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

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The value of research is in why and how it can benefit our society. Realizing the value of a research result can be direct through applications in the research context or be potential by researchers' insights on the work. In this chapter, we discuss the values of the research results in this dissertation.

Quantile regressions are applied throughout this dissertation and used to studying a particular quantile of our interest. You might ask that when we care about a particular quantile. The answer is that when we care about an outcome and know the outcome is in uncertainty so we want to find a threshold of this random outcome for securing our position when it happens. For individuals, we can concern about how much cash to be kept during a trip. If you are careless between cash and bank cards, you still somehow concern about your financial positions. You might think about how much you can invest in an asset based on your household balance sheets in the future. If you are at the standing point of a group, it is necessary to secure the financial position of the whole group so that the group can be still functioning at an optimal chance and cost while an adverse outcome happen. Besides financial positions, groups might also concern about other welfare positions, such as capacity for urgent patients in a hospital. We can see that quantiles are common in our concerns. And the tool of quantile regressions is straightforward for achieving a quantile of our interest.

Next, we are going to discuss about what we have researched with regard to quantile regressions in this dissertation, what information we can convey for benefiting our society, and what tools we provide for the society to reliably apply quantile regressions in their applications.

Chapter 2 introduces 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. When a noncausal model is selected for a time series, it seems that the future of the time series leads its movement. Actually, this noncausal model selection can be interpreted as the time series moved recklessly due to some external force. And it got dragged back by its intrinsic force until the intrinsic force surpasses the external one as the time series deviated far enough or long enough from its intrinsic level. This rule is not hard to understand with elastic bands. After identifying this noncausal characteristic and the external force in the time series, we can better cooperate with the time series at our positions. For instance, when a noncausal model is selected for a country's inflation rate time series, the local policy-maker should regulate and censor carefully such external forces in order to keep the inflation stable.

In Chapter 3, we found that the inference test performance in CAViaR models is not robust and unsatisfying always due to the inaccuracy in estimating 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. Implementing probabilistic modelling but without reliable inference testing, such as Wald tests for model specification testing, can be misleading. So we have developed up a method called *adaptive random bandwidth* (ARB) which can robustly approximate the time-varying conditional probability densities of CAViaR time series by Monte Carlo simulations. This method is a success in avoiding the haunting problem of choosing an optimal bandwidth and ensures the reliability of any CAViaR analysis based on the asymptotic normality of the model parameter estimator. This proposed method can be extended to general quantile regressions including multivariate cases easily and robustly. Having an accurate test statistic is important to obtain reliable models in financial applications. This ARB tool indeed helps our society to ensure reliability in analysing quantile regressions so as in the obtained quantiles for applications.

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. 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. Systemic risk should be carefully managed and censored over time as we know that it is a major contributor to the financial crisis of 2008. The consistency and asymptotic normality proofs of this generalized model are provided 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. The research work in this chapter helps policy-makers to take the contemporaneous effect in account for measuring the systemic risk of a financial institution, and also provides complementary statistical tools for them to better supervise the financial institution based on the systemic risk to the financial market therein.