DOCTORAL PROGRAMME

TIME SERIES CLUSTERING, TESTING OF MEMORY IN TIME SERIES AND QUANTIFYING DEPENDENCE IN VOLATILITY OF FINANCIAL TIME SERIES USING COMPLEX NETWORK THEORY

By

GIRIRAJ



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By

GIRIRAJ

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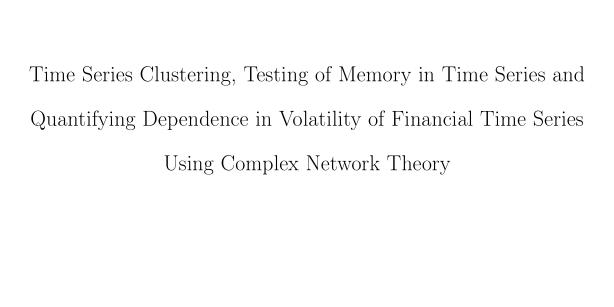
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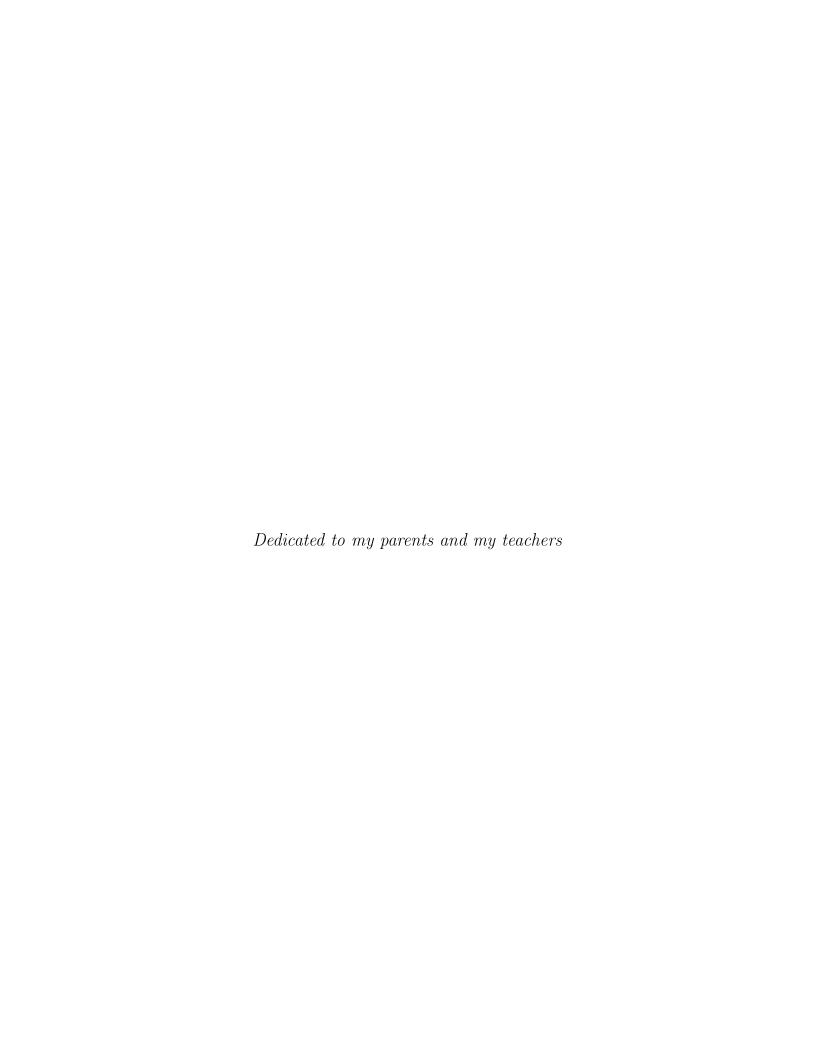
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Abstract

The four essays in this dissertation are grounded in the central and interconnected concepts of multifractality and long-range dependence observed in financial time series. We focus our attention particularly to the dependence behaviour of a suitable measure of volatility in financial asset returns. Therefore, the implications of our work are mostly in the area of financial risk management.

In the first three essays, we attempt to study the observed dependencies in financial time series from the lens of complex network theory. Specifically, we explore a relatively recent approach called visibility graphs, which involves mapping a time series to a complex network based on a particular geometric criterion.

In the first essay, we utilize the concept of visibility graphs, proposed by Lacasa *et al.* (2008), for developing a method to cluster multiple financial asset return series based on their underlying dependence characteristics. Using simulations, we show that the proposed method exhibits better clustering performance as compared to certain feature-based and model-based time series clustering techniques.

In the second essay, we build upon the concept of binary visibility graph, proposed by Ahadpour & Sadra (2012), to develop a reasonably powerful nonparametric test for the presence of memory in time series. The test is predicated on a statistic based on the principle of symbolic entropy.

In the third essay, we utilize a scaled version of the symbolic entropy based statistic (developed in the second essay) for estimating the memory in volatility of financial asset returns. We find that the estimator performs well at measuring varying magnitudes of long-range dependence in volatility.

In the fourth essay, we augment the Copula-Markov Switching Multifractal (MSM) model (Calvet & Fisher, 2004) by allowing the innovations in the margins to follow leptokurtic and skewed distributions, expecting to obtain better portfolio Value-at-Risk (VaR) forecasts during times of high market volatility. We find that the augmented Copula-MSM models exhibit better forecasting performance as compared to several traditional and popular VaR forecasting methods.