Frontiers of Time Series Analysis and Related Fields

An International Conference in Honour of Professor W.K. Li

July 26-27, 2013
Cheung On Tak Lecture Theatre (LT-E), Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong

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Peter Brockwell (Colorado State U)
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Rong Chen (Rutgers U)
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Simon S.M. Kwok (U of Sydney)
A.J. Lawrance (U of Warwick)
Dong Li (Tsing Hua U)
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Peter Robinson (LSE)
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JULY 26, 2013
FRIDAY

8:30 – 9:00	Registration
9:00 – 9:15	Opening
	(1) Opening Speech by Professor Howell Tong
	(2) Photo taking
9:15 – 9:45	*Discussion on Professor Tiao's proposal on industrial statistics*
Theme	*Threshold modeling*
Chairperson	*Mike K.P. So*
9:45 – 10:45	(1) Howell Tong *Some Thoughts Prompted by Wong & Li's Mixture AR Models*
	(2) Dong Li *Least squares estimation of threshold models: a practical two-stage procedure*
	(3) Muyi Li *Subsampling Inference in Threshold ARMA Models*
10:45 – 11:05	*Coffee Break*
Theme	*Long memory time series*
Chairperson	*Guodong Li*
11:05 – 12:35	(1) Peter M. Robinson *Panel Nonparametric Regression with Fixed Effects*
	(2) Hwai-Chung Ho *Block Sampling under Strong Dependence*
	(3) Jiti Gao *Estimation and Specification in Nonlinear and Nonstationary Time Series Models*
12:35 – 14:35	*Lunch*
Theme	*Dynamic Conditional Correlation*
Chairperson	*Albert C.S. Wong*
14:35 – 16:05	(1) Michael McAleer *Ten Things You Should Know About the Dynamic Conditional Correlation Representation*
	(2) Cathy W.S. Chen *Bayesian estimation of smoothly mixing time-varying parameter GARCH models*
	(3) Mike K.P. So *Vine-copula GARCH model with dynamic conditional dependence*
16:05 – 16:25	*Coffee Break*
Theme	*Quantile inference*
Chairperson	*Muyi Li*
16:25 – 17:55	(1) A.J. Lawrance *Exploratory Graphics for Financial Time Series Volatility*
	(2) Zongwu Cai *A New Semiparametric Quantile Panel Data Model with Estimating the Growth Effect of FDI*
	(3) Guodong Li *Quantile correlations and quantile autoregressive modeling*
18:30	*Conference Banquet*

Theme	*Positive time series*
Chairperson	*Shiqing Ling*
9:00 – 10:30	(1) Ruey S. Tsay *Parsimony Inducing Priors for Large Scale State-Space Models*
	(2) Ching-Kang Ing *Predictor selection for positive autoregressive processes*
	(3) Rong Chen *Prediction-Based Adaptive Compositional Model for Seasonal Time Series*
10:30 – 10:50	*Coffee Break*
Theme	*Time series inference I*
Chairperson	*Heung Wong*
10:50 – 12:20	(1) Kung-Sik Chan *Subset ARMA Model Specification via Regularization Methods*
	(2) Lajos Horvath *Test of independence for functional data*
	(3) Ke Zhu *Inference for ARMA models with unknown-form and heavy-tailed G/ARCH-type noises*
12:20 – 14:35	*Lunch*
Theme	*Financial models*
Chairperson	*Tom P.W. Fong*
14:35 – 16:05	(1) Peter Brockwell *High-frequency sampling and kernel estimation for continuous-time moving average processes*
	(2) Yiu-Kuen Tse *Intraday Value at Risk: An Asymmetric Autoregressive Conditional Duration Approach*
	(3) Simon S.M. Kwok *Specification Tests of Calibrated Option Pricing Models*
16:05 – 16:25	*Coffee Break*
Theme	*Time series inference II*
Chairperson	*Yingcun Xia*
16:25 – 17:55	(1) N.H. Chan *Group LASSO for Structural Break Time Series*
	(2) Henghsiu Tsai *Non-causal Non-normal Bivariate Time Series Modeling, with an Application to River Bank Erosion Assessment*
	(3) Qiwei Yao *Estimation in the Presence of Many Nuisance Parameters: composite likelihood and plug-in likelihood*
18:30	*Conference Dinner*

ABSTRACT OF PAPERS

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High-frequency sampling and kernel estimation for continuous-time moving average processes

Peter Brockwell, *Colorado State University*

Interest in continuous-time processes has increased rapidly in recent years, largely because of high-frequency data available in many applications. We develop a method for estimating the kernel function g of a second order stationary Lévy-driven continuous-time moving average (CMA) process Y based on observations of the discrete-time process YΔ obtained by sampling Y at times Δ, 2Δ, . . ., nΔ for small Δ. We approximate g by a function gΔ defined in terms of the Wold representation of YΔ and prove its pointwise convergence to g as Δ converges to 0 for continuous-time autoregressive moving average (CARMA) processes. Two non-parametric estimators of gΔ, based on the innovations algorithm and the Durbin–Levinson algorithm, are proposed to estimate g. For a Gaussian CARMA process, we give conditions on the sample size n and the grid spacing Δ(n) under which the innovations estimator is consistent and asymptotically normal as n goes to infinity. The estimators can be calculated from sampled observations of any CMA process, and simulations suggest that they perform well even outside the class of CARMA processes.
Joint work with Vincenzo Ferrazzano and Claudia Klüppelberg

A New Semiparametric Quantile Panel Data Model with Estimating the Growth Effect of FDI

Zongwu Cai, *University of Kansas*

In this paper, we propose a semiparametric quantile panel data model with correlated random effects in which some coefficients are allowed to depend on some smooth economic variables while other coefficients remain constant. A three-stage estimation procedure is proposed to estimate both functional and constant coefficients and the asymptotic properties of the proposed estimators are established. We show that the estimator of constant coefficients is root-N consistent and the estimator of varying coefficients converges in a nonparametric rate. Monte Carlo simulations are conducted to examine the finite sample performance. Finally, we apply the novel semiparametric quantile panel data model to estimate the impact of FDI on economic growth using cross-country data from 1970 to 1999.
Joint work with Linna Chen and Ying Fang

Subset ARMA Model Specification via Regularization Methods

Kung-Sik Chan, *Department of Statistics and Actuarial Science, University of Iowa*

In this talk, I will review some recent, consistent regularization methods useful for specifying a subset ARIMA model with univariate and multivariate time series. The methods will be illustrated by simulations and real applications.

Group LASSO for Structural Break Time Series

Ngai Hang Chan, *Department of Statistics, Chinese University of Hong Kong*

Consider a structural break autoregressive (SBAR) process

$$Y_t = \sum_{t=1}^{m+1} \beta_j^{0T} Y_{t-1} I(t_{j-1} \le t < t_j) + \varepsilon_t \ ,$$

where $Y_{t-1} = (1, y_{t-1}, \dots, y_{t-p})^T$, $\beta_j^0 = (\beta_{j0}^0, \dots, \beta_{ip}^0)^T \in R^{p+1}, j = 1, \dots, m+1, 1 = t0 < t1 < \cdots < tm + 1 = n + 1$, $\{t1, \dots, tm$ are change points, $\{\varepsilon_t\}$ are independent and identically distributed (i.i.d.) innovations with zero mean and unit variance. In practice, it is usually assumed that m is known and small, because a large m would involve a huge amount of computational burden in parameters estimation. By reformulating the problem in a regression variable selection context, the group least absolute shrinkage and selection operator (LASSO) is proposed to estimate an SBAR model when the number of change points m is unknown. It is shown that the number of change points and the locations of the changes can be consistently estimated from the data and the computation can be efficiently performed. Furthermore, the convergence rate of the breaks is shown to be nearly optimal. An improved practical version that incorporates group LASSO and stepwise regression variable selection technique are discussed. Simulation studies are conducted to assess the finite sample performance.

Bayesian estimation of smoothly mixing time-varying parameter GARCH models

Cathy W. S. Chen, *Department of Statistics, Feng Chia University, Taiwan*
Richard Gerlach, *Discipline of Business Analytics, University of Sydney, Australia*
Edward M.H. Lin, *Department of Statistics, Feng Chia University, Taiwan*

Smoothly time-varying (TV) GARCH models via an asymmetric logistic function mechanism are proposed, which are incorporated into the conditional volatility equation for capturing smooth volatility asymmetries in financial time series. The proposed models allow smooth transitions between multiple, persistent regimes. A Bayesian computational method is employed to identify the locations of smooth structural transitions, and for estimation and inference, simultaneously accounting for heteroskedasticity. The proposed methods are illustrated using simulated data, and an empirical study also provides evidence for smooth asymmetric time-varying volatilities in two international stock market return series. In addition, marginal likelihood is used to choose the optimal number of transitions in the TV-GARCH model. A prior is proposed to help ensure identification and allow accurate inference. We find significant improvements in fit from the proposed asymmetric smooth transition TV-GARCH models.

Prediction-Based Adaptive Compositional Model for Seasonal Time Series

Rong Chen, *Rutgers University*

We propose a new class of seasonal time series models, treating the seasonality as a stable composition through time. With the objective of forecasting the sum of next ℓ observations, a rolling season concept is adopted and a rolling conditional distribution structure is formulated. The probabilistic properties of the model, estimation and prediction procedures, and forecasting performance are studied and demonstrated with simulations and real examples.

Estimation and Specification in Nonlinear and Nonstationary Time Series Models

Jiti Gao, *Department of Econometrics and Business Statistics, Monash University, Melbourne, Australia*

This presentation focuses on new estimation and specification problems for multivariate nonlinear time series models, in which both stationary and nonstationary regressors are simultaneously involved. Meanwhile, discussion will also be given to some estimation problems for a class of general nonlinear and nonstationary time series models. Both simulated and real data examples are used to evaluate the proposed models and theory.

Block Sampling under Strong Dependence

Hwai-Chung Ho, *Institute of Statistical Science, Academia Sinica, Taipei*

This talk presents asymptotic consistency of the block sampling method for log-range dependent processes. The result extends earlier ones by considering functionals of linear processes which are not necessarily Gaussian. Under suitable conditions on a certain dependence measure, we prove the validity of the block sampling method. Its finite-sample performance is illustrated by a simulation study.

Test of independence for functional data

Lajos Horvath, *University of Utah, Salt Lake City UT 84112 USA*

We wish to test the null hypothesis that a collection of functional observations are independent and identically distributed against the alternative that the observations are dependent. Our procedure is based on the sum of the L^2 norms of the empirical correlation functions. The limit distribution of the proposed test statistic is established under the null hypothesis and consistency under the alternative when the sample size as well as the number of lags used in the statistic tend to ∞. A Monte Carlo study illustrates the small sample behavior of the test and the procedure is applied to data sets, Eurodollar futures and magnetogram records. The talk is based on a joint paper with Marie Hu\v{s}kov\'a and Gregory Rice.

Predictor selection for positive autoregressive processes

Ching-Kang Ing, *Institute of Statistical Science, Academia Sinica*

Let observations $y_1, \ldots, y_n$ be generated from a first-order autoregressive (AR) model with positive errors. In both the stationary and unit root cases, we derive moment bounds and limiting distributions of an extreme value estimator, $\hat{\beta}_n$, of the AR coefficient. These results enable us to provide asymptotic expressions for the mean squared error (MSE) of $\hat{\beta}_n$, and the mean squared prediction error (MSPE) of the corresponding predictor, $\hat{y}_{n+1}$, of y_{n+1}. Based on these expressions, we compare the relative performance of $\hat{y}_{n+1}$ ($\hat{\beta}_n$) and the least squares predictor (estimator) from the MSPE (MSE) point of view. Our comparison reveals that the better predictor (estimator) is determined not only by whether a unit root exists, but also by the behavior of the underlying error distribution near the origin, and hence is difficult to identify in practice. To circumvent this difficulty, we suggest choosing the predictor (estimator) with the smaller accumulated prediction error and show that the predictor (estimator) chosen in this way is asymptotically equivalent to the better one. Both real and simulated data sets are used to illustrate the proposed method.

Specification Tests of Calibrated Option Pricing Models

Robert A. Jarrow, *Cornell University - Samuel Curtis Johnson Graduate School of Management*
Simon Kwok, *University of Sydney - School of Economics*

In spite of the popularity of model calibration in finance, empirical researchers have put more emphasis on model estimation than on the equally important goodness-of-fit problem. This is due partly to the ignorance of modelers, and more to the ability of existing statistical tests to detect specification errors. In practice, models are often calibrated by minimizing the sum of squared difference between the modelled and actual observations. It is challenging to disentangle model error from estimation error in the residual series. To circumvent the difficulty, we study an alternative way of estimating the model by exact calibration. We argue that standard time series tests based on the exact approach can better reveal model misspecifications than the error minimizing approach. In the context of option pricing, we illustrate the usefulness of exact calibration in detecting model misspecification. Under heteroskedastic observation error structure, our simulation results shows that the Black-Scholes model calibrated by exact approach delivers more accurate hedging performance than that calibrated by error minimization.

Exploratory Graphics for Financial Time Series Volatility

A. J. Lawrance, *Department of Statistics, University of Warwick, Coventry, UK*

Although volatility is in the main stream of financial time series, I claim that there is little available data analysis methodology for exploring the evidence and form of volatility in time series data sets. In the usual paradigm of statistical modelling, this is something one might wish to do before working with particular volatility models. The talk presents a framework for non-parametric volatility graphics which allows exploration of the time progression of volatility and the dependence of volatility on past behaviour, mainly the latter. Plotting techniques are identified on the basis of a non-parametric autoregressive time series volatility model, and include bootstrap assessments of their reliability. They are illustrated on FTSE100 time series data. They are statistically validated by application to simulated volatile and non-volatile series, generated by both conditionally heteroscedastic and stochastic volatility models. Except for a comment or two, this is very much an applied statistics methodology talk.

Least squares estimation of threshold models: a practical two-stage procedure

Dong Li, *TsingHua University, Beijing, China, li20072010@gmail.com*

Threshold models have attracted too much attention and been widely used in econometrics, economics and finance for modeling nonlinear phenomena. Its success is partially due to its simplicity in terms of both model-fitting and model-interpretation. A popular approach to fit a threshold model is the conditional least squares method. However, as modeling data with threshold type of models the computational costs become substantial. This paper proposes a novel method, two-stage grid-search procedure, to quickly search the least squares estimate of the threshold parameter in threshold models. Compared with the standard grid-search procedure used in literature, our new method extremely reduces computational costs, which only requires least-squares operations of order $O(\sqrt{n}\,)$. Its validity is also verified theoretically. The performance of our procedure is evaluated via Monte Carlo simulation studies in finite samples.

Quantile correlations and quantile autoregressive modeling

Guodong Li, *University of Hong Kong, Hong Kong*

In this paper, we propose two important measures, quantile correlation (QCOR) and quantile partial correlation (QPCOR). We then apply them to quantile au-toregressive (QAR) models, and introduce two valuable quantities, the quantile autocorrelation function (QACF) and the quantile partial autocorrelation function (QPACF). This allows us to extend the Box-Jenkins three stage procedure (modelidenti_cation, model parameter estimation, and model diagnostic checking) from classical autoregressive models to quantile autoregressive models. Specically, the QPACF of an observed time series can be employed to identify the autoregressive order, while the QACF of residuals obtained from the _tted model can be used to assess the model adequacy. We not only demonstrate the asymptotic properties of QCOR, QPCOR, QACF, and PQACF, but also show the large sample results of the QAR estimates and the quantile version of the Ljung-Box test. Moreover, we obtain the bootstrap approximations to the distributions of parameter estimator and proposed measures. Simulation studies indicate that the proposed methods perform well in _nite samples, and an empirical example is presented to illustrate usefulness.

Subsampling Inference in Threshold ARMA Models

Dong Li, *TsingHua University, Beijing, China, li20072010@gmail.com*
Muyi Li, *Xiamen University, Xiamen, China, limuyi1981@gmail.com*

This paper considers subsampling inference for threshold autoregressive and move-average (TARMA) models. Of main interest is inference for the threshold parameter. It is well known that the limiting distribution of the corresponding estimator is non-normal and very complicate. We show that valid inference can be drawn by using the subsampling method. The subsampling inference can also be used for other regression parameters. Simulation studies evaluate small sample performance and an application illustrates how the methodology does work in practice.

Ten Things You Should Know About the Dynamic Conditional Correlation Representation

Michael McAleer, *Econometric Institute, Erasmus School of Economics, Erasmus University Rotterdam, and Tinbergen Institute, The Netherlands, and Department of Quantitative Economics, Complutense University of Madrid, Spain, and Institute of Economic Research, Kyoto University, Japan.*

The purpose of the paper is to discuss ten things potential users should know about the limits of the Dynamic Conditional Correlation (DCC) representation for estimating and forecasting time varying conditional correlations. The reasons given for caution about the use of DCC include the following: DCC represents the dynamic conditional covariances of the standardized residuals, and hence does not yield dynamic conditional correlations; DCC is stated rather than derived; DCC has no moments; DCC does not have testable regularity conditions; DCC yields inconsistent two step estimators; DCC has no asymptotic properties; DCC is not a special case of GARCC, which has testable regularity conditions and standard asymptotic properties; DCC is not dynamic empirically as the effect of news is typically extremely small; DCC cannot be distinguished empirically from diagonal BEKK in small systems; and DCC may be a useful filter or a diagnostic check, but it is not a model.

Panel Nonparametric Regression with Fixed Effects

Peter M. Robinson, *London School of Economics*

Nonparametric regression is developed for data with both a temporal and a cross-sectional dimension. The model includes additive, unknown, individual-specific components and allows also for cross-sectional and temporal dependence and conditional heteroscedasticity. A simple nonparametric estimate is shown to be dominated by a GLS-type one. Asymptotically optimal bandwidth choices are justified for both estimates. Feasible optimal bandwidths, and feasible optimal regression estimates, are asymptotically justified, with finite sample performance examined in a Monte Carlo study.
Joint work with J ungyoon Lee

Some Thoughts Prompted by Wong & Li's Mixture AR Models

Howell Tong, *London School of Economics*

1. Two equivalent approaches
2. Quantile
3. How many components?

Vine-copula GARCH model with dynamic conditional dependence

Mike K.P. So, *Hong Kong University of Science and Technology*

Constructing multivariate conditional distributions for non-Gaussian return series has been a major research agenda recently. Copula GARCH models combine the use of GARCH models and a copula function to allow exibility on the choice of marginal distributions and dependence structures. However, it is non-trivial to define multivariate copula densities that allow dynamic dependent structures in returns. The vine-copula method has been gaining attention recently in that a multidimensional density can be decomposed into a product of conditional bivariate copulas and marginal densities. The dependence structure is interpreted individually in each copula pair. Yet, most studies have only focused on time varying correlation. In this paper, we propose a vine-copula GARCH model with dynamic conditional dependence. We develop a generic approach to specifying dynamic conditional dependence using any dependence measures. The characterization also induces multivariate conditional dependence dynamically through vine decomposition. The main idea is to incorporate dynamic conditional dependence, such as Kendall's tau and rank correlation, not to mention linear correlation, in each bivariate copula pair. The estimation is conducted through a sequential approach. Simulation experiments are performed and five Hong Kong blue chip stock data from January 2004 to December 2011 are studied. Using t and two Archimedean copulas, it is revealed that Kendall's tau and linear correlation of the stock returns vary over time, which indicates the presence of time varying properties in dependence.

Intraday Value at Risk: An Asymmetric Autoregressive Conditional Duration Approach

Shouwei Liu and Yiu-Kuen Tse, *School of Economics, Singapore Management University*

We propose to estimate the intraday Value at Risk (IVaR) of stocks using real-time transaction data. Transaction data filtered by price duration are modeled using a two-state asymmetric autoregressive conditional duration (AACD) model, and the IVaR is computed using Monte Carlo simulation. Empirical analysis of stocks from the New York Stock Exchange (NYSE) shows that the IVaR estimated using the AACD method tracks closely to those using the Dionne, Duchesne and Pacurar (2009) and Giot (2005) methods. Backtesting results show that the AACD method performs the best against other methods.

Non-causal Non-normal Bivariate Time Series Modeling, with an Application to River Bank Erosion Assessment

Henghsiu Tsai, *Institute of Statistical Science, Academia Sinica, Taiwan, R.O.C.*

Extreme river bank erosion may destabilize a river so that the river may change its course, thus posing severe environmental and societal problems. Hence, prediction of river bank erosion is an important problem. River bank erosion is known to be related to
river curvature, where the curvature of a river segment is often characterized by the so-called sinuosity index; the sinuosity index is the ratio of the channel length to the down-valley length. While river curvature can be readily calculated via GPS, river bank erosion is very hard to measure and time-consumig. In this paper, we consider non-causal bivariate time series models for the prediction of river bank erosion based on river curvature. (This is a joint work with Kung-Sik Chan, Heiko Rachinger, and Keith Schilling)

Parsimony Inducing Priors for Large Scale State-Space Models

Ruey S. Tsay, *Booth School of Business, University of Chicago*

State-space models are commonly used in the engineering, economic, and statistical literatures. They are flexible and encompass many well-known statistical models, including random coefficient autoregressive models and dynamic factor models. Bayesian analysis of state-space models has attracted much interest in recent years. However, for large scale models, prior specification becomes a challenging issue in Bayesian inference. In this paper, we propose a flexible prior for state-space models. The proposed prior is a mixture of four commonly entertained models, yet achieves parsimony in high-dimensional systems. Here “parsimony" is represented by the idea that in a large system, some states may not be time-varying. Simulation and simple examples are used throughout to demonstrate the performance of the proposed prior. As an application, we consider the time-varying conditional covariance matrices of daily log returns of 94 components of the S&P 100 index, leading to a state-space model with 94_95/2=4,465 time-varying states. Our model for this large system enables us to use parallel computing.
(joint with H. Lopes & R. E. McCulloch)

Estimation in the Presence of Many Nuisance Parameters: composite likelihood and plug-in likelihood

Qiwei Yao, *London School of Economics and Political Science*

We consider the incidental parameters problem in this paper, i.e. the estimation for a small number of parameters of interest in the presence of large number nuisance parameters. By assuming that the observations are taken from a multiple strictly stationary process, the two estimation methods, namely the maximum composite quasi-likelihood estimation (MCQLE) and the maximum plug-in quasi-likelihood estimation (MPQLE) are considered. For the MCQLE, we profile out nuisance parameters based on lower-dimensional marginal likelihoods, while the MPQLE is based on some initial estimators for nuisance parameters. The asymptotic normality for both the MCQLE and the MPQLE is established under the assumption that the number of nuisance parameters and the number of observations go to infinity together, and both the estimators for the parameters of interest enjoy the standard root-n convergence rate. Simulation with a spatial-temporal model illustrates the finite sample properties of the two estimation methods. The study reveals the advantages of using the MCQLE when the number of nuisance parameters is large in relation to the sample size, the phenomenon observed in Engle et al. (2008) with a high-dimensional volatility model.

Inference for ARMA models with unknown-form and heavy-tailed G/ARCH-type noises

Ke Zhu, *Chinese Academy of Sciences*

Recent research reveals that the traditional inference is in-valid for the ARMA model with unknown-form and heavy-tailed G/ARCH-type noises. This paper is to develop a systematic procedure for statistical inference of this model. We first investigate the least absolute deviation (LAD) estimator and the self-weighted LAD estimator for the model. Both estimators are shown to be strongly consistent and asymptotically normal when he noise has a finite variance and infinite variance, respectively. However, their asymptotic covariance-matrix cannot be estimated directly from the sample. We then propose the random weighting approach for statistical inference under this nonstandard case. We further develop a novel sign-based portmanteau test for model adequacy. Simulation study is carried out to access the performance of our procedure and a real example is given to illustrate our procedure