Interdisciplinary Workshop

Econometric and Statistical Modelling of Multivariate Time Series

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Speakers - Abstracts

NONLINEAR FORECASTING OF MACROECONOMIC VARIABLES USING AUTOMATED MODEL SELECTION TECHNIQUES

AUTHOR

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ABSTRACT

In this paper, the attention is focused on a well-defined class of flexible models, the so-called single hidden-layer feed forward neural network models. Neural networks or multilayer perceptions are universal approximators that can arbitrarily accurately approximate any function satisfying rather mild regularity conditions. A major aim of our study is to see whether they, due to their flexibility, are as useful tools in economic forecasting as some previous studies have indicated.

A problem with these multilayer perceptions is how to specify their structure and estimate the parameters. Recently, White (2006) presented a solution that amounts to converting the speci cation and nonlinear estimation problem into a linear model selection and estimation problem. This leads to a model selection situation that is somewhat atypical, at least in time series econometrics, in which the number of variables may vastly exceed the number of observations. The second aim of this paper is to compare three methods for model selection capable of handling this situation. One is White's QuickNet, and the other two are the Marginal Bridge Estimator, well known to microeconometricians, and Autometrics, popular among time series econometricians.

In this study we consider multiperiod forecasts. There are two main ways of generating them. One is to specify and estimate a single model and generate the forecasts recursively from it. It is also possible to build a separate model for each forecast horizon and use it for obtaining the forecasts for the horizon in question. The third aim of this paper is to compare the performance of these alternatives, when the set of available models mainly consists of linear autoregressive, neural network and nonparametric ones. Nonlinear models, such as the neural network model, sometimes generate un-realistic or insane forecasts. This problem can at least partly be remedied by adjusting such forecasts by replacing them by more realistic values. Our fourth aim is to consider this possibility, called ltering the forecasts, and see whether it can improve the accuracy of macroeconomic forecasts from neural network models estimated using automatic modelling techniques. We consider two different lters for the purpose. It is possible to test linearity of the time series before any model selection and thus preclude nonlinear models when they seem superfluous. In theory this is not necessary if linear lags of the model to be forecast are included in the set of variables to select from in building the neural network model. Our aim is to find out whether or not such pre-screening improves the accuracy of the forecasts. The automated model selection is first applied to a strongly nonlinear series, Wolf's annual sunspot numbers 1700-2009, and a simulated series related to a model of this sunspot series. The monthly time series on industrial production and inflation from the 1960s onwards for the G7 and the four Scandinavian countries form the macroeconomic data set to be modelled and forecast. The considerations are restricted to univariate (autoregressive) neural network models. The forecast accuracy of the three automatic techniques is compared using the root mean square forecast error with a linear autoregressive model as a benchmark, and a ranking of the methods by absolute forecast errors. This is done for both un-ltered and ltered forecasts.

CAW-DCC: A DYNAMIC MODEL FOR VAST REALIZED COVARIANCE MATRICES

AUTHOR

LUC BAUWENS (Université catholique de Louvain) &
GIUSEPPE STORTI (University of Salerno)

ABSTRACT

A dynamic model for realized covariance matrices is proposed, assuming a Wishart conditional distribution. The expected value of the realized covariance matrix is specified in two steps: a model for each realized variance, and a model for the realized correlation matrix. The realized variance model is taken in the menu of existing univariate models. The realized correlation model is a dynamic conditional correlation model. Estimation is organized in two steps as well, and a quasi-ML interpretation is given to each step. Moreover, the model is applicable to very large matrices since estimation can be done by the composite likelihood method.

BIAS IN ESTIMATING MULTIVARIATE AND UNIVARIATE DIFFUSIONS

AUTHOR

JUN YU (Singapore Management University)

ABSTRACT

Multivariate continuous time models are now widely used in economics and finance. Empirical applications typically rely on some process of discretization so that the system may be estimated with discrete data. This paper introduces a framework for discretizing linear multivariate continuous time systems that includes the commonly used Euler and trapezoidal approximations as special cases and leads to a general class of estimators for the mean reversion matrix. Asymptotic distributions and bias formulae are obtained for estimates of the mean reversion parameter. Explicit expressions are given for the discretization bias and its relationship to estimation bias in both multivariate and in univariate settings. In the univariate context, we compare the performance of the two approximation methods relative to exact maximum likelihood (ML) in terms of bias and variance for the Vasicek process. The bias and the variance of the Euler method are found to be smaller than the trapezoidal method, which are in turn smaller than those of exact ML. Simulations suggest that when the mean reversion is slow the approximation methods work better than ML, the bias formulae are accurate, and for scalar models the estimates obtained from the two approximate methods have smaller bias and variance than exact ML. For the square root process, the Euler method outperforms the Nowman method in terms of both bias and variance. Simulation evidence indicates that the Euler method has smaller bias and variance than exact ML, Nowman's method and the Milstein method.

KEYWORDS

Bias, Diffusion, Euler approximation, Trapezoidal approximation, Milstein approximation.

ESTIMATION OF DIFFUSION MODELS WITH TIME-VARYING PARAMETERS

AUTHOR

DENNIS KRISTENSEN (Columbia University)

ABSTRACT

A general method for nonparametric estimation of time-varying parameters in multivariate diffusion models is proposed. Under regularity conditions, the estimators are shown to be consistent and asymptotically normally distributed. A key part of the asymptotic analysis is the approximation of the time-inhomogenous diffusion model by a time-homogenous stationary version. This allows for the local approximation of the non-stationary sample path by its stationary version. A simulation study shows the good finite-sample performance of the estimators. An empirical study employs the developed framework and tools to investigate parameter instability in a multi-factor term structure model for the Eurodollar yield curve.

VOLATILITY, CORRELATION AND TAILS FOR SYSTEMIC RISK MEASUREMENT

AUTHOR

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ABSTRACT

The Great Recession of 2007/2009 has motivated market participants, academics and regulators to better understand systemic risk. Regulation is now designed to reduce systemic risk. However, it is not yet clear how to measure systemic risk and in particular to determine which firms are the major contributors to the overall risk of the economy. This paper focuses on constructing measures of systemic risk based on public market data and consequently provides a quick and inexpensive approach to determining which firms deserve more careful scrutiny and regulation. The measure examined in this paper is the Marginal Expected Shortfall or MES. This is the expected loss an equity investor in a financial firm would experience if the overall market declined substantially. This measure can then be extrapolated to estimate equity losses for this firm in a future crisis and consequently the capital shortage that would be experienced as a consequence of the initial leverage. The contribution to systemic risk is then estimated as the percentage of capital shortfall that can be expected in a future crisis. MES depends upon the volatility of a firm equity price, its correlation with the market return and the comovement of the tails of the distributions. These in turn are estimated by asymmetric versions of GARCH, DCC and non-parametric tail estimators. Empirical results with 102 US financial firms find predictability in both time series and cross section and useful ranking of firms at various stages of the financial crisis.

KEYWORDS

Systemic Risk, Volatility, Correlations, Tails, Forecasting.

FACTOR MODELLING FOR HIGH-DIMENSIONAL TIME SERIES: A DIMENSION-REDUCTION APPROACH

AUTHOR

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ABSTRACT

Following a brief survey on the factor models for multiple time series in econometrics, we introduce a statistical approach from the viewpoint of dimension reduction. Our method can handle nonstationary factors. However under stationary settings, the inference is simple in the sense that the estimation for both the number of factors and the factor loadings is resolved by an eigenanlysis for a non-negative definite matrix, and is therefore applicable when the dimension of time series is in the order of a few thousands. Asymptotic properties of the proposed method are investigated under two settings: (i) the sample size goes to infinity while the dimension of time series is fixed; and (ii) both the sample size and the dimension of time series go to infinity together. In particular, our estimators for zero-eigenvalues enjoy the faster convergence rates. Furthermore the estimation for the number of factors shows the so-called «blessing of dimensionality» property at its clearest. Furthermore a two-step procedure is investigated for better identification of the number of factors when the factors are of different degrees of strength. Numerical illustration with both simulated and real data is also reported.

KEYWORDS

Bless of dimensionality, Curse of dimensionality, Eigenanalysis,
Fact convergence rates, Idiosyncratic component, Multivariate time series,
Nonstationarity, Ratio-based estimator.

CORRELATED RISKS VC CONTAGION IN STOCHASTIC TRANSITION MODELS

AUTHOR

CHRISTIAN GOURIÉROUX (University of Toronto & CREST) &
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ABSTRACT

There is a growing literature on the possibility to identify correlation and contagion in qualitative risk analysis. Our paper considers this question by means of a model describing the joint dynamics of a set of individual binary processes. The two admissible values correspond to bad and good risk states of an individual. The risk correlation and its time dependence are captured by introducing a dynamic frailty, whereas the contagion passes through the effect of the lagged number of individuals in the bad risk state. We study carefully the dynamic properties of the joint dynamic process. Then, we focus on the limiting case of large populations (portfolios) and reconcile the microscopic and macroscopic dynamic views of the risk. The difficulty to identify in finite sample risk correlation and contagion is illustrated by means of Monte-Carlo simulations.

KEYWORDS

Risk Dependence, Frailty, Systematic Risk, Contagion, Count Process, INAR Model, Compound Autoregressive Process, Affine Model, Credit Risk, Granularity Adjustment

THE DYNAMIC MIXED HITTING-TIME MODEL FOR MULTIPLE TRANSACTION PRICES AND TIMES

AUTHOR

ÉRIC RENAULT (University of North Carolina) &
THIJS VAN DER HEIJDEN &
BAS J.M. WERKER

ABSTRACT

We propose a structural model for durations between events and associated marks. Our model is structural in the sense that both durations and marks are generated by a multivariate underlying Brownian motion. In particular, we model the durations as the successive passage times of components of this Brownian motion relative to in itself random boundaries. The other, correlated, Brownian components generate the marks. These multivariate Brownian motions allow us to incorporate a vector of marks combined with a single duration generating process. Our model embeds in particular the class of stochastic conditional duration and autoregressive conditional duration models and, thus, also provides a multivariate extension of these. We illustrate the model on the Pepsi Bottling Group trading at NYSE and show that the duration dynamics are adequately captured by our model.

KEYWORDS

Duration modeling, hitting time, trading intensity, market microstructure.

MODELLING EXTREMES OF MULTIVARIATE TIME SERIES VIA THE TAIL PROCESS

AUTHOR

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ABSTRACT

Extremes of univariate heavy-tailed first-order Markov chains are known to behave under general conditions as a multiplicative random walk, the tail chain. This property is found to be a particular case of a much more general one stating that a stationary multivariate time series is multivariate regularly varying if and only if the following property holds: conditionally on the value of the process at a fixed time point being large (in norm), the process converges in the sense of finite-dimensional distributions to a limit process, the tail process. The tail process is found to possess a number of remarkable properties. Moreover, all kinds of interesting tail quantities can be expressed in terms of the tail process. A particularly rich class of examples is the one of linear time series with random coefficient matrices.

KEYWORDS

Extremes, heavy tails, regular variation, tail process.

MACROECONOMIC NEWS SURPRISES AND VOLATILITY SPILLOVER IN THE FOREIGN EXCHANGE MARKETS

AUTHOR

CHRISTIAN HAFNER (Université catholique de Louvain)

ABSTRACT

This paper addresses the central open issue in exchange rate economics: the link between exchange rate volatility and economic fundamentals. In the framework of a multivariate volatility model that allows for volatility spillover, we develop a new impulse response analysis to estimate and decompose the simultaneous effect of macroeconomic news surprises on the foreign exchange volatility. We show that news announcement effects include two components; a direct and an indirect effect induced by volatility spillover. We find that more than 50% of the total accumulated news effect on the Pound and the Yen are due to volatility transmission from the two major currencies and mainly from the Euro.

MARGINAL LIKELIHOOD FOR MARKOV-SWITCHING AND CHANGE-POINT GARCH MODELS

AUTHOR

JEROEN ROMBOUTS (HEC Montreal, Université catholique de Louvain)

ABSTRACT

GARCH models with fixed parameters are too restrictive for long time series due to breaks in the volatility process. Flexible alternatives are Markov-switching GARCH and change- point GARCH models. They require estimation by MCMC methods due to the path dependence problem. An unsolved difficult issue is the computation of their marginal likelihood, which is essential for determining the number of regimes or change-points. We solve the problem by using particle MCMC, a technique proposed by Andrieu, Doucet, and Holenstein (2010). We examine the performance of this new method on artificial data, and we illustrate its use on long series of index returns.

QUANTILES, TIME SERIES, AND SPECTRAL ANALYSIS

AUTHOR

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ABSTRACT

Whether linear or not, most time series models merely produce conditional distributions that are location-scale transformations of some innovation distribution, with (conditional) locations and scales depending on the past. This implies that all conditional quantiles result from the corresponding innovation quantiles via a simple linear transformation, which rules out any dynamics in the skewness, kurtosis, or tail index of the observations. Breaking with that approach, we adopt a more general, model-free approach, where all quantiles may yield their own dynamics. This requires a modification of the traditional time series toolkit, and we propose an appropriate modification of classical spectral analysis, where the role of the traditional L2 norm is played by the quantile-related weighted norm (involving the so-called check function).

NONCAUSAL VECTOR AR PROCESSES WITH APPLICATION TO FINANCIAL TIME SERIES

AUTHOR

RICHARD A. DAVIS (Columbia University)

ABSTRACT

Inference procedures for noncausal autoregressive (AR) models have been well studied and applied in a variety of applications from environmental to financial. For such processes, the observations at time t may depend on both past and future shocks in the system. In this paper, we consider extension of the univariate noncausal AR models to the vector AR (VAR) case. The extension presents several interesting challenges since even a first-order VAR can possess both causal and noncausal components. Assuming a non-Gaussian distribution for the noise, we show how to compute an approximation to the likelihood function. Under suitable conditions, it is shown that the maximum likelihood estimator (MLE) of the vector of AR parameters is asymptotically normal. The estimation procedure is illustrated with a simulation study for a VAR(1) process and with two real data examples. (This is joint work with Li Song).