally right after the contagion has taken place. This puts a significant constraint on structural estimation. Structural estimations of contagion have the problem that the channel has to be specified ex-ante, reduced from estimations, on the other hand, have the advantage that they are channel free and therefore might capture the existence of contagion that was not fully taken into account before the shock occurs.

We have first evaluated the extent of contagion in the credit default swaps in the euro region using a reduced form approach based on quantile regressions. As mentioned, contagion is measured as a shift in the propagation when large shocks occur i.e. comparing the highest quantiles and the middle ones. In this methodology when the coefficients are the same, it means that the underlying transmission mechanisms are the same, and that the econometric problems such as omitted variables and endogeneity are not significantly enough to provide a rejection. This is indeed the result they find. In other words, for every pair of countries in our data, the contagion at the extreme quantiles is not statistically different from the contagion that exists in the mid-quantiles. We examine sovereign credit default swaps (CDS) in the period from November 2008 to September 2011 of seven European countries on the euro area: France, Germany, Greece, Ireland, Italy, Portugal, Spain, and one European Member State that is not in the euro area: the United Kingdom.

The key results of this work are reported in charts 1 and 2 that show the values of the estimated coefficient of the connections of CDS respectively of France, Germany and Italy to changes of the CDS in the other countries across different quantile levels. Each chart shows the coefficient values for several quantile and for each other country.

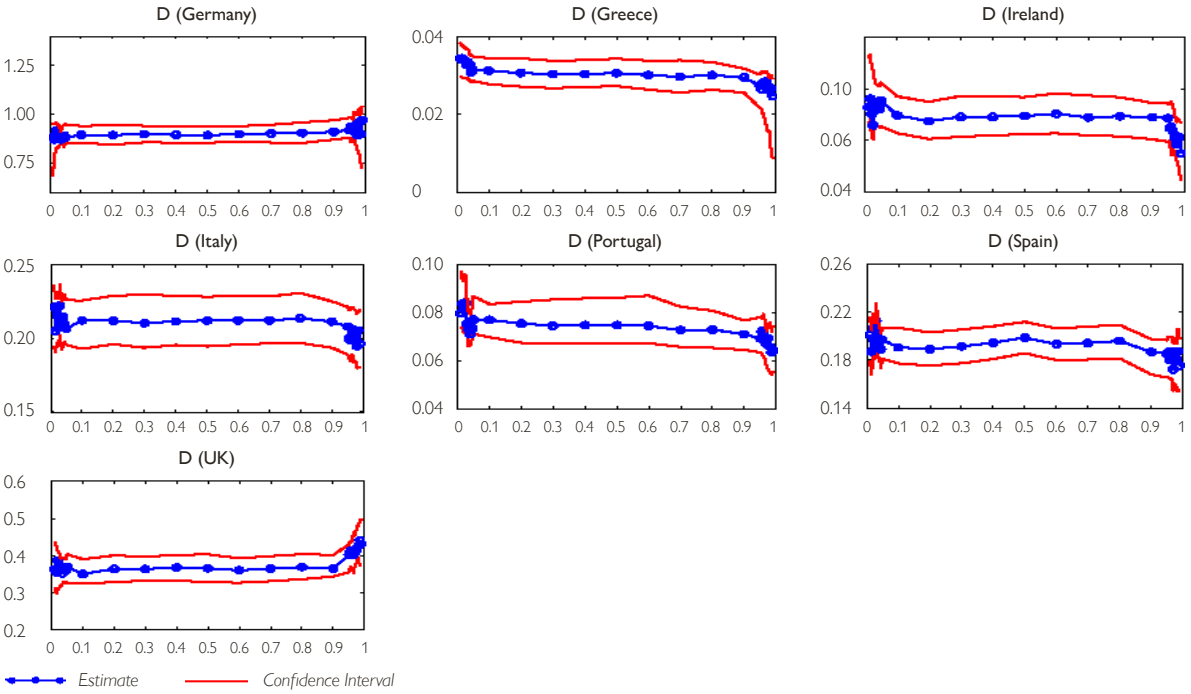
As the charts show, the coefficients are almost flat across the quantiles, suggesting that the dependence between the movements of any two CDS is not changing as a function of the size and sign of the movements.

All our results offer a consistent message: propagation of shocks in Europe's CDS has been remarkably constant between 2008 and 2011 even though in a significant part of that sample periphery countries have been affected by their sovereign debt and fiscal situations. In other words, all the increases in correlation we have witnessed the last two years is coming from larger shocks, and not from similar shocks propagated with higher intensity across Europe.

There has emerged in Europe a strong nexus between the credit risks of financial sectors and their sovereigns. If we investigate whether this nexus is also related to the banking sector cross-exposures and sovereign risk we could see that this is not the case. If we investigate for example France and rank the connections that French CDS have with those of the other countries we will obtain the ranking reported in

Chart 1

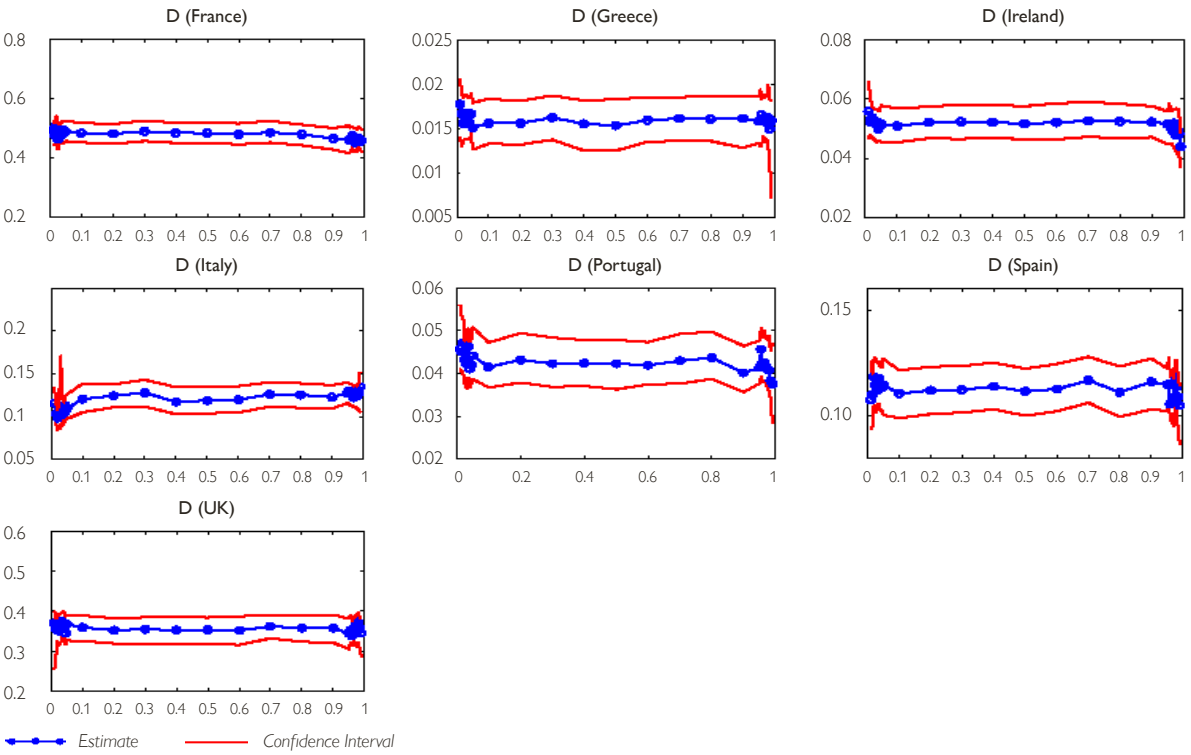
Quantile Regression Coefficients for French CDS



Source: Authors' calculations.

Chart 2

Quantile Regression Coefficients for German CDS



Source: Authors' calculations.

Table 1

Ranking of the French Banking Sector Cross-Exposures on Sovereign Risk of the Other European Member States and French CDS Connections on Sovereign Risk of the Other European Member States

	Germany	Greece	Ireland	Italy	Portugal	Spain	UK
Banking exposure	3	5	6	1	7	4	2
CDS	1	7	5	3	6	4	2

Source: Authors' calculations.

table 1 in the row CDS. If we repeat the same ranking by looking to the exposure the French banks have with respect to the other countries we obtain the ranking reported in the row marked "banking exposure".

As table 1 shows, linkages among the different countries are not strictly related to the European banking sector cross-exposures. There are clearly some other connections on top of these exposures that contribute to the spillover of risk among countries and among institutions. In line with this idea I per-

formed another research with the aim of mapping connections that contribute to systemic risk. I performed this research with my colleague in Venice Monica Billio, with Mila Getmansky from UMass Amherst and Andrew Lo from MIT Sloan. The paper titled: Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors was published in the issue of June 2012 of the Journal of Financial Economics.

We propose several econometric measures of connectedness based on principal-components analysis and Granger-causality networks, and apply them to the monthly returns of hedge funds, banks, broker/dealers, and insurance companies.

By definition, systemic risk involves the financial system, a collection of interconnected institutions that have mutually beneficial business relationships through which illiquidity, insolvency, and losses can quickly propagate during periods of financial distress. In this paper, we propose two econometric methods to capture this connectedness – principal components analysis and Granger-causality networks – and apply them to the monthly returns of four types of financial institutions: hedge funds, and publicly traded banks, broker/dealers, and insurance companies. We use principal components analysis to estimate the number and importance of common factors driving the returns of these financial institutions, and we use pairwise Granger-causality tests to identify the network of statistically significant Granger-causal relations among these institutions.

Our focus on hedge funds, banks, broker/dealers, and insurance companies is not coincidental, but is motivated by the extensive business ties be-

tween them, many of which have emerged only in the last decade. For example, insurance companies have had little to do with hedge funds until recently. However, as they moved more aggressively into non-core activities such as insuring financial products, credit-default swaps, derivatives trading, and investment management, insurers created new business units that competed directly with banks, hedge funds, and broker/dealers. These activities have potential implications for systemic risk when conducted on a large scale (Geneva Association, 2010). Similarly, the banking industry has been transformed over the last ten years, not only with the repeal of the Glass-Steagall Act in 1999, but also through financial innovations like securitization that have blurred the distinction between loans, bank deposits, securities, and trading strategies. The types of business relationships between these sectors have also changed, with banks and insurers providing credit to hedge funds but also competing against them through their own proprietary trading desks, and hedge funds using insurers to provide principal protection on their funds while simultaneously competing with them by offering capital-market-intermediated insurance such as catastrophe-linked bonds.

We find that all four sectors have become highly interrelated over the past decade, similarly increasing the level of systemic risk in the finance and insurance industries through a complex and time-varying network of relationships. In our work we demonstrate that these measures can also identify and quantify financial crisis periods, and seem to contain predictive power in out-of-sample tests. Our results show an asymmetry in the degree of connectedness among the four sectors, with banks playing a much more important role in transmitting shocks than other financial institutions. The economic and financial world is more complex than the one we are usually considering with monetary, macroeconomic and central bank models!