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Systemic risk and asymmetric responses in the financial industry ☆

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ABSTRACT

To date, an operational measure of systemic risk capturing nonlinear tail-comovements between system-wide and individual bank returns has not yet been developed. This paper proposes an extension of the CoVaR methodology in Adrian and Brunnermeier (2011) to capture the asymmetric response of the banking system to positive and negative shocks to the market-valued balance sheets of individual banks. Building on a comprehensive sample of U.S. banks in the period 1990–2010, the evidence in this paper shows that ignoring asymmetries that feature tail-interdependences may lead to a severe underestimation of systemic risk. On average, the relative impact on the system of a fall in individual market value is sevenfold that of an increase. Moreover, the downward bias in systemic-risk measuring from ignoring this asymmetric pattern increases with bank size. In particular, the conditional tail-comovement between the banking system and a bank that is losing market value belonging to the top size-sorted decile is nearly 5.5 times larger than the unconditional tail-comovement versus 3.3 times for banks in the bottom decile. The asymmetric model also produces much better fitting, with the restriction that gives rise to the standard symmetric model being rejected for most firms in the sample, particularly, in the segment of large-scale banks. This result is important from a regulatory and supervisory perspective, since the asymmetric generalization enhances the capacity to monitor systemic interdependences.

1. Introduction

Widespread financial contagion from massive unwinding of trade positions and balance-sheet deleveraging by large financial institutions threatened to collapse the financial system at the heart of the financial crisis. Aiming to prevent similar episodes, a considerable regulatory interest has been directed towards the modeling of tail-interdependences that characterize systemic-risk under an adverse scenario, originating a fast-growing literature on this topic; see Billio et al. (2012) for an overview. In this context, Adrian and Brunnermeier (2011) propose an econometric approach to estimate systemic risk contributions from individual banks to the whole financial system that has become a major reference in this field.[1] The so-called CoVaR is a bilateral measure of downside risk that, in the spirit of the well-known Value at Risk (VaR), determines the expected loss of the financial system conditional on the VaR of an individual institution. The contribution of the individual bank to the system, termed ΔCoVaR, is the incremental value of the CoVaR function conditional on the firm being in distress with respect to the value of the CoVaR function conditional on the average or normal state of the firm. The main advantage of this methodology is that it builds on a semiparametric econometric framework, namely, quantile regression, which does not require assuming the conditional distribution of returns. The key challenge of this approach, however, is to accurately specify the functional form that links the returns of an individual bank to the returns of the system.

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[1] According to Google Scholar, this study has been referenced by over 1,000 papers. The European Central Bank reports time-varying estimates of systemic risk in the Eurozone computed according to this procedure (http://sdw.ecb.europa.eu/browse.do?node=bbn3357).

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In this paper, we discuss the suitability of the functional form involved in the CoVaR model in Adrian and Brunnermeier (2011) and propose a direct extension intended to capture nonlinearities in tail comovements. Our paper is motivated by the crucial observation that the CoVaR model explicitly assumes that a shock initiated in or transmitted by an individual bank triggers the same characteristic response (in absolute value) in the overall system independently of whether this shock is positive or negative, *i.e.*, whether it is related to a true balance-sheet contraction or not. In sharp contrast, there are strong economic arguments supporting that idiosyncratic negative shocks are more likely to generate more intense systemic responses than positive shocks, particularly, if dealing with large-scale financial institutions. These arguments can be framed into two different perspectives.

From a general perspective in investment theory and microprudential risk management, asymmetric responses are rooted in how investors (in this context, bank stockholders, bondholders and depositors) generally perceive non-diversifiable risk and make financial decisions. In particular, risk-averse investors tend to care more about large downside losses than they do about upside gains, since they exhibit greater sensitivity to reductions in their level of financial wealth. This behavior is theoretically consistent with loss aversion or decreasing absolute risk aversion preferences (Gul, 1991; Barberis et al., 2001; Berkelaar and Kouwenberg, 2009), and there is considerable evidence supporting its empirical validity; see, for instance, Bekaert and Wu (2000), McQueen and Vorkink (2004), Engle and Manganelli (2004), Ang et al. (2006), and Bali et al. (2009).

From the viewpoint of financial stability, the complexity and strong interconnectedness among financial institutions make idiosyncratic balance-sheet shocks to an individual bank or to parts of the financial system likely to morph into systemic shocks. Consequently, there are specific channels of risk proliferation which underpin asymmetric system-wide tail comovements in the financial industry. First, banks are interconnected through the interbank market and securities lending transactions, whereby market players manage liquidity by holding short-term positions with their peers. An idiosyncratic shock that reduces the ability of a borrower to repay short-term debt also reduces the market value of the underlying claims held by the lender, thereby eroding the latter's ability to meet its maturing liabilities. The short-term wholesale funding market, therefore, creates a powerful channel of systemic contagion that propagates negative shocks; see, for instance, López-Espinosa et al. (2012) and references therein. The same argument applies to derivative transactions whereby counterparty risk may amplify market shocks.

Second, an extreme idiosyncratic shock that reduces the fair value of assets held by an individual institution may trigger a spiral of mark-to-market losses in firms holding similar securities; see Brunnermeier and Pedersen (2009). Stricken institutions that seek to restore their liquidity through asset fire sales create an additional channel of system-wide contagion because fire sales depress market prices further and create contagion across unrelated asset classes through proxy hedging.

Third, in an extreme environment, a large negative shock affecting a part of the financial system may reduce the confidence of investors in the whole system, leading depositors and lending counterparties to withdraw their holdings from sound institutions and across asset classes, thus precipitating widespread distress. Bernanke (1983) comes to the conclusion that bank runs were largely responsible for the systemic collapse of the financial industry and the subsequent contagion to the real sector during the Great Depression.

Finally, asymmetric responses may arise as a consequence of regulatory capital requirements as well. Under the Basel III standardized approach for credit risk, banks use external assessments from credit rating agencies to determine capital requirements for their exposures to financial institutions. Risk weights are determined according to a nonlinear criterion. For instance, the risk weight on a claim held on a certain bank is 50% if its credit rating is BBB. One notch rating upgrade to A leaves the risk weight unchanged at 50%, yet one notch rating downgrade to BB raises the risk weight of the claim to 100%. Hence, negative shocks that lead to downgrades in an individual bank can force the remaining banks to hold larger capital buffers against the claims on this bank, thereby depressing the return of the system as a whole. This effect is compounded by the asymmetric behavior of provisioning that kicks in when repayment of a claim on a specific bank remains past due for a specific period of time, amplifying the comovement in asset returns in bad times. Obviously, positive idiosyncratic shocks lack similar channels to spill over to the whole system.

All these arguments suggest that the tail-comovements in the financial system may be much more sensitive to downside losses than to upside gains. In such a case, the linear assumption involved in Adrian and Brunnermeier (2011) neglects a key aspect which would lead to underestimate the extent of systemic risk contribution of an individual bank in a downward market. We propose a direct extension of the original CoVaR procedure that encompasses the baseline model as a special case and which, more generally, allows us to capture asymmetric patterns in systemic tail-spillovers. We shall refer to this specification as asymmetric CoVaR in the sequel. This approach retains the tractability of the linear model, which ensures that parameters can readily be identified by appropriate techniques, and produces ΔCoVaR estimates which are expected to be more accurate in practice. Furthermore, given the resultant estimates, the existence of nonlinear patterns that motivate the asymmetric model can be addressed formally through a standard Wald test statistic.

The main contribution of this paper is to formally show that the insights from the existing literature on asymmetric comovements between financial assets carry over to systemic-risk measurement as well and, hence, should not be ignored. Whereas the systemic risk literature has proposed a number of alternative approaches to quantify systemic risk exposures, the analysis on whether tail-comovements may exhibit nonlinear responses against positive or negative shocks has received little attention. Brownlees and Engle (2011) use asymmetric TARCH models to model univariate volatility in the DCC setting in an approach that heavily builds on multivariate volatility-type modeling. However, this analysis only characterizes the well-known leverage effect in univariate volatility, without addressing different responses in downside-risk comovements attending to the sign of shocks. Building on a comprehensive sample of U.S. banks over the period 1990–2010, we characterize systemic interdependences both at the individual level and in a panel-data framework to formally address the empirical suitability of the symmetric CoVaR model. This analysis reveals the existence of strong asymmetric patterns that characterize the marginal contribution of individual banks to the total system, with the symmetric CoVaR model being generally rejected in favor of the asymmetric generalization for most banks, particularly, large-scale banks. Neglecting tail-nonlinearities gives rise to ΔCoVaR estimates that can largely underestimate the systemic importance of a firm. For instance, at the 1% shortfall probability, the cross-sectional median of the symmetric-based ΔCoVaR for large-capitalization banks in the top size-sorted decile is -0.013, whereas the corresponding median of the asymmetric-based ΔCoVaR is -0.071, *i.e.*, nearly 5.5 times greater in absolute terms. Remarkably, this pervasive effect appears to be systematically tied to the size of the firm: The larger the bank (and, hence, its systemic importance) as measured by either its total assets or liabilities, the greater the relative size of the underestimation bias in relation to the asymmetric model. For instance,