10th INTERNATIONAL INSTITUTE OF FORECASTERS' WORKSHOP

Multivariate Time Series Modelling and Forecasting: A summary

The "Multivariate Time Series Modelling and Forecasting" Workshop was held in Melbourne, Australia on the 18th and 19th February, 2013. More than 80 participants attended this two-day workshop which was hosted by the Department of Econometrics and Business Statistics, Monash University and organised by George Athanasopoulos and Farshid Vahid. George and Farshid acknowledge the Monash Research Accelerator Program at Monash University for the complete funding of the workshop.

George opened the proceedings by thanking all participants and in particular the presenters who had travelled from overseas. Professor Helmut Lütkepohl from DIW Berlin and Freie Universität Berlin delivered the opening keynote address on "Comparison of Methods for Constructing Joint Confidence Bands for Impulse Response Functions". This paper begins by reviewing a range of methods that are used to construct confidence intervals of the impulse response function in VAR analysis, then proposes a new variant for constructing joint confidence bands at all horizons. The proposed method is an adjusted version of the traditional Bonferroni method. The latter is generally conservative, because it increases the size of the bands to account for the stochastic dependence in the estimated impulse responses. The paper proposes an adjustment which narrows the bands, but still retains the correct asymptotic coverage. Monte Carlo simulation suggests that the adjusted Bonferroni method performs very well in terms of both the coverage level and the width of the band. The neighbouring path band proposed by Staszewska (2007) is a close competitor, but it lacks a theoretical basis. This paper therefore recommends the adjusted Bonferroni method for applied works.

Following on from the theme of the morning keynote address, the first session consisted of four papers on macroeconomic modelling. First, Sandra Eickmeier from Deutsche Bundesbank presented "Time Variation in Macro-Financial Linkages". This paper constructs a Bayesian VAR model with time-varying parameters, including U.S. GDP growth, inflation, and a few key financial indicators. The model is used to assess the contribution of financial shocks to GDP growth in the U.S., and to analyse possible changes in the volatility of financial shocks and their impact on GDP growth. It concludes that the contribution of financial shocks to the forecast error variance of GDP growth has changed considerably over time (being higher during the global financial crisis period), and that shocks from the housing sector have become more important to the real economy since the early 2000s.

The next paper, "Shifting Preferences at the Fed: Evidence from Rolling Dynamic Multipliers and Impulse Response Analysis", was presented by Matthew Greenwood-Nimmo, from The University of Melbourne. This paper develops a new method of modelling the Taylor rule in a system setting, which accounts for the mixture of I(0) and I(1) variables explicitly. When estimated using U.S. data, the model provides modest support for an inertial Taylor rule; however, inflation and the output preferences of the Fed vary significantly over time. More importantly, they find that the Taylor Principle was upheld robustly under Volcker (1979Q4:1987Q3), often upheld pre-Volcker, but rarely observed post-Volcker.

Lance Fisher from Macquarie University presented the third paper in this session: "Some Pitfalls in Modelling with a Mixture of I(1) and I(0) Variables". This paper shows that the presence of I(0) variables gives rise to identification restrictions of structural shocks, which have been often neglected in practice. A failure to impose these restrictions can lead to the false labelling of structural shocks as transitory, when in fact these shocks have long-run effects. The paper also shows that, in the mixed variable case, the sign restrictions associated with I(0) variables should be applied carefully.

The last paper in this session was presented by Jing Tian from the University of Tasmania, and was titled "On Trend-Cycle Decomposition and Data Revision". This paper is motivated by the well-documented finding of a large negative correlation between trend and cycle innovations. It discusses the economic implications of this finding, including the filtering and smoothing properties, and attempts to identify the direction of causality between these two innovations empirically. The results suggest that the filtered cycles under two different specifications of causal direction are very similar. Hence, more information is needed in order to identify the causal direction.

The afternoon session focused on copula and financial modelling and forecasting. Valentyn Panchenko from the University of New South Wales presented "Comparing the Accuracy of Copula-Based Multivariate Density Forecasts in Selected Regions of Support". This paper develops a testing framework which is set in the context of the Kullback-Leibler Information Criterion, and uses the out-of-sample conditional likelihood and censored likelihood to restrict the evaluation to the region of interest. Monte Carlo simulations show that the resulting test statistics have satisfactory size and power properties in small samples.

The second paper in this session, entitled "Copula Modelling of Dependence in Multivariate Time Series", was presented by Michael Smith from The University of Melbourne. This paper proposes a copula model which accounts for nonlinear serial and cross-sectional dependence directly. A D-vine is used for the joint distribution of the multivariate time series. The conditions for stationarity are derived, and a parallel algorithm for computing the likelihood is given. Two empirical examples are then used to illustrate the importance and flexibility of this approach.

Harald Scheule from the University of Technology, Sydney, presented "Dynamic Implied Correlation Modelling and Forecasting in Structured Finance", the last paper of this session. This paper suggests a dynamic panel regression for modelling and forecasting implied correlations. Random effects are introduced in order to account for unobservable time-specific effects on implied correlations. The empirical findings support the proposed dynamic mixed-effects regression correlation model even during the global financial crisis.

The last presentation for the first day was a keynote address by Professor Massimiliano Marcellino from European University Institute, Bocconi University and CEPR, on the topic of "Markov-Switching Mixed Frequency VAR Models". This paper introduces and discusses estimation and inference for Markov-switching mixed frequency VAR models. Two alternative formulations of the model are examined: one in state-space form, and the other through a stacked vector system. The two formulations are applied to the prediction of GDP

growth and business cycle turning points in the euro area. The results suggest that these models are useful for estimating the status of the economy in particular.

In the evening of this first day, all of the presenters and chairpersons enjoyed a workshop dinner while viewing a glorious Melbourne sunset at "Sails on the Bay", a restaurant which is situated on the edge of the beach and provides a panoramic view of the bay.

The second day of the workshop started with a keynote address on "Macroeconomic Modelling and Time Series Analysis: A Personal Polemic", delivered by Professor Don Poskitt from Monash University. This paper investigates a common practice in the DSGE modelling literature of using finite lag VAR models to approximate the true VARMA data generating process. It examines the theoretical behaviour of the finite VAR models, and shows that the overall error of the finite VAR approximation can be decomposed into two basic components: the estimation error, which stems from the difference between the parameter estimates and their population ensemble counterparts, and the approximation error, which comes from the difference between the theoretical minimum mean squared error $VAR(n)$ model and the true $VAR(\infty)$ process. Results based on a real business cycle model and a practical example suggest that the approximation error approaches its asymptotic value at a slower rate than does the estimation error. Using the sorts of sample sizes and lag lengths which are commonly employed in practice, the paper shows that finite $VAR(n)$ models are likely to exhibit substantial errors of both types. It then proposes a new method for identifying the structure of VARMA models in terms of a scalar ARMAX representation.

The next session included three papers on empirical forecasting. First, Andrey Vasnev from The University of Sydney presented a paper on "Practical Use of Sensitivity in Econometrics with an Illustration for Forecast Combinations". This paper first introduces the difference between absolute and relative sensitivities, and highlights the context-dependent nature of sensitivity analyses. The idea of relative sensitivity is then applied to combining forecasts, and sensitivity based weights are introduced. All of the concepts are illustrated using the European yield curve example. The results show that fit-based weights and sensitivity-based weights are complimentary.

The second paper in this session, "Air Quality Combination Forecasting with an Application to Bogota", was presented by Joakim Westerlund from Deakin University. The paper shows that forecast combination can produce more accurate forecasts for forecasting the air quality than commonly used alternatives, both in a simulation setting and for forecasting the actual air quality in Bogota.

Mark Doolan from Queensland University of Technology presented "Selecting Forecasting Models for Portfolio Allocation". This paper investigates the abilities of different loss functions to discriminate between competing forecasting models, which are applied to a mean-variance portfolio optimization problem. It is found that a likelihood-based loss function is usually preferred to the use of portfolio variance-based evaluation for selecting forecasting models in a portfolio allocation context.

The afternoon session had a theme of volatility modelling and Bayesian methods. Diaa Noureldin from the University of Oxford presented the first paper, on "Multivariate Rotated

ARCH Models". This paper introduces Rotated ARCH models, which are easy to estimate using covariance targeting. The basic structure is to rotate the returns, then fit them using a BEKK-type parameterization of the time varying covariance, whose long-run covariance is the identity matrix. The extension to DCC-type (dynamic conditional correlation) parameterization is given. Inference for these models is computationally attractive, and the asymptotics are standard.

The second presenter, Tomasz Woźniak, was from The University of Melbourne. His paper, "Testing Causality between Two Vectors in Multivariate GARCH Models", uses Constant Conditional Correlation GARCH models to model the risk associated with financial time series, and to make inferences about Granger causal relationships between second conditional moments. The restrictions for second-order Granger non-causality between two vectors are derived, and posterior odds ratios are used to assess the credibility of the non-causality hypotheses. The empirical results show that the pound-to-Euro exchange rate second-order causes the USD-to-Euro exchange rate, which confirms the hypothesis of Engle, Ito & Lin (1990).

Rodney Strachan, from the Australian National University, presented "Efficient Computation and Invariant Inference in the Static Factor Model". This paper develops computationally-efficient Bayesian methods for estimating static factor models, which are also invariant to the ordering of the variables. Taking the factor model as a reduced rank regression, the model parameters are identified. The paper uses parameter expansions to obtain a specification with standard conditional posteriors, and the sampler is efficient. An application to six exchange rate series is presented in order to demonstrate the effect of reordering, and the efficiency of the proposed sampling algorithm.

The workshop concluded with a keynote address from Associate Professor Andrew Patton from Duke University. His talk was entitled "Time-Varying Systemic Risk: Evidence from a Dynamic Copula Model of CDS Spreads". The paper proposes a simple, flexible class of dynamic factor copula models that can be applied to high dimensional problems. Although closed-form expressions for these models are generally not available, analytical results on tail dependence are available using extreme value theory. The paper uses the generalized autoregressive score model of Creal, Koopman and Lucas (2011) to capture the time-varying dependence. This model is applied to CDS (credit default swaps) on 100 U.S. firms, with a focus on systemic risk. The paper finds that: 1) time variation in the dependence structure is significant; 2) there is significant evidence of tail dependence, asymmetric dependence, and heterogeneous dependence; 3) the risk of systemic distress has increased since the global financial crisis.

Farshid closed the proceedings by thanking all participants for what had been a stimulating and innovative two-day workshop.

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