Essays on High Frequency Financial Econometrics

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Continuous time modeling has proved to be a tremendous success in theoretical analysis of finance. Yet only until recent years, the corresponding empirical analysis tool, namely high frequency econometrics, has been made possible in empirical analysis by the availability of intra-daily data and rapidly development of relevant statistical tools. The basic statistical properties of volatility and jumps have been thoroughly investigated by earlier work. My dissertation aims at extend this line or research by studying finer characteristics of financial returns (the first two papers) and integrating high frequency econometrics with continuous time theoretical analysis (the last paper).

The first paper examines the leverage effect, or the generally negative covariation between asset returns and their changes in volatility, under a general setup that allows the log-price and volatility processes to be Itô semimartingales. I decompose the leverage effect into continuous and discontinuous parts and develop statistical methods to estimate them. I establish the asymptotic properties of these estimators. I also extend the above methods and results to the situation where there is market microstructure noise in the observed returns. I show in Monte Carlo simulations that these estimators have good finite sample performance. When applying these methods to real data, the empirical results provide convincing evidence of the presence of the two leverage effects, especially the discontinuous one.

The second paper extends the notion of self-excitation in jumps to very broad families of continuous time models, proposes statistical tests to detect its presence in a discretely observed path at high frequency, and derives the tests’ asymptotic properties. The statistical setting is semiparametric: except for necessary parametric assumptions on the jump size measure, the other components of the model are essentially unrestricted. I design tests under two (complementary) null hypotheses to control both type I and type II errors. I analyze the finite sample performance of these tests in Monte Carlo simulations. When applied to high frequency asset price data, the empirical findings support the existence of self-excitation in asset price jumps.

The third paper provides a thorough integration of high frequency econometrics and finance. The theoretical analysis of portfolio and hedging error proposes a series of new quantities with financial significance, including a comprehensive decomposition of hedging error profile, to be estimated. The econometric analysis studies the asymptotic properties of their estimators, with special attention paid to the effects of latent state factors on the estimation, which may in turn sheds new light on the choices of optimal portfolio and hedging strategy with latent states. The combination of these two parts leads to various financial implications. The estimates of these proposed quantities can be used, for example, to evaluate the potential loss of some state factors not being tradable or observable, to compare the performance of two portfolios, and to identify the challenges to the effectiveness of a hedging portfolio, among others. More importantly, part of the hedging error profile is shown to be connected with risk premium. Hence, a statistical test can be derived from this relationship to test whether a given option pricing model correctly reflects the connection between the physical measure and the risk-neutral measure, as illustrated in the Monte Carlo simulation. In the empirical study, a selective example demonstrates how these new quantities may improve our understanding of financial risks.

To briefly summarize, my dissertation first explores and confirms certain dependence structures between asset return process and its risk components, including both volatility and jumps, and then demonstrates how high frequency econometrics, combined with theoretical analysis, could improve people’s understanding of financial market.