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Sovereign debt and systemic risk in the eurozone☆
A macroeconomic perspective

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ABSTRACT

The paper analyzes the eurozone crisis through the lens of a new systemic sovereign risk measure. This measure is built on countries' budgetary constraint and the Marginal Expected Shortfall (MES) estimated through a DCC-Garch model. We use daily data on government bonds yields 10*Y* and quarterly macroeconomic data over the period 2001 – 2013. Our measure, applied to the sovereign debt crisis of the euro area, captures countries' expected financing requirements in times of crisis. The results underline the most systemically important countries and their contribution to a potential system's default. Specifically, Italy and Greece are highlighted as the most systemically important countries in crisis times.

1. Introduction

The recent financial crisis and the subsequent European debt crisis, have compelled a number of Eurozone members to increase their public spending in order to support their respective banking sectors. Under this severe budgetary pressure, some countries encountered difficulties to raise the funds needed to finance their increasing debt. At the same time, "it brought the Eurozone itself on the brink of collapse" (Beetsma et al., 2015). In this context, identifying the most systemically important countries has become crucial. Even if for a certain number of economists (Eichengreen and Wyplosz, 2016) the crisis seems to have passed, the recent fiscal slippage of Spain and Portugal underline again that identifying countries with troubled public finances and their systemic importance remains a key issue in the Eurozone.

Systemic risk was a main driver of the crises and is at the core of all recent analyses concerning the Great Recession and the European debt crisis.[1] If the period preceding the financial crisis was by far characterized by a lack of suitable risk indicators, since the outbreak of the crisis, both practitioners and academics have tried to propose measures able to capture the risk accumulation. And the focus was mainly put on systemic risk measures. One way in which the present systemic risk measures can be classified is based on data used to compute them. We can distinguish between, on the one hand, market based measures and, on the other hand, measures which involve confidential information related to the balance sheet and to the financial position of each institution. While the latter are only available to regulators, the former have the advantage of being accessible to all interested parties, be that academics, practitioners or regulators. In the recent period, the measures based on publicly available data gained more attention. This can be explained by their success in identifying, using a simpler and more time effective methodology, the same systemically risky institutions as the ones proposed by the Financial Stability Board.

As a starting point to our analysis, we use a market based indicator and more precisely one of the most popular measures used in the financial literature: the Marginal Expected Shortfall[2] (MES, Brownlees and Engle (2016)). The MES measure has been largely used in the evaluation of systemic risk contribution of financial institutions Banulescu and Dumitrescu (2015); Benoit et al. (2016); Cai et al. (2015); Idier et al. (2014); Pagano and Sedunov (2016) but it was applied only once to another type of crisis, the European debt crisis (Popescu and Turcu, 2014). More precisely, Popescu and Turcu (2014) show that the MES[3] can successfully be applied to countries, if

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[1] Some examples include Arakelian et al. (2016); Betz et al. (2015); Pagano and Sedunov (2016); Pourkhanali et al. (2016) and Reboredo and Ugolini (2015).

[2] The MES allows to assess the expected loss an equity investor in a financial institution would experience if the market declines under a given threshold, over a certain time span.

[3] At countries level, the MES can be defined as the expected increase in a country's bond yield when the entire international government bonds market is under stress (Popescu and Turcu, 2014).

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adjustments are performed in order to adequately transpose this measure, initially developed for market risk, at macroeconomic level (i.e. taking into account the transition from financial institutions to countries).

In this paper, we propose a novel systemic sovereign risk measure which we further use to compute the contribution of Eurozone countries to systemic risk. To do this, we extend the analysis of Popescu and Turcu (2014) and use the MES to construct a more comprehensive systemic risk measure – the Expected Financing Requirements (EFR) of the Eurozone countries. We assume that an initial crisis emerging at the system's level[4] would create higher pressure on the economic situation of a particular country. This might further induce an amplification of the original systemic crisis, creating a negative externality for the entire system. Therefore, a country becomes systemically important when its financing requirements in stress times (the EFR) are so high that they would cause significant adverse consequences for the whole system.[5] The EFR, computed using publicly available data, allows us to detect sudden shifts in countries' systemic risk and goes beyond the existing standard global measures, such as the MES (Popescu and Turcu, 2014), whose common limit is that they are rarely theoretically grounded (Benoit et al., 2016).

The EFR is derived from the government budget constraint. Hence, it takes into account macroeconomic variables like public debt, growth rate, inflation and primary deficit. The measure is built in a stress test logic, *i.e.* conditional on a particular negative event concerning the government bonds market. We therefore condition the financing needs of a country on the occurrence of a systemic event, taking place at the Eurozone level. By doing this, we introduce in the budget constraint the MES version of Popescu and Turcu (2014). The idea behind this measure comes from the fact that, when analyzing systemic risk for financial institutions, two other concepts are usually underlined: "Too Big to Fail" (TBTF) and "Too Interconnected to Fail" (TITF). The first notion refers to the size of financial firms, whereas the second one to their linkages with the rest of the financial system. The status of TBTF or TITF for an institution normally insures its rescue by the government, because allowing it to default would cause even more damage to the entire system. Taking into account these two dimensions - size and interconectedness - when quantifying systemic risk seems therefore crucial. The same logic also applies to countries, as public authorities seem to have no choice other than coming to the rescue of problem countries, in order to avoid contagion and panic. In our analysis, the size of the country is captured by its public debt, whereas its interconnectedness with the system, by the MES.

The EFR is estimated based on data for 11 Eurozone countries, during the period 2001-2013. The results allow us to identify countries' contribution to systemic risk and to establish a ranking able to reveal the systemically important Eurozone members. Moreover, to take the analysis even further, EFR results are combined with countries probability of experiencing a systemic event, as well as with countries' credit ratings. Few papers construct or compare systemic risk measures at macroeconomic level. They are usually constructed in a financial stress dimension (Grimaldi, June 2010), MacDonald et al. (2015), as early warning systems (El-Shagi et al., 2013; Knedlik and Von Schweinitz, 2012) or analyze the euro area sovereign bond yield spreads dynamics and their determinants (Afonso et al., 2015), Perego and Vermeulen (2016); Silvapulle et al. (2016). Bernal et al. (2016) and Reboredo and Ugolini (2015) use, as we do, a financial risk measure and transpose it to countries. However, their approach is opposite to ours. In our case, systemic risk is defined as a global event that affects the bond market as a whole and generates difficulties for particular countries. For Bernal et al. (2016) and Reboredo and Ugolini (2015), systemic risk starts with the default of a particular country and spreads to the rest of the area. Their measure is based on a CoVar[6] approach whereas ours is constructed on the MES. To underline the differences between these two approaches, we can use the classification proposed by Drehmann and Tarashev (2011) with respect to systemic risk measures. In the financial sector, a top-down measure first determines systemic (i.e. system-wide) risk and then allocates it to individual institutions. A bottom-up measure first assumes distress in a particular institution and then evaluates the level of system-wide risk associated with that event. Therefore, we base our analysis on a top-down measure, while Bernal et al. (2016) and Reboredo and Ugolini (2015) choose a bottom-up systemic risk measure for their approach. Given this distinction, their measure will be directly related to default risk, whereas ours only indirectly implies the risk of default of a country without explicitly modeling it. Precisely, we model this risk as an increase in the difficulties to refinance outstanding debt.

The rest of the paper is structured as follows. Section 2 presents the theoretical framework used to derive the sovereign systemic risk measure. In section 3, we describe the econometric methodology employed to compute the EFR. In section 4, we propose an application of the measure to the euro area in order to determine which are the most systemically important countries. Section 5 concludes.

2. The theoretic framework

Our aim is to evaluate the expected financing requirements of countries in an integrated monetary area, such as the Eurozone, during a crisis which takes place at the area level. On this basis, we further determine which countries contribute the most to systemic sovereign risk. The approach we use is similar to the one applied to financial institutions. As defined by Brownlees and Engle (2016), the systemic risk of a financial institution is perceived as *"its contribution to the total capital shortfall of the financial system that can be expected in a future crisis"*. The idea underlying this definition is that, when the financial system undergoes a crisis, the failure of a financial firm - due to large capital losses - reinforces the crisis. Thus, the higher the capital shortfall for a firm, the greater its contribution to systemic risk.

In this paper, we transpose the framework used for financial institutions and assess countries' financing requirements. A country is systemically risky if it is likely to face large financing requirements at a time when the whole system is under stress, that is, when it becomes difficult to raise the necessary funds to repay outstanding obligations.[7] Important financing needs may come either from the bond yield imposed by the market or from a deteriorated economic situation of the country (its primary deficit, its debt level etc.). Therefore, the largest contributors to systemic sovereign risk are the countries that need to raise the highest amount of funds in stress times and whose financial difficulties, if not solved, will only deepen the crisis for the whole system.

2.1. Expected financing requirements

To identify and measure the financing requirements of a country, we start from the standard budgetary constraint equation. Let Y_{it} be the real GDP of country i at time t and let B_{it} be the real value of public debt.[8]. The government budget constraint combines the nominal interest rate r_{it}, the inflation rate π_{it}, net growth of real GDP g_{it} (between $t-1$ and t) and the primary deficit def_{it} in order to obtain the

[4] This can be due, for example, to a loss of investors' confidence or to a simultaneous rating downgrade for several countries in the area.

[5] Note that the focus is on the relation between the system and each country in particular and we do not aim at studying the contagion effects among countries.

[6] The CoVar captures the system losses when a firm is under stress (Adrian and Brunnermeier, July 2016).

[7] To deal with a need of funding, the government will have to issue new debt at a yield rate imposed by the market. We suppose that the country is unable to raise funds in any other way (i.e. seigneurage, increase in taxes, reduction of public investment.)

[8] The budget constraint is generally expressed in real terms to account for the effects of inflation (see Hall and Sargent (2011)).