What is the systemic risk exposure of financial institutions?

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ABSTRACT

I compare the performance of three measures of institution-level systemic risk exposure — Exposure CoVaR (Adrian and Brunnermeier, 2016), systemic expected shortfall (Acharya et al., 2016), and Granger causality (Billio et al., 2012). I modify Exposure CoVaR to allow for forecasting, and estimate the ability of each measure to forecast the performance of financial institutions during systemic crisis periods in 1998 (LTCM) and 2008 (Lehman Brothers). I find that Exposure CoVaR forecasts the within-crisis performance of financial institutions, and provides useful forecasts of future systemic risk exposures. Systemic expected shortfall and Granger causality do not forecast the performance of financial institutions reliably during crises. I also find, using cross-sectional regressions, that foreign equity exposure and securitization income determine systemic risk exposure during the 1998 and 2008 crises, respectively; financial institution size determines systemic risk exposure during both crisis periods; and executive compensation does not determine systemic risk exposure.

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1. Introduction

Events beginning in September 2008, including the collapse of Lehman Brothers and the rescue of AIG, showed the effects that a systemic crisis can have on the economy. The distress and even failure of some key institutions during that time prevented the financial system from functioning normally and led to further distress of financial institutions. Because regulators, investors, and executives had a limited understanding of the exposure of individual institutions to systemic risk, it was difficult for them to effectively manage institutions during the crisis. Thus, going forward, it is important to have an effective measure of the systemic risk exposure of financial institutions. A systemic risk exposure measure is a forecast of the performance of a financial institution conditional on a crisis. Therefore, such a measure makes it possible to assess which institutions will be seriously endangered if a crisis were to occur. Further, a knowledge of which institutions have higher systemic risk exposures relative to their peers will enable researchers and regulators to investigate what factors determine each institution’s level of systemic risk exposure.

This paper investigates the systemic risk exposure of U.S. financial institutions. I evaluate the ability of existing measures of systemic risk exposure to forecast the within-crisis performance of financial institutions. I consider two crisis periods: the LTCM crisis of 1998 and the Lehman Brothers crisis of 2008 (following Fahlenbrach et al., 2012). Because each measure was developed to explain the 2008 crisis, estimates using data from the 1998 crisis can serve as out-of-sample tests of each measure’s forecasting ability. I show that a modified version of the CoVaR measure based on Adrian and Brunnermeier (2016) is more effective in forecasting systemic risk exposure compared to other methods. I then study the determinants of a financial institution’s systemic risk exposure. I find that in 1998 exposure to foreign equities determines an institution’s systemic risk exposure; while in 2008 securitization activity determines an institution’s systemic risk exposure. I also find that institution size is an important factor, but variables which proxy for interconnectedness in the financial system (i.e. derivatives or inter-bank loans) may not play a role.

The three measures of institution-level systemic risk exposure I investigate are Exposure CoVaR (Adrian and Brunnermeier, 2016),
systemic expected shortfall (SES, Acharya et al., 2016), and Granger causality (Billio et al., 2012). Exposure CoVaR uses quantile regressions to estimate the sensitivity of the value-at-risk (VaR) of an institution’s assets to fluctuations in the VaR of the total assets of the financial system. VaR is defined as the loss that will not be exceeded at some specified confidence level (Hull, 2009). SES uses an expected shortfall methodology to estimate the sensitivity of an institution’s stock returns to overall stock market returns. Expected shortfall (ES) is defined as the expected loss an institution faces conditional on being in the tail of its distribution of returns (Hull, 2009). Granger causality quantifies the number of other institutions which cause the returns of a single institution. The Granger causality measure thus provides an estimate of the number of other financial institutions to which a single financial institution is connected. All three measures directly estimate the systemic risk exposure of a given financial institution. In contrast to systemic risk exposure measures which show how a crisis affects a financial institution, systemic risk contribution measures estimate the sensitivity of the financial system to a tail event in a single institution. This paper focuses solely on exposure to systemic risk.

The CoVaR model in Adrian and Brunnermeier (2016) is estimated unconditionally using all the available data dating back to 1986. This is in contrast to the other measures, which use only a portion of the data available at a given time. I therefore modify the CoVaR model of Adrian and Brunnermeier (2016) so that the measure at any point in time is estimated using only a limited portion of past data. Through most of the paper, I focus on estimates of CoVaR where I use two-year rolling windows of past data but I also discuss alternative implementations. My modification makes it possible for an institution’s systemic risk exposure to evolve over time. I call the modified measure “Adapted Exposure CoVaR” when it is estimated using these two-year rolling windows. Moreover, the Exposure CoVaR methodology examines the change in the risk exposure of an institution given that a systemic crisis occurs. Thus, it is not clear that a measure such as this will forecast the performance of a financial institution on an out-of-sample basis. Therefore, to estimate systemic risk exposure throughout the paper, I focus on a coefficient used within the CoVaR methodology. This coefficient, Adapted Exposure CoVaR beta, estimates the sensitivity of the market value of assets of an institution to changes in the market value of the assets of the entire financial system.

I show that, among these measures, the CoVaR methodology of Adrian and Brunnermeier (2016) is the measure which best forecasts the within-crisis performance of financial institutions over multiple crisis periods. Using a sample of the 25 largest banks, insurers, and brokers in the U.S., I demonstrate that a one-standard deviation increase in systemic risk exposure led to decreases of 0.82% and 1.60% in the market value of the assets of a given financial institution during the worst one-week periods of the LTCM and Lehman Brothers crises, respectively. This represents a decrease of 29.08% and 36.36% below the mean asset returns during each week. Neither SES nor Granger causality forecast the performance of financial institutions reliably during the worst weeks of these systemic crises.

I also examine the time-series properties of the measures of systemic risk exposure by estimating the ability of each measure to forecast future risk exposures. Such predictive power would help ensure that at the onset of a crisis, the set of “systemically important” institutions is not different from the group designated as such prior to the crisis. I find that Adapted Exposure CoVaR beta is more effective than other measures along this criterion. My regressions show that pre-crisis exposure in terms of Adapted Exposure CoVaR beta is positively related to within-crisis exposure levels, implying that institutions that are systemically risky prior to a crisis remain risky during the crisis. I do not find similar forecasting power for the SES or Granger causality measures.

I further find that estimating systemic risk exposures using different time-series of available data leads to different levels of estimated exposure for the same institution. Specifically, measures calculated using the entire set of available data prior to a crisis are not successful in forecasting the within-crisis performance of financial institutions. In contrast, measures calculated using data available in the two-year window before a crisis begins are successful in forecasting the within-crisis performance of financial institutions. This shows that systemic risk exposure changes dynamically over time within institutions, and that the modification to Exposure CoVaR that I propose is essential if it is to be useful as a forecasting tool.

This paper also examines how the systemic risk exposure measures perform in terms of forecasting stock returns during a crisis period. The market value of assets is an important measure, as it addresses the concern of institution solvency during crisis periods. However, stock returns are also integral to the viability of institutions, and they are used to calculate both SES and Granger causality. I find that SES forecasts stock returns during the Lehman Brothers crisis period, but does not forecast stock returns during the LTCM crisis period. Adapted Exposure CoVaR and Granger causality fail to forecast stock returns during both periods. Because these variables fail the out-of-sample forecasting test, they should not be used as forecasting tools in terms of stock returns.

I also examine the determinants of Adapted Exposure CoVaR beta. In cross-sectional regressions, I show that in the 1998 and 2008 crises, financial institutions with higher exposure to foreign equity and higher levels of securitization income, respectively, have larger Adapted Exposure CoVaR betas. In both crisis periods, larger financial institutions have greater Adapted Exposure CoVaR betas. I find that one-standard deviation increases in firm size are associated with an increase of 38.76–56.33% in Adapted Exposure CoVaR beta, while increases in foreign equity exposure and securitization income are related to increases of 10.85% and 8.86%, respectively. I also find that loans to other domestic financial institutions, derivatives positions, and executive compensation do not affect Adapted Exposure CoVaR beta. These results provide further evidence that Adapted Exposure CoVaR beta estimates the systemic risk exposure of financial institutions, and that these estimates are not sensitive to the underlying cause of a crisis period. Further, they are a first step toward a more general understanding of the determinants of systemic risk exposure.

Given that Adapted Exposure CoVaR beta is the measure which is best suited for forecasting the performance of financial institutions in terms of asset returns, I examine its properties in more detail. First, I find that Adapted Exposure CoVaR beta is successful in forecasting the within-crisis performance of financial institutions at a maximum of one year prior to the onset of a crisis period. Second, this measure is capable of forecasting an institution’s returns over periods longer than just the worst one-week period of a crisis. I find that Adapted Exposure CoVaR beta has forecasting ability over cumulative return windows spanning as long as five weeks around the worst week of a crisis. Third, I also find that Adapted Exposure CoVaR beta does not fluctuate simply due to the onset of a crisis, whereas other risk exposure variables tend to increase during a crisis period. This is because Adapted Exposure CoVaR beta is reflecting only an institution’s level of systemic risk exposure, rather than changes in the characteristics of an institution brought about by a systemic crisis. Lastly, I examine the performance of

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A group of measures focusing on system-wide systemic risk also exists. Though I do not explicitly focus on this literature, the group includes: Lehner (2005); Gray et al. (2007); Adams et al. (2014); Kritzman et al. (2010); and Giglio (2014). In general, these papers propose models which estimate the probability of a crisis throughout the entire system based on individual bank data.
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