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Measuring systemic risk in the Korean banking sector via dynamic conditional correlation models

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ABSTRACT

In this paper we study systemic risks in the Korean banking sector by using two famous systemic risk measures — the MES (marginal expected shortfall) and CoVaR. To compute both measures we employ Engle's dynamic conditional correlation model. Our empirical analysis shows, first, that although these two systemic risk measures differ in defining the contributions to systemic risk, both are qualitatively very similar in explaining the cross-sectional differences in systemic risk contributions across banks. Second, we find that systemic risk contributions are closely related to certain bank characteristic variables (e.g., VaR (value at risk), size and leverage ratio). However, there are differences between the cross-sectional and the time series dimensions in the effects of these variables. Last, using a threshold VAR model, we suggest an overall systemic risk measure – the aggregate MES – and its associated threshold value for use as an early warning indicator.

1. Introduction

Recently there has been active research measuring systemic risks. As a lesson from the global financial crisis, it has been recognized that a banking supervision that focuses only on individual financial institutions may neglect the contributions to systemic risk of individual financial institutions. In particular, there have been some studies on the measurement of systemic risks using financial market variables such as equity prices or credit default swap (CDS) spreads, to make use of the forward-looking nature of financial market variables.

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In this paper we investigate two systemic risk measures – the MES (marginal expected shortfall) and the CoVaR – which utilize equity market information. We apply both measures to the Korean banking sector. Until now, research on systemic risk has been mainly focused on the US financial system, which is characterized by the market-based "shadow banking" system. In contrast, the main players in Korean financial system are still commercial banks. Thus we may have results different from the existing studies when the bank-based financial system is analyzed through the lens of systemic risk. Our result may have important implications for other bank-based financial systems.

The MES has been employed by Acharya et al. (2010) and Brownlees and Engle (2012) to evaluate the systemic risk contributions of individual financial institutions. The CoVaR was proposed for the first time by Adrian and Brunnermeier in 2008, who computed the CoVaR by a quantile regression method. Since then, many applications of the CoVaR have been implemented to measure various economies' systemic risks. Particularly, Girardi and Ergun (2013) estimate the CoVaR by multivariate GARCH models. Details will be discussed in the next section.

The two systemic risk measures are different in the ways in which they view the contribution to systemic risk of an individual financial institution. The MES defines the systemic risk contribution as the expected equity returns of an individual financial institution conditional on the market being distressed (e.g., when daily market returns are below −2%). On the other hand, the CoVaR is defined as the VaR (value-at-risk) of the market returns (e.g., the 5% quantile of the conditional distribution of the daily market returns) conditional on the distress of a financial institution (e.g., when the equity return of that institution is at its VaR). As a measure of systemic risk, Adrian and Brunnermeier (2011) use ΔCoVaR as the difference between the VaR of the market returns conditional on a financial institution being under distress and the VaR of the market returns when the institution is in a normal state. In sum, the two measures differ in their directions given to the "cause and effect" behind systemic risk. On the "cause" side, the MES puts the distress of the market while the CoVaR places the distress of an individual financial institution. Both measures are popularly used systemic risk measures, and it is therefore important to understand how differently they evaluate the systemic risk contributions of financial institutions.

In addition to evaluating the systemic risk contributions of Korean banks via these two systemic risk measures, we propose an overall systemic risk indicator using the aggregate MES, since unlike the CoVaR measure the MES provides a reasonable economic interpretation. We can interpret the aggregate MES as the marginal expected shortfall of the returns of a portfolio consisting of individual banks' equities when the market returns fall below a certain threshold level. This aggregate systemic risk measure is similar in spirit to the overall SRISK index in Brownlees and Engle (2012). The overall SRISK index will be described in the next section. To use the aggregate MES for an early warning system, we apply a threshold VAR model to analyze the dynamic relationship between the systemic risk indicator and real economic activity. From analysis of this threshold VAR model, we can obtain a threshold value that can trigger a warning signal of financial instability.

To compute both systemic risk measures we use the dynamic conditional correlation (DCC) models proposed by Engle (2002), which are types of multivariate GARCH models. The multivariate GARCH models have an advantage in capturing the time-varying systemic risk exposure of a financial institution or the market — an advantage not shared by the quantile regression method that has also been very popular for measuring systemic risk. To compute the MES and the CoVaR measures, we depend respectively on Brownlees and Engle (2012) and Girardi and Ergun (2013). However, unlike their original methods we use the Monte Carlo simulation method to compute both systemic risk measures.

Our empirical analysis finds the following. First, that although the two systemic risk measures differ in defining systemic risk contributions, both are qualitatively very similar in explaining the cross-sectional differences in systemic risk contributions across banks. Second, that the systemic risk contributions are closely related to some bank characteristic variables (e.g., VaR, size and leverage ratio). However, there are differences between the cross-sectional and the time series dimensions in the effects of these variables. Lastly, that the dynamic relationship between financial shocks and real economic activity may vary substantially when the aggregate MES exceeds a certain threshold. The aggregate MES and its associated threshold value suggested in this paper are expected to offer useful information for financial instability monitoring.