Modeling Time Variation in Systemic Risk

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Systemic risk is a major threat to the stability of modern financial systems. In the interconnected system of financial institutions and sovereigns, the investigation of systemic risk involves a thorough study on the time variation of financial risks, and the dependence structure which may lead to systemic credit events. This thesis is written to provide a unified econometric framework that can be applied to measure financial systemic risk in a general and consistent way. The risk assessing framework is fitted to the financial markets, using equity returns and credit default swap spread changes. Both of these are usually asymmetrically distributed with fat-tails. Their variance and correlation are also changing over time, especially during crisis times. Our model is general enough to fit these non-Gaussian features and the time-varying conditional covariances as well. We document strong evidences of time variation of systemic risk and highlight the importance of capturing higher-order moments in modeling systemic risk.

In Chapter 2, we propose a new model for dynamic volatilities and correlations of skewed and heavy-tailed data. Our model endows the non-normal distribution with time-varying parameters driven by the score of the observation density function. The key novelty in our approach is the fact that the skewed and fat-tailed shape of the distribution directly affects the dynamic behavior of the time-varying parameters. It distinguishes our approach from familiar alternative models where distributional assumptions affect the likelihood but not the parameter dynamics. We present a modified expectation-maximization algorithm to estimate the model. Simulated and empirical evidence shows that the model outperforms its close competitors if skewness and kurtosis are relevant features of the data.

In Chapter 3, we propose a novel empirical framework to assess the likelihood of joint and conditional failure for Euro area sovereigns. Our model is based on a dynamic non-normal copula which captures all the salient features of the data, including non-normal changes in the price of Credit Default Swap (CDS) protection against sovereign default, as well as dynamic volatilities and correlations to ensure that failure dependence can increase in times of stress. We apply the framework to Euro area sovereign CDS spread changes from 2008 to mid-2011. Our results reveal significant time-variation in risk dependence and considerable spill-over effects in the likelihood of sovereign failures. We also investigate distress dependence around a key policy announcement by Euro area heads of state on May 9, 2010, and demonstrate the importance of capturing higher-order time-varying moments during times of crisis.

In Chapter 4, two new measures for financial systemic risk are computed based on the time-varying conditional and unconditional probability of simultaneous failures of several financial institutions. These risk measures are derived from a multivariate model that allows for asymmetric non-normal changes in the market value of financial firms' equity. Our model can be interpreted as a Merton model with correlated Lévy processes. This model incorporates dynamic volatilities and dependence measures and uses the overall information on the shape of the multivariate distribution. Our correlation estimates are robust against possible outliers and influential observations. For very large cross-sectional dimensions, we propose an approximation

based on a conditional Law of Large Numbers to compute extreme joint default probabilities. We apply the model to assess the risk of joint financial firm failure in the European Union during the financial crisis. By augmenting the dynamic parameter model with a few economic variables that capture situations of systemic stress, we find that including extra economic variables helps to explain systemic correlation dynamics.

In this thesis, we propose a multivariate econometric model for systemic risk and sovereign risk measurement. It is a disaggregated risk model with flexible time-varying dependence structure. As the financial returns are non-normally distributed, we rely on a general non-Gaussian distribution that captures different salient features of the data. Further we extend the study to financial risk modeling in a large system.