Essays in quantile regression models and their applications to financial time series

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Summary and Outlook

This chapter provides a brief summary of this dissertation. Following up this summary of our research work so far, an outlook of possible extensions to our work is also provided in the end.

This dissertation studies financial time series by quantile regressions. Quantile autoregressions (Koenker and Xiao, 2006) are applied in Chapter 2. Specifically, Chapter 2 introduced a new way to select between causal and noncausal models by comparing residuals from quantile autoregressions developed by Koenker and Xiao (2006) and from the time-reverse specifications. To adapt to heavy tailed distributions, we generalize the quantile autoregression theory for regularly varying distributions. This also confirms the validity of quantile autoregressions in analysing heavy tailed time series, such as explosive or bubble-type dynamics. It is natural to consider SRAR as a model selection criterion in the quantile regression framework. However due to the identification problem spotted in the SRAR plots as presented in this chapter, we propose to use the aggregate SRAR criterion for model selection. The robustness in its performance has been seen from all the results in this chapter. It is worth mentioning that when coefficients are constant in the underlying model with a symmetrically i.i.d. error term, the aggregate SRAR criterion is equivalently to select between forward and backward conditional mean models (termed by Gourieroux and Zakoian, 2017). However, the aggregate SRAR is a measure based on the whole dynamics of the underlying process, which is not dominated by the conditional mean information any more. This characteristic of the aggregate SRAR criterion indeed makes it robust in model selection even for some general situations such as with asymmetric distributed innovations.

In Chapter 3, we found that the inference test performance in CAViaR models is not robust and unsatisfying due to the estimation of the conditional probability densities of time series. We found that the existing density estimation methods cannot fully adapt to time-varying conditional probability densities of CAViaR time series. So in this chapter we have developed a method called *adaptive random bandwidth* which can robustly approximate the time-varying conditional probability densities of CAViaR time series by Monte Carlo simulations. This method not only avoids the haunting problem of choosing an optimal bandwidth but also ensures the reliability of CAViaR analysis based on the asymptotic normality of the model parameter estimator.

In Chapter 4, we generalized multivariate multi-quantile CAViaR models (MVMQ-CAViaR, see White et al., 2015) by incorporating CoVaR specification (see Adrian and Brunnermeier, 2011) into the model specification in this chapter. The proposed systemic MVMQ-CAViaR model presents a vector-autoregressive (VAR) specification of financial institutions' value-at-risk (VaR) as well as their CoVaR. This model generalization is able to capture contemporaneous tail dependence of financial institutions and market indexes so that we can interpret the systemic risks of the institutions over time. The consistency and asymptotic normality proofs of this generalized model are provided in this chapter along with some relevant inference tests, for which we implemented simulation tests and showed robust model performances. For tracing the transmission of a single shock to a financial institution in the financial system, we also constructed quantile impulse response functions (QIRF) accordingly in use of the local projection idea (Jordà, 2005) and expansion of estimated terms. Based on our simulation results, we can see that using the expansion terms of $\widehat{\boldsymbol{q}}_t$ is more robust than directly using $\widehat{\boldsymbol{q}}_t$ in the local quantile regression for QIRF estimation. An empirical application performed on big banks with the market index $S\&P500$ shows the significant contemporaneous effects of the big banks on $S\&P500$ so supports our methodology.

I would like to point out some possible extensions to our work for future research. Regarding Chapter 2, the aggregate SRAR is proposed as a new model criterion but no asymptotic behaviours or theoretical validity of this criterion has been established yet. Bootstrapping can be a potential tool to estimate the underlying noncausal model selection rate given a time series. So a hypothesis testing can be preformed accordingly with the null hypothesis being that the model selection result is false. In addition, mixed causal and noncausal models are still underdeveloped because of model estimators' consistency issue. It is worth finding out a way to obtain consistent estimators for mix causal noncausal models so that model selection in mixed causal and noncausal models can be investigated as a generalization. Regarding Chapter 3, the adaptive random bandwidth method can be extended to general quantile regressions including multivariate cases in theory. Test performances can be checked for this method in high-dimensional cases to see its robustness. This method also has the potential to achieve the second-order accuracy to Wald tests of nonlinear restrictions (Phillips and Park, 1988; de Paula Ferrari and Cribari-Neto, 1993) in quantile regressions. Regarding Chapter 4, the proposed systemic MVMQ-CAViaR model requires a predetermined contemporaneous effecting order. An automatic way of determining the contemporaneous dependence direction can be considered to develop up in theory. Moreover, the functional form of a contemporaneous term has not been commonly on consensus or developed enough to pass most model specification tests. An investigation on the functional form of contemporaneous effects in financial markets can be helpful.