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Systemic risk and bank size

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ABSTRACT

In this paper we analyse firm level systemic risk for US and European banks from 2004 to 2012. We observe that common systemic risk indicators are primarily driven by firm size which implies an overriding concern for "too-big-to-fail" institutions. However, smaller banks may still pose considerable systemic threats, as exemplified by the Northern Rock debacle in 2007. By introducing a simple standardisation, we obtain new risk measures that often prove to be superior predictors of financial distress during the 2007–2009 subprime crisis. We conclude that the new measures could be a valuable addition to the existing indicators employed in Basel III to identify systemically important banks.

1. Introduction

As a result of the sub-prime crisis of 2007–2009 and the sovereign debt crisis that followed, systemic risk in the finance industry has become a hot topic in academic and policy circles. This is because of the substantial damage a financial crisis may cause to the real economy (see, for example, Caprio and Klingebiel, 1996; Hoggarth et al., 2002) and the fact that financial institutions do not internalize the costs of such negative externality. As a consequence, addressing systemic risk is at the heart of new financial regulation such as the Dodd-Frank Act in the US and the new Basel III agreement. A capital surcharge is required by Basel III on domestic and global systemically important banks (BCBS, 2012, 2013). On the other hand, the Dodd-Frank Act explicitly emphasizes the need to provide enhanced regulation of firms and sectors that pose systemic risk (Richardson, 2011). A Pigouvian tax has also been proposed to force systemically important financial institutions (SIFIs) to internalise the costs of crises and thus reduce their severity (see Morris and Shin, 2008; Acharya et al., 2011, 2017; Bosma, 2016). However, the first step towards any solution to the problem of systemic instability is the derivation of accurate systemic risk indicators and the correct identification of SIFIs.

A variety of systemic risk measures has been proposed since the start of the sub-prime crisis. Bisias et al. (2012) provide a comprehensive summary, and emphasize that there is no single "pressure gauge" that can fully detect crises. Indeed, Hansen (2013) warns that model misspecification can be a serious challenge when trying to devise systemic risk measures. A possible solution is suggested by Giglio et al. (2016) who exploit the information content of a broad selection of systemic risk measures by combining them into indexes. Among the individual measures in the literature $\Delta CoVaR$ is one of the most popular. Put forward by Adrian and Brunnermeier (2016), it uses quantile regressions to measure the increased Value-at-Risk (VaR) of the financial system when a specific financial firm is in distress. Girardi and Ergun (2013) generalize the original

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$\Delta CoVaR$ by extending the definition of financial distress to include more severe events. Further refinements have been proposed by López-Espinosa et al. (2015) and Sedunov (2016). While $\Delta CoVaR$ focuses on system losses conditional on a bank's distress, most other indicators take the opposite view and determine the systemic risk posed by an institution as the institution's loss conditional on system distress. The idea is that the more a bank is susceptible to market upheavals, the more it can contribute to the severity of a crisis. This second set of measures can be based on reduced form or structural model approaches. *SRISK* as developed by Brownlees and Engle (2017) and Acharya et al. (2012) belongs to the former type. Lehar (2005)'s indicator is an example of the latter. It exploits the capital structure of a bank in a Merton-type framework to assess its default risk. This information is then embedded into a systemic risk indicator expressed as a regulator's risk exposure to the bank's default.

The main contribution of this paper is the introduction of standardised systemic risk measures. Although large banks are commonly considered of systemic importance and firm size is typically an important driver of systemic risk measures (see, for instance, De Jonghe, 2010; Hovakimian et al., 2012; Huang et al., 2012; Vallascas and Keasey, 2012; Zhang et al., 2015; Laeven et al., 2016; Sedunov, 2016), there is growing evidence that size may not be a persistent determinant of systemic risk in past crises (Weiβ et al., 2014), nor be a prominent contagion factor among large international banks (Lopez-Espinosa et al., 2012, 2013). We propose a standardisation of systemic risk indicators that enables us to control for the overshadowing effect of firm size and bring forth other factors that contribute to the systemic importance of an institution, namely interconnectedness and default risk. Specifically, interconnectedness has attracted a lot of interest in recent years and has led to the development of models of interbank lending and contagion through networks (Poledna et al., 2015; Kanno, 2015; Hautsch et al., 2015; Betz et al., 2016).[1] Danielsson et al. (2016) question the reliability of current systemic risk measures on the basis that they entail substantial estimation risk. Our standardised indicators could help to address this concern in that, even though they are straightforward extensions of existing models, yet they appear to improve systemic risk forecasting.

Our second contribution is a new measure of systemic risk for individual banks. We propose a hybrid indicator that extends the structural model proposed by Lehar (2005) to embed a time varying default barrier. This is then combined with the conditional capital shortfall proposed by Brownlees and Engle (2017) and Acharya et al. (2012) to gauge bank distress in a crisis. Through a structural model, one can explicitly define a crisis as the joint default of a group of institutions. In Brownlees and Engle (2017), a crisis event is instead defined as a 40% decline in the 6-month cumulative return of a stock market index. However, not all large stock price corrections may trigger collective defaults.[2] For instance, the burst of the internet bubble in the early 2000s led to a stock market contraction of about 50% from peak to trough (for S&P500 as well as FTSE100) but without the systemic implications seen during the recent Great Recession. In this sense, the crisis condition used by Brownlees and Engle (2017) is more "systematic", while the structural model approach is more "systemic". Our findings suggest that the systemic risk rankings produced by our new (non-standardised) hybrid indicator are consistent with the designation of systemic importance given to US and European banks by the Financial Stability Board (FSB), and with rankings obtained by Brownlees and Engle (2017)'s indicator. Such consistency is not unexpected as it is primarily driven by size effects. Moreover, the standardised version of our hybrid indicator appears to be one of the best predictors of bank distress, across all other indicators studied in the paper. Occasionally, it outperforms all the other measures in our out-of-sample tests. Specifically, for US banks, the new standardised measure is the best pre-crisis predictor of the largest contractions in bank stocks during the 2007–2009 crisis. For European banks, it is the best in-crisis predictor of the largest stock price drops during the second phase of the crisis. The unquestionable relevance of size as a core systemic risk factor combined with the importance of non-size factors when predicting bank risk in a crisis lead to the conclusion that standardised and non-standardised measures complement one another and both should be considered by financial researchers and for regulatory purposes.

The rest of the paper is organized as follows. Section 2 describes our methodology. Section 3 introduces the sample and data sources. Section 4 presents our empirical results and Section 5 concludes.

2. Methodology

In this Section, we first develop our hybrid systemic risk indicator, *rSYR*. Then, we discuss our standardisation procedure to control for size effects.

2.1. A hybrid systemic risk indicator

In order to measure the systemic risk posed by individual institutions, we define financial distress as the event that occurs when a bank's assets fall below the bank's debt at a future time t. The actual market value of total assets of a financial firm $A_{i,t}$

[1] Taking into account feedback loops, a network based structural model is also adopted by Gauthier et al. (2012) to examine the impact of macro-prudential capital requirements on systemic risk. Paltalidis et al. (2015) use networks to model contagion at the country level and find that sovereign risk is the most important channel that amplifies systemic risk in the Euro area. The nexus between systemic risk and sovereign risk is also confirmed by Pagano and Sedunov (2016) at the country level and by Black et al. (2016) with a bank level analysis.

[2] While our definition of a financial crisis is also sensitive to negative stock market returns, a big drop in the market index is in itself not enough to trigger a systemic crisis. In our model, unlike in Brownlees and Engle (2017) the vulnerability of the banking system measured by its effective short term leverage is also important. It is conceivable that banks may not default even after a severe stock market contraction if their leverage is low. On the other hand, a milder erosion of market value might have systemic consequences in a high leverage scenario.