

Preface

This book provides the foundation of statistical inference for financial engineering, which is a huge integration of economics, probability theory, statistics, time series analysis, operation research, etc. Black and Scholes introduced the modern option pricing theory assuming that the price process of an underlying asset follows a geometric Brownian motion. However, empirical studies for the price processes show that they do not follow the geometric Brownian motion, and that they often behave like as non-Gaussian dependent processes. Motivated by this, we investigate what stochastic models can describe the actual financial time series data sufficiently, and how to estimate the proposed models optimally. Concretely, we introduce various stochastic processes, e.g., non-Gaussian linear processes, nonlinear processes, long-memory processes, locally stationary processes, etc. For them we will develop the theory of optimal statistical inference based on local asymptotic normality (LAN), which is due to Le Cam. This book also describes a variety of statistical approaches, e.g., discriminant analysis, empirical likelihood method, control variate method, quantile regression, realized volatility, etc. The philosophy is that financial engineering should be constructed on optimal statistical approaches for plausible stochastic processes.

[Chapter 1](#) discusses time series modeling for financial data, and how to estimate such models optimally. The models include general non-Gaussian vector linear processes, nonlinear time series models, e.g., ARCH, CHARN, etc., and locally stationary processes, etc. Their inference is developed by LAN-based optimal theory. We give an approach based on integral functionals of nonparametric spectral estimators, which are applicable to a lot of problems in financial statistics. Option pricing will be discussed for a class of discretized diffusion processes. Also we address the problem of classification for locally stationary processes, and apply the results to actual financial data by use of dendrogram.

[Chapter 2](#) deals with empirical likelihood approaches for financial data. Since the observations are often supposed to be dependent, we will introduce an estimating function which corresponds to the differential functional of Whittle likelihood, i.e., empirical likelihood in frequency domain. After explaining the asymptotic properties of the frequency domain empirical likelihood estimator, we also introduce the extensions of the empirical likelihood method such as Cressie-Read power-divergence statistic and generalized empirical likelihood. As an application, we consider the generalized empirical likelihood estimation

method for the multivariate stable distributions. Several real data analyses are also included.

Chapter 3 gives applications of two statistical methods to the financial time series data. The first one is the control variate method. The control variate method is a method to reduce the variance of estimators by use of some information of another process, which is correlated with the process concerned. This method has been discussed in the case when the data are i.i.d. Since financial time series data are often dependent, we extend this method to dependent data and give the application to financial econometrics. The second one is the instrumental variable method. We introduce a stochastic regression model where the explanatory and disturbance processes are correlated. For this we apply the instrumental variable method to estimate the regression coefficients consistently. We also address the problem of CAPM to our analysis.

Chapter 4 introduces two techniques, which can be utilized in study of financial risks. The first one is the method called Quantile Regression (QR), which can be used to analyze the conditional quantile of financial assets. There, by means of rank-based semiparametrics, we provide the statistically efficient version of QR inference under the autoregressive conditional heteroskedasticity (ARCH). The second technique, the Realized Volatility (RV), estimates the conditional variance, or “volatility” of financial assets. Revealing the fact that its inference can be greatly affected by the existence of additional noise called market microstructure, we introduce and study the asymptotics of some appropriate estimator under the microstructure with ARCH property.

This book is suitable as a professional reference book on finance, statistics, and statistical financial engineering, or a text book for students who specialize these topics.

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