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Measuring systemic risk: A factor-augmented correlated default approach

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ABSTRACT

In this paper, we extend existing correlated default models for measuring systemic risk by proposing a model that incorporates an observable common factor that features conditional heteroscedasticity. The addition of the common factor helps to effectively capture realistic time-varying characteristics in individual asset return volatility as well as return correlations. We apply the model for large US financial institutions. The common factor proves its importance in explaining asset return dynamics and measuring systemic risk. We also apply the model in the context of systemic risk contribution analysis and show its applicability.

1. Introduction

The proper functioning of a financial system is crucial for economic stabilization and growth, and its malfunctioning can entail very high costs for the economy (see e.g., Hoggarth et al., 2002). Therefore, financial regulators have been alert to maintain financial stability by using various measures. In particular, they have paid more attention to the soundness of financial systems since the recent global financial crisis occurred during 2007–2009. The soundness of the financial system cannot be guaranteed by simply ensuring the soundness of individual financial institutions. The riskiness of the financial system as a whole (i.e., systemic risk) can be magnified through two channels: contagion and asset correlation.

In the case of contagion, financial institutions are inter-dependent within the payment system or via direct loans. An initial financial institution gets into trouble and then other institutions may become distressed as a result. Early theoretical works on this type of systemic risk focus on lending between institutions (Rochet and Tirole, 1996) or the payment system (Cohen and Roberds, 1993). For

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empirical results, refer to, for example, Humphrey (1986), Angelini et al. (1996), and Furfine (2003). Recently, network models have been applied for this analysis, including Boss et al. (2004), Muller (2006), Nier et al. (2006), and Martinez-Jaramillo et al. (2010). Upper (2007) summarizes the research on financial contagion. Analysis from this contagion viewpoint requires detailed data on mutual exposure between institutions with various characteristics, thereby limiting its applicability. Furthermore, several works document evidence of small effects of the financial contagion channel; see, for example, Lang and Stulz (1992), Elsinger et al. (2006), Jorion and Zhang (2007, 2009), and Helwege (2010).

In lieu of the aforementioned counterparty risk, we often observe in a financial crisis that a common factor simultaneously throws multiple financial institutions into financial distress. Under this viewpoint, the assets of financial institutions are correlated because of their exposure to such common factors. The common factors may have various forms, for example, belonging to the same industry (Helwege and Kleiman, 1997), exposure to a certain asset class (Fenn and Cole, 1994), information problems (Duffie and Lando, 2001; Yu, 2005), or macroeconomic factors (Helwege, 1996). Many empirical studies document strong effects of indirect inter-dependencies whereby markets also negatively respond to other institutions that are not directly related (but only indirectly related through a common factor) to a distressed institution. (See, for example, Crabbe, 1991; DeAngelo et al., 1994; Eichengreen and Mody, 2000; Fenn and Cole, 1994; and Jorion and Zhang, 2007, 2009.) De Nicolo and Kwast (2002) argue that financial consolidation raises the correlations of stock returns, and thereby the systemic risk as well. Nijskens and Wagner (2011) document that while institutions may have shed their individual credit risk through Credit Default Swaps (CDSs) or Collateralized Loan Obligations (CLOs), their correlations actually increase and the systemic risk becomes greater.

In this paper, we follow the correlated default approach and propose a model in order to measure the systemic risk more accurately by using stock-market data. Balance-sheet information on financial institutions is available only on a relatively low-frequency (typically quarterly) basis and often with a significant time-lag while stock-market data provide timely, forward-looking information. CDS market data also deliver useful information about default probabilities but are available only for limited entities.[1] This paper is closely related to Lehar (2005) and extends it in several aspects. Lehar (2005) employs Merton's (1974) option pricing approach to estimate the default probability of individual financial institutions. We model the asset value of an individual financial institution as being exposed to an observable common factor as well as an unobservable individual factor. By introducing a common factor, we intend to effectively capture time-varying characteristics in asset correlations between financial institutions. This modeling feature contrasts with Lehar (2005) where asset correlations are basically constant over time and the time-varying property is obtained only through an exponentially-weighted moving average scheme. In addition, the common factor acts as a driving force of co-movement among the default probabilities of financial institutions. Moreover, the common factor is modeled to capture the volatility-clustering phenomenon in equity returns. We believe that these realistic modeling features help to measure the systemic risk more accurately.

This paper also has an implication for systemic risk contribution analysis regarding which considerable literature has recently emerged. For example, Adrian and Brunnermeier (2010) propose a value-at-risk-based measure, called CoVaR, which quantifies how much an institution adds to the overall systemic risk. Acharya et al. (2010) devise an expected-shortfall-based measure by using the net equity returns of individual institutions conditional on the worst market outcome. They show that the measure has the ability to predict risks during a financial crisis. Both studies successfully estimate individual systemic risk contribution; however, they do not provide an overall systemic risk level. In fact, both loosely define systemic risk by using the worst market outcome event and do not explicitly define default events for individual institutions. Contrasting with them, this paper presents a model to permit the estimation of individual systemic risk contributions as well as the overall systemic risk level.

We apply the newly proposed model for measuring the systemic risk of a group of 50 large US financial institutions for the period from January 1974 to March 2010. Our main findings are as follows. First, featured with time-varying volatility, the common factor significantly contributes to the

[1] Huang et al. (2009) utilize CDS market data for measuring the systemic risk of a group of major financial institutions.