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Within and *between* systemic country risk. Theory and evidence from the sovereign crisis in Europe

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ABSTRACT

We propose a hierarchical Marshall–Olkin model of countrywide systemic risk. At the lower level, we model the systemic risk of a crisis within the banking system (that we call “within” systemic risk) and at the higher level we model the probability of a joint default of the banking system and the public sector (that we call “between” systemic risk). We apply the model to four countries of Northern Europe and four of Southern Europe. In Northern Europe, Germany ranks third for soundness of the banking system but first for country safety. The opposite findings are obtained for Netherlands. In Southern Europe, the Italian banking system ranks first for soundness, quite above Spain, while Italy is aligned with Spain for countrywide risk. Differences in default time correlations between the banking and the public sectors explain these findings.

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1. Introduction

In the current phase of the financial crisis, the question attracting most of the attention and debate is the mutation and transmission of the credit virus from the banking system, where the epidemic started, to the Governments' balance sheets, and then back from sovereign obligors to the balance sheet of banks. On one side, banks are repeatedly stress-tested against possible scenarios of default of a European obligor; on the other, the implied guarantee traditionally offered by the Governments to the financial system induces opacity and fragility in the balance sheets of the Governments themselves. This link between financial and sovereign crisis appears the main instance of financial contagion *between* sectors that has been addressed in some contributions (see for example BIS, 2011). The other paramount feature highlighted by the crisis, particularly in the hottest periods of the financial turmoil in 2008 and the sovereign crisis in 2010–2011, is the contagion *within* the financial sector, mostly driven by counterparty risk and liquidity (see Allen and Gale, 2000; Brunnermeier, 2009). The dynamic analysis of systemic risk within the financial sector shows that this sector may contribute to amplify economic fluctuations (see Brunnermeier and Pedersen, 2009; Battiston et al., 2012; Mittnik and Semmler, 2012).

In this paper we propose a methodology to address systemic risk both *within* the financial sector and *between* the financial sector and the public one. The method consists of two steps. The first is an estimate of the probability of a systemic event from marginal default probabilities of a set of obligors and their rank correlations. The systemic event is

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conceived as the simultaneous default of the banks in the sample, and the probability is represented by the intensity of this event, that is its instantaneous probability. The analysis, which is carried out on a sample of banks for 8 European countries, enables us to extract the probability of a collapse of the financial system in each country. The second step consists of estimating the common factor of a collapse of the banking system and of the Government at the same time, for each of the eight countries. From a technical point of view, we implement a hierarchical Marshall–Olkin copula model, in which at a lower level we estimate the marginal default intensity common to the obligors in the banking system, and we compute the marginal default intensity of the Government; at the upper level, then, we use a copula function (which in our application is again the Marshall–Olkin one, but could be different) to estimate the probability of a joint default of the banking system and the Government itself.

The use of the Marshall–Olkin copula provides a set of useful measures of *between* and *within* systemic risk. These measures are represented by the parameters of the copula that have the straightforward interpretation of the ratio between the instantaneous probability of a systemic default event and the instantaneous default probability of each obligor in the set. The closer this parameter to one, the higher the relevance of the systemic event for the default of the obligor, or, which is the same, the lower the idiosyncratic (obligor-specific) component of the probability of default. More explicitly, if we find that the parameter corresponding to the Government is equal to one, that means that whenever the Government gets into default, the same happens to the banking system. If at the same time the parameter of a systemic collapse of the banking system is low, that means that a collapse of the banking system may occur without bringing about a sovereign crisis. In a sense, the estimation technique proposed in this paper enables to single out the probability of a collapse of a country as a whole, and it is a good candidate to represent country risk.

The contribution of our paper is both empirical and methodological. As for the technical method, the novelty is that we apply a Marshall–Olkin model for the estimation of a systemic banking crisis, rather than standard Gaussian copulas used in other (few) applications. The advantage of the Marshall–Olkin model is that it may allow for a positive measure for the event of simultaneous default of two or more banks, which instead is zero in Gaussian and all other absolutely continuous copula models. Moreover, to the best of our knowledge this is the first attempt in literature to model, by a hierarchical structure, and to estimate the joint probability of default of the banking system of a country and the corresponding Government. On empirical grounds, the paper contributes to the evaluation of the link between the banking system and sovereign risk in Europe, and how it changed through the crisis. The contribution introduces new measures of this link. One is the correlation of default times of the banking system and the sovereign obligor, which is typical of Marshall–Olkin applications. We also measure the relative relevance of a systemic shock to both the banking system and the Government, identifying which of the two carries a higher degree of specific risk.

Finally, our work, which uses CDS quotes for financial and sovereign obligors, provides an analysis and an interpretation of the co-movement of such markets during the crisis. In fact, following the dramatic consequences of the Lehman Brothers default, many Governments announced and implemented rescue plans for the financial sector, creating the expectation of a wide bail-out policy. This expectation clearly emerges from CDS quotes: the default risk priced by the market shows a remarkable co-movement between the financial sector and the Government sector. This co-movement actually hides a measure of country risk, that could be hedged by taking a long position in a market and a short position in the other.

The plan of the paper is the following. After reviewing the literature most closely related to our work (Section 2), we lay out a multivariate intensity based model of a banking crisis (Section 3), and a hierarchical model of a countrywide crisis affecting both the banking and the public sectors (Section 4). In Section 5 we present our empirical evidence, using a sample of 35 large banks located in eight European countries: we provide here a market based estimate of the systemic default risk within the financial sector and between the two sectors (bank and public); we also provide some information to give an economic interpretation of our statistical findings. Section 6 summarizes our main results. Finally, the Appendix provides detailed information on our sample.

2. Related literature

This paper contributes to the techniques of measurement of systemic credit risk either within or between sectors, as well as to models addressing the economics of the link between the credit risk of the public and the financial sectors. As for the literature on the systemic risk measurement, several measures have been proposed of the loss incurred by any firm in a sector conditional on a financial crisis of the rest of the sector. The loss may be measured using standard risk management techniques, such as conditional Value-at-Risk (Adrian and Brunnermeier, 2010) or Expected Shortfall (Acharyia et al., 2010), or actuarial techniques such as the insurance premium to be paid to face the financial distress of obligors in the banking system. While our work is also in the spirit of actuarial applications, it differs from the rest of this research because its focus is on the probability of a credit event, rather than the mix of it with the severity. In fact, it is well known that there is much more information in the market concerning default probability rather than recovery risk. In particular, the CDS quotes that we use to extract the probability of default assume a fixed 40% recovery by market convention. So, in our work we aim at computing the probability of a systemic event, that is understood as default of the banking system and the public sector at the same time, whilst the severity of the loss from this systemic event is not addressed. This way, we are able to obtain more neat results, that could be complemented with data on loss severity, once these could be available

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