The 35th International Symposium on Forecasting

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ISF 2015 PROCEEDINGS

Monday, 22 June

Keynote Session I (Room: RC)

Hal Varian
Chief Economist, Google; Emeritus Professor, University of California, Berkeley, USA

Clive Granger Memorial Keynote Address: **Google Tools for Data**

Google provides several tools for data gathering, including Google Trends, Google Correlate, and Google Consumer Surveys. This talk reviews these tools and describes how they can be used for statistical analysis of various sorts. We focus particularly on Bayesian methods.

9:45am-11:00am Forecasting Practitioner Track 1 (Room: MR10)

Thomas J. Goldsby, Harry T. Mangurian, Jr. Foundation Professor in Business and Professor of Logistics, Fisher College of Business, The Ohio State University

Macrotrends: Big Forces at Work in Our Economy, Our Business, and Supply Chains
Most senior managers and executives find themselves consumed with the day-to-day management of the business. This session encourages business leaders to step back and recognize major issues that are changing the economic landscape that will influence business success and failure in the coming years. Specifically, this session will explore the following forces shaping business: (1) Population shifts and the ensuing changes in market growth and demand, (2) Impending scarcity on several key materials, (3) Climate change, and (4) Emerging technologies. Beyond mere "food for thought," careful consideration of these macrotrends can influence the winners and losers in the years ahead.
Discussants: Ram Ganeshan, Fotios Petropoulos

9:45am-11:00am IS Forecasting Financial Time Series (Room: MR8)
Chair: Jeroen Rombouts

Monitoring Forecasting Performance: Identifying when and why return prediction models work
Allan Timmermann, University of California, San Diego; **Yinchu Zhu**, University of California, San Diego

We propose new ways to conduct conditional forecast evaluation tests which help identify economic states in which a financial forecasting model performs better than some benchmark. Such tests are relevant when a forecasting model does not dominate the benchmark across all economic states and shed light on the economic sources of predictability. Empirical tests show that the predictive power of popular state variables over U.S. stock returns is far from stable over time and changes in ways that reflect the underlying economic state. Similar results reveal time-varying predictability of U.S. stock market volatility and returns on momentum trading strategies. We explore whether this evidence can be used to improve performance in ex-ante investment strategies.

Variance risk premia:estimation and international evidence
Francesco Violante, CREATES Aarhus University; Jeroen Rombouts, Essec Business School

This paper proposes a new approach to retriving the variance risk premium (VRP). In a simple framework, we allow for measurement error in realized and implied variance as well as discontinuities. This is done in

a signal extraction setup. The parameters of the model are straightforwardly estimated by maximum likelihood using the Kalman filter. To disentangle the VRP from expected variance swap payoff we use a switching approach with a regime that becomes active during events of unusually high volatility. In conrast with the full non-parametric approach typically used in the literature, the extracted VRP from our lightly parameterized model is, consistently with the theoretical construct, always negative and shows appropriate characteristics in terms of smoothness, dynamics and persistence. Using series of realized and implied variances computed respectively from 5-minute returns and option data on the underlying index, we apply our new approach to retrive the VRP of several international market indices.

Sparse Change-Point Models
Jeroen Rombouts, ESSEC; Arnaud Dufays, CORE

Change-point specifications constitute flexible models that capture structural changes by allowing for switches in the model parameters. Nevertheless most models suffer from an over-parametrization issue since typically only one latent state variable drives the breaks. This implies that all parameters have to change when a break happens. We introduce sparse change-point processes, a new approach for detecting which parameters change over time. We propose shrinkage prior distributions allowing to control model parsimony by limiting the number of parameters which evolve from one structural break to another. Well-known applications are revisited to emphasize that many popular breaks are, in fact, due to a change in only a subset of the model parameters. It also turns out that sizable forecasting improvements are made over standard change-point models.

9:45am-11:00am IS Density Forecasting (Room: MR7)
Chair: Helena Veiga

A Multivariate Heavy-Tailed Distribution with Dynamic Equicorrelation
Trino-Manuel Ñiguez, University of Westminster; Javier Perote, University of Salamanca

This paper proposes a new semi-nonparametric (SNP) method for the modelling of the density of portfolio returns. The distribution we obtain, named Multivariate Moments Expansion (MME), is specified through a weighted sum of a parametric density which weights are given by polynomials defined in terms of the moments of the density used as basis. The MME pdf preserves the flexibility typical of SNP methods to fit any target density being more tractable theoretically. We demonstrate that Gaussian MME formally admits the implementation of the Dynamic Equicorrelation (DECO) model of Engle and Kelly (2012) allowing to account for skewness and heavy-tails. We provide evidence on the applicability of our model through a density forecasting comparative analysis for a portfolios of ten assets.

Forecaster's Dilemma: Extreme Events and Forecast Evaluation
Sebastian Lerch, Heidelberg Institute for Theoretical Studies; Thordis Thorarinsdottir, Norwegian Computing Center; Francesco Ravazzolo, Norges Bank; Tilmann Gneiting, Heidelberg Institute for Theoretical Studies

In discussions of the quality of forecasts in the media and public, attention often focuses on the predictive performance in the case of extreme events. Intuitively, accurate predictions on the subset of extreme events seem to suggest better predictive ability. However, it can be demonstrated that restricting conventional forecast verification methods to subsets of observations might have unexpected and undesired effects and may discredit even the most skillful forecasters. Hand-picking extreme events is incompatible with the theoretical assumptions of established forecast verification methods, thus confronting forecasters with what we refer to as the forecaster's dilemma. For probabilistic forecasts, weighted proper scoring rules provide suitable alternatives for forecast evaluation with an emphasis on extreme events. Using theoretical arguments, simulation experiments and a case study on density forecasts of U.S. inflation and gross domestic product growth, we illustrate the forecaster's dilemma and the use of weighted proper scoring rules.

Model uncertainty and the forecast accuracy of ARMA models

Joao Henrique G. Mazzeu, Universidad Carlos III de Madrid; Esther Ruiz Ortega, Universidad Carlos III de Madrid; **Helena Veiga**, Universidad Carlos III de Madrid

The objective of this paper is to survey the literature on the effects of model uncertainty on the forecast accuracy of linear univariate ARMA models. We consider three specific uncertainties: parameter estimation, error distribution and lag order. The results are illustrated with simulated and real data.

9:45am-11:00am IS Forecasting using common features (Room: MR1)
Chair: Joao Victor Issler

Risk Assessment of the Brazilian FX Rate

Wagner Gaglianone, Central Bank of Brazil; Jaqueline Marins, Central Bank of Brazil

In this paper, we construct several multi-step-ahead density forecasts for the foreign exchange (FX) rate based on statistical, financial data and economic-driven approaches. The objective is to go beyond the standard conditional mean investigation of the FX rate and (for instance) allow for asymmetric responses of covariates (e.g. financial data or economic fundamentals) in respect to exchange rate movements. We also provide a toolkit to evaluate out-of-sample density forecasts and select models for risk analysis purposes. An empirical exercise for the Brazilian FX rate is provided. Overall, the results suggest that no single model properly accounts for the entire density in all considered forecast horizons. Nonetheless, the GARCH model as well as the option-implied approach seem to be more suitable for short-run purposes (until three months), whereas the survey-based and some economic-driven models appear to be more adequate for longer horizons (such as one year).

Local Unit Root and Inflationary Inertia in Brazil

Francisco Marcos Rodrigues Figueiredo, Banco Central do Brasil; **Osmani Teixeira de Carvalho Guillén**, Banco Central do Brasil and Ibmec; Wagner Piazza Gaglianone, Banco Central do Brasil

The purpose of this paper is to study the persistence of Brazilian inflation using quantile regression techniques. To characterize the inflation dynamics we employ the Quantile Autoregression model (QAR) of Koenker and Xiao (2004, 2006). In this model, the autoregressive coefficient may assume different values in distinct quantiles, allowing testing the asymmetry hypothesis for the inflation dynamics. Furthermore, the model allows investigating the existence of a local unit root behavior, with episodes of mean reversion sufficient to ensure stationarity. In other words, the model enables one to identify locally unsustainable dynamics, but still compatible with global stationarity. In addition, the model can be reformulated in a more conventional random coefficient notation, in order to reveal the periods of local nonstationarity. Another advantage of this technique is the estimation method, which does not require knowledge of the innovation process distribution, making the approach robust against poorly specified models. An empirical exercise with Brazilian inflation data and its components illustrates the methodology. As expected, the behavior of inflation dynamics is not uniform across different conditional quantiles. In particular, the results can be summarized as follows: (i) the dynamics is stationary for most quantiles of the sample period; (ii) the process is nonstationary in the upper tail of the conditional distribution; and (iii) the periods associated with local unsustainable dynamics can be related to those of increased risk aversion and higher inflation expectations.

Forecasting Multivariate Time Series under Present-Value-Model Short- and Long-run Co-movement Restrictions

Joao Victor Issler, Getulio Vargas Foundation; Osmani Guillen, Getulio Vargas Foundation; Diogo Saraiva, Getulio Vargas Foundation; Alain Hecq, Maastricht University

Using a sequence of nested multivariate models that are VAR-based, we discuss different layers of restrictions imposed by present-value models (PVM hereafter) on the VAR in levels for series that are subject to present-value restrictions. Our focus is novel -- we are interested in the short-run restrictions

entailed by PVMs (Vahid and Engle, 1993, 1997) and their implications for forecasting. Using a well-known database, kept by Nobel-Prize recipient Robert Shiller, we implement a forecasting competition that imposes different layers of PVM restrictions. Our exhaustive investigation of several different multivariate models reveals that better forecasts can be achieved when restrictions are applied to the unrestricted VAR. Moreover, imposing short-run restrictions produces forecast winners 70% of the time for the target variables of PVMs and 63.33% of the time when all variables in the system are considered.

9:45am-11:00am IS Probabilistic energy forecasting (Room: MR2)
Chair: Jooyoung Jeon

A Markov-Switching Vector Autoregressive Stochastic Wind Generator for Multiple Spatial and Temporal Scales
Amanda Hering, Colorado School of Mines; **Karen Kazor**, Colorado School of Mines; William Kleiber, University of Colorado at Boulder

Despite recent efforts to record wind at finer spatial and temporal scales, stochastic realizations of wind are still important for many purposes and particularly for wind energy grid integration and reliability studies. Most instances of wind generation in the literature focus on simulating only wind speed, or power, or only the wind vector at a particular location and sampling frequency. In this work, we introduce a Markov-switching vector autoregressive (MSVAR) model, and we demonstrate its flexibility in simulating wind vectors for 10-min, hourly and daily time series and for individual, locally-averaged and regionally-averaged time series. In addition, we demonstrate how the model can be used to simulate wind vectors at multiple locations simultaneously for an hourly time step. The parameter estimation and simulation algorithm are presented along with a validation of the important statistical properties of each simulation scenario. We find the MSVAR to be very flexible in characterizing a wide range of properties in the wind vector, and we conclude with a discussion of extensions of this model and modeling choices that may be investigated for further improvements.

Probabilistic Spatio-Temporal Renewable Energy Forecasting
Emil Banning Iversen, Technical University of Denmark; Pierre Pinson, Technical University of Denmark; Juan Miguel Morales, Technical University of Denmark; Jan Kloppenborg Møller, Technical University of Denmark; Henrik Madsen, Technical University of Denmark

The variable and partly predictable power production from renewable energy sources yields unprecedented challenges in power system operations and electricity markets. Full benefits from renewable energy integration can only be reached by issuing probabilistic forecasts and embedding them into operational decision processes. The variety of decision-making problems, combined with the tremendous increase in power production sites, data quantity and types, calls for a profound rethinking of our approach to renewable energy analytics. More specifically, decision-making problems requiring probabilistic forecasts for multiple lead times and spatial locations arise in numerous applications. Generating those forecasts is challenging since requiring potentially complex models with large parameter space, as well as even larger amounts of data for parameter estimation. Evaluating such multivariate probabilistic forecasts is also a current challenge. We discuss a framework for the modeling of the space-time dependence of forecast errors, to be used as a basis for space-time probabilistic forecasting of renewable energy generation. As a basis for discussion we consider the case of spatio-temporal forecasts of solar power generation over California, for which we attempt to model their interdependence structure while reducing the parameter space and hence minimizing computational costs.

Short-term Density Forecasting of Wave Energy Using ARMA-GARCH Models and Kernel Density Estimation
Jooyoung Jeon, University of Bath; James W. Taylor, University of Oxford

Wave energy has great potential as a renewable source of electricity. Installed capacity is increasing, and with developments in technology, wave energy is likely to play an important role in the future mix of

electricity generation. The short-term forecasting of wave energy flux is needed for the efficient operation of wave farms and power grids, as well as for energy trading. The intermittent nature of wave energy motivates the use of probabilistic forecasting. In our approach, we evaluate the accuracy of probabilistic forecasts of wave energy flux from a variety of methods, including unconditional and conditional kernel density estimation, univariate and bivariate ARMA-GARCH models, and a regression-based method proposed in the literature. The bivariate ARMA-GARCH models are implemented with Gaussian, Student t and skewed t distributions, and with different pairs of variables, such as (1) wave height and wave period, and (2) wave energy flux and wind speed. Our empirical analysis uses two separate periods of hourly data from the FINO1 research platform in the North Sea to evaluate density forecasts, up to 72 hours ahead, for the wave energy flux. The empirical study indicates that a bivariate ARMA-GARCH model for wave height and wave period led to the greatest accuracy overall for wave energy flux density forecasting, but as the lead time increases, its usefulness reduces.

9:45am-11:00am RS Forecast Combination (Room: MR4)
Chair: Emrah Gulay

What should the number of individual models in a combined forecast be selected?
Serkan Aras, Dokuz Eylul University; Emrah Gulay, Dokuz Eylul University

Combining various forecasting models is an important tool in forecaster's toolbox with the hope of attaining more accurate forecasts. Many papers have showed that selecting single models as dissimilar models in a combination method would lead to better forecasting performances. However, there is no certain knowledge about the number of individual models to be used in any combination method. This paper tries to empirically find the optimal number for single models with the help of statistical tests. In order to reach some conclusions, a comprehensive experiment is conducted by using well-known real-world time series data from different fields. Also, many forecasting methods which are rivals to each other and several widely used combination methods are employed. Empirical results indicate that it is possible to find statistically significant differences in the number of single models for all investigated combination methods. Furthermore, some valuable suggestions for practitioners are included.

Reduction of forecast errors – A new forecast combination approach applied to realized and implied volatility forecasts
Till Weigt, University of Münster; Bernd Wilfling, University of Münster

In this paper, we propose a new forecast combination approach to volatility forecasting by combining different pieces of information hidden in implied and realized volatility forecasts. In considering k alternative forecast models of the same target variable, it is well-known that the information contained in the past forecast errors of any specific model cannot be used separately to systematically improve future forecasts of that model. We can, however, use the contemporaneous correlation between past forecast errors of all models to systematically improve the future forecasts of every model. Technically speaking, we use a VAR(p) model to simultaneously regress the current forecast model of each model on the past forecast errors of models involved. The resulting forecasts of this VAR(p) model represent our revised future forecast errors, which we then subtract from the genuine future forecasts. We show that the MSE of the revised future forecasts is smaller than the MSE of the genuine forecasts. This novel methodology, which we call Vector Autoregressive Forecast Error Combination (VAFEC), belongs to the group of so-called forecast combination methods. In contrast to conventional combination methods, which calculate optimal combination weights to generate one superior forecast, our VAFEC method improves each forecast on its own by modelling the forecast error. The VAFEC approach appears to be particularly useful when combining realized volatility forecasts with implied volatility forecasts. Instead of using a specific implied-volatility forecast model, it is possible – due to the specific VAFEC structure – to use implied volatility itself as raw data. Thus, VAFEC can be viewed as the natural combination of implied volatility (in raw-data form) and realized volatility forecasts. In an empirical study we compare the out-of-sample properties of our VAFEC approach with those of alternative volatility-forecasting methods and combinations of these. For this purpose, we consider three benchmarks. (1) The genuine forecasts itself, (2) the realized volatility

forecasts with implied volatility as external regressor and (3) the average combination of realized and implied volatility forecasts. Our Model Confidence Set (MCS) comparison shows that the VAFEC approach outperforms the alternative benchmark methodologies out of sample.

A Novel Method for Combined Forecasts
Emrah Gülay, Dokuz Eylul University; Serkan Aras, Dokuz Eylul University

Many researchers have been studied on combining forecasting methods from the late 1960s until today. A large number of published studies in forecasting area show that the theories and applications of combining forecasts have become more and more interesting and important day by day. It is known that combining forecasts from different single models generally lead to significant improvement in forecasting accuracy. Literature shows that the performance of combination methods may vary with the selection of individual models to be used in forecasting. In this study we propose a new algorithm method based on directional forecasts and estimated error variance to combine forecasts from different individual models. One of used individual time series models is the autoregressive integrated moving average model (ARIMA). Other models used in the study are artificial neural networks (ANNs), which have been widely studied in time series forecasting, and nonlinear time series models. Combined forecast can be a simple average of individual forecasts, a median of individual forecasts or a weighted average combination of them. We employ five different individual models to generate individual forecasts. Six popular combination methods are applied, and their forecasting performance is evaluated by using well-known five real world time series data in this area. Simple average combination method is used as benchmark throughout the study. The results show that combined forecasts of the proposed method are likely to be preferred to individual model forecasts and combined forecasts of other combination methods.

9:45am-11:00am RS Forecast Evaluation 1 (Room: MR5)
Chair: Herman Stekler

Out-of-sample forecast prediction -- what have we missed?
Luiz Lima, University of Tennessee, Knoxville; **Fanning Meng**, University of Tennessee, Knoxville

Stock return forecasts based on individual predictive regression models are biased at the same direction. Standard forecast combination methods, such as the mean forecast, are able to lower forecast variance but they fail to substantially reduce bias, resulting in return forecasts that are outperformed by the historical average. We show that a forecasting method based on the weighted average of the quantile function of stock returns estimated by LASSO, consistently outperform the historical average model and other forecast combination methods. This happens because the new forecasting method is able to substantially reduce forecast bias at the expenses of a very low increase in forecast variance.

[Forecast Evaluation in the panels of forecasts: empirical evidence](#)
Marina Turuntseva, RANEPA; Ekaterina Astafieva, RANEPA

Standard methods of forecast evaluation include the testing such properties of forecasts as an unbiasedness, an efficiency and a non-autocorrelationness. The test procedures are simple. For example, the standard test for unbiasedness suggests to estimate regression of h–step ahead forecast errors on a constant and to test the significance of this constant. Obviously, such tests are not powerful when the number of observations is small. But what will it be if we have a panel of forecasts? I.e. we have 1, ..., h –step ahead forecasts for each of T periods (months, quarters, years)? Intuitively, if use all information we have, we would increase the power of tests. Using 62 panels of real-time forecasts consisting of 1, …, 6–step ahead forecasts for 89 months we show that we can't reject the null about unbiasedness for each of six individual forecast series (for six different horizons) for each of 62 forecast series while we could reject it when we use test adapted for the panel of forecasts. The rejection frequency depends on the type of test. We got the similar results for the efficiency tests.

Evaluating Qualitative Forecasts: The FOMC Minutes, 2006-2010
Herman Stekler, George Washington University; Hilary Symington, Barnard College

We present a methodology for evaluating and interpreting qualitative forecasts. The minutes of the FOMC meetings are used as a case study. This permits us to observe the forecasting process and determine the information that was used in generating the qualitative forecasts. Our results show that the FOMC examined an extensive amount of GDP and sectoral data and the indicators that usually foreshadow economic developments. Nevertheless, the FOMC did not predict the Great Recession in advance or recognize it quickly.

9:45am-11:00am RS Forecasting Inflation 1 (Room: MR3)
Chair: Roberto Duncan

Forecasting U.S. Inflation using U.C. Phillips Curve Model
Zhaokun Zhang, VU University Amsterdam; Siem Jan Koopman, VU University Amsterdam

We examine the predicting ability of different forecasting models for quarterly U.S. inflation. In particular, we consider the Phillips curve model and its extension with unobserved component. We compare the predicting ability with a set of univariate time series models. For all these models, we extend them with time-varying coefficients. Several tests are conducted to show the significance of the forecasting performance for several forecast horizons and for a rolling window evaluation. The results indicate that the unobserved component (UC) Phillips curve model produces the highest forecasting precision for U.S. inflation among the considered candidates.

Macroeconomic Monitoring and Visualizing News: US Inflation and Output Interactions in Real Time
David de Antonio Liedo, National Bank of Belgium; Jean Palate, National Bank of Belgium; Mats Maggi, National Bank of Belgium; Philippe Charles, National Bank of Belgium

This article presents the first nowcasting solution that accounts for the joint behavior of quantities and prices in real time. The model also provides an automatic interpretation of the forecasting updates for multiple horizons in terms of the unexpected part of both new data releases and revisions to past data. For instance, a worse than expected inflation release will have an impact on the forecasting updates for GDP, but the sign of that impact will depend on the remaining news too. The reason is a bad surprise in inflation data may be accounted for by a combination of positive supply shocks (e.g. oil) and demand factors.

Forecasting Local Inflation with Global Inflation: When Economic Theory Meets the Facts
Roberto Duncan, Ohio University; Enrique Martinez-Garcia, Federal Reserve Bank of Dallas

This paper provides both theoretical insight as well as empirical evidence in support of the view that inflation is largely a global phenomenon. First, we show that inflation across countries incorporates a significant common factor that can be approximated with global inflation. Second, the contribution of global inflation to local inflation depends on the structural features of the economy. Global inflation may arise from a common trend component, but it arises in the data at business cycle frequencies as well. We show that in theory a role for global inflation in local inflation dynamics emerges over the business cycle even with country-specific shocks (no common shocks), flexible exchange rates and complete international asset markets through cross-country trade spillovers. Third, we identify a very robust "error correction mechanism" that brings local inflation rates back in line with global inflation which explains the relative success of inflation forecasting models based on global inflation (e.g., Ciccarelli and Mojon (2010)). Fourth, we argue that the solution to the workhorse New Open Economy Macro (NOEM) model of Martínez-García and Wynne (2010) can be approximated by a finite-order VAR and estimated using Bayesian techniques to forecast domestic inflation incorporating all relevant linkages with the rest of the world. This NOEM-BVAR provides us with a tractable model of inflation determination that can be tested empirically in forecasting.

Finally, we use pseudo-out-of-sample forecasts to assess the NOEM-BVAR at different horizons (1 to 8 quarters ahead) across a selection of 17 OECD countries at quarterly frequency over the period 1980-2014. In general, we find that the NOEM-BVAR model produces a lower root mean squared prediction error (RMSPE) than its competitors---which include most conventional forecasting models based on domestic factors and also the recent models based on global inflation. In a number of cases, the gains in smaller RMSPEs are statistically significant.

11:15am-12:30pm Forecasting Practitioner Track 2 (Room: MR10)

Steve Morlidge, Satori Partners

Managing the Performance of a Forecasting Process
For practitioners it is important that forecasting should, like every other process, add value to the business. In this talk Steve will explain how to measure the *how much value* any forecast adds and what scope there is to improve this, mindful of the fact that some error is unavoidable. He will also describe the shortcomings of some traditional error metrics and how to overcome them and share examples of how more robust measurement systems can be used to improve the quality of forecasts.
Discussants: Aris Syntetos

11:15am-12:30pm IS Early Warnings 1 (Room: MR7)
Chair: Manfred Kremer

Characterizing the Financial Cycle: Evidence from a Frequency Domain Analysis
Till Strohsal, Freie Universität Berlin; Christian Proano, The New School of Social Research; Jürgen Wolters, Freie Universität Berlin

A growing strand of literature hypothesizes that the financial cycle is considerably longer and larger than the business cycle and that its importance is growing over time. This paper proposes an empirical approach which is suitable to test these hypotheses. We parametrically estimate the whole spectrum of financial and real variables to obtain a complete picture of their cyclical properties. We provide strong statistical evidence for the hypothesized features of the financial cycle in the US, but somewhat weaker evidence for UK data. For Germany, distinct characteristics of the financial cycle are, if at all, much less visible.

Capital Flows and Macroprudential Policies – A Multilateral Assessment of Effectiveness and Externalities
Christian Friedrich, Bank of Canada; John Beirne, European Central Bank

This paper assesses the effectiveness and associated externalities that arise when macroprudential policies (MPPs) are used to manage international capital flows. Using a sample of up to 139 countries, we examine the impact of eight different MPP measures on cross-border bank flows over the period 1999-2009. Our panel analysis takes into account the structure of the banking system as well as the presence of potential cross-country and cross-asset class spillover effects. Our results indicate that the structure of the domestic banking system matters for the effectiveness of MPPs. We specifically find that a high share of non-resident bank loans in the MPP-implementing country reduces the domestic effectiveness of most MPPs, while a high return on assets in the domestic banking system has the opposite effect. Our results on the spillover analysis indicate that both types of spillover can occur. First, we find that a high return on assets in the banking system of countries other than the MPP-implementing one leads to a reduction, and a greater degree of trade integration leads to an increase in spillovers across countries. However, the economic significance of the results suggests that only a limited number of countries will tend to experience

substantial geographical spillover effects. Second, we also find some evidence of spillover effects across asset classes within countries.

Macroeconomic effects of financial stress and the role of monetary policy: A VAR analysis for the euro area
Manfred Kremer, European Central Bank

This paper analyses an otherwise standard macro-financial VAR model for the euro area that includes - apart from conventional measures of output, inflation, and monetary policy - a composite indicator of systemic financial stress, namely the CISS index, and total assets of the ECB balance sheet. The latter variable shall capture the overall stance of the various forms of unconventional monetary policy measures taken by the ECB during the crisis in pursuit of its political mandate. I find, first, that the CISS is an important predictor for the core variables in the system, namely for output growth, monetary policy interest rates and, but less so, for inflation. This predictive ability is confirmed by standard exclusion tests, impulse response functions, forecast error variance decompositions, and by counterfactual simulations. Block exogeneity tests suggest that the predictive power remains robust against the inclusion of a broad set of real and financial control variables, thereby ruling out spurious causality of the CISS for macroeconomic developments. Second, the monetary policy rate and the ECB balance sheet growth rate are found to respond significantly to CISS shocks with the expected signs, i.e. the policy rate decreases and the balance sheet expands in reaction to an unpredicted increase in financial stress. Applying the tests of direct and indirect (Granger-)causality put forward in Hsiao (1982), I furthermore find that the monetary policy rate responds to variations in the CISS only indirectly, whereas the ECB balance sheet reacts directly. The indirect lagged reaction of the policy interest rate seems to reflect some genuine information contained in the CISS about the expected course of the economy. This pattern of direct responses of the ECB balance sheet, in combination with indirect reactions of the policy rate to variations in financial stress, may lend support to the view that the ECB's standard and non-standard monetary policies during the crisis were effectively guided by its declared "separation principle". Third, the cumulated structural policy rate shocks suggest that the stance of conventional monetary policy may have become constrained by the zero lower bound in 2013. Fourth, an expansionary stance in the ECB's conventional and unconventional monetary policy tools seems to provide some moderate support to economic activity over the medium-term, whereas no visible impact on inflation is found. In addition, an easier monetary policy stance helps calm financial stress.

11:15am-12:30pm IS Expectation Formation and Policy Implications (Room: MR3)
Chair: Xuguang (Simon) Sheng

Inflation, Information Rigidity, and the Sticky Information Phillips Curve
Cesar Carrera, Central Bank of Peru; Nelson Ramirez, Central Bank of Peru

The Great Moderation is characterized for being a stable period in terms of macroeconomic conditions, specially in inflation. In terms of the sticky information theory, this environment may provide few incentives for agents to update information on inflation and then a new slope of the sticky information Phillips curve should be observed. We estimate the degree of information rigidity implied by the sticky information Phillips curve proposed by Mankiw and Reis (2002). Using threshold models we identify regimes of high and low inflation and find that each regime is associated with a specific degree of information stickiness. We find evidence that agents update information faster when inflation is higher.

Forecaster Inattention: Measurement, Determinants and Policy Implications
Xuguang (Simon) Sheng, American University; Zidong An, American University

Using the Survey of Professional Forecasters dataset during 1968-2014, we provide direct econometric estimates of time varying inattention, defined as the common component in forecasters' inattentiveness when predicting many economic variables. Based on this measure, we find that professional forecasters

update their information sets every four months on average, and they are less inattentive in periods of recession and high economic uncertainty. Through the time varying structural vector autoregression model, we explore if inattention alters the real effect of monetary policy. Our empirical estimates show that the same sized monetary shock has larger and more persistent real effects when the degree of inattention is high. Our findings contribute to the literature on the transmission of monetary policy shocks and suggest inattention as an additional explanation why policy might become less effective during recessions.

Optimal Asset and Attention Allocation
Daniel Andrei, UCLA Anderson; Michael Hasler, University of Toronto

We consider the dynamic optimal strategy of an investor who can simultaneously manage her portfolio and acquire information about the expected returns of the risky asset. We show that the optimal level of attention to news is a hump-shaped function of expected returns and an increasing function of return variance and uncertainty. For unusually high values of variance and uncertainty, however, investment becomes too risky, resulting in a low risky asset position and therefore low attention. The same mechanism generates an inverse relationship between attention and risk aversion. Our empirical analysis lends support to the predictions of the model.

11:15am-12:30pm IS ICT&Communications 1 (Room: MR1)
Chair: Mohsen Hamoudia

Broadband Access in America: Status, Forecasts, and Politics
Lawrence Vanston, Technology Futures, Inc.

We have been forecasting broadband access in the U.S., in total and by data rate, since the early 1990s with remarkable success. These forecasts--and actual progress--have been driven by the evolution of subscriber needs for ever-increasing bandwidth and the ability of operators to deliver that bandwidth economically. Until recently, American broadband progress has occurred with a minimum of government involvement, with competitive forces being sufficient, at least for the majority of customers. This has made forecasting relatively easy since the basic principles of technology/market development have applied. However, in the last year broadband has become highly politicized in the U.S., adding a wild card to the forecasting process. In this presentation we discuss the fundamental drivers behind broadband evolution, provide our current forecasts for broadband access(including Gigabit services), and sort out the political factors at play and assess their likely effect.

Yhe Demand for Business Broadband
Paul Rappoport, Temple University; James Alleman, University of Colorado

In 2015 we take for granted that businesses require access to internet service, and that, if fast broadband were available, higher speeds would be preferred to slower speeds, ceteris paribus. Whereas the assumption to access to the internet is on firm footing, the second assumption of the preference for more speed is not as straightforward. Speed is one of many components that describe the demand for business internet access. This paper reviews the existing literature on business demand for access to the internet. The paper focuses on small and medium businesses (SME). The review seeks to identify determinants of demand (price, type of operations, degree of automation, online sales, importance of a firm's web site, collaboration and conferencing requirements and so forth) and how the internet has become an important tool for achieving growth, maintaining competitiveness and increasing efficiency. The review covers broadband adoption in the U.S. and in OECD countries. A model of broadband demand is presented that imputes the bandwidth required based on factors such as the size of the firm, the firm's industry classification and the classification of workers in the firm. Both input-output tables and industry-employment tables are used in this model. The imputed bandwidth estimate along with price is then used to as a factor in a model of broadband adoption. Broadband adoption is based on individual observations based from sources such as broadband scout.

Econometric Analysis of the Optimal Window Sequencing of Motion Picture Releases

Aniruddha Banerjee, Centris Marketing Science; Dan Freeman, Centris Marketing Science; Michael Guan, Centris Marketing Science

"Convergence" has driven the world of broadband and video (including movies and TV shows) together to form the emerging world of digital content. When digital content starts to compete with old-fashioned mechanisms for delivering video content or entertainment, a number of interesting (and even unanticipated) consequences follow. Multiple options for fulfilling demand for content are likely to increasingly drive optimization decisions for alternative mechanisms of delivery. An important case in point is the highly lucrative motion picture and entertainment industry in the US. Motion pictures (or movies) are almost always first released in theaters and then subsequently (and after an appropriate period of time) in alternative formats, such as DVD/Blu-ray, subscription-based streaming services like Netflix, Amazon Prime, or Hulu Plus, syndicated or rerun channels on television, etc. To maximize revenues from all of these formats, a movie producer or studio has to choose the optimal period of time for each and to avoid cannibalizing revenues from one format by releasing into the next format prematurely. Given the amount of money at stake, the sequence of optimal windows for all formats is an important strategic issue. Complicating this sequencing problem is the increasingly easier access to digital versions of movies and shows, which can be accessed through legitimate streaming or downloading sites or non-sanctioned file-sharing services (or "piracy" as popularly known). The role of advertising is another factor in selecting the sequence of optimal windows. This paper begins an exploration of optimal window sequencing problem. Starting with a two-format case (theaters and DVD/Blu-ray) it builds an optimization model that yields to mathematical expressions for revenue functions for the two formats. Using panel data on revenues constructed from public sources, econometric estimation of those revenue functions will yield parameter estimates which indicate the circumstances under which aggregate revenue from both formats can be maximized. These parameter estimates are expected to also depend on extraneous factors such as movie genre, advertising effort, and incidence of piracy (in digital form). The purpose of the paper will be to reveal how these factors need to be taken into account when determining the optimal window sequencing strategy for movies of various genres. An extension to multiple release formats (three or more) will also be considered.

11:15am-12:30pm IS Information use in Supply Chain Forecasting (Room: MR4)
Chair: Dilek Onkal

Information use in supply chain forecasting

Robert Fildes, Lancaster University Centre for Forecasting; Paul Goodwin, Bath University Management School; Dilek Onkal, Bilkent University

Forecasts lie at the heart of supply chain operations: production and inventory planning and scheduling, logistics, marketing and finance all rely on short-term disaggregate forecasts at SKU level. Yet there has been little research carried out into the way such forecasts are actually produced and the factors that influence their effectiveness. In contrast to the academic research literature the practitioner literature is awash with descriptions and recommendations as to how 'Sales and Operations Planning (S&OP)' processes can be used to effectively integrate cross-functional information to produce forecasts. The forecasts within S&OP are usually produced based on an initial statistical forecast which is subsequently adjusted judgmentally. After the statistical forecast is produced, the forecaster may receive information from other functional areas such as marketing and may adjust the statistical forecast to reflect this additional information. Such judgmentally adjusted predictions are then adopted as final forecasts across the supply chain, reflecting functional integration, important in the development of an effective forecasting function. But which aspects of the S&OP process lead to improved accuracy and which are counterproductive. To address this research gap in part, the aim of this presentation is to identify how forecasters respond to information that reflects the various countervailing events and trends that are expected to influence sales. Results from a number of experiments in a realistic simulation of the supply chain forecaster's task environment show various biases in how participants respond to the pieces of

information available to them, overweighting some and underweighting others. Following on from the presentation the panel will discuss future research needs and how the S&OP process could be made more effective.

The Sum and Its Parts: Judgmental Hierarchical Forecasting
Mirko Kremer, Frankfurt School of Finance and Management; Enno Siemsen, University of Minnesota; Douglas Thomas, Penn State University

Firms require demand forecasts at different levels of aggregation to support a variety of resource allocation decisions. For example, a retailer needs store-level forecasts for a particular item to manage inventory at the store but also requires a regionally-aggregated forecast for managing inventory at a distribution center. In generating an aggregate forecast, a firm can choose to make the forecast directly based on the aggregated data or indirectly by summing lower-level forecasts (i.e., bottom-up). Our study investigates the relative performance of such hierarchical forecasting processes through a behavioral lens.

We identify two judgment biases that affect the relative performance of direct and indirect forecasting approaches: a propensity for random judgment errors, and a failure to benefit from the informational value that is embedded in the correlation structure between lower-level demands. Based on these biases we characterize demand environments where one hierarchical process results in more accurate forecasts than the other. Further, using field data, we demonstrate how to estimate the relevant correlation structure of lower-level demands.

11:15am-12:30pm RS Energy Forecasting 1 (Room: MR2)
Chair: Xavier Brossat

Forecasting the impact of renewable energies in the competition with non-renewable sources
Claudia Furlan, University of Padua; Cinzia Mortarino, University of Padua

Energy provision is a crucial issue currently faced at the international level by national governments. Fossil fuels are impaired by depletion and environmental pollution. Nuclear energy is loosing its competitiveness especially in the last years, since safety costs, after Fukushima accident, have increased. Renewable energies are quite recent and, often, specific policy instruments are necessary to make them economically competitive and facilitate their adoption. Although some problems, as storage, are still to be solved, renewable energies seem to be a viable option for producing electricity in a safe and clean way. However, how feasible is this way? Which share of the non-renewable energies electricity market can they replace? The evolution of energy technologies' adoption can be studied within the approach of diffusion of innovations, since energy technology is an innovation following the definition of Rogers (1962). The diffusion of an innovation in a social system is characterized by dynamics, which usually give rise to a life cycle. The Bass model and its extensions are widely used in this contest since they take into account the main latent drivers of the evolution of a new product in a social system with interpersonal communications: first adoptions by innovators and later adoptions due to imitators. The competition starts when two or more concurrent innovations enter the market and this can push or slow the growth of all the competitors, affecting the dynamics of diffusion. Guseo and Mortarino (2014) have recently developed a model (UCRCD) based on Bass dynamics, that allows to study two competitors at time, with interpersonal communication active both within each innovation and across the two innovations. In this work, we analyzed oil, natural gas and nuclear energy as non-renewable energies, while solar and wind power as renewable energies. Data consist of annual consumptions drawn from BP company data set, which starts in 1965. The unit of measurement is Mtoe, to allow comparisons among energies. First we studied, with the UCRCD model, the competition between nuclear and renewable (wind plus solar) energies, and then between non-renewable (oil plus gas plus nuclear) and renewable energies. We considered data at the world level and also specifically pertaining to some of the big actors: the US, Europe, China. Forecasts of the evolution of the competing technologies are given for each actor, and the interpretation of parameters is performed to explain differences in the competition among the actors.

Using Surrogate Data to Mitigate the Risks of Natural Gas Forecasting on Unusual Days

Paul E. Kaefer, Marquette University; Babatunde Ishola, Marquette University
Ronald H. Brown, Marquette University; George F. Corliss, Marquette University

Energy utilities see higher risk when forecasting demand for their operating areas (service territories) on days that are high-demand or difficult to forecast. These days often have unusual weather patterns, for example, days that are much colder than normal or have a significant temperature difference from the previous day. Due to their unusual nature, historical data describing these days are scarce. We address this problem by using transformed surrogate (or analogous) data to supplement available historical data. We present a method that successfully transforms historical natural gas consumption data and temperature variables from operating areas in different geographic regions and climates, with different customer bases to an operating area we need to forecast. Data from donor areas are transformed to match characteristics of a target area using a domain-specific transformation algorithm. Data transformed in this way are scaled via a multi-dimensional model to match the target data. The transformed data then is used to build models to forecast demand in areas that have insufficient historical data or historical data that lacks data with unusual weather patterns. Models trained on historical data augmented with surrogate data deliver consistently more accurate forecasts in out-of-sample testing than models trained on historical data alone. Marquette University GasDay is qualified to work on this problem, working with about 30 energy utilities of varying sizes from different places around the United States. We use data sets from these utilities to test our surrogate data algorithms. This paper presents the method used and results from out-of-sample tests.

Multi-step estimator for covariates selection in Additive Model for forecasting portfolio of "Electricité de France " customers

Xavier Brossat, EDF/RD; Anestis Antoniadis, Université Joseph Fourier Grenoble; Jean-Michel Poggi, Université de Paris-SUD ORSAY; Yannig Goude, EDF/RD; Vincent Thouvenot, EDF/RD

For electricity providers, forecasting electricity demand is a key activity as it is one of the most important entries for production planning and trading on the electricity demand. The methods for forecasting portfolio of "Electricité de France (EDF)" customers evolved these ten last years. That is mainly with the evolution of the energy and electric context in particular. The development of unavoidable energy and in particular intermittent energy is a true challenge for the management of the production park, and crucially raises the question of global and local optimisation. The arrival of smart grids offers the possibility to pilot consumption. The changes in pricing including the valuation of interruptions as well as the evolution of usage under the current economic and environmental pressures have lead us to reexamine and refine our approach to simulate and forecast the demand. This is better known thanks to the contribution of smart meters however their arrival posses new problems in terms of treatment and of massive data management. Indeed, we have now to analyze and forecast some thousands time series, which can be influenced in different ways by different covariates. This led to an important need to develop some automatic methods of covariates selection and estimation of their effect. Here, we adopt for time prediction a semi-parametric approach based on additive models. We consider two forecast horizons, a middle term one (from few weeks to 1 year ahead) and a short term one (to next day). The middle term forecast is a fundamental task for maintenance planning and more generally risk management of electricity providers. The short term forecast is a major task for production units planning and grid management. We present an automatic procedure for covariate selection in an additive model and a method to correct middle term forecasting error for short term forecasting. The first method is obtained by a combination of two penalized regression methods: the Group LASSO estimator (which is consistent in selection) and P-Splines estimator (which is consistent in estimation). For short term correction, we use some auto-regressive models. We apply the methods on the EDF customer's consumption load demand, which is an aggregate level of load forecasting. The goal of the application is to select covariates in a large covariate dictionary. This study allowed us to check ours procedures are efficient on well-know data. We could apply our method on some local substations.

11:15am-12:30pm RS Forecasting Financial Data 1 (Room: MR8)
Chair: Angi Roesch

Predictable predictability: time-varying momentum and reversal in safe haven vs. risky assets
Valerio Poti, University College Dublin; Tom Conlon, University College Dublin

In this paper, we will extend the work initiated by Potì and Siddique (2013) aiming to further explore the role of risk capital, with special emphasis on its possible interaction with market micro-structure features, as a key driver of variation of predictability. These authors find evidence of time-varying currency mispricing as a function of the availability of risk capital, which can be seen as preliminary evidence of 'predictability of predictability'. In the proposed research paper, we will further investigate the empirical evidence on predictability of predictability for a broader set of asset classes and attempt to explain it. To do so, we will build on the model put forth by Potì and Siddique (2013), with special emphasis on the role of capital constraints and limited capital mobility in determining the magnitude and time variation of predictability, extending it so as to be able to explain the distinct components of predictability, namely momentum and reversals, and their variation over time and across assets. In this respect, the model predicts that short term momentum (reversal) strategies should be profitable during recessions (expansions) in the case of risky assets, when there is abundance (scarcity) of risk capital, and therefore scarcity (abundance) of mispricing, whereas the opposite pattern should hold in the case of 'safe heavens', because capital moves from the former to the latter over the business cycle. Using data on the S&P500 and gold, taken to represent the universe of risky assets and safe heavens, respectively, we find preliminary evidence in support of the model. In particular, we find that, during recessions, it is profitable to initiate long-run reversal strategies on the S&P and short-run momentum strategies on gold. According to our model, this is because, during recessions (expansions), risk capital flows out of risky assets (safe heavens) and into safe havens (risky assets), thus allowing the former to deviate from its efficient price while forcing the latter to converge to its efficient price. In the paper, we will test the model using a wider set of risky assets (i.e., a wider set of equity market indices, the Fama and French risk-factor mimicking portfolios, high interest rate currencies, risk arbitrage, etc.) and 'safe heavens' (including other precious metals and commodities, low interest rate currencies).

[On the Construction and Analysis of Financial Time-Series-Oriented Lexicons](#)
Chen-Yi Lai Lai, University of Taipei, Chuan-Ju Wang, University of Taipei,
Ming-Feng Tsai, University of Taipei

Informational balance, stability and systemic risk in networks of financial markets
Angi Roesch, FOM University of Applied Sciences; Harald Schmidbauer, Istanbul Bilgi University

One way to assess the degree of interaction between financial markets is to measure return-to-volatility spillovers from one market to another in terms of forecast error variance decompositions (fevds) of daily returns on their equity prices. This framework lends itself to an interpretation of financial markets as nodes in a directed network with edge weights defined by spillovers. Concepts of network connectedness carry over, and several market connectedness measures have been proposed, including an average connectedness index. From a network point of view, a shock (news) to one market triggers a cascade of perturbations changing the network's status with respect to informational balance among markets, and the question of sensitivity to shocks and stability in terms of speed of shock digestion arises. The network's spillover matrix can be translated into the transition matrix of a Markov process running forward, or backward, in time. This enables us to study entropy-related aspects of shock dynamics, leading us to an assessment of intrinsic network properties which can be subject to monitoring across time. Therewith, systemic breaks as they are happening or immediately after that become detectable, and systemic risk can be assessed on a daily basis. We consider the example of 'The Systemic Five': Dow Jones (New York), FTSE (London), sx5e (euro area), SSEC (Shanghai), and N225 (Tokyo).

11:15am-12:30pm RS Methodology (Room: MR5)
Chair: Nan Zou

Optimal estimation bandwidth for time-varying predictive regressions
Yuying Sun, University of Chinese Academy of Sciences; Yongmiao Hong, Cornell University; Shouyang Wang, University of Chinese Academy of Sciences.

While forecasting is of importance in finance, economics and government, it is far from clear how to choose the optimal sample for estimation forecasting models. When we forecast GDP in 2015, for example, should we use the last 20 years of data or the last 5 years of data? When we forecast the stock index tomorrow, how much data do we need? There is strong evidence of changes and nonlinear feature in economic and financial time series, and the earliest data irrelevant to the present data-generation process may lead biased parameter estimates and forecasts. It is obvious that the performance of forecast is greatly sensitive to the length of the sample. Besides, considering many restrictions imposed on the functional forms of parameters, this paper proposes a novel method to select the optimal bandwidth to estimate parameters by a particular nonparametric smoothing technique-local linear regression and improve the accuracy of prediction in time-varying models commensurately. The idea is to examine the trade-off between the bias and variance of forecast errors, estimate the smooth time-varying parameters by local smoothing and minimize different objective functions, such as the mean square forecast error, conditional mean square forecast error or global square forecast error, to derive optimal bandwidth. The rates and exact methods of optimal bandwidth are established under the a-mixing conditions and local stationary assumptions respectively. Simulation studies are conducted to assess the property of forecast under various types of structure changes and compare forecast performance with other methods including rolling forecast, cross validation. Specifically, the results obtained are more encouraging than the method proposed by Inoue et al. (2014). When applied to forecast US real inflation and S&P 500 stock index, the proposed method tends to improve upon conventional methods.

Test seasonal unit root with seasonal block bootstrap
Dimitris Politis, UC San Diego; **Nan Zou**, UC San Diego

When testing seasonal unit roots in a semi-parametric setting, the block bootstrap method is not directly applicable if the innovations have periodic components. In this talk we propose seasonal block bootstrap seasonal unit root test as a remedy, with illustrations of its asymptotic and finite sample behavior.

LASSO-type penalties for covariate selection and forecasting in time series
Evandro Konzen, Federal University of Rio Grande do Sul; **Flavio A Ziegelmann**, Federal University of Rio Grande do Sul

This paper studies some forms of LASSO-type penalties in time series to reduce the dimensionality of the parameter space as well as to improve the out-ofsample forecasting performance. Particularly, we propose a method which we call WLadaLASSO (Weighted Lag adaptive LASSO), which assigns not only different weights to each coefficient but also further penalizes coefficients of higher-lagged covariates. In our Monte Carlo implementation, the WLadaLASSO is superior in terms of covariate selection, parameter estimation precision and forecasting, when compared to both LASSO and adaLASSO, especially for small sample sizes and highly correlated covariates. An empirical study illustrates our approach for U.S. risk premium forecasting with good results.

1:45pm-3:00pm Feature Speaker (Room: MR1/2/3)
Chairperson: Pilar Poncela, Universidad Autonoma de Madrid

Barbara Rossi
ICREA Professor, Universitat Pompeu Fabra, Barcelona GSE and CREI, Spain

Forecasting in Unstable Environments: What Works and What Doesn't

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1:45pm-3:00pm Forecasting Practitioner Track 3 (Room: MR10)

Ram Ganeshan, D. Hillsdon Ryan Professor of Business, Raymond A. Mason School of Business, The College of William and Mary

Managing Supply Chains in a Digital Interconnected Economy
Supply chain managers face an increasingly difficult mandate. Customer preferences are constantly changing; today's supply chains are complex and global; the risks in the supply chain have become multi-faceted; and stakeholders, in addition to profits, are demanding environmental and social balance. On the other hand, the growth of the Internet, social media and web-centric software has transformed how supply chains are managed. The usual stumbling blocks of poor information availability and incompatible organizational structures are being "blown to bits" by the widespread availability of these so-called digital technologies. These technologies enable supply chain partners to engage with each other, generate new revenue streams, and improve resource efficiency. This talk will explore how the explosion of "digital" has revolutionized the management of supply chains, including the practice of forecasting. I will illustrate how web-centric software, embedded devices (including mobile), big data analytics, distributed/additive manufacturing, robotics, and similar technologies are transforming how supply chains are managed.
Discussants: John Mello, Enno Siemsen

1:45pm-3:00pm RS Health Forecasting 1 (Room: MR4)
Chair: Min Feng Deng

Spatial Heterogeneity and Asymmetric Spatial Autocorrelation
Min Feng Deng, Swinburne University of Technology

Observational similarities and important differences between spatial heterogeneity and asymmetric spatial autocorrelation are investigated via a simulated dynamic spatial panel model. The former suggests a shift in level in the spatial landscape, while the latter suggests asymmetries in spatial interactions. It will be shown that it is difficult to distinguish between spatial landscapes generated from spatial heterogeneity and those generated from asymmetric spatial autoregressive structures. Mistaking one for another could lead to significant biases in model estimates, inferior in-sample fits, and poor out-of-sample forecasts. This issue deserves considerable attention, as it affects our fundamental understanding of a spatial process. For instance, in a study of diffusion of diseases, a disease that is distributed heterogeneously due to geographically unique conditions might suggest the need for location-specific treatments of the population, while a disease that is distributed heterogeneously due to directional spatial interactions might suggest the need for targeting the specific channels through which it spreads.

Forecasting Influenza Incidence Rates of US States
Olivia Xie, University of Southern California

In this paper, we propose a spatial panel vector autoregression, which generalizes the spatial dynamic panel data models with individual fixed effects to allow for multivariate vector observations and higher order lags. The regression residuals can be independently or spatial autoregressively distributed. The model is estimated by profile QMLE. The finite sample performance of the profile QMLE is evaluated by Monte Carlo simulations. Information criteria and likelihood ratio test are used to select the lag orders and test the residual specifications. The model is then used to estimate and forecast the incidence rates of influenza-like illness (ILI) in the United States, where we combine weekly ILI incidence rate data by Google Flu Trends and the office of Centers for Disease Control and Prevention for 48 US continental states plus Washington D.C., and then we estimate the model, where the spatial weight matrix is the row normalized state geographical adjacency matrix. We find that our model can achieve very satisfactory in-sample estimates and out-of-sample forecasts based on Google Flu Trends and CDC ILI incidence rate data. We compare the estimations and forecasts of the ILI incidence rates against univariate spatial dynamic panel data model of Google Flu Trends ILI incidence rates, and we find that our model significantly outperforms the univariate spatial dynamic panel data in the in-sample estimations and out-of-sample forecasts of the ILI incidence rates. The estimated model is also used to conduct an impulse response analysis of the dynamic diffusions of California flu shock.

1:45pm-3:00pm RS Software & Teaching (Room: MR5)
Chair: Robert Nau

Spreadsheet software for forecasting from regression models
Robert Nau, Duke University

Spreadsheet software for forecasting from regression models varies widely in terms of the user interface, the detail and design of the output, and support for best practices of analysis. This talk will give a brief overview of some of the market-leading products and compare features with a free add-in, RegressIt (http://regressit.com), which was originally designed for teaching an advanced elective on forecasting at Duke University and is now publicly available and widely used.

Robust Real-Time Automated Forecast Combination in SAS
Yongchen Zhao, Towson University

This document describes the content and use of a user-written SAS R macro that performs robust real-time automated forecast combination. In addition to several standard forecast combination methods (including the Bates and Granger method), the newly developed aggregated forecast through exponential reweighting (AFTER) algorithm and a new recursive forecast combination algorithm for dependent heterogeneous data are implemented. Both the new algorithms have been found to be robust to heterogeneity and structural instability of the forecasts. An real-world example based on the U.S. Survey of Professional Forecasters is also presented in this document.

Forecasting eSchool
Nikoletta Zampeta Legaki, National Technical University of Athens; Konstantinos Nikolopoulos, Bangor Business School; Vassilis Assimakopoulos, National Technical University of Athens

Forecasting eSchool is an online destination for nascent, existing and aspiring forecasters that teaches through entertaining content. The concept behind it, is to teach the basic principles of forecasting to whoever is interested in. Forecasting skills are in high demand not only for under graduate and post graduate students but also for practitioners who deal with forecasting problems in their everyday life, without having the suitable academic background. The aim of forecasting eSchool is to attract many people around the world in order to get started with a new technology and learn study by doing. In this terms, this study present preliminary results from the application of the first game of the students in national technical

university of Athens. Forecasting courses are not offered in Business School programming because of their complexity. In addition, most forecasting exercises tend to be highly technical, decreasing students interest. However, the benefits of experiential learning, within in business education are extensively published. Considering also that, student's interest, facilitated from involvement, concentration, activation and enjoyment, was shown to relate to the level of comprehension, the gamification of forecasting educational process can enhance students' learning. Taking into account that technology is moving quicker than ever, learning basic forecasting principles can be attractive and feasible for everyone interested in, using only his own browser, through Forecasting eSchool. Forecasting eSchool is composed of three different courses. Each forecasting course is built around a creative theme and storyline so that a user feels like he is playing a game, not just sitting in a classroom. More specifically, Forecasting eSchool teaches important outcomes from milestones published researches and it will be available to host further important conclusions from researches. There are three different games, which are already designed: "Horses for Courses", "Ruled based Forecasting" and "Hierarchical Forecasting", taken their names from the respective researches. However, only the first game is in practice, during the spring semester at under graduate students, with results showing great interest of students. The effects of the game is measured and evaluated further, underlining the importance of game in forecasting education compared to traditional methods. Perspectives of the presented study are to outspread the use of gaming in forecasting teaching by creating more and more games and last but not least, to straighten out forecasting principles to a wide range of users, from practitioners to students.

3:30pm-5:10pm Forecasting Practitioner Track 4 (Room: MR10)

Michael Gilliland, Product Marketing Manager**,** SAS

Role of the Sales Force in Forecasting
 It is commonly believed that soliciting input from the sales force on customer level forecasts will improve the overall performance of a company. But this belief is based on three assumptions: that salespeople can accurately predict their customers' future buying behavior, that salespeople will provide an honest forecast to their management, and that improving customer-level forecasts improves company performance. This presentation looks at literature on the role of the sales force in forecasting (spanning over 50 years!), and finds little evidence in support of these assumptions. It examines various performance incentive systems designed to encourage honest forecasting, and shows that even if accurate customer-level forecasting were possible, it may have little impact on overall company performance.

Discussants: Simon Clarke, Robert Fildes

3:30pm-5:10pm IS Business Cycle 1 (Room: MR3)
Chair: Gian Luigi Mazzi

Using financial information flows to anticipate business cycles
Gian Luigi Mazzi, Eurostat; Laurent Ferrara, University Paris West Nanterre

In this report, we assess some financial variables, namely oil prices and stock prices, in their ability to anticipate in real-time economic cycles in the euro area. Based on previous Eurostat reports and academic papers, it seems indeed that financial variables are well related to business cycles but present a very weak dependence with growth and acceleration cycles. In this report, our aim is twofold. First, we assess whether stock and oil prices are related to the business cycle during the recent 2008-09 and 2011-13 euro area recessions and we try to integrate this information in the real-time BCCI, the Eurostat business cycle coincident indicator. Second, we evaluate whether financial flows can be useful for nowcasting the euro area real GDP growth rate by using a mixed-frequency model, recently put forward in the econometric

literature. In addition, more recent research put a lot of emphasis on financial volatility in its ability to anticipate business cycle turning points. We mainly focus on this issue in the paper.

Great Moderation and Great Recession: From plain sailing to stormy seas?
María Dolores Gadea-Rivas, Universidad de Zaragoza; Ana Gomez-Loscos, Bank of Spain; Gabriel Pérez-Quirós, Bank of Spain
Many have argued that the Great Recession of 2008 marks the end of the Great Moderation of the eighties and nineties. This paper shows this is not the case through painstaking empirical analysis of the data. Output volatility remains subdued despite the tumult created by the Great Recession. This nding has important implications for policymaking since a lower volatility of output (the hallmark of the Great Moderation) is associated with lower recoveries.

Forecasting Euro Area Recessions in real-time with a mixed-frequency Bayesian VAR
Inske Pirschel, Kiel Institute for the World Economy

In this paper I use the predictive distribution of the back-, now- and forecasts obtained with a mixed-frequency Bayesian VAR (MF-BVAR) to provide a real-time assessment of the probability of a recession in the euro area for the period from 2003 until 2013. Using a dataset that consists of 135 monthly data vintages and covers 11 soft and hard monthly indicators as well as quarterly real GDP, I show that the MF-BVAR is able to capture current economic conditions extremely well. For both recession periods in the sample, the Great Recession of 2008/2009 and the European debt crisis 2011/2013, the MF-BVAR real-time recession probabilities soar right at the onset of the pending slump of GDP growth. By contrast a BVAR estimated on quarterly data detects both recessions with a substantial delay. While typically non-linear discrete-choice or regime switching models have to be used to predict rare events such as recessions, my results indicate that the MF-BVAR can not only compete with other nowcasting approaches in terms of the accuracy of point forecasts, but also reliably detect rare events through the corresponding predictive distribution which is easily available as a by-product of the estimation procedure.

Business cycle analysis and forecasting using advanced spectral methods and data-based low-order models
Andreas Groth, University of California, Los Angeles; Dmitri Kondrashov, University of California, Los Angeles; Mickael Chekroun, University of California, Los Angeles; Michael Ghil, Ecole Normale Supérieure, Paris and University of California, Los Angeles, USA

In this talk, we present a study of U.S. business cycle dynamics based on multivariate singular spectrum analysis (M-SSA). This method provides a robust way to identify and reconstruct oscillations, even in the presence of modulation or intermittency. We show such oscillations to be associated with co-movements across the entire economy and address the problem of spurious cycles generated by the use of detrending filters. The results of this analysis help us contrast the prevailing theory of random shocks with that of endogenous dynamics. Recent findings about the macroeconomic response to natural disasters in a non-equilibrium dynamical model (NEDyM) have shown a more severe response to natural disasters during expansions than during recessions. We show by using BEA data that the behavior of the U.S. economy changes significantly from one phase of the business cycle to another: the recession phase is dominated by a five-year mode, while the expansion phase exhibits more complex dynamics, with higher-frequency modes coming into play. We conclude that the variations so identified cannot be generated by random shocks alone, as assumed in ÔrealÕ business-cycle models, and that endogenous, deterministically generated variability has to be involved. We will further demonstrate how this information on endogenous dynamics can be be put to good use in the prediction context, and discuss the application of low-order inverse empirical models to the forecasting of business cycles. We rely here on empirical model reduction (EMR), which is a data-driven methodology for constructing nonlinear, multi-layer stochastic models from partial observations. Prediction skill will be discussed in the theoretical context of NEDyM simulations and be transferred to prediction exercises on the BEA data.

3:30pm-5:10pm IS Early Warnings 2 (Room: MR1)
Chair: Tobias Knedlik

Application of systemic risk early warning indicators for macroprudential policy
Marcin Lupinski, National Bank of Poland

Subsequent waves of the financial crisis emphasised importance of the systemic risk and caused leading central banks to introduce mix of monetary and macropriudential policy to safeguard stability of their financial systems and prevent spillover of the negative effects to the real sphere of the economies. The central issue associated with introduction of the macroprudential policy was to define measures of systemic risk and develop analytical tools allowing monitoring and forecasting financial distress in a similar manner to the application of macroeconomic data projection used as an analytical background of the monetary policy. As a part of this background leading central banks, supervisors and international institutions prepared analytical dashboards based on balance sheets or market data to monitor growing tensions in the financial systems. Unfortunately a lot of these solutions applied individual time series or simple coincident indicators of balance sheets/market data and performed rather poorly in forecasting systemic risk threats. This paper is presents advanced composite systemic risk measures for Polish banking sector, that can be used not only to monitor but as well as to warn macroprudential policy decision makers about increasing systemic risk. Mentioned indicators are constructed in the way allowing to catch as much as possible complex dynamics and multiple sources of the threats to Polish banking sector stability. Three different sets of data gathered for 20 Polish banks for the period of 2009-2013 are used to create mentioned indicators: balance sheet measures, equity based market data and macroeconomic time series. Proposed early warning indicators are computed with two approaches: variation of the RAMSI model of Aikman et al. (2009) and mixed-measurment dynamic factor model (MM-DFM) of Koopman, Lucas and Schwaab (2010). Multivariate logit model is applied as a benchmark. The predictive power of constructed indicators is checked with three testers using: 1) Granger causality, 2) extreme events prediction statistics based on McFadden R-squares/Wald test p-values and 3) early break point detection algorithm. In conclusion some practical hints and advices will be given about application of computed indicators presented to decision makers in the form of heatmap dashboards for macroprudential policies.

Indicators used in the decision making for setting the counter-cyclical capital buffer
Simo Kalatie, Bank of Finland; Helinä Laakkonen, Bank of Finland; **Eero Tölö**, Bank of Finland

According to the EU legislation, the national authorities should use the principle of 'guided discretion' when setting the counter-cyclical capital buffer (CCB) that increases the banks' resilience against systemic risk associated with periods of excessive credit growth. This means that the decision should be based on the signals given by a pre-determined set of early warning indicators, but that there should also be room for discretion, as there is always uncertainty involved in the use of early warning indicators. European Systemic Risk Board (ESRB) recommends that the authorities should use the deviation of the ratio of credit-to-GDP from its long term trend (the credit-to-GDP gap) as the primary indicator when setting the CCB. In addition, designated authorities should use in their decision making indicators that measure external imbalances, private sector credit developments and debt burden, overvaluation of property prices, mispricing of risk and strength of bank balance sheets. Based on an empirical analysis with data on EU countries and a large assortment of potential indicators, we propose a set of suitable early warning indicators for each of these categories.

The impact of bank capital on economic activity – Evidence from a Mixed-Cross-Section GVAR model
Marco Gross, European Central Bank; Christoffer Kok, European Central Bank; Dawid Zochowski, European Central Bank

We develop a Mixed-Cross-Section Global Vector Autoregressive (MCS-GVAR) model for the 28 EU economies and a sample of individual banking groups to study the propagation of bank capital shocks to the macroeconomy. We conduct various simulations with the model to assess how capital ratio shocks influence bank credit supply and aggregate demand. We distinguish between \emph{contractionary} and \emph{expansionary} deleveraging scenarios and confirm the intuitive result that only when banks choose

to achieve higher capital ratios by shrinking their balance sheets economic activity would be at risk to contract. If banks raise equity capital and invest that, the real economic implications tend to be more benign. The model can be used to establish ranges of impact estimates for capital-related macroprudential policy measures, including counter-cyclical capital buffers, systemic risk buffers, G-SIB buffers, etc., also with a view to assessing the cross-country spillover effects of such policy measures. We highlight the importance for macroprudential policy makers to give clear guidance to banks as to how certain macroprudential policy measures should be implemented --- depending on what measure is considered, during which phase in the business cycle, and for what particular purpose.

Are EU scoreboard adjustments leading to better forcasts of crises?
Tobias Knedlik, Fulda University of Applied Sciences

The Macroeconomic Imbalances Procedure includes a scoreboard of economic indicators used as an early warning system. The current construction of the scoreboard includes eleven indicators, of which two allow for different thresholds for euro and non-euro countries. Elsewise, the scoreboard follows a "one size fits all" approach. While previous research has shown that a panel approach for early warning systems is often a necessity for calibration purposes, in particular in the absence of past crises in some of the countries, it has also been shown that considering country specifics makes early warning systems more accurate. The present paper illustrates the advantage of more specific early warning systems for different country groups within the European Union.

3:30pm-5:10pm IS Forecasting with Combinations and Hierarchies (Room: MR9)
Chair: Nikolaos Kourentzes

Forecasting with Temporal Hierarchies
George Athanasopoulos, Monash University; Rob J Hyndman, Monash University; Nikolaos Kourentzes, Lancaster University; Fotios Petropoulos, Cardiff University

Using information from cross-sectional time series hierarchies often results in improved forecasting accuracy across. In this paper we introduce the concept of forecasting individual time series using temporal hierarchies. Temporal hierarchies comprise the observations of the highest frequency of a time series at the bottom level (say monthly), observations of the lowest frequency at the top level (annual) and in-between frequencies in the intermediate levels of the hierarchy (say, bimonthly, quarterly, semi-annual, etc.). By forecasting each of these components individually and then combining them using hierarchical time series approaches we observe two important results. Firstly, we observe significant improvements in forecast accuracy at all levels of aggregation for the observed time series. Secondly, we generate reconciled forecasts across the different aggregation levels resulting to short, medium and long-run reconciled forecasts. We perform a detailed simulation study in order to get an in-depth understanding of the forecast improvements we observe empirically.

To combine forecasts or to combine forecast models?
Devon Barrow, Coventry University; Nikolaos Kourentzes, Lancaster University

In the 46 years since the seminal work of Bates and Granger on the combination of forecasts, research has been rather consistent in concluding both empirically and theoretically, that the combination of forecasts improves accuracy over selecting a single 'best' forecast. However, nearly all of research has focused on the combination of forecasts ignoring the obvious question which arises; what about combining the forecast models themselves. In this paper we try to answer this question: Are there benefits to be gained from the combination of individual forecast models rather than the forecasts themselves? By exploring the combination of forecast models we focus on the combination of model elements, such as parameters and components, resulting in a single forecast model as compared to multiple forecast models whose forecasts are then combined. This approach promises savings in terms of reduced computational time in producing forecasts, and simplicity and interpretability from the use of a single (combined) forecast model, while mitigating modelling uncertainty. Using the family of exponential smoothing algorithms and the ARIMA methodology, and the Bagging approach based on bootstrapping, we generated multiple forecast models

(and forecasts). We assess the impact of Bagging in terms of the diversity of forecast model structures generated and investigate the use of the mean and median combination methods in combining the resulting forecasts and forecast models using real and simulated time series.

Forecasting hierarchical time series through trace minimization

Shanika Wickramasuriya, Monash University; George Athanasopoulos, Monash University; Rob Hyndman, Monash University

Forecasts of hierarchical time series are required in many applied settings including forecasting demand in product or geographical hierarchies. It is often important that the forecasts at lower levels of the hierarchy add up exactly to the forecasts at higher levels of the hierarchy (we refer to these as aggregate consistent forecasts). The available literature in this area varies from simple methods such as bottom-up and top-down to much more statistically sophisticated methods such as combination forecasts that combine forecasts for each series in the hierarchy to make them aggregate consistent (Hyndman, Ahmed, Athanasopoulos and Shang, 2011), utilizing a Generalized Least Squares (GLS) estimator of a regression model. However, the latter needs an estimate of the variance covariance matrix of the reconciliation errors (i.e. the errors that arises due to forecasts of the series not being aggregate consistent), which is not known in practise. Therefore, approximations have been proposed based on OLS (Hyndman, Ahmed, Athanasopoulos and Shang, 2011), and weighted least squares where weights are given by the inverse of the variances of one-step ahead in-sample forecast errors (Hyndman, Lee and Wang, 2014). However, so far none of the methods have been able to obtain a feasible GLS estimator by incorporating the information of a full variance covariance structure. The ultimate goal of a set of aggregate consistent forecasts is to produce realizations that are fairly close to the true values which are yet to be observed. This paper proposes a new method of obtaining aggregate consistent forecasts through minimizing the mean squared error of the aggregate consistent forecasts across the entire hierarchy. The resulting weights matrix is identical to the GLS estimator with the variance covariance matrix given by h-step ahead independent forecast errors of the series in the whole hierarchy. We evaluate the effectiveness of the proposed method over the aforementioned methods by exploring the hierarchical nature of Australian domestic tourism data. The results show that the proposed method produces more accurate forecasts over others across the entire hierarchy.

Using Temporal Hierarchies in Practice

George Athanasopoulos, Monash University; Rob J Hyndman, Monash University
Nikolaos Kourentzes, Lancaster University; Fotios Petropoulos, Cardiff University

Temporal hierarchies is a new concept in forecasting that relies in modelling a time series at multiple temporal aggregation levels and combining the resulting forecasts. For example a time series originally sampled at a monthly frequency is modelled at bi-monthly, quarterly, semi-annually and annually temporally aggregated series. Forecasts are produced at each level, which are then optimally combined. This has advantages in terms of model identification, estimation and mitigating sampling uncertainty. It has been shown that this results in improved forecasting accuracy, especially for longer term horizons. Although improved accuracy is desirable, we argue that the most valuable advantage of temporal hierarchies comes from reconciling the short, medium and long term forecasts, which match operational, tactical and strategic decision making. Typically in practice different forecasts are produced for different planning horizons, as a single model is unable to produce accurate forecasts for all. However, these forecasts are often misaligned, crucially in terms of the projected trends, causing problems for the decisions and plans that are based on them. Temporal hierarchies align these, thus providing additional benefits to an organisation on top of improved forecasting accuracy. We demonstrate the benefits of using temporal hierarchies in forecasting using a real case study, highlighting the advantages of this new forecasting methodology for practice.

3:30pm-5:10pm IS Intermittent Demand Forecasting (Room: MR4)
Chair: Stephan Kolassa

[Forecast accuracy measures for intermittent demand](#)
Stephan Kolassa, SAP Switzerland

Recent papers have drawn attention to a puzzling fact: based on standard forecast accuracy measures like the MAD, MASE or wMAPE, a nonsensical zero forecast frequently appears to be optimal for intermittent demand time series. We will give a simple explanation for this phenomenon and argue that the MAD, MASE and wMAPE are not useful accuracy measures in forecasting intermittent demands. Instead, we argue for assessing the entire predictive distribution. To this end, we propose an adaptation of the Probability Integral Transform to work with discrete data. The proposed method is illustrated on two real datasets of 1,000 daily demands each.

Forecasting of Compound Erlang Demand
Aris Syntetos, Cardiff University; Zied Babai, Kedge Business School; Shuxin Luo, Hebei University of Science and Technology

Intermittent demand items dominate service and repair inventories in many industries and they are known to be the source of dramatic inefficiencies in the defense sector. However, research in forecasting such items has been limited. Previous work in this area has been developed upon the assumption of a Bernoulli or a Poisson demand arrival process. Nevertheless, intermittent demand patterns may often deviate from the memory-less assumption. In this work we extend analytically previous important results to model intermittent demand based on a compound Erlang process, and we provide a comprehensive categorisation scheme to be used for forecasting purposes. In a numerical investigation we assess the benefit of departing from the memory-less assumption and we provide insights into how the degree of determinism inherent in the process affects forecast accuracy. Operationalised suggestions are offered to managers and software manufacturers dealing with intermittent demand items.

[New Variants of Croston's Method](#)
Steven Prestwich, University College Cork

For forecasting intermittent demand the well-known Croston method, or one of its variants, is often applied. Unfortunately, when demand obsolescence occurs most variants continue to forecast the same nonzero demand forever. This motivated two recent variants that are designed to handle obsolescence: between demands the forecasts of the Teunter-Syntetos-Babai method decay exponentially via smoothing, while those of Hyperbolic-Exponential Smoothing decay hyperbolically via Bayesian updating. Both are unbiased on stochastic intermittent demand. I introduce a new variant called Linear-Exponential Smoothing that is also unbiased, decays linearly to zero in a finite time, performs well in experiments, and asymptotically handles obsolescence better than other methods.

On the performance of parametric and non-parametric distribution estimation methods for intermittent demand
M Zied Babai, Kedge Business School; **John E Boylan**, Lancaster University

Intermittent demand is characterised by occasional demand arrivals interspersed by time intervals during which no demand occurs. The estimation of the demand distribution of such patterns is a very important and challenging task for forecasting and stock control. In this context, parametric and non-parametric methods have been proposed in the academic literature to deal with the estimation of the cumulative distribution function as well as the percentiles of such demand patterns. With regard to non-parametric methods, two approaches have been discussed in the literature, namely aggregation and bootstrapping methods. In this paper, we analyse the performance of these methods by means of a simulation investigation. A sensitivity analysis is developed with regard to the length of the demand history and the demand lumpiness. The results allow insight to be gained on the relative performance of the estimation methods.

3:30pm-5:10pm IS Nowcasting 1 (Room: MR2)
Chair: Edward Knotek

Conditional Forecasting Using Nowcasts of Financial Variables in Vector Autoregressions
Edward Knotek, Federal Reserve Bank of Cleveland; Saeed Zaman, Federal Reserve Bank of Cleveland

A body of research has documented that the inclusion of financial variables assists in forecasting macroeconomic indicators, while recent research has shown that the inclusion of good nowcasts of those macroeconomic indicators can also improve forecast accuracy. This paper considers the role of good nowcasts of financial variables in making conditional forecasts of real and nominal macroeconomic indicators in the context of standard quarterly Bayesian vector autoregressions (BVARs). We show that the average of the daily observed values of a financial variable to any point within a quarter constitutes an optimal nowcast. Based on real-time, out-of-sample forecasting exercises, we find that the inclusion of nowcasts of financial variables by themselves leads to gains in forecast accuracy for inflation and unemployment relative to unconditional forecasts. Incorporating financial nowcasts on top of nowcasts of real and nominal variables generally helps improve the forecast accuracy for both sets of macroeconomic indicators, beyond including only the real and nominal nowcasts alone. These results are strongest when our evaluation period includes the Great Recession. Conditional forecasts generated from our quarterly BVARs augmented with nowcasts of key financial, real, and nominal variables rival the forecast accuracy of mixed-frequency VARs (MF-VARs) and mixed-data sampling (MIDAS) models that can explicitly incorporate the high-frequency characteristics of financial data.

A financial conditions index using targeted data reduction
George Kapetanios, QMUL; **Simon Price**, Bank of England and City University London; Garry Young, Bank of England

Financial conditions indices (FCIs) aim to summarise the state of financial markets. In principle they differ from the related monetary conditions indices by being composed of real variables (e.g. spreads rather than levels of rates). We construct two types of measure using UK data. One is relatively standard, a principal component (PC) of a medium sized set of relevant financial (and, following the literature, some monetary) indicators. Our proposed alternative is new, taking information from a large set of macroeconomic variables weighted by the joint covariance with subsets of financial indicators, using multiple partial least squares (MPLS). Thus unlike standard FCIs which weight specific financial variables together by some means, our approach aims to weight latent factors from a macroeconomic data set using information from financial variables. These two contrasting methods give impressions of financial market tightness which are similar but differ in detail. Both are useful for forecasting monthly GDP in a quasi-real-time evaluation performed over three years to 2014, but the MPLS based FCIs are superior to that based on the PC. Both outperform the Goldman Sachs FCI by a substantial margin. A MPLS FCI emphasising private spreads is the best overall performer, and is particularly good at low forecast horizons. We also use the MPLS FCI to identify credit supply shocks in a monthly VAR, where the main effects relative to one excluding it are to make the initial impact of a credit shock on output growth unambiguously negative, to reduce lending and to reveal an increased uniformly positive impact on spreads.

Asymmetric Forecast Densities for U.S. Macroeconomic Variables from a Gaussian Copula Model of Cross-Sectional and Serial Dependence
Michael Smith, University of Melbourne; Shaun Vahey, University of Warwick

Most existing reduced-form macroeconomic multivariate time series models employ elliptical disturbances, so that the forecast densities produced are symmetric. In this paper, we use a copula model with asymmetric margins to produce forecast densities with the scope for severe departures from symmetry. Empirical and skew t distributions are employed for the margins, and a high-dimensional Gaussian copula is used to jointly capture cross-sectional and (multivariate) serial dependence. The copula parameter matrix is given by the correlation matrix of a latent stationary and Markov vector autoregression (VAR). We show that the likelihood can be evaluated efficiently using the unique partial correlations, and estimate the copula

using Bayesian methods. We examine the forecasting performance of the model for four U.S. macroeconomic variables between 1975:Q1 and 2011:Q2 using quarterly real-time data. We find that the point and density forecasts from the copula model are competitive with those from a Bayesian VAR. We show that during the recent recession the forecast densities exhibit substantial asymmetry, and that this avoids some of the pitfalls of the symmetric forecast densities of the Bayesian VAR. The asymmetries in the predictive distributions of GDP growth and inflation are similar to those found in the probabilistic forecasts from the Survey of Professional Forecasters. Last, we find that unlike the linear VAR model, our Gaussian copula model can capture nonlinear dependence between U.S. macroeconomic variables.

Density forecasting in the presence of rare shocks and non-linearities
Michal Franta, Czech National Bank

One of the responses of economic research to the Great Recession consists of a thorough examination of shock distributions assumed in macroeconomic models. The attention has shifted towards error distributions with fat tails. Another stream of the research revived by the Crisis focuses on non-linearities in economic relationships – the prominent example being the interaction between financial markets and the real economy. The paper sheds some light on the respective roles of non-linearities and fat-tailed error distributions in density forecasting. More precisely, based on US data a threshold VAR with reduced form errors distributed according to the Student's t-distribution is estimated and accuracy of resulting density forecasts is assessed. Density forecasts are compared with a linear version of the model and with a version assuming normally distributed errors.

3:30pm-5:10pm RS Forecasting Crisis and Recessions (Room: MR5)
Chair: Ullrich Heilemann

Accurate Forecast, Wrong Message: Could The Start Of The 2008-9 Recession In Germany Have Been Foreseen?
Ullrich Heilemann, Universität Leipzig; Susanne Schnorr-Bäcker, Federal Statistical Office

This paper examines the start of the Great Recession 2008-9 in Germany. It asks "whether or not the data that were available in real time were clearly signaling a turn that was neither predicted in advance nor identified contemporaneously" (Fintzen, Stekler 1999, p. 310). The forecasters investigated includes those by 13 major national and international institutions published between April and December 2008; the "data available" were official statistics for Germany and for the European Union region, major surveys, and indicators. The results show that the forecasts for 2008 were rather accurate by historical standards, but did not signal the possibility or the probability of a recession. They confirmed the recession only when the economy was already in it. Data had early sent a number of warnings but the reaction of the forecasters to them had been hesitant or reluctant. The data available to forecasters were not ambiguous or misleading with one exception, nor were there meaningful revisions. The results do not allow for generalizations but so far it seems that since 60 years German forecasters have a low prior to predict recessions.

Forecasting DSGE economies during a recession using a state space setting with skewed shocks
Grzegorz Koloch, Warsaw School of Economics

Our paper provides explicit formulae (similar to the Kalman filter procedure) for the likelihood function, filtration densities and prediction densities for a linear state space model in which shocks are allowed to be skewed. In particular, we work with a so called closed skew normal distribution, introduced by Genton (2004), which nests a normal distribution as a special case. Closure of the distribution with respect to all necessary transformations in the state space setting is guaranteed by a simple regularization procedure which does not affect the value of the likelihood function. Presented formulae allow for estimation, filtration and prediction of such models as vector autoregressions and first order perturbations of DSGE economies, in which shocks are allowed to be skewed. The outlined approach allows for assessment of asymmetries in observed data, shocks, impulse responses and confidence intervals of forecasts. Advantages of allowing shocks to follow a skewed distribution involve capturing asymmetric inflation risks in central banks forecasts (and fan-charts) and producing more plausible probabilities of deep but rare recessionary

episodes with DSGE/VAR filtration and forecasting. As an empirical application, we produce forecasts from a medium size DSGE model, Schorfheide (2000), during the period of the recent financial crisis and confront these forecasts with the ones obtained from a normal-distribution based DSGE model (i.e. from the same model in which skewness is fixed to be zero). We discuss how parameter estimates change when skewed shocks are allowed for and we show how estimates of shock's skewness parameters, and therefore the sampling distribution of shocks, evolve over time during the recession. Incorporation of skewness improves forecasting properties of the DSGE model during the downturn, since momentum in skewness helps to produce a series of shocks with the same sign (negative ones), which accumulate to a more pronounced deviation from the model's steady state equilibrium without the necessity of assuming that shocks which occurred were extremely improbably far from their mean value.

Predicting Recessions: Does a Wishful Bias Exist?
Sergey Smirnov, Higher School of Economics; Daria Avdeeva, Higher School of Economics

There is evidence in the economic literature that near cyclical peaks an optimistic bias exists in private expert forecasts of real GDP growth rates. Other evidence concerns differences in the accuracy of GDP forecasts made during expansions and those made during contractions. It has also been hypothesized that a wishful bias may hamper the ability to recognize the beginning of a recession in real-time. We tested consensus forecasts of quarterly GDP growth rates taken from SPFs conducted by PhilFed and found that they may be seen as unbiased only for time horizons j=0,1,2; for greater horizons they are over-optimistic. This over-optimism may also be observed for (j=1, 2) for forecasts made at peaks (at these moments the consensus usually points only to a slowdown of the economy but not to a contraction). Lastly, over-optimism may be observed for nowcasts (j=0) during cyclical contractions, including the first two quarters of a recession (in these cases the reality is usually worse than expected). Taken together, all these facts mean that some aversion to predicting US recessions exists. There are two possible reasons for this: a) experts rely too heavily on extrapolations (then changes in medium-long tendencies would be missed in real time); b) there is a wishful bias in forecasts against predicting recessions (this reluctance may be rooted in psychological factors). We give some arguments in favor of the thesis that the second factor is more important.

Heterogeneous Agents, the Financial Crisis and Exchange Rate Predictability
Daniel Buncic, University of St. Gallen; Donat Piras, University of St. Gallen

We construct an empirical heterogeneous agent model which optimally combines forecasts from fundamentalist and chartists agents and evaluate its out-of-sample forecast performance using daily date covering the period from January 1999 to June 2014 for six of the most widely traded currencies. We use daily financial data such as level, slope and curvature yield curve factors, equity prices, as well as risk aversion and global trade activity measures in the fundamentalist agent's predictor set to obtain a proxy the market's view on the state of the macroeconomy. Chartist agents rely upon standard momentum, moving average and relative strength index indicators in their predictor set. The individual agent specific forecasts are computed using the recently proposed flexible dynamic model averaging framework and are then aggregated into a model combined forecast using a forecast combination regression. We show that our empirical heterogeneous agent model produces statistically significant and sizable forecast improvements over the standard random walk benchmark, reaching out-of-sample R^2 values of 1.41, 1.07, 0.99 and 0.74 percent at the daily one-step ahead horizon for 4 out of the 6 currencies that we consider. Forecast gains remain significant for horizons up to three-days ahead. We show further that for 5 out of the 6 currencies, a substantial part of the forecast gains are realised over the September 2008 to February 2009 period, that is, around the time of the Lehman Brothers collapse. The time series evolution of the dynamic model combination weights shows that for the first half of the out-of-sample evaluation period, fundamentalist agents dominated the combination forecasts, while the last third of the out-of-sample period was driven by chartist agents.

3:30pm-5:10pm RS Forecasting VaR and ES (Room: MR8)
Chair: James W. Taylor

Predicting the expected shortfall corresponding to value at risk forecasts produced by quantile models

James W. Taylor, University of Oxford

Value at risk (VaR) is widely used as a measure of financial market risk. One approach to VaR forecasting is to model directly the conditional quantile for a chosen probability level. This is the approach taken with conditional autoregressive VaR models, which are estimated using quantile regression. Directly modelling a quantile avoids the need for a distributional assumption, and allows the dynamics of a quantile to differ for each probability level. However, by focussing on a particular quantile, such approaches provide no information regarding the magnitude of the exceedances beyond the quantile. The conditional expectation of these exceedances is the expected shortfall (ES), which is a measure of market risk that is receiving increasing attention. In this paper, we introduce a method for predicting the ES corresponding to the VaR forecasts produced by quantile models. The method enables the joint modelling of the VaR and ES, with parameters estimated using maximum likelihood based on an asymmetric Laplace density. This estimation approach has been shown to be equivalent to quantile regression. We present an empirical study using daily stock indices.

Asymmetry and Extreme Value in Gold and General Financial Markets

Junmao Chiu, Yuan Ze University; **Chih-Chiang Wu**, Yuan Ze University; Wen-Chin Shih, Yuan Ze University

Gold is widely perceived as a good diversification or safe haven tool for general financial markets. To fully understand the potential, this paper proposes a range-based volatility model with skewed-t copula to investigate the joint distribution and dynamics of gold, stock and bond markets. We find the strikingly explanatory ability to volatility structures provided by the price range information and the significant evidence of asymmetric tail dependence across gold, stock and bond markets. We implement an asset-allocation strategy, which takes into account higher-order moments and nonlinear dependence, to explore their economic importance. The results show that between 54 and 652 basis points and between 28 and 340 basis points are earned annually when acknowledging the price range information and asymmetric dependence, respectively.

Predicting Market Risk with Combinations of GARCH-Type Models

David Ardia, Laval University; **Jeremy Kolly**, Laval University

We study the impact of parameter and model uncertainty on financial risk measures. To this end, we evaluate the predictive performance of several GARCH-type models estimated via Bayesian and maximum likelihood (ML) techniques. In addition to individual models, several combination methods proposed in the literature are considered (e.g. optimal pooling and censored optimal pooling). For log-returns of stocks in the Dow Jones 30 index universe, we find that combination weights exhibit a common dynamics across time series and that integrating the parameter uncertainty tends to reduce weights' volatility across series. For Value-at-Risk estimates, integrating out the parameter uncertainty does not seem to have an impact on the model performance. Individual GJR and exponential GARCH models, together with linear pool with uncensored optimal weights frequently outperform other models/combinations. No discrimination is obtained for the Expected Shortfall.

Expected Shortfall or VaR, the Basel III Dilemma. A Stochastic Dominance Approach

Chia-Lin Chang, National Chung Hsing University; **Juan-Angel Jimenez-Martin**, Complutense University of Madrid; Esfandiar Maasoumi, Emory University; Teodosio Perez-Amaral, Complutense University of Madrid

The Basel III Accord requires that banks and other Authorized Deposit-taking Institutions (ADIs) communicate their daily risk forecasts to the appropriate monetary authorities at the beginning of each

trading day, using one of a range of alternative risk models to forecast Value-at-Risk (VaR). The risk estimates from these models are used to determine the daily capital charges (DCC) and associated capital costs of ADIs, depending in part on the number of previous violations, whereby realized losses exceed the estimated VaR. Recently, the Basel Committee on Banking Supervision (BCBS) has published a consultative document which presents the Basel Committee's initial proposals with regards to trading book capital requirement policies. A key element of the proposal is moving the quantitative risk metrics system from VaR to expected shortfall (ES). The Basel Committee pointed that "a number of weaknesses have been identified with using value-at-risk (VaR) for determining regulatory capital requirements, including its inability to capture tail risk." For this reason, the Committee considered using expected shortfall (ES), which is a coherent risk measure and has already become common in the insurance industry, though not in the banking industry. Although ES is mathematically superior to VaR, its practical implementation and large calculation requirements pose operational challenges to financial firms. Here we show that ES is computationally feasible with common software and usual personal computers. We also find that ES gives different answers to VaR and is found to be preferred to VaR in common situations using simulations based on S&P500.

3:30pm-5:10pm RS Survey Data (Room: MR7)
Chair: Olga Bespalova

Evaluating the ECB's Survey of Professional Forecasters Under Asymmetric Loss and Higher Moments
Julian Hoss, Darmstadt University of Technology

Since Elliott, Komunjer and Timmermann (2005, 2008), the idea of evaluating forecasts by backing out the form parameters from a family of loss functions and simultaneously testing for the forecasts' rationality has been widely applied. For example, Krüger and Hoss (2012) used the approach on German business cycle forecasts to measure the efficient use of the information contained in financial variables. While EKT's approach allows for asymmetry of the loss function and nests the symmetric cases of the MAE and the MSE, it concentrates exclusively on the first moment of the forecast errors. In the spirit of EKT's approach, we expand the loss function to include higher moments and evaluate how this changes the form of the loss function. The prevalent procedures for conducting such expansions are the Taylor series expansion, which Jondeau and Rockinger (2006) applied to utility functions to maximize portfolio allocations' expected end-of-period wealth, and the exploitation of a Gram-Charlier distribution of the variable of interest, as suggested by Christodoulakis (2005) in the context of optimality of financial forecasts. These approaches require the loss function to be differentiable as many times as the number of moments included, which rules out the family of lin-lin and quad-quad loss used by EKT. The functions used here are the linex loss function, introduced by Varian (1974), and a modified version of the linex loss function proposed by the author. Apart from being sufficiently differentiable, the former exhibits the desirable property of nesting quadratic loss when the shape parameter converges to zero, while the latter has a symmetric special case. The approach presented in this paper is applied to the quarterly business cycle forecasts obtained from the ECB's survey of professional forecasters, where the sample moments are calculated using the variables of interest over the last three years known to the forecasters. Alternatively, to reduce the high weight of past observations, the moments are calculated using cross sectional forecast errors of the individual forecasters and exponential smoothing. First results obtained indicate that: (1) the forecasters' loss functions are rather asymmetric, (2) the direction of asymmetry is more conclusive for inflation and GDP growth forecasts compared to unemployment forecasts, (3) with respect to past forecast errors, the forecasts are predominantly rational, (4) up to four moments are relevant to the form of the loss function, (5) including higher moments reduces the degree of asymmetry in the loss function.

Getting a New Angle on Rationality of SPF Individual Forecasters
Victoria Petrenko, Gaidar Institute for Economic Policy

This paper examines the rationality of individual Survey of Professional Forecasters participants using rationality test for multiple forecast horizons. We derived rationality test for multiple horizons under assumption that forecaster's loss function is similar to one proposed in Elliott, Komunjer and Timmermann

(2005) but allowing the asymmetry parameter vary over forecast horizons. For the majority of forecasters under consideration our assumption of time-varying asymmetry parameter is crucial. Moreover, symmetric loss function specification is not appropriate for a large part of SPF participants. Besides, we find interconnection between the forecast accuracy and forecaster rationality. Rational forecasters tend to submit more precise projections of CPI inflation rate than SPF median forecast. This is true for all forecast horizons except for the current quarter projection. In addition, the distribution of loss function asymmetry parameters for different forecast horizons is studied. Forecasters tend to have symmetric loss function for nowcasting. However, the asymmetry parameter distribution across forecasters becomes bimodal with the increase in the forecast horizon. The asymmetry parameter distribution is shifted to the left for those forecasters who predict more accurately than the median SPF forecast. Those forecasters whose projections statistically do not differ from the median forecast have an asymmetry parameter distribution shifted to the right. The results are similar for different actual data vintage and both for linear and quadratic loss functions.

Re Banks Forward-Looking in their Loan Loss Provisioning? Evidence from Senior Loan Officer Opinion Survey (SLOOS)
Saeed Zaman, Federal Reserve Bank of Cleveland; Lakshmi Balasubramanyan, Federal Reserve Bank of Cleveland; James Thomson, University of Akron

Our paper makes a fundamental contribution by studying loan loss provisioning over the credit cycle as three distinct phases. Looking at the three distinct phases of the financial crisis – the precrisis period, crisis period, and post crisis period – is important as loan loss provisioning is driven by different factors in each, in part due to extensive shifts in (or in the application of) regulatory rule. We show evidence of forward-looking loan loss provisioning by utilizing Senior Loan Officer Opinion Surveys (SLOOS) which provide useful controls for credit cycle information. Though the SLOOS dataset is a restricted sample and generalizability to a broader sample could potentially be a stretch, we control for credit cycle factors as part of an identification strategy to sort out changes in the credit market equilibrium. We contribute to the growing literature on forward-looking loan loss provisioning and early in the cycle loss recognition by incorporating a broader range of available credit information.

Qualitative survey-based forecasts: evaluating directional accuracy using the ROC curves analysis and measuring macroeconomic uncertainty (World Economic Survey of the U.S. economy).
Olga Bespalova, The George Washington University

In this paper I contribute to the theory and practice of the evaluation of the directional accuracy of the qualitative survey-based consensus forecasts in several aspects. The empirical example in this paper uses the Center for Economic Studies Ifo Institute World Economic Survey (further - WES) survey forecasts for the U.S. economy performed in 1989:Q1 to 2014:Q2. First, I use a novel method of the Receiver Operating Characteristic (further - ROC) curves analysis to compare a variety of rules and thresholds that survey users can employ to interpret the qualitative survey results. I show that the conclusion obtained by the survey end users will highly depend on their choice of threshold, forecasting rule, and symmetry assumptions. I use the ROC curves and their derivatives to analyze the usefulness of the WES directional forecasts of the US economy, and conclude on how the WES should be interpreted to maximize its predictive power. Second, I suggest a method to measure uncertainty coming from the disagreement between the experts when the survey results are presented only as the weighted average consensus value score. I derive the proposed measure of macroeconomic uncertainty based on the WES responses about the U.S. economy, and show its correlation with the other known uncertainty measures. While this paper focuses on the survey results assuming three categories of responses, the methodology can be extended to higher number of categories.

Tuesday, 23 June

8:30am - 9:40am
Keynote Session II (Room: RC)

Dimitris N. Politis

Professor of Mathematics, University of California, San Diego, USA

Model-free Prediction and Regression: a Transformation-based Approach to Inference

Prediction has been traditionally approached via a model-based paradigm, i.e., (a) fit a model to the data at hand, and (b) use the fitted model to extrapolate/predict future data. Due to both mathematical and computational constraints, 20th century statistical practice focused mostly on parametric models. Fortunately, with the advent of widely accessible powerful computing in the late 1970s, computerintensive methods such as the bootstrap and cross-validation freed practitioners from the limitations of parametric models, and paved the way towards the `big data' era of the 21st century. Nonetheless, there is a further step one may take, namely going beyond even nonparametric models. The Model-Free Prediction Principle is based on the simple notion of transforming a complex dataset to one that is easier to work with, e.g., i.i.d. or Gaussian. As such, it restores the emphasis on observable quantities, i.e., current and future data, as opposed to unobservable model parameters and estimates thereof. Coupled with resampling, the Model-Free Prediction Principle further allows us to go beyond point prediction in order to construct frequentist prediction intervals without resort to unrealistic assumptions such as normality. Interestingly, being able to predict a response variable Y associated with a regressor variable X taking on any possible value seems to inadvertently also achieve the main goal of modeling, i.e., trying to describe how Y depends on X. Hence, as prediction can be treated as a by-product of model fitting, key estimation problems can be addressed as a by-product of being able to perform prediction. In other words, a practitioner can use Model-Free Prediction ideas in order to additionally obtain point estimates and confidence intervals for relevant parameters leading to an alternative, transformation-based approach to statistical inference.

9:45am-11:00am Forecasting Practitioner Track 5 (Room: MR10)

Simon Clarke, Group Director of Forecasting, Coca-Cola Refreshments

Creating and Sustaining a Collaborative Forecasting Process
Building and sustaining a collaborative forecasting process requires clear decisions to be made that are often not clear. Based on practical experience, this session will give forecasters a clear understanding of the most important topics to focus on and alternatives to consider.

Discussant: Steve Morlidge

9:45am-11:00am IS Density Forecasting of Macroeconomic Variables (Room: MR3)
Chair: Ana Galvao

A comprehensive evaluation of macroeconomic forecasting methods

Ana Galvao, University of Warwick; Andrea Carriero, Queen Mary University of London; George Kapetanios, Queen Mary University of London

Our forecasting evaluation compares the forecasting performance of four state-of-art multivariate forecasting models: Factor-Augmented Distributed Lag (FADL) Models, Mixed Data Sampling (MIDAS) Models, Bayesian Vector Autoregressive (BVAR) Models and a medium-sized Dynamic Stochastic General Equilibrium Model (DSGE). We look at these models to predict output growth and inflation. Our evaluation considers not only relative point forecasting performance, but also measures of the relative accuracy of density forecasts. We use data from seven countries: US, UK, Euro Area, Germany, France, Italy and Japan. We assess the importance of employing large datasets in comparison with medium-sized ones in macroeconomic forecasting by exploiting three statistical forecasting models adequate to large dimension datasets (Factor, BVAR and MIDAS). Our results suggest that the rank of forecasting models depends on the loss function, that is, ranks based on root mean squared forecast errors differ from the ones based logarithm scores. Structural models (medium-sized DSGE models) improve long-horizon density forecasts of inflation in comparison with reduced-form models. The use of monthly indicators improves the accuracy of current quarter forecasts (nowcasts) for both output growth and inflation. There are only limited gains from using large datasets (100-150 indicators) instead of medium-sized (14 indicators) datasets for both macroeconomic variables considered. There is very limited support to the claim that we can use the same multivariate forecasting model (either a BVAR or a DSGE) to provide accurate forecasts of both output growth and inflation.

Using Entropic Tilting to Combine BVAR Forecasts with External Nowcasts

Fabian Krueger, Heidelberg Institute for Theoretical Studies; **Todd Clark**, Federal Reserve Bank of Cleveland; Francesco Ravazzolo, Norges Bank and BI Norwegian Business School

This paper shows entropic tilting to be a flexible and powerful tool for combining medium-term forecasts from BVARs with short-term forecasts from other sources (nowcasts from either surveys or other models). Tilting systematically improves the accuracy of both point and density forecasts, and tilting the BVAR forecasts based on nowcast means and variances yields slightly greater gains in density accuracy than does just tilting based on the nowcast means. Hence entropic tilting can offer --- more so for persistent variables than not-persistent variables --- some benefits for accurately estimating the uncertainty of multi-step forecasts that incorporate nowcast information.

Nowcasting Business Cycles: a Bayesian Approach to Dynamic Heterogeneous Factor Models

Michele Modugno, Federal Reserve Board; Antonello D'Agostino, European Stability Mechanism; Domenico Giannone, Federal Reserve Bank of New York; Michele Lenza, European Central Bank

We develop a framework for measuring and monitoring business cycles in real time. Following a long tradition in macroeconometrics, inference is based on a variety of indicators of economic activity, treated as imperfect measures of an underlying index of business cycle conditions. We extend existing approaches by permitting for heterogenous lead-lag patterns of the various indicators along the business cycles. The framework is well suited for high-frequency monitoring of current economic conditions in real time - nowcasting - since inference can be conducted in presence of mixed frequency data and irregular patterns of data availability. Our assessment of the underlying index of business cycle conditions is accurate and more timely than popular alternatives, including the Chicago Fed National Activity Index (CFNAI). A formal real-time forecasting evaluation shows that the framework produces well-calibrated probability nowcasts that resemble the consensus assessment of the Survey of Professional Forecasters.

9:45am-11:00am IS ICT&Communications 2 (Room: MR1)
Chair: Mohsen Hamoudia

More Powerful Tests of Predictive Accuracy with an Application to Predictions of Economic Growth Based on Broadband Infrastructure for OECD Countries

Xin Dang, University of Mississippi; Walter Mayer, University of Mississippi; Gary Madden, Curtin University

This paper investigates whether predictions of future economic growth can be improved by using standard measures of broadband infrastructure. The investigation is carried out by comparing the predictive accuracy of dynamic panel models of economic growth estimated with and without measures of broadband infrastructure. Tests of predictive accuracy are employed to test the hypothesis that measures of broadband infrastructure can improve predictions of GDP growth after controlling for standard growth determinants.

A Different Approach to Deriving Price and Income Elasticities: Applications to Telecommunications and Gasoline & Motor Oil
Lester D. Taylor, University of Arizona

The primary purpose of the present communication has been to demonstrate how a framework developed from data embodied in surveys of households' consumer expenditures can be used to calculate complete arrays of own- and cross-price elasticities. The procedure is illustrated for simulated changes of ±10% in the price of telecommunications and for ±50% and -50% /+75% changes in the price of gasoline & motor oil. The engine for the analysis, whose construction is described in detail in Taylor (2013), is a matrix of "intra-budget" coefficients that represent the direct relationships amongst the different categories of expenditure in households' budgets. In the present exercise, the elements of this matrix, for 18 categories of expenditure, are constructed from the information in 28 quarters of data (2006 through 2012) from the ongoing BLS Survey of Consumer Expenditure, and are defined as the mean values over the 28 quarters of data of the sets. A strength of the framework is that price changes can be translated immediately into real-income effects, which in turn allows for straightforward separation of income and substitution effects. Indeed, the only conceptual difference between income and substitution effects in this framework and in the traditional Hicks-Allen setting is that compensation for the real-income effect is with respect to the budget constraint rather than with respect to the original indifference surface. Also, an interesting empirical result of the present exercise is the appearance of apparent "Giffen" goods in unexpected places, that is, of positive own-price elasticities. In the conventional theory of consumer behavior, Giffen goods can arise only in the context of inferior goods (i.e., goods that have a negative income elasticity) which account for a significant share of total expenditure. By this criteria, one would accordingly not expect telecommunications and gasoline & oil to qualify. However, when feedbacks from the effects on other categories of expenditure taken into account, own-price elasticities that, ceteris paribus, are negative can switch to positive.

Forecasting cpu demand in cloud computing services
Harald Schmidbauer, Istanbul Bilgi University; Angi Roesch, FOM University of Applied Sciences

Providers of cloud computation services may save costs by dynamically scaling hardware resources allocated to servers. This requires forecasting the demand for CPUs (and other hardware components). The superposition of different user demand profiles may result in complex intra-day, daily, and weekly demand intensity patterns, which need not be constant over time. A forecast should capture the overall structure of expected demand as well as react to deviations from it observed in real time. Forecasting accuracy needs to be evaluated in intervals, owing to the discrete nature of CPUs provided. Wavelets are a promising tool in such a situation. We have developed "WaveletComp", a software package within the R project under the GPL license, providing the special functionality useful for forecasting (for example, ridge extraction of the wavelet power spectrum). Examples using data from a cloud service provider demonstrate the accuracy of a wavelet-based forecasting approach in this field.

9:45am-11:00am IS Inflation (Room: MR5)
Chair: Gian Luigi Mazzi

Quantile-based density forecasts of Euro Area inflation using output gap estimates
James Mitchell, Warwick University

This paper seeks to understand whether output gap estimates offer greater predictive power for inflation if one acknowledges uncertainty about whether the output gap relates to mean inflation or another quantile. For example, it is possible that the output gap does not help explain the mean value of inflation, as captured by ordinary linear regression, but explains extreme values of inflation (in the tails of the inflation density). This paper therefore uses quantile regression methods to construct density forecasts for inflation. It therefore looks for a nonlinear relationship between the output gap and inflation. An application to the Euro Area tests whether we can better explain movements in inflation if we acknowledge this potential nonlinearity and construct density forecasts from quantile regressions. The results are encouraging, suggesting that quantile regression offers a more flexible and accurate means of constructing density forecasts than just assuming Gaussianity. However, relative to a quantile autoregression conditioning on the output gap does not deliver better calibrated density forecasts on an out-of-sample basis. This is despite the clear in-sample evidence that the output gap better explains inflation when inflation is high.

Inflation forecasts: Are market-based and survey-based measures informative?
Magdalena Grothe, European Central Bank; **Aidan Meyler**, European Central Bank

This paper analyses the predictive power of market-based and survey-based inflation expectations for actual inflation. We use the data on inflation swaps and the forecasts from the Survey of Professional Forecasters for the euro area and United States. The results show that both, market-based and survey-based measures have a non-negligible predictive power for inflation developments, as compared to statistical benchmark models. Therefore, for horizons of one and two years ahead, market-based and survey-based inflation expectations actually convey information on future inflation developments.

A Closer Look at the Phillips Curve Using State-Level Data
Anil Kumar, Federal Reserve Bank of Dallas; Pia Orrenius, Federal Reserve Bank of Dallas

Studies that estimate the Phillips curve for the U.S. use mainly national-level data and find mixed evidence of nonlinearity, with some recent studies either rejecting nonlinearity or estimating only modest convexity. In addition, most studies do not make a distinction between the relative impacts of short-term vs. long-term unemployment on wage inflation. Using state-level data from 1982 to 2013, we find strong evidence that the wage-price Phillips curve is nonlinear and convex; declines in the unemployment rate below the average unemployment rate exert significantly higher wage pressure than changes in the unemployment rate above the historical average. We also find that the short-term unemployment rate has a strong relationship with both average and median wage growth, while the long-term unemployment rate appears to only influence median wage growth.

9:45am-11:00am RS Demand Forecasting 1 (Room: MR4)
Chair: Huijing Chen

Integrating End Uses of Water into Demand Forecasting: Case Study
Ram Chandra Sarker, Swinburne University of Technology; Shirley Gato-Trinidad, Swinburne University of Technology

An integrated water demand model has been developed for Greater Melbourne. This model integrates end uses of water, population in terms of household statistics and climate factors such as temperature and rainfall. Water consumption data for Greater Melbourne from Yarra Valley Water, Australia, and daily rainfall and daily temperature from Bureau of Meteorology, Australia (BOM Station# 086071) from January 1, 1997 to December 31, 2007 has been used in developing this model. The model comprises of

three components such as base use, (ii) potential seasonal use, and (iii) short-memory use. Base use was modelled using end uses of water, potential water using heat function, and short-memory use using transfer function noise model and ARIMA model. Then these three components were integrated to obtain the total water demand. The model was validated using dataset from January 1, 2008 to December 31, 2009. The result shows that end uses of water can be integrated to total water demand with R2=0.52. Also it is found that transfer function noise model yields better result than ARIMA model.

Exploiting business intelligence of water companies. ForWarD: an online water demand forecasting tool.
Evangelos Spiliotis, National Technical University of Athens; Achilleas Raptis, National Technical University of Athens; Elektra Skepetari, National Technical University of Athens; Vassilios Assimakopoulos, National Technical University of Athens

Nowadays, water companies face numerous challenges including decreasing water supply and increasing population. In order to overcome the problems arising from these challenges and optimize their services, companies must be able to predict water demand, as well as the population distribution and its consumer habits. Obtaining this kind of information is of significant importance leading towards an efficient mid-term planning in respect to water storage, distribution, expansion and upgrading of the existing supply network. At present, most of the models used to produce mid-term forecasts are regression models based on annual data collected through various surveys. This means that in general no detailed information can be provided to the water companies, apart from the trend of the market in the forthcoming years. In this paper, an integrated online forecasting tool is presented, developed to forecast mid-term water demand in the county of Attica, Greece. Using proper time-series forecasting models, the tool produces monthly forecasts of the water demand, the number of water supplies and the per water supply consumption of selected areas. Given the raw data available per postal code, the user can form regions of his choice by aggregating them, analyse them through clustering and statistical methods and examine their future behavior. The whole forecasting process is automated and applicable through a friendly and easy to use interface, so that no forecasting expertise or training is required from the user. Moreover, due to its architecture, the database of the system is updated in real time with no penalty on the execution time of the forecasting procedure, providing the user remotely with a comprehensive and detailed monitoring of the network and exploiting that way the business intelligence of the company.

An Empirical Bayes Approach to Improving Individual and Group Seasonal Indices
Huijing Chen, University of Portsmouth; John Boylan, Lancaster University

Estimating seasonal patterns from short-term demand data can be a challenging task due to short data history and noisiness of the data. Our previous research has shown evidence of improved forecasting accuracy if seasonality can be estimated from a group of similar items either from a product family or across depot locations. Shrinkage methods have also been proposed to dampen the individual seasonal indices. In this paper, we develop a James-Stein type of shrinkage estimator developed from an Empirical Bayes perspective, i.e. the parameters from the prior distribution are themselves estimated from data. Our estimator is different from previous suggestions in the literature in that it allows information from similar series to be used. Simulation results show how this new estimator compares with individual and group seasonal indices methods.

9:45am-11:00am RS Density/Interval Forecasting (Room: MR9)
Chair: Thilaksha Tharanganie

Density forecasting using a functional data approach
Thilaksha Tharanganie, Monash University; Rob Hyndman, Monash University

We consider the problem of forecasting a time series of density functions, with an estimated density function at each time period. A data set comprising many observations is recorded at each time period, and the associated probability density function is to be estimated for each time period. A logspline approach is applied to each data set separately where each estimated density has common knots but different

coefficients. These estimated densities form a ``functional time series''. We forecast future densities by decomposing the functional time series into orthonormal functional principal components and their uncorrelated principal component scores. Different sets of future densities are forecasted using univariate time series models applied to the scores obtained from various decomposition algorithms: functional principal component analysis, and eight projection pursuit algorithms for robust principal component analysis. We apply our methods to two simulated data sets (unimodal and bimodal) and four real data sets. The four real data sets comprise UK and Australian income and age data over many years with thousands of observations per year. We evaluate the calibration of our density forecasts using a form of probability integral transforms. Proper scoring rules are then used to evaluate the relative sharpness of the density forecasts. We conclude that two of the projection pursuit algorithms produce relatively good forecast densities.

Bracketing Rates and the Aggregation of Quantile Assessments
Yael Grushka-Cockayne, University of Virginia; **Victor Richmond Jose**, Georgetown University; Kenneth Lichtendahl, University of Virginia; Robert Winkler, Duke University

Research on the wisdom of crowds has shown that the aggregate forecasts can lead to better forecasts. In this paper, we begin by examining how the aggregation of quantiles can lead to better probability forecasts than aggregating probability estimates. Next, we extend the notion of bracketing introduced in the point forecasting literature to this setting. By looking at the different rates at which forecasters' different quantiles bracket the truth, we develop new measures for evaluating the quality of a crowd's forecasts. In this context, we highlight the connection between the piecewise-linear scoring rule and its point-forecasting counterpart. Finally, we draw some insights from these quantile bracketing rates that could help inform us on how we aggregate quantiles to reduce systematic biases and to harness the wisdom of the crowd.

[Semiparametric Estimation of Interval-valued Time Series Using Extreme Value Approach](#)
Wei Lin, Capital University of Economics and Business; Gloria Gonzalez-Rivera, UC Riverside

Existing models in the current literature for interval-valued time series mainly focus on the regressions of minimum and maximum (or center and radius) of intervals on its lag terms with no or restrictive assumption on the distribution of error terms. Such specification ignores the extreme nature of the lower and upper bounds of intervals. In this paper, we assume that there is an underlying stochastic process for the interval-valued time series, and that the lower and upper bounds of the intervals are the realized extreme observations (minima and maxima) based on the random draws from the conditional densities of underlying stochastic process which is strictly stationary. Then the analysis of interval-valued time series is decomposed into two parts. The first part is the classical point-valued time series analysis for the underlying stochastic process, for which the time series of centers is used as a proxy. The second part is to model the conditional mean of the lower/upper bounds nonparametrically, since the conditional mean of extreme value is often highly nonlinear and intractable. Correspondingly, we propose a two step procedure for the estimation of interval-valued time series: construct and estimate a parametric model for the time series of centers, and obtain the estimated conditional moments of it; and then perform nonparametric regression of lower/upper bounds with the estimated conditional moments as the regressors. Bases on the literature on nonparametric regression with generated regressors, the effect of parameter uncertainty in the second step is asymptotically negligible given some regularity conditions, and therefore, our two-step estimator has typical nonparametric convergence rate. In the empirical application, we compare our two-step estimator with its competing approaches using high frequency financial data of stock returns, and find that our proposed two-step estimator is more accurate in the sense of delivering smaller losses than those from its competitors.

Reproduction of Simple Forecasting Methods in the M Competitions
John E Boylan, Lancaster University; M Zied Babai, Kedge Business School; Maryam Mohammadipour, Middlesex University; Aris Syntetos, Cardiff University

The M-Competitions set new standards for transparency of data and methods in forecasting research. The datasets have always been available to researchers and the methods in the M1 competition were documented in the appendices of the paper. Nevertheless, it is not a straightforward exercise to reproduce the results in the highly-cited M1 and M3 papers. In this presentation, we shall outline the process and results obtained in our attempt to reproduce the results of the simpler methods of the M1 and M3 competitions, excluding more complex procedures such as ARIMA and Bayesian Forecasting methods, and excluding the software packages evaluated in the M3 Competition. The purpose of the study is threefold. Firstly, we wish to document any assumptions which need to be made and which were not made explicit in the original papers. Secondly, we evaluate the sensitivity of the accuracy results to these assumptions. Finally, we will publish our own set of results, with fully documented procedures, which can act as a reference point for further research studies utilising the M1 and M3 datasets. As in our previous work reproducing the seasonal shrinkage research of Miller and Williams, we worked in two independent teams, comparing the results between each of the teams as well as with the results published in the M-Competition papers. We shall present our results in three stages, enabling a detailed evaluation of the error measures in Stage 1, the seasonal adjustment procedure in Stage 2, and the forecasting methods themselves in Stage 3.

The Stochastic Order of Forecast Error Losses
Wilmer Martinez-Rivera, Banco de la Republica, Manuel Hernandez-Bejarano, Banco de la Republica; **Juan Julio-Roman**, Banco de la Republica

We propose to assess the performance of $k >= 2$ forecast procedures by exploring the distributions of forecast errors and error losses. We argue that forecast accuracy should be assessed through stochastic loss order rather than expected loss order. We propose to explore forecast error loss distributions under two settings; when a strict (but unknown) stochastic order exists in the losses of all alternatives, and when that order happens in subsets of them. Thus, analysis of variance techniques become useful in this setting. In spite of the fact that loss stochastic order is stronger than loss moment order, our procedures are at least as powerful as competing tests and are robust to their correlation, autocorrelation and heteroskedasticity settings. Moreover, since our approach does not require samples of the same size, its scope is also wider. Finally, We illustrate the usefulness of our proposals by evaluating a set of real world forecasts.

Residual-augmented IVX predictive regression
Matei Demetrescu, Christian-Albrechts-University of Kiel; **Paulo Rodrigues**, Bank of Portugal and Nova School of Business and Economics
Although bias correction in predictive regressions was intended to stabilize the size properties of OLS-based predictability tests, we argue that it may also improve on the power, in particular so for IVX based testing. Concretely, in this paper we discuss theoretically the large-sample behavior of the IVX-statistic subject to a bias correction analogous to Amihud et al. (2004), both under stationarity and the more realistic context in which predictors exhibit near-integrated dynamics. Our main objective is to characterize the effects of the bias-reduced adjustments on the asymptotic distribution of the IVX-statistic in a generalized context and discuss the validity of the procedure when predictors are stationary as well as near-integrated. In addition, we conduct an exhaustive Monte Carlo analysis to investigate the small-sample properties of the test procedure and analyse its sensitivity to the distinctive conditions that characterize predictive regressions in practice, such as strong persistence, endogeneity, non-Gaussian innovations and heterogeneity. An empirical application of the new procedure to illustrate its usefulness is also provided.

9:45am-11:00am RS Forecasting Financial Data 2 (Room: MR8)
Chair: Sinem EYUBOGLU

Can high frequency trading strategies constantly beat the market?
Viktor Manahov, The University of York

Policy makers are still debating whether or not high-frequency trading (HFT) is beneficial or harmful to financial markets. We develop four artificial stock markets populated with HFT scalpers and aggressive high frequency traders using Strongly Typed Genetic Programming (STGP) trading algorithm. We simulate real-life HFT by applying STGP to real time millisecond data of Apple, Bank of America, Russell 1000 and Russell 2000 and observe that HFT scalpers front-run the order flow generating persistent profits. We also use combinations of forecasting techniques as benchmarks to demonstrate that HFT scalping strategies anticipate the trading order flow and constantly beat the market.

Predicting Intra-day and Day of the Week Anomalies in Turkish Stock Market
Kemal Eyuboglu, Karadeniz Technical University; **Sinem Eyuboglu**, Karadeniz Technical University; Rahmi Yamak, Karadeniz Technical University

According to Efficient Market Hypothesis which is presented by Fama (1965) in the finance literature, any investor cannot gain abnormal returns. But various anomalies such as day or week effect which are frequently observed at the stock markets provide some abnormal returns to investors. Existing anomalies at the stock markets are very important for the investors' profits and their decision process. In the related literature, many studies found various anomalies for the different national and international stock markets. But most of them used aggregate data in their econometric analysis. The question is whether the same anomalies exist in the sub-indexes such as communication, transportation, banking, mining etc. The purpose of this study is to investigate whether there are the same anomalies such as intra-day effect and day of the week effect for 24 Borsa Istanbul (BIST) sub-indexes. The data used in this study are daily and cover the period of 03.01.2005-11.02.2015 for Turkey. Statistical results show that there is an evidence for intra-day effect for all 24 sub-indexes (except communication) and day of the week effect in 11 sub-indexes for this period. Accordingly temporal predictability of returns in the BIST indexes is under a strong intra-day effect and weak day of the week effect. Moreover the existence of anomalies in the stock market show that investors are not rational, in other words these anomaly patterns weak the validity of Efficient Market Hypothesis in the context of Borsa Istanbul.

9:45am-11:00am RS Forecasting the Relationship between macro and financial sectors (Room: MR7)
Chair: Mark Flood

Macroeconomic Patterns in System-Wide Liquidity Regimes
Mark Flood, Office of Financial Research; John Liechty, Penn State U.; Tom Piontek, Office of Financial Research

We explore statistical commonalities among granular measures of market liquidity with the goal of illuminating system-level patterns in aggregate liquidity. We calculate daily "invariant" price impacts (Kyle and Obizhaeva, 2014) to assemble a granular panel of liquidity measures for equity, corporate bond, and futures markets. We estimate Bayesian models of hidden Markov chains and use Markov chain Monte Carlo analysis to measure the latent structure governing liquidity at the system-wide level. Three latent liquidity regimes---high, medium, and low price-impact---are adequate to describe each of the markets. Focusing on the equities subpanel, we test whether a collection of macroeconomic time series can recover the estimated liquidity dynamics. This allows an economically meaningful attribution of the latent liquidity states and yields meaningful predictions of liquidity disruptions as far as 15 trading days in advance of the 2008 financial crisis.

Financial Institutions During the Business Cycle: Is the Financial Cycle Synchronized with the Business Cycle?
Fernando Arias Rodriguez, Banco de la Republica; Celina Gaitan Maldonado, Banco de la Republica; Johanna Maricela Lopez Velandia, Banco de la Republica

Using the financial statements of Banks and related institutions, a proposal is made for a financial cycle chronology for Colombia from 1990 until the middle of 2013. Its interaction with the business cycle proposed by Alfonso, Arango, Arias, Cangrejo y Pulido (2012) is also examined. Two approaches are used here: One rule-based (Bry and Boschan, 1971, and Diffusion Indexes) and one based on information extracted from the data (Novelty Detection). Evidence is found to support the existence of synchronization between the financial and business cycle, although the chronologies and related features of each cycle rely on the definition and the approach adopted.

The real-time predictive content of asset price bubbles for macro forecasts
Benjamin Beckers, DIW Berlin

In light of the recent large swings in stock and housing prices accompanied by ample global liquidity, the role of monetary policy in the build-up of asset price bubbles has been questioned. This paper will contribute to the debate whether central banks can and should stronger "lean against the wind" of emerging bubbles. Against this background, the paper will reevaluate if new advances in real-time bubble detection, as brought forward by Phillips et al. (2011), can timely detect bubble emergences and collapses. Here, the paper suggests a combination approach of different bubble indicators to account for the uncertainty around start and end dates of asset price bubbles. Additionally, the paper will then investigate if these indicators carry predictive content for inflation, output growth and recession events when the real-time availability of all variables is considered. It finds that a combination approach of asset price bubbles is well suited to detect the most common stock and house price bubbles in the U.S. and shows that this indicator can improve output forecasts, however, only when the real-time availability of real variables is respected.

11:15am-12:30pm Forecasting Practitioner Track 6 (Room: MR10)

John Mello, Professor of Supply Chain Management and Director, Center for Supply Chain Management, Arkansas State University

Strategies for Demand and Supply Integration
Effective demand-supply integration (DSI) is an increasingly acute problem in industry, prompted by pressure from large retailers on manufacturers to provide higher levels of service while reducing inventory costs. Meanwhile, the advent of online ordering has further complicated matters by creating multiple distribution options. I identify two basic DSI strategies, internal and external collaboration, point out interrelationships between those strategies, and discuss various tactics currently used by companies to improve demand-supply integration. External collaboration tactics can also be used to inform S&OP of current and future demand from customers.

Discussants: Michael Gilliland, Ram Ganeshan

11:15am-12:30pm IS Frontiers in Electricity Forecasting 1 (Room: MR2)
Chair: Tao Hong

MEFM: An R package for long-term probabilistic forecasting of electricity demand
Rob Hyndman, Monash University; Shu Fan, Monash University

I will describe and demonstrate a new open-source R package that implements the Monash Electricity Forecasting Model, a semi-parametric probabilistic approach to forecasting long-term electricity demand. The underlying model proposed in Hyndman and Fan (2010) is now widely used in practice, particularly in Australia. The model has undergone many improvements and developments since it was first proposed, and these have been incorporated in this R implementation. The package allows for ensemble forecasting of demand based on simulations of future sample paths of temperatures and other predictor variables. It requires the following data as inputs: half-hourly/hourly electricity demands; half-hourly/hourly temperatures at one or two locations; seasonal (e.g., quarterly) demographic and economic data; and public holiday data. Peak electricity demand forecasting is important in medium and long-term planning of electricity supply. Extreme demand often leads to supply failure with consequential business and social disruption. Forecasting extreme demand events is therefore an important problem in energy management, and this package provides a useful tool for energy companies and regulators in future planning.

Combining sister load forecasts
Tao Hong, University of North Carolina at Charlotte; Bidong Liu, University of North Carolina at Charlotte; Jiali Liu, University of North Carolina at Charlotte

Many studies have shown evidence that combining forecasts usually yields a more accurate forecast than each individual forecast. Most of these studies are based on combining independent forecasts, the forecasts generated by independent experts and/or based on independent techniques. In reality, this approach often takes significant human and/or computational resources. This paper proposes a practical method that does not rely on independent forecasts for combination. Instead, the individual forecasts are sister forecasts, which are created by varying attributes of the variable selection process, such as length of history, threshold for stopping the process, and partition of the data. In this paper, we will introduce the concept of sister models and sister forecasts using a case study based on the data from the load forecasting track of the Global Energy Forecasting Competition 2014. Combining the sister load forecasts using several methods, such as trimmed mean, winsorized mean, and regression, we show that these simple methods can help reduce the Mean Absolute Percentage Errors of individual forecasts by about 10%.

SAS Energy Forecasting: Hourly load forecasting for all horizons
Bradley Lawson, SAS Institute

Electric utilities require energy forecasting for four time horizons; very short-term for 24 hours for energy market operations, seven days for energy market operations and short-term maintenance planning for generating units and transmission facilities, three to five years for budgeting, financial planning and maintenance planning, and up to 50 years for resource (generation, transmission, and distribution) and financial planning. Traditionally the forecasting for time frames up through 7 days was on an hourly basis and the forecasting for longer periods was on a monthly basis. However, most long term forecasts are transformed into hourly forecasts to be used as input to detailed planning simulation models. Electric energy consumption is affected by many variables, many of them unidentified/unquantified as the residential, business and industrial customers go about their daily activities. It is clear, however, that electric consumption is weather sensitive as temperature affects the demand for cooling and heating. It is also clear that the daily patterns of residences, shops, and manufacturing facilities affect the hour to hour demand for electricity. A review of data across a year shows that the response to temperature change varies by considerably within months, days of the week, and by hour. SAS built the Energy Forecasting solution to capture the effects of weather, month of year, day of week and hour of day. The SAS Energy Forecasting solution provides hourly forecasting for all time periods in a single solution. The process starts with basic multiple regression models and additional variables and combinations are sequentially tested for model improvement. Models are tested at each iteration of the process to prevent over-fitting. Second stage

models are developed using UCM, ARIMAX, Exponential Smoothing, and Neural Nets. SAS EF is structured to provide automatic weather range scenarios and automatic economic growth scenarios. The presentation will provide an overview of the process and underlying methodologies and a short demonstration of the software.

11:15am-12:30pm IS The Impact of systemic Risk: defaults, Risks and Flows (Room: MR8)
Chair: Massimiliano Caporin

Credit risk around the world: Inference on world, country and industry factors
Bernd Schwaab, European Central Bank; Siem Jan Koopman, VU University Amsterdam; Andre Lucas, VU University Amsterdam

This paper investigates the dynamic properties of systematic default risk conditions for firms from different countries, industries, and rating groups. We use a high-dimensional non-linear non-Gaussian state space model to estimate common components in corporate defaults in a 41 country sample between 1980Q1-2014Q4, encompassing both the global financial and euro area debt crises. We find that macro and default-specific world factors are a first order source of default clustering across countries. Defaults cluster more than what is implied by shared exposure to macro factors, indicating that other factors are of first-order importance. For all firms, deviations of systematic default risk from macro fundamentals are correlated with net tightening bank lending standards, strongly suggesting that bank credit supply and systematic default risk are inversely related.

Statistically validated financial intraday lead-lag relationships
Dror Kenett, Boston University

According to the leading models in modern finance, the presence of intraday lead-lag relationships between financial assets is negligible in efficient markets. With the advance of technology, however, markets have become more sophisticated. To determine whether this has resulted in an improved market efficiency, we investigate whether statistically significant lagged correlation relationships exist in financial markets. We introduce a numerical method to statistically validate links in correlation-based networks, and employ our method to study lagged correlation networks of equity returns in financial markets. We analyze high frequency data of stock returns traded at the New York Stock Exchange, focusing on intra-day correlation seasonalities. We uncouple the contribution of auto-correlations, lagged cross-correlations, and volatility to determine the observed intra-day pattern of synchronous correlations. Studying two distinctly separate time periods (2001-2003 versus 2011-2013), we demonstrate how the role of auto and lagged correlations have changed in the dynamics of the market.

Network banks exposures and variance spillovers in the Euro area
Massimiliano Caporin, University of Padova; Monica Billio, University of Venice; Lorenzo Frattarolo, SAFE - Goethe University Frankfurt; Loriana Pelizzon, SAFE - Goethe University Frankfurt

We propose a spatial approach to model risk spillovers using financial time varying proximities based on actual claims among financial entities. We show how these methods could be useful in (i) isolating influential and fragile entities and important risk channels, (ii) investigating the role of portfolio composition in risk transfers, and (iii) computing target exposures able to reduce the overall system volatility. Our empirical application uses banks foreign exposures provided by BIS as a proxy for the euro area cross country holdings. We find that Ireland, Greece and France are playing a central role in spreading risk in the European stock markets and this spillover effect can be traced back to a physical claim channel: banks foreign exposures.

11:15am-12:30pm RS Forecasting for the Touristic Sector (Room: MR9)
Chair: Miriam Scaglione

Modelling and Forecasting the UK Inbound Tourist Demand Volatility

Bee Cheng Khoo, Oxford Brookes University; Wei Chong Choo, Universiti Putra Malaysia

Many previous studies have conducted investigation on the topic of tourism demand and its forecasts. However, this study shifts the focus from tourism demand, the mean level of a time series, to the variance of the series, which is the volatility of tourism demand. The data used are the monthly totals of UK inbound tourism demand. This study will introduce the concepts and theories of generalized autoregressive conditional heteroscedastic (GARCH) volatility models and apply them to the UK inbound tourism demand. Four GARCH volatility models are employed to estimate the conditional volatility of monthly arrivals of inbound tourists into UK. In addition, the performance of smooth transition exponential smoothing (STES) on forecasting the volatility of UK tourism demand will be compared to GARCH models and other ad hoc methods. We found that monthly seasonality effect exists in the conditional mean equations and the estimated GARCH model revealed that the impact of news shocks is quite likely to persistently influence UK inbound tourism demand volatility. In addition, through investigating the EGARCH and GJRGARCH models, the asymmetric and leverage effects of news shocks (good or bad news) exist in the volatility of monthly UK tourism demand. The presence of leverage effects indicates that the negative news shock produced more volatility than positive news shock in the variance of monthly inbound tourism demand in UK. Furthermore, STES outperforms GARCH models and several ad hoc methods in post-sample forecasting of UK tourism demand volatility.

A similarity-based self-evolutionary model set for railway arrival forecasting

Tsung-Hsien Tsai, National Quemoy University

Accurate short-term arrival forecasting is essential for railway operators to conduct daily operations such as demand management strategies. With the fluctuation of railway data based on multiple temporal influencers, having one universal model structure for achieving accurate forecasting is less likely possible. The aim of this study is to propose a model set in terms of case-based reasoning for dealing with different data situations. Instead of using conventional time series data for model construction, this study adopts the advantage of curve similarity through the investigation of booking curves formed by reservation data. The proposed model prototype has five modules. First, model structure module literally determines the structure of the constructed model including form and symbol of parameters. Secondly, given a predetermined model structure, similarity evaluation module is responsible for identifying similar booking curves from the historical database based on the characteristics of the forecast target. Thirdly, sample selection module decides how many and which samples should be selected for computing predictions. Forth, prediction module integrates essential information of the selected samples and generates forecasts. Last but not least, learning module searches for parameters applied in the whole proposed model including those for model structure and temporal influencers. Since parameters may have either real or 0/1 values, this study utilizes the framework of genetic algorithm for simultaneously obtaining parameter values and achieving the goal of learning. The proposed model is tested by using real railway reservation data. The initial results show that for data series with distinct characteristics may need respective model variation. Currently, more tests and comparisons are conducted in order to further validate forecasting capability of the proposed model. The use of reservation data for model construction is relatively rare in comparison with arrival data in the literature. Hopefully, the outcome of this study may shed some light on the use of reservation data and also the construction of advanced booking models for improving predictive accuracy.

Monitoring Tourism Frequentation Using Mobiles Data
Miriam Scaglione, HES-So Sierre - Institute of tourism; Pascal Favre, HES-So Sierre - Institute of tourism

Since 2004, one of the main research track of the Institute of tourism of the HES-SO Valais has been data focus on whether data collected by third-party players can increase the quality and timeliness of the information and the decision making process in tourism. In the first part of the research process, explanatory variables such as number of tickets in supermarkets, weights of collected garbage, traffic count as well as meteorological data were included in our simulations (a total number of 260 explanatory variables have been used) in the frame of Flash Indicators methods. In the second part, the inclusion of mobile data has opened highly interesting research avenues and a great innovation potential, but added at the same time extra difficulties related to Big Data handling, privacy issues and real-time basis frequency estimations. This presentation shows of some experiences carried out on some Swiss destination (Fribourg and Valais) using the algorithm developed by the ITO and the HEFR. The results suggest that not only a real time frequentation, splitting by kind of tourism (overnights and excursionists) is possible but also clustering of main tourism trajectories by group of tourist such as origin countries. The research was possible thank to the collaboration with Swisscom.

11:15am-12:30pm RS Forecasting Regional Business Cycles (Room: MR5)
Chair: Nariyasu Yamasawa

Forecasting on the Regional Level Using Regional Input-Output Tables
Jaroslav Sixta, University of Economics; Jakub Fischer, University of Economics

Regional input-output tables represent an extraordinary tool for forecasting. A pity is that they are not used very often even they are sometimes difficult to obtain. Usually, official statistical authorities do not publish regional input-output tables with some exception (like the U.S. Bureau of Economic Analysis). It means that pure regional input-output tables are very scarce and they are usually compiled for groups of countries. We demonstrate how they can be compiled and used for a relatively small regions of the Czech Republic, country with about 10 million inhabitants. Our regional input-output tables are product by product tables with 82 rows and columns and they are prepared for all 14 regions (NUTS 3 level) of the Czech Republic. These regional input-output tables combine officially published regional accounts and national symmetric input-output tables. The key issue of their construction lies in the definition of statistical unit (local kind of activity unit) and its decomposition between regions. They are based on the combination of top-down method and direct construction from data sources. Our approach to forecasting is presented on the use of simple input-output analysis with regional specifics that requires very careful interpretation. Leontief's main principles are used in combination with current national accounts' principles. Results of such analysis are usually significantly influenced by the correct definition of interregional export and import and identification of regional (local) producers. Besides, the regions are very interdependent and induced changes in a particular region will influence other regions in line with level of their mutual dependence. The paper presents both brief description of the methodology and the example of forecasting issues based regional input-output tables. The case of dependency between the regions is deeply discussed and main issues are tackled and explained.

Regional Surveys – Identifying Uncertainty and Forecasting Economic Growth
Katja Drechsel, Halle Institute for Economic Research; Brigitte Loose, Halle Institute for Economic Research

Policy makers in regional institutions are more and more interested in a frequently and timely assessment and projection of economic growth – in particular on regional GDP forecasts. However, regional data is only available with substantial delay for the German states from the German statistical office. Hence, particular weight is given to own survey data besides the official "hard data" to improve the regional GDP and gross value added forecasts. The study analyzes the performance of the IWH construction and industry surveys for the economic development and outlook of the East German economy. We examine whether these surveys are useful to improve the nowcast of the current and the forecast of the next quarter of GDP.

Given the even number of response possibilities of these surveys all answers can be taken into account. This is also a big advantage compared to the ifo business climate index for East Germany where responses that correspond to "unchanged" are neglected. However, the overall performance of both indices is compared. In addition, this study uses the responses of the IWH survey to identify the uncertainty of the entrepreneurs for the assessment of the economic situation. Firms' predictions in previous periods about expected changes will be compared with their assessment of realized changes. Derived from cross-sectional disagreement we can derive a measure of ex post forecast error uncertainty.

Nowcasting of Gross Regional Product and Analyzing Regional Business Cycle
Nariyasu Yamasawa, Atomi University

This study attempt to analyze the relationships between the prefectures' business cycles in Japan. There are many studies about business cycle synchronization in Europe and East Asia. We apply country level analysis to prefecture-level. First, we attempt to estimate monthly real Gross Regional Product (GRP) for 47 prefectures in Japan. It enables us to investigate the present condition of regional economy. The official annual GRP is published late. It is published two years after the concerned period. Our real monthly GRP is published two months later after the concerned period. We estimate it by various monthly data and using panel data estimation technique. Second, we extract business cycles from real monthly GRP by band pass filter. We consider that we should remove shorter cycle series (noise) and longer cycle series (trend) in order to investigate a pure relationship of business cycles between prefectures. Third, we investigate lead-lag relationship between prefectures' business cycles. We found that prefectures' business cycle differ significantly. Further, we investigate spatial relationship between prefectures' business cycles. These results help us to forecast prefectures' business cycles.

11:15am-12:30pm RS Forecasting with unobserved Components (Room: MR1)
Chair: Keith Ord

Forecasting Compositional Time Series: A State Space Approach
Ralph Snyder, Monash University; **Keith Ord**, Georgetown University; Anne Koehler, Miami University of Ohio; Adrian Beaumont, Melbourne University; Keith McLaren, Monash University

A method is proposed for forecasting composite time series such as the market shares for multiple brands. Its novel feature is that it relies on multi-series adaptations of exponential smoothing combined with the log-ratio transformation for the conversion of proportions onto the real line. It is designed to produce forecasts that are both non-negative and sum to one; are invariant to the choice of base series in the log-ratio transformation; recognize and exploit features such as serial dependence and non-stationary movements in the data; allow for the possibility of non-uniform interactions between the series; and contend with series that start late, finish early, or which have values close to zero. The method relies on appropriate innovations state space models to describe stochastic elements of the time series, yields maximum likelihood estimates of parameters, generates prediction distributions in addition to point forecasts, and computes the probabilities of market share increases together with prediction intervals. It is illustrated using data on the annual market shares of the major (groups of) brands in the U.S. automobile market, over the period 1961 – 2013.

Applying SSA.Boot procedure to forecast time series
Fernando Luiz Cyrino Oliveira, Pontifical Catholic University of Rio de Janeiro; Paula Medina Maçaira, Pontifical Catholic University of Rio de Janeiro

Produce reliable and accurate forecasts is essential and the main goal in any method of time series analysis. The SSA.boot procedure, developed by the authors, combines the use of Singular Spectrum Analysis (SSA) with Bootstrap and the automatic procedures ets and auto.arima, from software R, to forecast time series. The idea is to join these approaches in the following steps: (i) decompose the original series into signal and white noise using SSA technique; (ii) apply the Bootstrap procedure to the noise series, generating new P noise series; (iii) add to the P new noise series the signal, resulting in P synthetic series; (iv) fit, to each one

of the P synthetic series, the automatics procedures ets and auto.arima; (v) generate h-steps-ahead forecasts for each synthetic series with the respective fitted models; and (vi) make the simple average of the P forecasts. The performance of the proposed approach is evaluated by comparing it with the results of the application of ets and auto.arima directly to the original data through the errors measures Root Mean Square Error (RMSE), Mean Absolut Error (MAE) and Mean Absolut Percentage Error (MAPE). The study case lies on the application of SSA.boot in eight real time series (co2, MotorVehicle, elec, UKDriverDeaths, gas, uselec, ukcars, and usgdp), available in R. The results shows that for each one of the series the best error measures were produced with the proposed approach (SSA.boot), and in 75% of cases there was a significantly improvement in the errors measures when compared to the obtained by applying the ets or auto.arima straight to the original series. Also, the findings indicate that the proposed methodology enhances the errors measures of others techniques applied in series without simulation when the forecast period is up to 10% the length of the training period. Some research is in progress for improving the results obtained, as well as for considering a method to extract automatically the window size and the numbers of eigentriple in SSA. All computational work is done using the R 3.0.1 software.

11:15am-12:30pm RS Judgmental Forecasting 1 (Room: MR4)
Chair: Dilek Onkal

Using Forecast Advice: Role of Optimism vs Pessimism in Scenarios

Dilek Onkal, Bilkent University; Paul Goodwin, University of Bath; M. Sinan Gonul, Middle East Technical University; K. Zeynep Sayim, HotelSchool The Hague

Scenarios constitute effective tools for information sharing by depicting alternative storylines of possible futures. Recent research suggests that decision makers effectively utilize optimistic/pessimistic scenarios as channels of forecasting advice. However, the scenarios used in these studies are not only optimistic/pessimistic in tone and content, but are also labeled as such. Current work focuses on exploring whether the effects of scenarios originate from their content or from framing.

Allowing for promotion effects in judgmental forecasting: Effects of series type and provision of formal forecasts

Shari De Baets, University College London; Nigel Harvey, University College London

While statistical forecasting methods can generate predictions based on the logical and systematic processing of information and can handle large amounts of data (Goodwin & Wright, 2010), they have difficulties with discontinuities, unexpected events and external influences (Armstrong & Collopy, 1998; Goodwin, 2002; Hughes, 2001). One example is the occurrence of promotional investments by a company and its effect on future sales numbers: the prediction of rare promotional events remains a difficult problem (Goodwin & Fildes, 1999). This study was conducted to examine how forecasters perform in predicting sales numbers when the time series are subject to occasional promotional events. This was investigated in a series of experiments by varying within experiments (a) the difficulty of the time series: independent versus autoregressive (AR(1)), (b) presence of a statistical forecast and forecast history, and across experiments: (c) the presence of feedback and (d) the relationship between the promotional expenditure and the effect on sales. Analysis of Experiment 1 (linear relationship, no feedback) indicates that forecasts are too low when promotions are present and too high without promotions, suggesting an anchoring effect on the mean of the series. This effect increases with the presence of a statistical forecast. Results of Experiment 2 (S-shaped relationship, no feedback) generally confirm those of Experiment 1 but also show that forecasters who are asked to graph the relation between promotion size and the effect of promotion tend to linearize it. Two additional experiments are currently being run: one investigating the effect on forecasting performance of providing immediate outcome feedback and one on the effect of providing explicit information about the relationship between the promotional expenditure and sales increase.

11:15am-12:30pm RS Macroeconomic Forecasting 1 (Room: MR3)
Chair: Antonio Garcia-Ferrer

It's Not Just for Inflation: The Usefulness of the MedianCPI in BVAR Forecasting
Saeed Zaman, Federal Reserve Bank of Cleveland; **Brent Meyer**, Federal Reserve Bank of Atlanta

In this paper we investigate the forecasting performance of the median CPI in a variety of Bayesian VARs (BVARs) that are often used for monetary policy. Until now, the use of trimmed-mean price statistics in forecasting inflation has often been relegated to simple univariate or "Philips-Curve" approaches, thus limiting their usefulness in applications that require consistent forecasts of multiple macro variables. We find that inclusion of an extreme trimmed-mean measure—the median CPI—significantly improves the forecasts of both headline and core CPI across our wide-ranging set of BVARs. While the inflation forecasting improvements are perhaps not surprising given the current literature on core inflation statistics, we also find that inclusion of the median CPI improves the forecasting accuracy of the central bank's primary instrument for monetary policy—the federal funds rate. We conclude with a few illustrative exercises that highlight the usefulness of using the median CPI.

Assessing the Fed's Greenbook Forecasts of Foreign GDP Growth
Neil Ericsson, Federal Reserve Board; Emilio Fiallos, Rutgers University; J Seymour, Federal Reserve Board

This paper examines publicly available Fed Greenbook forecasts of several foreign countries' GDP growth, focusing on potential biases and inefficiencies in the forecasts. Standard tests typically fail to detect biases or inefficiencies in the forecasts. However, recently developed dummy saturation techniques detect economically sizable and highly significant time-varying biases that depend on the business cycle inter alia. Estimated biases differ not only over time, but by country and across the forecast horizon.

Monitoring leading and coincident indicators in the vicinity of turning points
Antonio Garcia-Ferrer, Universidad Autonoma de Madrid; Marcos Bujosa, Universidad Complutense. Madrid; Aranzazu de Juan, Universidad Autonoma de Madrid; Pilar Poncela, Universidad Autonoma de Madrid

Based on a small scale multivariate approach for building composite leading and coincident indicators for the Spanish economy,we present a monitoring forecasting exercise of the behavior of such indexes at the moments where they are mostly needed: the vicinity of turning points. Our indicator indexes, based on the low frequency components of a few monthly economic variables were able to predict the onset of the Spanish recessions and recoveries, the GDP growth cycles and the classical industrial production cycles, both historically and in real time. Also our LI provides considerable aid in forecasting annual and quarterly GDP growth rates during the last recession and recovery. Using only real data available at the beginning of each forecast period our indicator one-step ahead forecasts compares favorably with other alternatives. At the time of this writing (16.3.2015), both the coincident and the leading indicators show healthy behavior indicative of expected positive growth of the Spanish economy in the short/medium run.

11:15am-12:30pm RS Nonlinear Models (Room: MR7)
Chair: Zeynep Senyuz

A Nonlinear Generalization of Factor Models for Forecasting Financial Time Series with Many Predictors
Ali Habibnia, London School of Economics

This paper proposes a nonlinear generalization of factor models based on artificial neural networks for forecasting financial time series with many predictors. The proposed model would be able to capture both non-linearity and non-normality of a high dimensional dataset. The experimental results indicate that the

complex real world time series like financial data are rarely pure linear or nonlinear. They consist of both linear and nonlinear components. Therefore, in this paper we optimize a neural network model containing a linear part simultaneously. The model considers both linear and nonlinear patterns in a high dimensional time series at the same time. We show how a linear factor model can be represented as a special case of this neural network factor model. It means that, if there is no non-linearity between variables, the model will work like a linear model.

Forecasting with VAR models: Fat Tails and Stochastic Volatility

Ching-Wai (Jeremy) Chiu, Bank of England; Haroon Mumtaz, Queen Mary University of London; Gabor Pinter, Bank of England

In this paper, we provide evidence that fat tails and stochastic volatility can be important in improving in-sample fit and out-of-sample forecasting performance. Specifically, we construct a VAR model where the orthogonalised shocks feature Student's t distribution and time-varying variance. We estimate this model using US data on output growth, inflation, interest rates and stock returns. In terms of in-sample fit, the VAR model featuring both stochastic volatility and t-distributed disturbances outperforms restricted alternatives that feature either attributes. The VAR model with t disturbances results in density forecasts for industrial production and stock returns that are superior to alternatives that assume Gaussianity, and this difference is especially stark over the recent Great Recession. Further international evidence confirms that accounting for both stochastic volatility and Student's t-distributed disturbances may lead to improved forecast accuracy.

Evolution of equilibrium dynamics in money markets

Emre Yoldas, Federal Reserve Board; Zeynep Senyuz, Federal Reserve Board

We develop a comprehensive empirical framework to monitor stress in short-term funding markets and to characterize their time-varying dynamics during a period including the financial crisis of 2007-2009 as well as its aftermath. Our model accounts for nonlinearity in the means, the volatilities, and the correlations of money market rates. We model the long-run relationship between four pairs of interest rates that form the commonly monitored spreads using a threshold-VEC model, and use their spreads to identify regimes characterized by different levels of funding stress in each money market segment they represent. We then model time-varying volatilities and correlations of the rates in a DCC framework. Our results show that interest rates started displaying nonlinear dynamics mainly at the onset of the crisis. Dislocations observed during financial turmoil led to persistently lower rate correlations in the aftermath of the crisis, although such correlations are still sizable.

1:45pm-3:00pm Feature Speaker (Room: MR1/2/3)
Chair: Rob Hyndman, Monash University

Tilmann Gneiting
Group Leader, Computational Statistics, Heidelberg Institute for Theoretical Studies (HITS), and Professor of Computational Statistics, Karlsruhe Institute of Technology (KIT), Germany

***IJF Invited Lecture*: Evaluating Forecasts: Why Proper Scoring Rules and Consistent Scoring Functions Matter**
Making and evaluating forecasts are two sides of the same coin, in that improvements in forecast methodologies depend on our ability to adequately assess their quality. However, the comparison and ranking of forecasters bears pitfalls, and inferences about predictive performance can be defective in practice, unless decision theoretic principles are followed. I will survey the rapidly expanding interdisciplinary literature on proper scoring rules and consistent scoring functions, which are key tools in the evaluation of probabilistic forecasts and point forecasts, respectively. Principles and techniques will be illustrated in simulation examples and case studies.

1:45pm-3:00pm Forecasting Practitioner Track 7 (Room: MR10)

Paul Goodwin, Professor Emeritus, University of Bath

Harnessing your Judgment to Achieve Greater Forecast Accuracy
All forecasting involves judgment to some extent. But what should be the balance between management judgment and computer-based forecasting? What is the best role for judgment? Can the accuracy of judgment be improved? Do meetings of groups of people produce more accurate judgmental forecasts than individuals?

This talk will look at the strengths and limitations of forecasts based on management judgment compared to forecasts obtained from computer algorithms. It will show where judgment can make the best contributions to improving accuracy and where its application is best avoided. It will then evaluate the effectiveness of different methods that have been proposed for improving the value of management judgment in forecasting so that a blueprint for best practice can be identified.

1:45pm-3:00pm IS Forecasting Challenges for Health (Room: MR7)
Chair: tbd

Machine Learning and Breast Cancer Prediction
Tae Yoon Lee, SAS Institute Inc.; Youngme Seo, Citi Bank

Machine learning has been used and considered a valuable tool to identify, classify, detect, and distinguish tumors and other malignancies in cancer research. Due to advantages of machine learning and the advent of new technologies, many cancer researchers have attempted to apply machine learning for cancer prediction and prognosis including Artificial Neural Networks (ANN), Bayesian Networks (BN), Support Vector Machines (SVM), Self-Organizing Maps(SOM) and Decision Trees (DT). However, it is challenging to use machine learning methods for desired outcomes and accurate prediction of cancer because of certain strengths and weaknesses. This paper attempts to make comparisons of various machine learning methods to perform breast cancer survivability and recurrence using SEER dataset. It also aims to propose which machine learning methods are more appropriate than others based on target variable, data structure, and purpose of research.

Health Analytics Transforming the Structure of the Delivery System
Paul Savage, Iona College, Center for Health Analytics

The US Health Care System is being transformed, ostensibly to achieve the 'Triple Aims' of higher quality, lower costs, and better patient experience (access). The adoption of Accountable Care strategies are driving institutions and physician at all levels to create Networks of providers from all the various silo's into an economic model that is 'Risk' based if not outright creating an insurance entity. The scope of these changes are functionally comparable to the introduction of Prospective Payment (1980's), the creation of Medicare/Medicaid (1960's) or even the formation of the health insurance industry during the Great Depression; leaving no one unscathed in attempting to predict the future of how the industry will evolve or the fundamental metrics associated with understanding the needs of our respective communities. No longer can we assume that the prevalence of a disease or condition within a population cohort can be used to forecast resource needs in the future. In actuality the intervention of some organizations have reduced the prevalence of strokes, fractured hips, heart attacks and even some cancers by thirty and forty percent in some communities while the technology has accelerated the migration from inpatient care services to ambulatory surgery centers and physician office settings. The Center for Health Analytics is undertaking a series of research projects to measure the transformation of markets that are adopting more patient centered care models, encouraged by the State and Federal initiatives to re-design the Medicaid reimbursement system (DSRIP).

Working with State level Advisory Boards, the Center help define the expanding data needs while developing metrics and models to describe the expectations to be made in various markets. These predictive modeling efforts have taken a broad 'Data Scientist' perspective, adding value to the transaction data environment while migrating to longitudinal pattern recognition, refining the classification methods and other techniques in the application of predictive analytics.

1:45pm-3:00pm RS Forecasting for Management (Room: MR5)
Chair: Hyunsook Lee

Conservatism-Matching Analysts and their Performance

Jay Jung, KAIST; Sonya Lim, DePaul University; Jinhan Pae, Korea University; **Choong-Yuel Yoo**, KAIST

This study investigates whether analysts can benefit from understanding a target firm's conditional conservatism. In particular, we examine the forecasting performance of analysts when they match the asymmetric timeliness of their earnings forecast revisions (i.e., forecast conservatism) with the asymmetric timeliness of firms' reported earnings (i.e., accounting conservatism). We find that better conservatism-matching analysts produce more accurate earnings forecasts and elicit stronger market reactions to their forecast revisions. Further, better conservatism-matching analysts issue more profitable stock recommendations and have more favorable career outcomes, such as a lower probability of turnover, staying longer in the profession, and promotion to a more prestigious brokerage house. Our results indicate that analysts' ability to understand accounting conservatism is an important reflection of analyst expertise and professional success.

Assessment of Forecasting: A Comparison of Timeliness Indexes for Construction Projects

Diana M. Franco, Universidad Industrial de Santander; Guillermo Mejía, Universidad Industrial de Santander

A common issue in worldwide construction companies is to complete projects both on time and within the budget initially planned. Most construction companies use traditional control systems that detect the expected final deviations from both cost and time tardily, which affects the good performance of the projects. In consequence, project managers and contractors face several drawbacks to make decisions properly. The current project management systems use control techniques predominantly based on budget's deviation at date rather than cost deviation at project completion. Nonetheless, forecasting techniques can help managers to monitor the project performance providing early warnings about overruns and delays. Thus, the assessment of forecasting techniques becomes an important evaluation factor within a project control system. The traditional forecasting methods have been commonly evaluated by the accuracy criterion, but this approach conveys little about how early the decision makers notice a warning signal. Recently, some authors have introduced timeliness indicators as another important criterion to assess the performance of project forecasting methods. These authors suggest computing a timeliness index based on the normalized deviation between the forecast and the actual values along the project timeline. This study compared the proposed timeliness indexes for 31 construction projects by statistical techniques of classification such as contingency tables and logistic regression. Results from the analysis showed some inconsistences when these indexes assessed both cost and schedule predictions, under particular conditions. Additionally, the analysis identified some issues to show properly the levels of timeliness and precision of the forecasts together. These preliminary findings provide contractors and project managers useful information to help them make better decisions and undertake effective corrective actions to achieve the project goals.

Market Prediction and Preliminary Feasibility Study for the Government R&D programs in Korea

Hyunsook Lee, Korea Institute of S&T Evaluation and Planning

Since 2008, preliminary feasibility study (PFS, hereafter) has been introduced to every new R&D program over approximately M as a part of the effective budget compilation process due to the fast growth in the

R&D budget, like .2B in 2015 whereas .1B in 2006. This PFS involves an investigation of a R&D program in three categories; technological, policy, and economic feasibilities. Only the assessed budget from the PFS on a program satisfying given criteria from these categories can be allocated in the next fiscal year budget planning. Among subcategories in order to assess program feasibility, market prediction has played an critical role in decision making, namely concluding whether a program is feasible or not. Although numerous factors are considered in order to estimate the cost and benefit of a government investment, market prediction has been a critical factor in deducing BC values quantifying the economic feasibility of a government-intent-to-invest program. The choice of market prediction methodology is affected by technology prediction acquired in the process of evaluating technological feasibility. In this presentation, after the process of Korean R&D PFS is briefly described, a few market prediction cases are presented to demonstrate this complicated decision making process of which conclusion tends to be related to the choice of market prediction methodology since the most of PFS requires market prediction of a long period such as at least a technology life cycle in addition to a proposed program duration. Results from statistical analysis are presented to demonstrate this relationship. In addition, pros and cons of market prediction methodologies in the PFS for government R&D programs are discussed.

1:45pm-3:00pm RS Health Forecasting 2 (Room: MR8)
Chair: Achilleas Raptis

RIFIS – Radiology Information & Forecasting Integrated System

Achilleas Raptis, National Technical University of Athens; Nikoletta-Zabbeta Legaki, National Technical University of Athens; Vaggelis Ntavelis, National Technical University of Athens; Niki Kontoe, National Technical University of Athens; Artemis Semenoglou, National Technical University of Athens; Vassilis Assimakopoulos, National Technical University of Athens

Management information systems incorporating forecasting techniques have been successfully used by many a profit organization and in versatile fields to facilitate managerial decisions, by giving an insight into the future. Because of the high costs involved in health care, such techniques should also be adopted by hospitals and their departments. In this regard, this study presents an innovative system named Radiology Information & Forecasting Integrated System (RIFIS). RIFIS is consisted of two interacting subsystems: Radiology Information Subsystem (RIS) and Forecasting Information Subsystem (FIS) supporting management workflow and decision making based on forecasting. RIS is a common networked software suite designed to support operational workflow and business analysis within a radiology department. The innovation lies on the addition of FIS, which is an integrated business forecasting support system, incorporates a wide range of the available knowledge and experience in the field of forecasting, while it fully utilizes the up-to-date software potential. FIS implements analysis and preparation of time series, forecasting methods such as exponential smoothing, theta, etc., monitoring and evaluation of them, on time series from the radiology department operation, giving guidelines to managerial decisions. Finally, our study suggests the implication of forecasting integrated system as component of a Hospital Information System as more beneficial.

Forecasting Branded and Generic Pharmaceutical Life Cycles

Samantha Buxton, Swansea University; Marwan Khammash, University of Sussex; Kostas Nikolopoulos, Bangor University; Philip Stern, Exeter University

This paper will look at modelling and forecasting of branded and generic pharmaceutical lifecycles with a 1 year forecasting horizon. The focus will be on pharmaceutical life cycles around the time of patent expiry as the sales of the branded pharmaceutical decline and the sales of the corresponding generic equivalent increase. Understanding the patterns of decline and the associated generic growth is increasingly important and the market is currently worth over £5bn in the UK in 2013 and while it is greater than any other industrial sector in the UK it has declined from £7bn in 2009. The number of 'blockbuster' drugs also continues to decline. As a result the pharmaceutical industry makes efforts to extend the commercial life of their brands and the ability to forecast sales is of increasing importance in this regard. The paper also provides for effective governance because the use of a branded drug when a generic equivalent is available

ultimately results in wasted resources. The pharmaceutical prescription data comes from a database known as JIGSAW. The prescription drugs that were modelled were those that had the highest number of prescriptions within the database. There were five models originally used to model and forecast this data. These were: Bass Diffusion, Repeat Purchase Diffusion Model, Moving Average, Exponential Smoothing and the Naïve. Based on previous research it was expected that the more complex models would produce more accurate forecasts for the branded and generic life cycles than the simple benchmark models. As none of the complex models yielded results more significant than those of the Naïve model, it was thought to be appropriate to add additional models to the analyses. The additional models added were: Holt Winters Exponential Smoothing, Auto-Regressive Integrated Moving Average (ARIMA), Robust Regression, Regression over t, Regression over t-1 and Naïve with drift. The empirical evidence presented here suggests that the use of the ARIMA provided the most accurate and robust method of modelling and forecasting branded pharmaceuticals. For the generic equivalents the empirical evidence suggests that the Naïve model with the addition of a 70% trend would provide the most accurate and robust modelling and forecasting method.

1:45pm-3:00pm RS Judgmental Forecasting 2 (Room: MR4)
Chair: Hyo Young

Application of the data-cube forecasting to collaborative planning and Vendor Managed Inventory
Igor Gusakov, self-employed S&OP consultant

In this presentation, I show how the concepts of data cube forecasting can be applied to integrate statistical forecasts and judgmental adjustments in Vendor Managed Inventory (VMI), thus improving collaboration between manufacturer and distributor in a supply chain. To place a correct order, the distributor (or, in case of VMI, the manufacturer) requires three types of data: what is in distributor's stock right now; what was already sent by manufacturer but is still on the way; what is the distributor's sales forecast. The first two types of data can be easily retrieved from the distributor's and manufacturer's accounting system respectively; however the sales forecast is the challenge. A forecast can be viewed as having two components: a statistical projection and a set of judgmental adjustments. The latter is often done to factor in the effects of Volume Building Blocks (VBB): promotions and other special events that affect sales. While both manufacturer and distributor can execute the statistical forecast, it is the manufacturer who is responsible for activities such as pricing or media advertising. The distributor, in turn, might provide local promo activities. So both the manufacturer and distributor must plan the VBBs collaboratively. Perhaps the best way do this is through a web-based OLAP tool with a write-back option. OLAP stands for online analytical processing and provides users with all necessary features, such as data visualization, access rights, and ability to implement judgmental adjustments (including remote access via mobile devices). Absent however from OLAP is statistical forecasting itself. Data-cube forecasting can fill this gap by embedding statistical forecasting methods into the OLAP tool, thus integrating key aspects of forecast generation, reconciliation, and reporting.

Cultural Differences in Judgmental Forecasting
Summer Xia Meng, University of Bath; Paul Goodwin, University of Bath; Sheik Meeran, University of Bath

Previous research has established that: i) judgmental prediction intervals tend to be too narrow for the stated coverage probability, showing that people exhibit overconfidence; ii) mis-calibration is common in probability forecasting (i.e. subjective probabilities tend not match the true probabilities) ; iii) judgments can be sensitive to different frames in forecasting tasks (e.g. whereas overconfidence is revealed in judgmental prediction intervals, underconfidence is found in probability judgments); iv) a cross-cultural difference exists in general knowledge probability judgments (overconfidence is much higher when people have a Chinese, rather than a Western, cultural background). This paper reports on two experiments that were designed to examine whether Chinese people exhibit different levels of overconfidence compared to Western people, in judgmental forecasting when they are asked to make either probability or interval

forecasts . A follow-up survey assessed whether any differences could be explained by a lack of familiarity with probabilistic thinking among Chinese people.

The Impact of Non-financial Incentives on Judgmental Forecasting Performance

Hyo Young Kim, KAIST Business School; Yun Shin Lee, KAIST Business School; Duk Bin Jun, KAIST Business School

The purpose of this study is to assess the effects of non-financial motives on judgmental forecasting behavior and performance. There is an ongoing debate in the social sciences about whether or not financial or non-financial incentives can influence judgment and decision making. Our aim is to extend this debate by examining whether or not non-financial motives have an impact on forecasting accuracy. We design the non-financial motives as image-related rewards/punishments by releasing the actual/false rankings of forecasting performance to each subject and measure the impact that these motives have on forecasting performance. Overall, non-financial incentives improved forecasting performance. Moreover, when individuals were deceived with last ranking independently of their actual performance, their performance were significantly better than when they were deceived with first ranking. This phenomenon is consistent with loss aversion, i.e., an individual's tendency to avoid losses is stronger than the tendency to acquire gains. Competitors who are behind view their performance as a loss and work harder than those who are ahead to avoid the loss. In contrast, subjects who are consistently told that they are ranked first perform worse because leading participants tend to slack off. However, when non-financial incentives are combined with financial rewards, forecasting performance declines.

3:30pm-5:10pm Forecasting Practitioner Track 8 (Room: MR10)

Fotios Petropoulos, Cardiff Business School, Cardiff University

Forecasting Support Systems: Ways Forward

 Forecasting Support Systems (FSSs) refer to a set of processes with an objective of accurately forecasting variables of interest within a company. Such systems may not be limited to a set of statistical methods, but also include interactions between statistical outputs and management judgment, procedures for storing, retrieving and presenting information in an effective way, as well as a modern, efficient and intuitive user interface. This talk will focus on ways that current FSSs can be improved in three dimensions: (i) technological, by using open-source software and web-based enabled features, (ii) methodological, by adopting state-of-the-art methods and frameworks, and (iii) design, towards a better integration of management judgmental. Finally, possible extensions of standard FSSs as to include foresight aspects are discussed and the concept of the Forecasting-Foresight Support System is introduced (F^2SS, Spithourakis et al., 2015, *IJF*).

Discussants: Paul Goodwin, Eric Stellwagen, Stephan Kolassa

3:30pm-5:10pm IS Advanced tools for seasonal adjustment, time-series analysis and nowcasting (Room: MR3)
Chair: Gian Luigi Mazzi

Real-Time Forecasting Evaluation with JDemetra+

David de Antonio Liedo, National Bank of Belgium; Jean Palate, National Bank of Belgium

This paper presents an innovative forecasting evaluation library that takes into account the calendar of macro-economic releases in order to provide a realistic simulation of out-of-sample forecast errors in both multivariate and univariate time series models. The library is meant to be an independent module in JDemetra+ (JD+), which is an Open Source time series software written in Java. JD+ is mostly used in statistical agencies for the analysis of seasonality, but it also supports the use of state-of-the-art models developed for nowcasting in macro and macro-financial applications. The forecasting evaluation library

presented here complements the in-sample based measures of fit that are typically reported in time series models. The key advantage of our forecasting evaluation library is that it allows us to replace the standard concept of forecasting horizon by "information scenarios", which are more suitable for real-time forecasters. Thus, we allow users to evaluate the forecasts obtained under pre-specified information assumptions that mimic the availability of data in real time forecasting scenarios. As an input, the algorithm requires the approximate publication delay for each one of the time series that enters the model. The library incorporates multiple tests to assess the statistical significance of relative forecast accuracy measures, as well as the concept fixed-event forecasts. The latter will enable us to understand how the accuracy of different forecasting models improves over time as they approach the actual realization. The empirical part presents two applications. On the one hand, our forecasting evaluation machinery will be used to compare the univariate forecasts obtained with the automatic model selection algorithm TRAMO with those obtained with other procedures. Given that state-of-the-art seasonal adjustment methods rely on univariate time-series forecasts, reducing the size of the errors is an obvious way of reducing revisions in seasonally adjusted data. The second application deals with multivariate time series models. In particular, we will assess the relative performance of alternative parameterizations of SUTSE models both at forecasting and at back-casting temporally disaggregated data. The results provide additional and valuable information regarding the reliability of the alternative models considered beyond the in-sample statistics often reported, which do take into account the quality of the predictor variables, but not their timeliness.

JDemetra+, The New European Software For Seasonal Adjustment
Dominique Ladiray, INSEE; **Sylwia Grudkowska**, European Central Bank

JDemetra+ is a new open source tool for seasonal adjustment (SA) that has been developed by the National Bank of Belgium in cooperation with Eurostat and the BundesBank. JD+ has been developed to provide a set of reusable and extensible components, following a standard technology, compatible with the environment of most European statistical institutions. JDemetra+ is not only a user-friendly graphical interface, comparable to its predecessor, Demetra+, but also a set of open Java libraries that can be used to deal with time series related issues like the SA processing of large-scale data sets, other SA methods, temporal disaggregation, benchmarking, business cycle analysis etc. JDemetra+ is built around the concepts and the algorithms used in the two leading SA methods, i.e. TRAMO/SEATS and X13-Arima-Seats. They have been reengineered, following an object-oriented approach, that allows for easier handling, extensions or modifications. JDemetra+, version 2.0.0, has been officially released on February 2nd, 2015.

JDemetra+, a new tool for time series analysis
Jean Palate, National Bank of Belgium

JDemetra+ is a new open source tool for time series analysis, mainly developed by the National Bank of Belgium. Its primary goal is to provide the European Statistical System (ESS) with modules that enables the implementation of the ESS Guidelines on seasonal adjustment (SA). It is partly built around the concepts and algorithms used in the two leading SA methods, i.e. Tramo-Seats and X12-Arima/X13-Arima-Seats. Beside those algorithms, JDemetra+ also contains a rich state space framework that provides efficient solutions to various related time series problems, like more general unobserved components estimation, benchmarking, temporal disaggregation, nowcasting, forecasting… After discussing the main goals behind the development of this new tool, completely written in Java, we give an overview of its design, of its contents and of its extension capacities. We also provide a couple of representative examples that illustrate the power and the versatility of the software, from a statistical point of view. In a first application, we compare different model-based seasonal adjustment approaches, including structural models and the canonical decomposition of seasonal ARIMA models, by means of the tools developed in Seats (Wiener-Kolmogorov filters) and by means of the Kalman filters. In a second example, we present a multi-variate benchmarking algorithm that extends the univariate Cholette's method using an efficient state-space representation; such a method may be used, for instance, to force aggregation constraints between several seasonally adjusted series. So, JDemetra+ can make the creation of complex statistical production systems, in the SA domain but also in other time series domains, significantly easier.

An advanced tool for revision analysis
Rosa Ruggeri Cannata, Eurostat; Gian Luigi Mazzi, Eurostat; Dario Buono, Eurostat; Bogomil Kovachev, Eurostat

A revision is broadly defined as any change in the value of a statistic released to the public. Revisions can occur either when new observations (one additional month or quarter) become available and some past values are modified or when the current and /or some past values are modified. Data are generally revised in order to incorporate new, improved information. Therefore, revisions are unavoidable whenever statistics are produced that report promptly on economic developments. Analysis of revisions is then of paramount relevance in particular when assessing the performance of alternative nowcasting and forecasting models, as shown in several recent studies. We present a tool for revision analysis developed by Eurostat for the European Statistical System as a plug-in of the JDemetra+ software, the new standard software for performing seasonal adjustment. The tool offers a wide range of possibilities covering descriptive and parametric revision analysis to be performed on vertical, horizontal or diagonal vintages extracted from a real-time database. The descriptive measures cover a number of summary statistics aiming to assess the size, variance, skewness and bias of revisions; such measures can be useful to analyse the volatility and direction of revisions, the presence of bias in preliminary estimates, the robustness of first released estimates, and to perform a first analysis of reliability of estimates in terms of how often the sign of later releases changes with respect to the sign of earlier ones. The tool also includes a module on regression-based parametric analysis covering the check of bias based on OLS regression, the efficiency of revisions, and to check if revisions are news or noise. Several tests are included to measure heteroscedasticty, such as the Breusch and Pagan test and the White's general test, and normality test such as the Jarque-Bera test. Furthermore, the tool includes a module for VAR-based analysis covering a set of unit root tests, such as Dickey –Fuller and augmented Dickey-Fuller tests, some autocorrelation tests and some cointegration and comovement tests. We also present an extended application to some Principal European Economic Indicators (PEEIs). For this application, we mainly rely on the PEEIs vintages database developed at Eurostat for the euro area, the European Union and Members States starting in 2001.

3:30pm-5:10pm IS Business Cycle 2 (Room: MR7)
Chair: Inske Pirschel

Structural Breaks in Potential GDP of Four Major Economies: just impaired credit or the «New Normal»?
Alexander Apokin, CMASF; Irina Ipatova, CMASF

This paper investigates the factors behind the recent growth slowdown (so-called «the Secular Stagnation») in the US, euro area, China, and Japan using the metrics of potential output growth. Specifically, our results offer limited support for a supply slowdown hypothesis (Gordon, 2012), while not supporting an impaired credit transmission channel hypothesis (Reinhardt and Rogoff, 2009a). We estimate potential output growth with a variety of multivariate Kalman filters accounting for inflation, unemployment, and private credit dynamics («finance-neutral» estimates) and subject our estimates to structural breaks tests. We detect structural breaks between 2008 and 2010 for all countries with Bai-Perron search procedure, the result being robust to the filter, specification and sample choices, with no significant difference between ordinary and «finance-neutral» estimates. We proceed with Chen-Liu test to detect negative level shift outliers in The Great Recession for euro area and Japan. Moreover, Chen and Liu test finds scarce evidence of temporary change outliers during The Great Recession if estimates account for labour market indicators.

Trend estimation of multivariate time series with controlled smoothness
Victor Guerrero, Instituto Tecnológico Autónomo de México; Alejandro Islas-Camargo, Instituto Tecnológico Autónomo de México; Leticia Ramírez-Ramírez, Instituto Tecnológico Autónomo de México

We present an extension to filtering techniques to estimate trends of multivariate time series. The proposed method is based on a vector signal-plus-noise representation of Penalized Least Squares, requires only the first two sample moments, and introduces an index of smoothness. This index allows setting in advance a

desired amount of smoothness to achieve. We provide a closed-form expression for calculating trend estimates with their corresponding variance-covariance matrices, and present a detailed algorithm for smoothing bivariate time series. The method is evaluated with a simulation study and implemented for a real application with Mexican and U.S. GDP data.

The role of structural breaks in forecasting trends and cycles in U.S. real GDP

Mardi Dungey, University of Tasmania; Jan Jacobs, University of Groningen; **Jing Tian**, University of Tasmania

Output gaps play an important role in fiscal and monetary policy formulation, often necessarily including the need for forecasts. In this note we focus on forecasting output gaps with Beveridge-Nelson (1981) trend-cycle decompositions and show how these are affected by assumptions concerning correlated innovations and structural breaks. The results confirm that controlling for structural breaks is an important component of improving forecast performance in this framework.

Transmission of international policy uncertainty shocks in the Canadian economy

Lilia Karnizova, University of Ottawa

This paper investigates how shocks to economic policy uncertainty in the US are transmitted internationally. The empirical model is cast in a structural vector autoregression framework that incorporates international and domestic blocks. The model includes measures of economic policy uncertainty, constructed by Baker, Bloom and Davis, as well as macroeconomic indicators of inflation, unemployment and interest rates. In relation to the previous SVAR research on policy uncertainty, this paper isolates the role of monetary policy in the transmission of policy uncertainty shocks that originate outside of the domestic economy. This is done by constructing hypothetical responses of domestic variables to an international policy uncertainty shock in the absence of the monetary policy reaction, and comparing these hypothetical responses with the actual impulse responses. The model is applied to the case of the Canadian economy. Canada provides an interesting case study for several reasons. This country has had a relatively stable monetary and fiscal policy over the recent financial crisis and recovery, and its economic recession has been much less severe than in many other countries. Yet, Canada is a small open economy, closely integrated with the US economy and susceptible to external shocks. Uncertainty about US policies largely influences the measured index of policy uncertainty in Canada, and Canada has been found to be a net importer of global uncertainty. In the SVARs, shocks to US policy uncertainty have significant demand-type effects on the Canadian unemployment and inflation in the short run. The magnitude of these responses is mitigated by monetary policy easing that follows the adverse uncertainty shock.

3:30pm-5:10pm IS Nowcasting 2 (Room: MR5)
Chair: Marco Lippi

A state space model for early estimates of unemployment

Duncan Elliott, Office for National Statistics

The UK Labour Force Survey publishes estimates of unemployment for the UK each month (t). Due to the survey design these estimates are for an approximately quarterly reference period, with the mid-month of the reference period referring to t-3. A state space model that deals with aspects of the survey design, in particular survey error autocorrelation and potential rotation group bias has been developed to provide monthly estimates of unemployment up to t-2. This paper explores the possibility of extending the current model to include administrative data on out of work benefits (the Claimant Count) to inform early estimates of unemployment at t-1.

Simple Robust Tests for the Specification of High-Frequency Predictors of a Low-Frequency Series
J. Isaac Miller, University of Missouri

I propose two simple variable addition test statistics for three tests of the specification of high-frequency predictors in a model to forecast a series observed at a lower frequency. The first is similar to existing test statistics and I show that it is robust to biased forecasts, integrated and cointegrated predictors, and deterministic trends, while it is feasible and consistent even if estimation is not feasible under the alternative. It is not robust to biased forecasts with integrated predictors under the null of a fully aggregated predictor, and size distortion may be severe in this case. The second test statistic proposed is an easily implemented modification of the first that sacrifices some power in small samples but is also robust to this case.

Improving short-run predictions of GDP by statistical methods by subjective information
Jasper de Winter, De Nederlandsche Bank; Jos Jansen, De Nederlandsche Bank

This project investigates how short-run forecasts of real GDP derived from statistical procedures may be improved by subjective forecasts by financial analysts in real time. A reliable assessment of the current state of the economy and its prospects in the short run is of great importance to both policy makers and private agents, especially in volatile times. The project builds upon the results of a pseudo-real time analysis by Jansen, Jin and de Winter (2012) who found that predictions by financial analysts are rather poor forecasting devices in themselves, but do seem to contain valuable information that statistical models fail to pick up. We will use a dynamic factor model as a purely mechanical forecasting device to extract the predictive information from a large dataset of monthly indicators, such as industrial production and consumer and producer confidence. We then try to enhance model-based forecasts by forecasts by financial analysts, which are partly determined by 'judgment'. We follow a strictly real time setup, using only available information, including preliminary figures and revisions on GDP and industrial production data. The analysis will cover the G7 countries.

Dynamic Factor Models with infinite dimensional factor space. Forecasting US monthly macroeconomic series.
Mario Forni, Faculty of Economics; Alessandro Giovannelli, Università Tor Vergata Roma; **Marco Lippi**, Einaudi Institute for Economics and Finance; Stefano Soccorsi, Università di Roma La Sapienza

The paper studies the pseudo real-time forecasting performance of three different factor models. We compare the method recently proposed by Forni et al. (2015) and Forni et al. (2014) with those proposed in Forni et al. (2005) and Stock and Watson (2002a) within a real data forecasting exercise. A large panel of macroeconomic and financial time series for the US economy which includes the Great Recession and the subsequent recovery is employed. In a rolling window framework, we find that the first two methods, based on spectral estimation, outperform the third. Substantial gains from regularized combinations of different inflation forecasts produced with the model in Forni et al. (2015) are also found.

3:30pm-5:10pm IS Tourism Forecasting (Room: MR4)
Chair: Haiyan Song

International Ecotourism in Central America and the Caribbean and Regional Economic Convergence: Evidence from Dynamic Panel Estimation
Ulrich Gunter, MODUL University Vienna; M. Graziano Ceddia, MODUL University Vienna; Bernhard Tröster, Austrian Foundation for Development Research

Using annual data for the period 1995–2012 for seven Central American and Caribbean countries (Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, and Panama), six different open-economy neoclassical growth models that allow for international (eco-) tourism are estimated using dynamic panel-data estimation techniques. The use of a dynamic panel estimator, notably the Arellano-Bond or difference GMM estimator, has the following advantages relative to static panel estimation: (1) by

introducing the lagged dependent variable (log of real GDP per capita) as additional regressor it allows for the presumably dynamic nature of the relationship between the endogenous and the explanatory variables, (2) it makes it possible to differentiate between short-run and long-run contributions of the explanatory variables, and (3) it permits the investigation of the issue of regional economic convergence within a tourism-driven growth framework. In addition, having a well-specified growth model is advantageous for (long-term) GDP forecasts for the region as well. The main result of the investigation is that not only international tourist arrivals per capita have a highly significant impact on the log of real GDP per capita (thereby yielding evidence for the classical tourism-led growth hypothesis) but that also five different sustainability indicators interacted with international tourism have a positive impact on economic development on top of international tourism. The five sustainability indicators applied in the present study are the Environmental Sustainability Index (ESI), the Environmental Performance Index (EPI), the Travel and Tourism Competitiveness Index (TTCI), terrestrial protected areas (in % of total land area), as well as terrestrial and marine protected areas (in % of total territorial area). For all six models, the estimated coefficient of the lagged dependent variable is highly significant and within the expected range so that regional economic convergence in the sense of so-called beta convergence to a common steady-state growth path is ensured. The results for seven countries are complemented by very similar estimation results applying terrestrial protected areas as well as terrestrial and marine protected areas for a set of 12 Central American and Caribbean countries (the seven countries mentioned above plus Belize, Dominica, Grenada, St. Lucia, as well as St. Vincent and the Grenadines), for which ESI, EPI, and TTCI were not available, thus corroborating the validity of the specification. In addition, also typical control variables are generally significant and feature the algebraic signs as expected from economic growth theory.

Systematic correction of anchoring bias: An application in the design of tourism demand forecasting support system
Zixuan Gao, The Hong Kong Polytechnic University; Haiyan Song, The Hong Kong Polytechnic University

With the help of forecasters' domain knowledge and expertise in the forecasting task, judgmental forecasting is good at predicting the irregular pattern of time series. Studies about combination of judgmental forecast and statistical forecast are always one of the main streams in the time series forecasting literature. However, forecaster's cognitive bias is always unavailable in the judgmental forecasting process and thus has become the main source of judgmental forecasting errors. A general review of literature shows that research of cognitive bias in judgmental forecasting is limited; and studies about effective debiasing strategies in this area are even scarcer. To fill in the gap, the current study proposes a debiasing model that aims to reduce the forecast error caused by a commonly identified cognitive bias – anchoring bias. The model is theoretically developed based on the assumptions that a forecaster's cognitive bias expressed in his/her forecasting process would not change in two closed forecasting seasons; and the contribution of anchoring bias to the forecast error in two closed forecasting seasons would not be significantly different. Therefore, the decomposed forecast errors associated with one's anchoring bias in a forecasting season would provide valuable information for his/her next judgmental forecasting season. From a practical perspective, the proposed debiasing model is applied in the judgmental forecasting module of the Hong Kong Tourism Demand Forecasting System (HKTDFS). Specifically, the debiasing model is implemented by both informative and suggestive guidance; and the effectiveness of both debiasing strategies are further tested by a two-stage laboratory experiment using HKTDFS. In this experiment, 75 participants are invited to participant in predicting tourist arrivals from source markets to Hong Kong. The experiment results indicate that the proposed debiasing model can effectively reduce forecaster's anchoring bias through judgmental forecasting exercise. In particular, the debiasing strategies in the form of informative guidance (performance feedback) can help forecasters to improve their forecast accuracy when the judgmental forecasts are anchored on their desired outcomes; whilst, suggestive guidance (system suggest forecast) has been proved to be more effective than informative guidance in reducing anchoring bias when forecasters anchor their forecasts on the baseline forecast (usually the statistical forecast) or the latest observations of the time series to be forecast.

[An Empirical Study on Judgmental Forecasting Behaviour in Tourism](#)
Shanshan Lin, Zhejiang University; Haiyan Song, The Hong Kong Polytechnic University

This study examines the characteristics of judgmental forecasting tasks and explores the judgmental forecasting behaviour of tourism practitioners and researchers by using quarterly forecasts of visitor arrivals from six source markets (namely China, Japan, Taiwan, Australia, the UK, and the USA) to Hong Kong. It uses a Web-based forecasting support system (Hong Kong Tourism Demand Forecasting System, HKTDFS) to structure the judgmental forecasting procedure and aggregates experts' judgmental adjustments via a two-round Delphi survey. A range of error measures and statistical tests were employed to measure the accuracy of statistical and judgmentally adjusted forecasts, to evaluate different types of adjustments and to explore the relationship between adjustments and forecast accuracy. The results suggested that the data of lower variability were related to higher forecast accuracy or lower absolute percentage error (APE) value. The forecasts generated by the practitioners were significantly better than those made by academics based on the mean absolute percentage error (MAPE) and root mean squared percentage error (RMSPE). Positive adjustments were very much larger than negative adjustments. It seemed that there was no clear pattern from which the relationship between the size of adjustment and accuracy improvement can be determined.

Predicting equilibrium relationships between tourism demand and carbon system
Yuan He, Bournemouth University; **Shuang Cang**, Bournemouth University; Hongnian Yu, Bournemouth University

Tourism which is one of the world's leading industries has a huge promotion of economic and social development, tourism development will greatly affect the structure and processes of ecosystems, as it will reduce non-renewable natural resources. Therefore, "sustainable" needs to be considered as the first priority in tourism development. Equilibrium of tourism demand and carbon system plays a significant role in sustainable development of tourism. This research identifies if there is an equilibrium relationship exist between tourism demand and carbon system. Prediction of tourism arrivals (tourism system) and solid waste and sewage (carbon system) based on equilibrium can also be obtained from DES model. Leshan city, one of famous tourism destinations located western of China, is used as an experiment case study. Policies suggestions for developing the regional ecotourism destination are discussed. Experiment results show that the medium prediction with around three years is more proper for tourism and carbon systems for this case study.

3:30pm-5:10pm IS Uncertainty and Economic Activity (Room: MR9)
Chair: Zeynep Senyuz

Measuring Global and Country-specific Macroeconomic Uncertainty
Ezgi Ozturk, International Monetary Fund; Xuguang (Simon) Sheng, American University

Using monthly survey data from the Consensus Forecast over the period of 1989-2013, we propose new measures of global and country-specific macroeconomic uncertainty. With a panel of professional forecasters, we define the uncertainty of a typical macroeconomic variable as the sum of disagreement among individual forecasters and the perceived variability of future common shocks. We then construct an index of country-specific uncertainty by aggregating the uncertainty measures of a range of variables, including output growth, inflation, interest rates, unemployment rate, current account and government budget balance. Finally, we create a measure of global uncertainty by appropriately weighting uncertainty at the country levels. Our new measures prove useful in studying the impact of local and global uncertainty shocks both within and across countries.

Banking Industry Risk and Macroeconomic Implications
Francisco Covas, Federal Reserve Board; **Emre Yoldas**, Federal Reserve Board; Egon Zakrajsek, Federal Reserve Board

We analyze time-varying risk in the banking industry and explore its connections with macroeconomic activity in the context of uncertainty shocks. We find that there is at least one common factor in banks' return residuals beginning in early 1990s representing banking industry specific risks. The explanatory power of such factors has been trending up since early 1990s and increased dramatically after the passage of the Gramm-Leach-Bliley Act in 1999. Moreover, the estimated latent banking risk factors exhibit significant volatility clustering. Based on these findings, we form a comprehensive measure of uncertainty specific to banking industry that reflects time variation in the second moment of the latent risk factors, exposures of banks to these factors, as well as explanatory power of such factors in the cross section of bank return residuals. The constructed measures lead broad measures of uncertainty, such as the VIX, during the 2007-2008 financial crisis. We explore macroeconomic implications of the banking industry uncertainty shocks by computing impulse responses of key macroeconomic aggregates based on Bayesian VARs and local projection methods. The results from this exercise underscore the critical role of uncertainty shocks in the banking sector and their propagation to the broad financial system and the economy.

What are the Macroeconomic Effects of High-Frequency Uncertainty Shocks?
Laurent Ferrara, Banque de France; Pierre Guérin, Bank of Canada

Following the Great Recession, econometric models that better account for uncertainty have gained increased attention, and so have increased the amount of works to evaluate the effects of uncertainty shocks. In this paper, we evaluate the impact of high-frequency uncertainty shocks on a set of low-frequency macroeconomic variables representative of the U.S. economy. Rather than estimating models at a same common low-frequency, we use recently developed econometric methodology that allows us to avoid aggregating high-frequency data before estimating models. The impulse response analysis uncovers various salient facts. First, in line with the existing literature, high-frequency uncertainty shocks are associated with a broad-based decline in economic activity. Second, we find that credit and labor market variables react the most to uncertainty shocks. Third, we find that the responses of macroeconomic variables to uncertainty shocks are relatively similar across single-frequency and mixed-frequency data models, suggesting that the temporal aggregation bias is not acute in this context. Finally, we show that some macroeconomic variables exhibit a non-linear response to uncertainty shocks

Consumer Inflation Uncertainty and the Macroeconomy: Evidence from a New Micro-Level Measure
Carola Binder, University of California, Berkeley

This paper introduces a micro-level measure of consumer inflation uncertainty. Literature on cognition and communication documents that people use round numbers as a communicative tool to convey uncertainty. I construct an uncertainty measure that exploits consumers' tendency to round their inflation forecasts to multiples of five on the Michigan Survey of Consumers. I document cross-sectional and time series properties of the measure and provide support for its validity. Mean inflation uncertainty is countercyclical and positively correlated with inflation disagreement, inflation volatility, and the Economic Policy Uncertainty Index. Inflation uncertainty varies more in the cross section than over time, so a major benefit of this new measure is its cross-sectional dimension which enables micro-level analysis of the relationship between uncertainty and consumption. More uncertain consumers are more reluctant to spend on durables, cars, and homes, and their spending attitudes are less sensitive to interest rates. The measure also has applications to inflation dynamics and monetary policy. For example, the expectations of more-certain consumers can be used to improve Phillips curve estimation.

3:30pm-5:10pm RS Forecasting with Mixed data (Room: MR2)
Chair: Yunjie Wei

Real-Time Forecasting with a MIDAS VAR
Stefan Neuwirth, ETH Zurich; Heiner Mikosch, ETH Zurich

This paper presents a stacked vector MIDAS type mixed frequency VAR (MFVAR) forecasting model that intends to be general and yet compact, flexible and yet parsimonious in terms of parametrization as well as easy to estimate. First, we develop a compact mixed frequency VAR framework for multiple variables and multiple frequencies using a stacked vector approach. Second, we integrate the mixed frequency VAR with a non-linear Almon MIDAS polynomial scheme which is designed to reduce the parameter space while keeping models flexible. Third, we show how to recast the resulting stacked vector MIDAS type non-linear MFVAR into a linear equation system that can be easily estimated equation by equation using standard OLS. In order to empirically evaluate the predictive accuracy of our model, we conduct a pseudo out-of-sample forecasting exercise using US real-time data. The MFVAR substantially improves accuracy upon a standard VAR for different VAR specifications: Root mean squared forecast errors for, e.g., GDP growth are reduced by 30 to 50 percent for forecast horizons up to six months and by about 20 percent for a forecast horizon of one year.

Forecasting Private Consumption with High Frequency Data
António Rua, Banco de Portugal

Up to now, the use of daily data for forecasting macroeconomic aggregates with MIDAS (Mixed Data Sampling) regressions has been restricted to financial data, see for example Ghysels, Sinko and Valkanov (2008), Monteforte and Moretti (2008), Ghysels and Wright (2009), Hamilton (2007), Tay (2006). The aim of this paper is to forecast private consumption using electronic payments data namely data collected from Automated Teller Machines (ATM) and Points-Of-Sale (POS) which is available on a daily basis. As far as we know this is the first paper that attempts to forecast with MIDAS approach using non-financial daily data. This reflects the fact that it is unusual to have non-financial data available at a daily frequency. The focus is on the Portuguese case which is an interesting case per se. In fact, in Portugal, such type of technology has a very high penetration rate with the advantage of the data being compiled by a single entity which allows it be timely and useful for the real time economic assessment and policy making. This makes Portugal a natural case study. On top of that, the Portuguese economy has experienced a turbulent evolution over the last years with the Great Recession and the subsequent European sovereign debt crisis which led to a profound macroeconomic adjustment process. Hence, it constitutes a very challenging period by any standards for forecasting purposes. Besides the daily ATM/POS data, we also consider more standard regressors as monthly retail sales and monthly consumers confidence indicator to forecast quarterly private consumption. We find that taking on board high frequency data improves forecasting performance. In particular, the use of a novel daily ATM/POS indicator, delivers results very promising and encouraging.

The relative importance of hard and soft data for GDP forecasting – a real time mixed frequency analysis
Katja Drechsel, Halle Institute for Economic Research; Rolf Scheufele, Swiss National Bank

In this paper we reexamine the relative role of soft and hard data in terms of short-term GDP forecasting. We employ mixed frequency models (MF-VARS and MIDAS models) and real time data to investigate the relative role of survey data (ifo, pmi and KOF data) relative to industrial production and goods exports in Germany and Switzerland. Special emphasis is given to the real-time data flow of surveys, production and turnover. We find clear evidence that it matters a big deal whether one relies on first or final release indicator data for the out-of-sample experiment. By taken into account data revisions, the relative importance of survey data increases notably and even matter quite closely before the official GDP release. Therefore our analysis strongly suggests that the exclusive reliance on hard data can be misleading and that surveys should be part of the information set, irrespectively of the state of information.

Forecasting Inflation Index Using MIDAS Regressions: Based on the Dynamic Relationship between GSVI and Inflation
Yunjie Wei, Academy of Mathematics and Systems Science; Xun Zhang, Academy of Mathematics and Systems Science; Shouyang Wang, Academy of Mathematics and Systems Science

With the wide use of Internet, search data are expected to reflect people's expectation and be used as a predictor for selective macro-economic indicators. In order to improve the accuracy of forecasting, as high frequency data, Google search volume index (GSVI) has been used to forecast macro-economic variables. This paper applies the Panel Vector Autoregressive Model (PVAR) to examine the dynamic relationship between GSVI and Consumer Price Index (CPI). A Mixed Data Sampling (MIDAS) model with GSVI is proposed to forecast CPI of 14 countries, including 10 developed and 4 developing economics. Empirical results indicate that GSVI has high correlation with CPI; the response of CPI to GSVI is positive and strongly significant, vice versa. However, the feedback of GSVI to CPI is much stronger for developing economies compared with developed economies. And the paper proves the usefulness of GSVI for CPI forecasting in an out-of-sample forecasting experiment using 14 countries' monthly inflation data from 2006M01 to 2014M05, the MIDAS models including GSVI outperform the multivariate regression models on average and verify the effectiveness of treating GSVI as an efficient indicator for CPI.

3:30pm-5:10pm RS Forecasting Financial Data 3 (Room: MR8)
Chair: David Rapach

Equity Investing with Targeted Constant Volatility Exposure
Nicolas Papageorgiou, HEC Montreal; **Jonathan Reeves**, University of New South Wales; Michael Sherris, University of New South Wales

This paper proposes a forecasting approach that enables targeted constant volatility equity portfolios to be constructed with minimal transaction costs incurred. These portfolios are constructed with stocks and stock index futures contracts overlays. The overlays are based on one-day-ahead stock index return volatility forecasts from an outlier corrected GARCH(1,1) model. It is found that certain targeted constant volatility portfolios can generate substantial improvements in performance, both in terms of return and risk, resulting in long-run cumulative return out-performance relative to the stock index benchmark. Important features of these targeted constant volatility portfolios is their reduced exposure to stock market crashes and their low transaction costs relative to other approaches. These results are of particular relevance to the construction of portfolios for pension funds where controlling downside risk without negatively impacting return performance is important.

Improving Return Predictability Using Variance-of-Variance Premiums
Yang-Ho Park, Federal Reserve Board

This paper reports that the variance-of-variance premium (VVP), the difference between the risk-neutral and physical measures of variance-of-variance, has strong predictability for stock returns, especially at very short horizons. Furthermore, pooling both information on the VVP and the variance premium (VP) can deliver a large amount of statistical and economic gain compared to using either of them alone. These results corroborate the finding of Bollerslev, Tauchen, and Zhou (2009) that volatility-of-volatility risk is a critical driver of time-varying risk premiums. Finally, the results hold in the international stock markets and are robust to traditional predictors, investor sentiment proxies, and funding constraints.

The peer performance of hedge funds
David Ardia, Laval University; Kris Boudt, Vrije Universiteit Brussel

The industry standard to measure the peer performance of hedge funds is to rank the funds based on their risk–adjusted performance and conclude that the fund outperforms the peers with a worse ranking. When all funds perform equally well, this rate of out–performance is a random number between zero and one, depending on how lucky the fund is. We avoid this pitfall and introduce peer performance ratios that account for the uncertainty in estimating the performance differential of two funds. For the hedge funds in the HFR database over the period 2008–2012, we find that overall the rate of equal–performance dominates the out– and under–performance such that percentile rank–based analyses of peer performance tend to be too optimistic about the out–performance of the funds with a relatively good ranking, and too pessimistic about the under–performance of the funds with a worse ranking. Consistent with the presence of decreasing returns to capital, we find that the under–performance rate tends to increase when the fund has more assets under management and that, because of reputation risk, large funds with a long track record tend to have a higher equal–performance ratio. Finally, we show that improvements in peer performance are positively associated with higher returns in the next quarter.

Industry Interdependencies and Cross-Industry Return Predictability
David Rapach, Saint Louis University; Jack Strauss, University of Denver; Jun Tu, Singapore Management University; Guofu Zhou, Washington University in St. Louis

We use the adaptive LASSO from the statistical learning literature to identify economically connected industries in a general framework that accommodates complex industry interdependencies. Our results show that lagged returns of interdependent industries are significant predictors of individual industry returns, consistent with gradual information diffusion across industries. Using network analysis, we find that industries with the most extensive predictive power are key central nodes in the production network of the U.S. economy. Further linking cross-industry return predictability to the real economy, lagged employment growth for the interdependent industries predicts individual industry employment growth. We also compute out-of-sample industry return forecasts based on the lagged returns of interdependent industries and show that cross-industry return predictability is economically valuable: an industry-rotation portfolio that goes long (short) industries with the highest (lowest) forecasted returns exhibits limited exposures to common equity risk factors, delivers a substantial alpha of over 11% per annum, and performs very well during business-cycle recessions, especially the recent Great Recession.

3:30pm-5:10pm RS Web Data (Room: MR1)
Chair: Samaneh Beheshti-Kashi

Forecasting city arrivals with Google Analytics: the merits of big data shrinkage techniques and forecast combination
Ulrich Gunter, MODUL University Vienna; Irem Önder, MODUL University Vienna

This article investigates the predictive ability of 10 Google Analytics website traffic indicators from the website of the DMO of Vienna for the actual arrivals to this city destination. Big Data such as website traffic data are data that are too large and complex to analyze with standard methods (Snijders, Matzat, & Reips, 2012). Block Granger causality tests show that Google Analytics indicators jointly Granger-cause total arrivals to Vienna, but since this causality is not monodirectional vector autoregression (VAR) becomes an appropriate model class. As the study sample is quite small (2008M08 – 2014M10) and in order to prevent over-parameterization, methods for big data shrinkage recently proposed in the literature are applied to create three rival forecast models to the classical VAR of dimension 11: (1) Bayesian estimation of the VAR of dimension 11 (BVAR), (2) reduction to and OLS estimation of a factor-augmented VAR of dimension 3 (FAVAR) by extracting 2 factors from the 10 Google Analytics indicators, and (3) an application of estimation technique (1) to the FAVAR of dimension 3 (2), the so-called Bayesian FAVAR (BFAVAR). The ex-ante out-of-sample forecasting performance for these four multivariate models is evaluated in terms of standard accuracy measures (RMSE and MAE) for forecast horizons h= 1,

2, 3, 6, and 12 months ahead relative to three univariate benchmarks (MA(2), ETS, and naïve-1). Results based on the single models show that FAVAR and BFAVAR generally outperform their multivariate competitors (classical VAR and BVAR) across horizons, but that overall MA(2) and ETS perform best except for one case. The over-parameterized classical VAR of dimension 11 performs worst on a regular basis and is also significantly outperformed by its competitors according to Hansen tests for horizons h=1, 2, and 3 as is the simple naïve-1 benchmark. Finally, four methods of forecast combination are evaluated: (a) uniform combination, (b) combination according to Bates-Granger weights, (c) combination according to forecast encompassing tests, and (d) a combination of methods (b) and (c) only recently introduced in the literature. Methods (b) to (d) are designed to mitigate the impact of bad forecast models (classical VAR and naïve-1) on the combined forecast. For horizons h=3, 6, and 12, the combined forecasts outperform the forecasts of the single models in four cases, whereby only in two cases the more sophisticated methods (b) and (c) can beat the simple uniform combination.

Measuring Uncertainty with Google Trends
Maria Elena Bontempi, University of Bologna; **Roberto Golinelli**, University of Bologna; Matteo Squadrani, University of Bologna

The interest in macroeconomic uncertainty has seen in recent years a significant increase, as witnessed by the number of papers covering this topic (see, among the others, Baker et al., 2013, Bloom, 2009, Julio and Yoox, 2012, Jurado et al. 2015). However, uncertainty is not directly measurable and, for this, quantitative analyses involving it must rely on several proxies whose estimates are not fully agreed upon. Moreover, must studies focus on the latent generating process of uncertainty and not on the amount of uncertainty actually perceived by people, which is influenced by both the available information and its spread over time and across individuals. The aim of the paper is to fill this gap by introducing a measure of macroeconomic uncertainty based on the intensity of information search on internet, which we believe depends on the uncertainty about the outcome of a particular political debate or economic issue weighted by its subjective relevance perceived by people. To do so, we use Google Trends (Varian, 2014) focusing on the use of search-terms linked with macroeconomic policy in order to capture the level of information needed by people to reduce their uncertainty about economic and policy questions. In particular, our empirical analysis uses data about internet searches on Google for specific search terms chosen according to the list of 210 terms used by Baker et al. (2013) to develop their news-based economic uncertainty index. In order to summarize this large amount of information, we employ alternative empirical approaches, ranging from simple averages to factor analysis. Then, we investigate, both qualitatively and quantitatively, the relationship between these Google Trends measures and alternative benchmark estimates of economic uncertainty, such as the Economic Policy Index (EPU) of Baker et al. (2013) and its news-based component, the h-months ahead macro-uncertainty indexes of Jurado et al. (2015), and the CBOE Volatility Index (VIX). In particular, we use shrinking and selection algorithms (such as Lasso), and Bayesian model averaging (BMA) procedures to investigate the relationship between each uncertainty proxy and our Google-based measures of uncertainty. We find statistically significant relationships between many of the factors obtained from the principal components analysis and the benchmark proxies for uncertainty listed above. However, given that not all the factors are significant, not every policy category has the same importance in explaining the different uncertainty proxies, as many queries useful in explaining one of them are not relevant for the others.

Twitter and Fashion Forecasting: An Exploration of Tweets regarding Trend Identification for Fashion Forecasting
Samaneh Beheshti-Kashi, BIBA – Bremer Institut für Produktion und Logistik GmbH

The fashion industry faces serious challenges in terms of accurate demand forecasting. While production decisions have to be made at an early stage, precise demand information only become available several months later. One main characteristic of the fashion industry is long time-to-market compared to short selling periods. Consequently, it is hardly possible to replenish successful products. Therefore, companies will have losses in terms of stock-outs or overstocked inventories. In order to avoid these losses accurate forecasts are needed. We suggest examining social media text data to support baseline forecasts. This research explores the question if the microblogging service Twitter can be an appropriate source for extracting relevant features in order to predict future fashion trends. Mainly we tackle the following

questions regarding the Tweets: can we extract information regarding colors, cuts, materials or fashion styles of a product? And if this is given how these words do occur together? For this purpose we collected Tweets which are either brand related, product type related or event related. The analysis is divided into two parts: In the first step, the pre-processing of the text data, we applied tokenization, stopword filtering, stemming and case transformation. In a second step, we applied Associations Rules in order to examine co-occurrences of the extracted words and Clustering (k-Means) to explore the tweeting behavior of the users on brands and fashion events. The analysis shows that working with tweets, we have to tackle with a lot of noisy data. Though, it is possible to extract information regarding colors, materials or fashion styles. However, this work is more a qualitative approach to the topic and we suggest validating our examination with larger data sets.

Google Trend and Forecasting Performance of Alternative Exchange Rate Models
Levent Bulut, Ipek University

In this paper, for the first time in the literature on the exchange rate disconnect puzzle, internet search data via Google Trend is utilized to nowcast the known variates of two structural exchange rate determinations models; purchasing power parity (PPP) model and Monetary model for 12 OECD countries' exchange rates for the period Jan 2004 –June 2014. Then, by using the point-forecast criterion, the out-of-sample forecasting performance of these two structural models were tested against the null of random walk with drift and without a drift. The results indicate that, in out of sample forecasting of exchange rate returns, a parsimonious model that uses only the Google search data do perform as good as the structural models. Also, after including the Google search entries that are related to the fundamentals of each structural model, the out-of-sample forecasting performance increased significantly. For PPP, seven out of twelve currencies that were failed to outperform the random walk with a drift null can now outperform the null with google trend data. For the Monetary model, this is the case for four countries. The results are similar against the driftless random walk null. Our interpretation of these very interesting findings is that Google search data can help picking up the market expectations of macro fundamentals that were not being fully captured by the official data.

Wednesday, 24 June

8:30am - 9:40am
Keynote Session III (Room: RC)

Joel Cohen

Abby Rockefeller Mauzé Professor of Populations, The Rockefeller and Columbia Universities, USA

The human population: projections and predictions

According to many demographers, population projections forecast populations conditional on assumed trends in births, deaths and migration, while population predictions unconditionally forecast what is expected to happen (sometimes with an associated probability or confidence). This expository, non-technical talk will review some recent innovations in population projections and population predictions, compare their methods and results, and identify where more remains to be done. From areas of general agreement, what appears to be known about the future of the human population in the 21st century? How useful are the methods of population projection and prediction in trying to influence future population?

9:45am-11:00am Forecasting Practitioner Track 9 (Room: MR10)

Robert Fildes, Director, Lancaster Forecasting Centre

Improving Forecast Quality in Practice: Survey and Panel Discussion
This session examines the results of an important new survey on the key elements for improving the quality of the forecasting function. Much academic research has focussed on statistical or economic models; however organizations seldom use these more complicated models even where there is evidence they provide benefits. A lot more is involved here than software and statistical methodology, important though they are; it's also about removing organizational impediments, developing appropriate performance benchmarks and motivational incentives, and improving data reliability and flow within the organization. And how helpful is a well-thought through S&OP process?

Panelists: Scott Armstrong, Stephan Kolassa, Fotios Petropoulos, Eric Stellwagen

9:45am-11:00am IS Forecaasting the transportation demand (Room: MR1)
Chair: Mohsen Hamoudia

An ARIMA-GARCH-Bootstrap based method applied for forecasting the air passenger demand

Maria Rosa Nieto, Universidad Anahuac Mexico Norte; Rafael Bernardo Carmona-Benitez, Universidad Anahuac Mexico Norte

The estimation of the air transportation passenger (pax) demand is important for airport design, planning, investment, and for opening new routes. A good forecast guarantees the economic viability of the air transportation business because it reduces risks for lack of potential market. The estimation of pax demand per route is of extreme importance not only for opening new routes and business opportunities, it is also important for government investment decisions such as the increase of airport infrastructure and the enhancement of new markets, such decisions must be supported by proper planning, which depends directly on a good forecast of pax demand. It is therefore necessary to ensure that infrastructure designers and planners take into account the forecast growth for the lifetime of an airport reaches the expectations of its original planning. This information is important and can be obtained by applying time series models or development of econometric models. In literature, there are different time series methods and econometric models that are used or develop for estimating the air transportation pax demand. These methods are mainly ARIMA, Moving Averages, Exponential Smoothing, Winters, Grey Model and a number of econometric models based primarily on multiple regressions and panel data. Contrary, GARCH and GARCH-Bootstrap methods, to our knowledge, have never been used to forecast air pax demand. These time series methods are applied mainly in the financial area to forecast time series volatility, since pax demand is highly volatile, the main objective and contribution of this study is to apply and demonstrate that the ARIMA-GARCH-Bootstrap method can be used to forecast pax demand in the air transportation industry. In this study, the ARIMA-GARCH-Bootstrap method is applied to forecast the air pax demand using data from the United States. The results of its application are compared with the results obtained by applying the most commonly used models in the industry. The forecasting methods presented in this paper are set up by analyzing The United States domestic air transport market (Bureau of Transportation Statistics, 1991-2014) approximately 4380 data points.

Forecasting the Air Transportation Demand: An application at Amsterdam Schiphol Airport using Bagged Holt Winters assisted by Compression-Based Dissimilarity measure

Tiago Mendes Dantas, Pontifical Catholic University of Rio de Janeiro; Fernando Luiz Cyrino Oliveira, Pontifical Catholic University of Rio de Janeiro

This study aims to obtain accurate forecasts with prediction intervals for the monthly time series of total passengers onboard at the Amsterdam Schiphol airport, which can be considered as a proxy for air transport demand. To do so, we propose an approach that incorporates a Compression Based Dissimilarity measure to BaggedETS, called Bagged CDM Holt Winters (Bagged CDM HW). The results show that, to this particular problem, the new approach is able to generate better forecast when compared with other methods, such as BaggedETS, ARIMA, Holt Winters, Neural Networks and Naive method.

Forecasting Occupancies in Urban Networks with Volume-weighted adaptive LAD LASSO
Yiannis Kamarianakis, Arizona State University; **Mario Giacomazzo**, Arizona State University

Traffic Control Centers (TCCs) monitor road traffic in urban road networks using sensors that report (typically every 5 minutes) at least two variables: traffic volume and road occupancy. TCCs identify congestion by threshold exceedances for the levels of occupancies and require accurate short-term forecasts (from 5 minutes up to 1 hour) in order to assess whether congestion mitigation actions (eg modified signal plans) should be performed. This work develops parametric time series models that take into account varying costs of forecasting errors, with costs depending on the levels of traffic volumes. The models account for space-time dependencies, cross-correlations of traffic variables and regime-switching dynamics; parameter estimation is performed with weighted adaptive LAD LASSO. Forecasting accuracy of the proposed models versus ARIMA and 3 naïve estimators is evaluated using data from the TRB traffic forecasting competition.

9:45am-11:00am IS Frontiers in Electricity Forecasting 2 (Room: MR2)
Chair: Tao Hong

The myths of residual simulation for probabilistic load forecasting
Jingrui Xie, SAS Institute; Tao Hong; Tom Liang, NCEMC; Chongqing Kang

Grid modernization has brought in various active demands and intermittent and distributed generation resources to challenge the traditional power system planning and operation practices. As a result, more and more decision making processes rely on probabilistic forecasts as an input. However, the research on the applications of load forecasting has been heavily relying on unverified distributions of load forecasting errors, such as normal distributions. In this paper, we apply a proper scoring rule, the pinball function, to evaluate a set of probabilistic load forecasts, focusing on understanding how residual simulation would affect the quality of forecasts with different underlying linear regression models. We present two case studies to reveal the myths of Residual Simulation for Probabilistic Load Forecasting, one based on data from a large generation and transmission cooperative in the U.S., and the other based on data from the probabilistic load forecasting track of the Global Energy Forecasting Competition 2014.

Quantile regression algorithms for forecasting uncertainty in electricity smart meters data
Souhaib Ben Taieb, King Abdullah University of Science and Technology; Rob J. Hyndman, Monash University; Marc G. Genton, King Abdullah University of Science and Technology

Smart electricity meters are currently deployed in millions of households to collect detailed individual electricity consumption data. Compared to traditional electricity data based on aggregated consumption, smart meter data are much more volatile and less predictable. There is a need within the energy industry for probabilistic forecasts of household electricity consumption to quantify the uncertainty of future electricity demand, in order to undertake appropriate planning of generation and distribution. Smart meter data provide the data to meet this need. We adopt a quantile regression approach where a different model is estimated for each quantile of the future distribution by minimizing the pinball loss. We propose to compare different quantile regression methods in terms of forecast accuracy for different quantiles and different forecast horizons, and in terms of computational time. Our experiments will be based on a smart meter dataset collected from 3639 households in Ireland at 30-minute intervals over a period of 1.5 years. We present some preliminary results obtained for one smart meter together with some planned future work.

Electricity demand interval forecasting with Quantile Regression Averaging
Jakub Nowotarski, University of North Carolina, Charlotte and Wrocław University of Technology; Bidong Liu, University of North Carolina, Charlotte; Tao Hong, University of North Carolina, Charlotte; Rafał Weron, Wrocław University of Technology

Majority of the load forecasting literature has been on point forecasting, which provides the expected value for each step throughout the forecast horizon. In the smart grid era, the electricity demand is more active and less predictable than ever before. As a result, probabilistic load forecasting, which provides additional information on the variability and uncertainty of future load values, is becoming of great importance to power systems planning and operations. This paper proposes a practical methodology to generate probabilistic load forecasts by performing Quantile Regression Averaging (QRA) on a set of sister point forecasts. There are two major benefits of the proposed approach: 1) it can leverage the development in the point load forecasting literature over the past several decades; and 2) it does not rely so much on high quality expert forecasts, which are rarely achievable in load forecasting practice. To demonstrate the effectiveness of the proposed approach and make the results reproducible to the load forecasting community, we construct a case study using the publicly available data from the Global Energy Forecasting Competition 2014. Comparing with the benchmark methods that utilize the variability of a selected individual forecast, the proposed approach leads to dominantly better performance as measured by the pinball loss function and the Winkler score.

9:45am-11:00am IS Nowcasting 3 (Room: MR5)
Chair: Michele Modugno

Forecasting Emerging Markets Equities – the Role of Commodity Beta
Huiyu Huang, Grantham, Mayo, Van Otterloo & Co., LLC

Emerging markets are dominated by heavy commodity exporting and importing countries. On one hand you have Russia and Brazil, and on the other hand you have China and India. One important factor driving the diverging behavior of their equity returns is the underlying global commodity prices especially energy. This paper investigates the role of such commodity sensitivity (beta) together with commodity price movements in forecasting emerging country-sector returns. A rotation strategy based on commodity dynamics and equity betas to commodities is shown to deliver significant risk-adjusted excess return over S&P IFCI EM benchmark.

Macroeconomic Nowcasting Using Google Probabilities
Luca Onorante, Central Bank of Ireland; Gary Koop, University of Strathclyde

Many recent papers have investigated whether data from internet search engines such as Google can help improve nowcasts or short-term forecasts of macroeconomic variables. These papers construct variables based on Google searches and use them as explanatory variables in regression models. We add to this literature by nowcasting using dynamic model selection (DMS) methods which allow for model switching between time-varying parameter regression models. This is potentially useful in an environment of coecient instability and over-parameterization which can arise when forecasting with Google variables. We extend the DMS methodology by allowing for the model switching to be controlled by the Google variables through what we call Google probabilities. That is, instead of using Google variables as regressors, we allow them to determine which nowcasting model should be used at each point in time. In an empirical exercise involving nine major monthly US macroeconomic variables, we nd DMS methods to provide large improvements in nowcasting. Our use of Google model probabilities within DMS often performs better than conventional DMS.

Nowcasting China
Michele Modugno, Fed Board; Silvia Miranda-Agrippino, Now-Casting Economics; Domenico Giannone, New York Fed; Lucrezia Reichlin, London Business School

In this paper, we construct a synthetic indicator to monitor and summarize the informational content of the Chinese macroeconomic data flow. The index is optimally extracted in real-time from a heterogeneous set of data, published at different frequencies and in a nonsynchronous fashion, that we selected to best represent the Chinese economy. We evaluate the forecasting ability of the index in nowcasting Chinese real GDP in real time. We find that the forecasts implied by our index are at least as accurate as market forecasts and outperform forecasts implied by other existing indices. Further, our index-based forecasts are continuously updated and thus timelier than forecasts implied by other existing indices or produced by international institutions, including the IMF and the OECD.

9:45am-11:00am RS Demand Forecasting 2 (Room: MR4)
Chair: Zuhaimy Ismail

How Change of the Relative Importance of Product Attributes to Consumers can Influence New Product Sales Forecasting Methods; the Consumer Electronic Goods in the UK
Semco Jahanbin, University of Bath; Paul Goodwin, University of Bath; Sheik Meeran, University of Bath; Joao Quariguasi Frota Neto, University of Bath

Customer preferences are not stable, especially where a consumer needs to make a complex or unfamiliar decision. This is, to some extent connected with the theory of bounded rationality, which asserts that decision-makers have a limited capability to process information. As a result they use or recall only a

certain subset of attributes during the decision-making process. If the subset changes over time, perhaps because some attributes become more or less salient, then clearly the relative importance of the attributes in the decision making process will change as well. Another reason for instability of customer preferences is the rapid technological development in consumer electronics products. As a result, some attributes have become more (sometimes less) important over relatively short periods of time. In this research the instability of consumer preferences for different attributes for a purposive sample of electronics products will be examined and compared from different angles with the aim of finding its influence on choice based conjoint analysis as a new product sales forecasting method. If evidence of changes in the relative importance of features is found through this comparison, it means that a static choice based model based on consumer responses made prior to the launch of a product may soon become out of date and hence any forecasts based on the models may have large errors. If not, it provides reassurance for those using static CBC models for forecasting sales of products with short life cycles.

Variable selection of exogenous leading indicators in demand forecasting

Yves R. Sagaert, Ghent University; Nikolaos Kourentzes, Lancaster University;
El-Houssaine Aghezzaf, Ghent University; Bram Desmet, Solventure

Demand forecasting models are often univariate or incorporate only limited short-term promotional information. These do not anticipate changing markets, even though long-term demand forecasts are required. Extending forecasting models with exogenous information could enrich the final prediction. The challenge is to use the typically limited historical data to both identify the univariate structure and appropriate leading indicators from a set of potential variables. A key issue is to be able to distinguish between correlated and causal variables. Although variable selection is a well researched problem in regression type model building, it is far from resolved. In our context it is further exacerbated by the limited data that is typical in business forecasting applications, where the historical sales observations are far less than the number of potential leading indicators. Various methodologies, from simple heuristics to shrinkage estimators, such as LASSO, are investigated to overcome the variable selection problem for demand forecasting. These are empirically evaluated in a case study using real demand data from a manufacturer and leading macro-economic indicators from the various global markets the manufacturer trades in.

Forecasting New Vehicle Demand with Limited Sales Data

Zuhaimy Ismail, Univerisiti Teknologi Malaysia; Noratikah Abu, Univerisiti Teknologi Malaysia

Forecasting diffusion of new product or new technologies is usually carried out using aggregate diffusion models. This paper presents a newly modified Bass Model for forecasting the diffusion of new vehicle or an innovation in the Malaysian society. The purpose of this model is to represent the level of spread on the new vehicle among a given set of the society in terms of a simple mathematical function that elapsed since the introduction of the new product. New product or new technologies normally has limited amount of data available. This model will then be used to forecast the sales volume. A procedure of the proposed diffusion model was designed and the parameters were estimated. Results obtained by applying the proposed diffusion model and numerical calculation shows that the model is robust and effective for forecasting demand of the new vehicle. An application of the methodology is also illustrated, providing short-term forecasts for the newly launched Proton Car and its penetration. The results reveal that the methodology is capable of producing improved predictions and this study conclude that the newly developed bass diffusion of demand function has significantly contributed for forecasting the diffusion of new product.

9:45am-11:00am RS Demography/Social Security/Elections (Room: MR9)
Chair: Scott Armstrong

A New Approach for a Forecasting Model in the Estimation of Social Security Benefits

Chandrasekhar Putcha, California State University at Fullerton; **Brian Sloboda**, US Department of Labor

There is a great interest to revamp the present model for social security. Hence, this paper first develops a model which is used in arriving at the present social security benefits. Then, suggestions are provided to improve the social security model. As stated, this paper develops a method to forecast social security. The present formula for calculation of social security benefits, while based on a person's lifetime earnings, uses adjusted or "indexed" earnings to account for changes in average wages since the earnings were recovered. The indexed earnings, which are more than actual earnings, are used to calculate the actual social security benefits. This index factor varies widely in a period of 60 years - from 14.12 in 1953 to 1.0 in 2013. Interestingly, the federal government reduced the index factor to 1.0 in 2012. Therefore, the indexed earnings will be same as actual earnings for future social security calculations, resulting in possible reductions in future social security benefits. Hence, an attempt is made in the present research to study the current formula for calculation of social security benefits in detail, suggest appropriate changes, and propose an improved model that realistically estimates social security benefits. To start, a functional relationship in the form of a specific model will be fitted between the index factor and the cumulative number of years. As a result, a new model will be derived. All of these options will be examined, and the best model will be fitted given the data. The results should be useful to researchers in economics, public policy, and other disciplines.

Reconciling forecasts of infant mortality rates at national and sub-national levels: A bottom-up method

Han Lin Shang, Australian National University

Mortality rates are often disaggregated by different attributes, such as sex and region. Forecasting mortality rates at national and sub-national levels plays an important role in making societal policies associated with national and sub-national levels. Independent forecasts at sub-national levels may not add up to the forecasts at national level. To address this issue, we consider the problem of reconciling mortality rate forecasts from the viewpoint of grouped time-series forecasting (Hyndman, Ahmed, Athanasopoulos and Shang, 2011, Computational Statistics and Data Analysis). We introduce a bottom-up method to produce point forecasts of mortality rates that are aggregated appropriately across different levels of a hierarchy. Using the regional infant mortality rates in Australia, we investigate the one-step-ahead to 20-step-ahead point forecast accuracy. The proposed bottom-up method is useful for forecasting demographic rates at national and sub-national levels.

Effect of conservatism on the accuracy of forecasts from econometric models

Andreas Graefe, LMU Munich; **J. Scott Armstrong**, University of Pennsylvania; Kesten Green, University of South Australia

With the objective of improving the accuracy of election forecasts, we examined three evidence-based forecasting guidelines that are relevant to forecasting with causal models. The guidelines suggest: (1) modifying estimates of the strength of variable effects to account for uncertainty, (2) combining forecasts from diverse models, and (3) utilizing all variables that are important. We applied the guidelines to eight established U.S. presidential election-forecasting models and tested the effects on forecast accuracy by calculating cross-validated out-of-sample forecasts. Modifying effect sizes reduced error compared to the errors of the original model forecasts by about 5% on average. Combining forecasts from the eight models reduced error by 36%. And including all 25 variables from the eight models in a single equal-weights index model reduced error by 46%.

9:45am-11:00am RS Exponential Smoothing (Room: MR7)
Chair: Slawek Smyl

Complex Exponential Smoothing for Time Series Forecasting
Ivan Svetunkov, Lancaster Centre for Forecasting; Nikolaos Kourentzes, Lancaster Centre for Forecasting

This paper presents Complex Exponential Smoothing (CES), a new model that is capable of capturing a wide variety of time series structures without requiring model selection. CES is based on conventional exponential smoothing but also attempts to capture the "information potential", an unobserved part of the time series that typical time series models do not consider. The observed time series is modelled together with the information potential using complex variables, resulting in a very flexible model. In this paper we extend CES to the seasonal case. The proposed model can capture known forms of seasonality, as well as new ones that are neither additive nor multiplicative. We introduce a model selection procedure to choose between non-seasonal and the new seasonal CES based on Akaike information criterion. We empirically evaluate the performance of CES with model selection against ETS and ARIMA on simulated and real data, finding that CES performs best.

Fitting and Extending Exponential Smoothing Models with Stan
Slawek Smyl, Microsoft; Qinqin Zhang, Microsoft
Time series forecasting is a fundamental challenge to various industries like retail and finance. Most of the classical forecasting models, including regression, ARIMA, exponential smoothing, assume that the characteristics of input data can be fully captured except for mean-zero Gaussian noise terms. However, this assumption is frequently invalid for highly volatile data with heavy-tail distributions. Analytical tractability is a big obstacle combating non-Gaussian noise terms. But with Stan (http://mc-stan.org), a probabilistic programming language implementing full Bayesian statistical inference, implementing innovative time series forecasting algorithms becomes easier. In this study, we discuss a few extensions to Holt-Winters Exponential Smoothing algorithm including: 1) using a robust error distribution (Student) 2) allowing sigma to grow non-linearly with time series data 3) capturing error distribution during fitting stage and using this information during future paths' simulation phase, e.g. by skewing the error distribution We demonstrate improvements brought by this framework in forecasting with irregular, real life data sampled from some Microsoft online services. We also discuss the situations under which we suggest to implement this framework instead of classical forecasting models with standard errors. Last but not least, we supplement the paper with sample codes we use to generate the examples in RStan.

9:45am-11:00am RS Forecasting Financial Data 4 (Room: MR8)
Chair: Jae Kim

International Stock Return Predictability: Evidence from New Statistical Tests
Amelie Charles, Audencia Nantes; Olivier Darne, LEMNA, University of Nantes; **Jae Kim**, La Trobe University

We investigate whether stock returns of international markets are predictable from a range of fundamentals including key financial ratios (dividend-price ratio, dividend-yield, earnings-price ratio, dividend-payout ratio), technical indicators (price pressure, change in volume), and short-term interest rates. We adopt two new alternative testing and estimation methods: the improved augmented regression method and wild bootstrapping of predictive model based on restricted VAR form. Both methods take explicit account of endogeneity of predictors, providing bias-reduced estimation and improved statistical inference in small samples. From monthly data of 16 Asia-Pacific (including U.S.) and 21 European stock markets from 2000 to 2014, we find that the financial ratios show weak predictive ability with small effect sizes and poor out-of-sample forecasting performances. In contrast, the price pressure and interest rate are found to be strong predictors for stock return with large effect sizes and accurate out-of-sample forecasts.

Nowcasting public finance in Italy
Laura Carabotta; Peter Claeys

Tracking developments in public finance using high-frequency data has become ever more important in the framework of budgetary surveillance in the EU. Different methods have shown some success in predicting annual budget outcomes as compared to official forecasts (Onorante et al., 2010, Paredes et al., 2009, Pedregal and Pérez, 2010 and Pérez, 2007). We use monthly cash data of the Central Government sector in Italy since 1992 to track intra-annual fiscal developments, on both revenue and expenditure categories, and add leading indicators on the business climate, or internet searches to nowcast fiscal trends. Simple time-series models augmented with real-time data can produce quite accurate forecasts of the annual budget deficit. The forecast anticipates a few breaks that are not captured in official or private forecasts for the Italian deficit. This gain does not result in significant gains in performance over time, however, as in other forecasts. Public deficits remain hard to predict due to political and economic uncertainties.

Predicting U.S. Stock Market Return: Evidence from the improved Augmented Regression Model
Doureige Jurdi, La Trobe University; Jae Kim, La Trobe University

We examine the predictability of US stock market return using a range of financial indicators representing the economic fundamentals. We adopt the (improved) augmented regression method developed by Kim (2014), which addresses the problem of endogeneity of predictive regression and mitigates the Stambaugh bias for parameter estimation and statistical inference. Using moving sub-sample windows to a long time series from 1926 to 2012, we evaluate the time-variation of predictability and conduct statistical inference free from data snooping bias. Overall, we find little evidence of in-sample and out-of-sample predictability for US stock market return. In-sample predictability is found to be statistically significant (at a conventional level of significance) from time to time, but its effect size is negligible in most cases. We also find weak evidence of predictability of stock market return when evaluating multi-step ahead (out-of sample) forecasts generated by the (improved) augmented regression. Mean variance investors realize sporadic economic gains in utility based on predictive regression forecasts relative to naïve model historic average forecasts.

9:45am-11:00am RS Forecasting Inflation 2 (Room: MR3)
Chair: Daniel G. Garces Diaz

Threshold and Seasonal Rationality in Inflation Forecasts
Nathan Goldstein, Bar-Ilan University; Ben-Zion Zilberfarb, Bar-Ilan University

We suggest extending standard rationality tests, to take account of threshold and seasonal effects that may characterize expectations behavior. We apply our approach to a unique Israeli data set of inflation forecasts, taking advantage of the vast changes in inflation levels and dynamics during the sample period. The survey period can be divided to three distinct sub-periods of high, moderate and low inflation rates. Standard tests of bias and efficiency did not reject rationality only for the high inflation sub-period, while indicating deviations from rationality in the low and especially the moderate inflation sub-periods. Thus, it was not clear from standard testing if deviations from rationality are consistent with the inflation level. Therefore, we propose to split the sample according to the inflation level endogenously by applying a threshold estimation procedure. The findings demonstrate that expectations behavior did correspond to the inflation level, where forecasts behave more rationally under high inflation rates than under low rates. Furthermore, the evidence suggests that the threshold itself may be changing according to the general inflation environment of the period. Deviations from rationality also respond to the inflation cycle, with diminishing bias in times of rising inflation. In addition, we take advantage of the fact that the forecasts refer to seasonally unadjusted inflation rates and find that forecasts fail to capture the true seasonal pattern of the inflation series. Finally, combining the threshold, cycle and seasonal effects altogether in a single regression, shows that their significance still holds. It further provides a detailed description of forecasters' state-dependence behavior, deviating and turning back to rationality in a dynamic manner. The recent approaches of information rigidities may suggest a way to understand our findings, where we stress in

advance the possibility of a dynamic rational behavior which may correspond to the changes in information rigidities. The seasonality findings offer the possibility of more "technical" forms of biases that may also exist in survey forecasts and should be controlled as well, while examining the more "structural" forms of biases.

Interest Rate Disagreement and the Shape of Inflation Fan Charts
Malte Knüppel, Deutsche Bundesbank; **Guido Schultefrankenfeld**, Deutsche Bundesbank

To investigate potential determinants of the shape of forecast inflation fan charts, we analyze the historical interest rate voting patterns of the Bank of England's Monetary Policy Committee, the Magyar Nemzeti Bank's Monetary Council and the Sveriges Riksbank's Executive Board. We find that current disagreement on the level of the policy rate translates into the asymmetry, but not the width of the subsequent forecast inflation fan charts of the Bank of England and of the Sveriges Riksbank. The opposite is true for the Magyar Nemzeti Bank. As fan charts are usually seen to represent the common view of all members of the decision-making body, we argue that such fan-chart modifications serve to accommodate minority views on monetary policy.

Changes in Inflation Predictability in Major Latin American Countries
Daniel G. Garces Diaz, Banco de Mexico

Forecasts of inflation in the United States since the mid eighties have had smaller errors than in the past, but those conditional on commonly used variables could not beat univariate ones (Stock and Watson, 2007). This was patently clear during the recent "missing deflation puzzle." This paper shows through simple modifications to the classical monetary model that something similar occurred in those major Latin American economies that achieved their own ``Great Moderation.'' For those countries that did not attain macroeconomic stability, inflation forecasting remained as before. Allowing that the causality among variables changes when the monetary regime does permits to fit a parsimonious inflation model to all available data (eight decades for one country and five for the others). The high goodness of fit and the good out-of-sample forecasting properties of the model for each country within each monetary regime suggests that, apart from the instrument set by the central bank, it is difficult to find other valid explanatory variables for inflation. This result includes, as a special case, the behavior of inflation as noise around a constant that has been observed in the Latin American countries that successfully applied inflation targeting.

11:15am-12:30pm IS Seasonal Adjustment (Room: MR1)
Chair: Tucker McElroy

The application of the Wiener-Hopf factorization to signal extraction decompositions
Tucker McElroy, U.S. Census Bureau

A long-standing deficiency of the decomposition routine of Hillmer and Tiao (1982), which is implemented by SEATS to seasonally adjust millions of time series around the world, is that the decomposition may not always exist; when it does exist, it is not unique, although the canonical decomposition essentially claims uniqueness through its imposed definition. This paper presents a new approach to the problem, by intepreting spectral quantities in the Hillmer-Tiao decompostion as cross-spectra rather than as spectral densities. Then we obtain a unique decomposition, which always exists, and we can apply signal extraction formulas that allow for cross-correlation of the latent components; this behavior, known as hysteresis, is an algebraic corrollary of the decomposition of the fitted model. We describe the method's implementation, and apply to economic series.

Seasonal Adjustment of Hybrid Time Series
Keith Phillips, Federal Reserve Bank of Dallas; Jianguo Wang, Federal Reserve Bank of Dallas

Hybrid time series data often require special care in estimating seasonal factors. Series such as the state and metro area Current Employment Statistics produced by the Bureau of Labor Statistics (BLS) are composed

of two different source series that often have two different seasonal patterns. In this paper we address the process to test for differing seasonal patterns within the hybrid series. We also discuss how to apply differing seasonal factors to the separate parts of the hybrid series. Currently the BLS simply butts up the two different sets of seasonal factors at the transition point between the benchmark part of the data and the survey part. We argue that the seasonal factors should be extrapolated at the transition point.

Statistical Forecasting to Validate Annual and/or Seasonal Survey Estimates: An example from Statistics Canada

Steven Matthews, Statistics Canada; Susie Fortier, Statistics Canada; Frederic Picard, Statistics Canada

This presentation will describe how forecasting is being used to validate estimates produced from several business surveys at Statistics Canada. For a number of surveys, updates to methodology are being implemented that could potentially result in breaks in the time series of survey estimates. A strategy has been developed to determine if breaks in the estimates exist for individual time series, and to apply corrections where required to meet the needs of data users. An important component of the strategy includes the use of statistical forecasting techniques to generate baseline estimates for comparison with survey results for each time series. Since both annual and monthly surveys are affected, a seasonal component is included in the model where appropriate. In this talk, the strategy used to select the forecasting model will be discussed, and summary results on various aspects of the performance of the models are given. An initial quality indicator for the forecasts will also be presented, along with results and lessons learned from the project.

11:15am-12:30pm IS Simple Forecasting for Better Public Policies (Room: MR7)
Chair: Kesten Green

Are dangerous warming forecasts consistent with the Golden Rule?

J. Scott Armstrong, Wharton School, University of Pennsylvania; Kesten Green, University of South Australia Business School

The Golden Rule of Forecasting requires forecasters to be conservative by forecasting in a way that is consistent with cumulative knowledge about the situation and about forecasting. Violating the average guideline increases forecast errors by more than 40%. We examined whether the United Nations Intergovernmental Panel on Climate Change's (IPCC's) forecast of dangerous manmade global warming was derived in a way that is consistent with the Golden Rule. To do that, we rated the IPCC's forecasting procedures against the Golden Rule Guidelines checklist of 28 items. We did the same for the evidence-based no-trend forecast. We found that the no-trend forecast procedure was consistent with 19 of the 20 relevant guidelines, whereas the IPCC's approach was consistent with none of the Golden Rule Guidelines. Policy decisions based on forecasts that flout the Golden Rule seem likely to harm welfare.

Forecasting Health Care Reform: Application of Simple Forecasting and the Golden Rule
Elaine Deschamps, Caseload Forecast Council

Predicting the impact of the Affordable Care Act, particularly the Medicaid Expansion, is a major challenge facing state policy makers, budget writers, and forecasters. Criteria for Simple Forecasting and the Golden Rule are applied to a case study of Medicaid enrollment forecasting in Washington State. We examine how techniques such as decomposition, judgmental input, combining forecasts, and applying simplicity criteria impact forecast accuracy and user understanding of the forecasts. This analysis includes quantitative components, such as an evaluation of forecast error for top-down versus bottom-up forecasts, and qualitative components, such as an assessment of a Medicaid forecast technical workgroup in improving the quality of domain knowledge, reducing bias, assessing data quality, critically reviewing methodologies, and improving user understanding of the forecasts.

Are IPCC climate-forecasting methods too complex?

Kesten Green, University of South Australia Business School; Scott Armstrong, Wharton School, University of Pennsylvania

The United Nations Intergovernmental Panel on Climate Change's (IPCC's) forecast of dangerous manmade global warming is an important influence on public policy decisions in many countries. Rational policies require that policy makers obtain forecasts from evidence-based methods. A review of comparative studies found that sophisticatedly simple methods, which can be readily understood by decision makers, provide forecasts that are substantially more accurate than those from more complex methods. Using a checklist of nine items, we assessed the simplicity of the IPCC's forecasting procedures. The checklist items cover the understandability of the forecasting process and models, and the clarity of the relationships between the model outputs, forecasts, and decisions. Our checklist responses gave the IPCC procedures a "simplicity rating" of 1.7 or 19%. In contrast, a "no-trend forecast," obtained a simplicity rating of 8.4 or 93%. We suggest that making policy decisions on the basis of forecasts from poorly understood procedures could be characterized as "faith-based policy making."

11:15am-12:30pm RS Demand Forecasting 3 (Room: MR4)
Chair: Donald Parent

Automatic time series classification and clustering

Yue Li, SAS Institute Inc; **Pu Wang**, SAS Institute Inc

When dealing with hierarchical forecasting, the hierarchy is one of the keys to generate good forecast. The user-provided hierarchy information often focus on planning purpose, which makes it easier to understand and manage the data. However, such hierarchy might not be good enough for modeling the demand. Retail data can be used as a typical example, which usually contains a large amount of time series, with different length of history, demand cycle, active selling seasons and demand pattern, etc. The merchandise often build the hierarchy based on product attributes like department, brand etc., without considering individual demand features. Conducting a uniform forecasting model based on such hierarchy is mostly likely to result in a low accuracy forecast. A better solution is to create a modeling hierarchy, and build customized modeling strategies for each or a group of series. This is not a trivial task and is impossible to get done manually. The SAS Demand Classification and Clustering provides a data-driven approach to enhance the given planning hierarchy by providing additional time series segmentation information. The final goal is to improve the forecast without loss of the ease of data management. It identifies the features of each time series, and then groups the series based on the features. It also provides guidance on the type of models to use and the appropriate levels for forecast reconciliation. This paper presents the philosophical ideas behind SAS Demand Classification and Clustering Solution and how it can help in improving forecast accuracy for retail data.

Service Parts Demand Forecasting -- Seasonal Peaks using Weather Wisdom

Donald Parent, Nissan North America

Automotive Service Parts time series demand forecasts for original equipment manufacturer (OEM) supply chains utilize various types of forecasting methods. Seasonality continues to be a frontier with substantial supply chain and financial impact that requires relevant short term forecasts throughout the entire life cycle phases that exhibit various seasonal patterns, trends and turning points. The aim of this research is to assess the feasibility, usefulness and application of external data like the Farmer's Almanac seasonal predictions, NOAA climate predications, 3rd party or syndicated data providers, folk forecasting, and historic personal experience when forecasting service parts seasonal demand. Pattern correlations, part categories and clustering are also explored along with seasonal naïve and other univariate methods. Regression type explanatory variables and influencers on demand examples are presented that need to be comprehended or isolated if known. Measuring seasonal predications for both statistical baselines with and without judgmental overrides provides closed loop feedback for continuous improvement as there are few mulligans but rather plenty of reactionary effort if not adequately anticipated further beyond ordinary lead

times and planning horizons. Even with lean, agile, quick response supply chains, the uncertainties, risks and volatility of seasonal demand remains a frontier to predict the timing, magnitude and duration of seasonal peaks and troughs automatically for 1000's of part SKU's with the appropriate amount of value-added human analytical intervention and investment in safety stock.

A Multistage Modeling Strategy for Hierarchical Demand Forecasting Automation

Pu Wang, SAS Institute Inc; Alex Chien, SAS Institute Inc; Yue Li, SAS Institute Inc; Jingrui Xie, SAS Institute Inc

The rapid development of information technologies in the recent decade provides forecasters with huge amount of data, as well as massive computing capabilities. However, "sufficient" data and strong computing power do not necessarily translate into good forecasts. Different industries and products all have their unique demand patterns. There is not a one-size-fits-all forecasting model or technique. For example, in the consumer package goods (CPG) industry, demand at store-SKU level is usually sparse and noisy, which makes it difficult to extract price and promotional effects. For high frequency data such as hourly grocery basket transactions, it is inappropriate and inefficient to apply traditional time series models. A good forecasting model must be tailored for the data to capture the salient features and satisfy the business needs. This paper presents a multistage modeling strategy for hierarchical demand forecasting automation. The proposed strategy does not have restrictions on the forecasting techniques or models. It provides a general framework to build a forecasting system in three stages. In the first stage, it develops a model to extract salient features across multiple time series. And then the extracted features are transformed into an adjustment factor to generate the forecast at the aggregated level. In the second stage, the feature extraction technique is applied again to generate forecast for each individual time series at lower levels. In the third stage, it combines the forecasts obtained from the previous two stages, and conducts a top-down reconciliation to generate the final forecast.

11:15am-12:30pm RS Energy Forecasting 2 (Room: MR2)
Chair: Reinaldo Castro Souza

Modelling peak electricity demand using extreme value theory with time varying parameters: An application to South African data

Caston Sigauke, University of the Witswatersrand

Electricity demand data generally exhibits nonconstant mean and variance. The modelling of South African hourly electricity demand for the period 2006 to 2010 using extreme value theory with time varying parameters is discussed in this paper. Electricity demand is influenced by means or averages as well as by tails of probability distributions (extremes). In electricity demand forecasting it is necessary to depart from the average thinking and model extreme peak electricity demand as this causes problems for system operators as well as decision makers in the electricity sector.

Treating the Electricity Demand for Power Dispatch in a Sthocastic Manner: a Study Case of Brazil

Reinaldo Castro Souza, PUC-Rio; Gheisa Roberta, PUC-Rio; Fernando Luiz Cyrino Oliveira, PUC-Rio; Bruno Bastos, PUC-Rio; Paula Macaira, PUC-RIo

Energy planning and management have always represented a great challenge for most countries all over the world. Since the beginning of industrial revolution, one of the main bottlenecks to economy growth was energy availability, not just due to electricity shortage but also due to the scarcity of other energy resources. Therefore, the necessity to develop methodologies and procedures to predict electricity needs became prominent and a major issue for both academics, government and electricity companies. Based on the methodologies and framework constructed, it is possible to define what actions should be taken to fulfill the electricity demanded by the society. On the actual Brazilian Dispatch model, the electricity demand is treated on a deterministic manner. The main objective from the article is to make an effort to treat the electricity demand forecast on Brazilian Dispatch model on a stochastic manner. To achieve this goal, on the first part of the article the state of art of electricity demand forecast models applied to electricity long-term forecasts will be analyzed through a systematic review of academic articles from indexed journals and

also models used by international and governmental institutions will be overviewed. Considering all the information extracted from the systematic review, an electricity demand forecast model is developed. The idea is to treat the electricity demand forecast on stochastic manner using a bottom-up approach to conceive different forecasts, where issues like distributed generation, energy efficiency and energy saving scenarios and changes on electricity consumer´s behavior will be one of the main issues addressed to develop different electricity forecasts. On the article, just the residential and tertiary sectors will be studied. Further improvements will be done to also develop stochastic electricity demand forecasts considering the industrial sector.

11:15am-12:30pm RS Macroeconomic Forecasting 2 (Room: MR3)
Chair: Alain Kabundi

Forecasting Italian Industrial Production using disaggregated information in conditional vector autoregression.
Riccardo Corradini, ISTAT; Carmine Pappalardo, ISTAT

The paper proposes a model for the short term forecast of the Italian Industrial Production Index. Following the forecasting literature concerning the use of the disaggregate information (e.g., Hendry and Hubrich, 2011), we develop a model for the prediction of the aggregate IP index which includes the disaggregated information related to its sub-components. Predictions are obtained in the form of conditional forecast using a vector auotegression (VAR) approach. Specifically, we produce suitable conditional forecasts (up to 3-steps ahead) using alternative techniques (Kalman filter, Bayesian techniques). According to our findings, once the disaggregate information is included in the aggregate model, the forecasting accuracy of the aggregate forecast improves significantly compared to a benchmark model close to business cycle's turning points, as it better accounts for to the increasing heterogeneity in the cyclical behavior of sub-sectors (Van Nieuwerburgh and Veldkamp, 2006). Overall, using the same information set, we do not find significant differences between the different methods used to perform conditional forecasts.

The Pairwise Approach to Model a Large Set of Disaggregates with Common Trends
Guillermo Carlomagno, UC3M; Antoni Espasa, UC3M

The objective of this paper is to model and forecast all the components of a macro or business variable. Our contribution concerns cases with a large number (hundreds) of components where multivariate approaches are not feasible. We extend in several directions the pairwise approach originally proposed by Espasa and Mayo-Burgos (2013) and study its statistical properties. The pairwise approach consists on performing common features tests between the N(N-1)/2 pairs of series that exist in a group of N of them. Once this is done, groups of series that share common features can be formed. Next, all the components are forecast using single equation models that include the restrictions derived by the common features. In this paper we focus on discovering groups of components that share single common trends. The asymptotic properties of the procedure are studied analytically. Monte Carlo evidence on the small samples performance is provided and a small samples correction procedure designed. A comparison with a DFM alternative is also carried out, and results indicate that the pairwise approach dominates in many empirically relevant situations. A relevant advantage of the pairwise approach is that it does not need common features to be pervasive. A strategy for dealing with outliers and breaks in the context of the pairwise procedure is designed and its properties studied by Monte Carlo. Results indicate that the treatment of these observations may considerably improve the procedure's performance when series are 'contaminated'. An illustration to the US CPI shows the usefulness of the procedure.

Forecasting Key Macroeconomic Variables in South Africa with Large-Scale Models
Alain Kabundi, South African Reserve Bank

This paper forecasts key macroeconomic variables in South Africa in a data-rich environment. The study covers quarter data from 1990Q1 to 2014Q4. Large Bayesian VAR and Factor models outperform small-scale models. In addition, the performance large-scale models is comparable to that of Nowcasting model

for GDP growth, even though the latter approach benefits from information flow within the quarter. The news analysis indicates the importance of soft data in forecasting both variables. In addition, the findings point to the relevance of nowcasting models relative to traditional econometrics models in forecasting the present and the near future.

11:15am-12:30pm RS Temperature Forecasting (Room: MR9)
Chair: Kevin W. Murphy

A forecasting method using a wavelet-based mode decomposition and application to the ENSO index
Adrien Deliège, University of Liège; Samuel Nicolay, University of Liège

This work consists of a presentation and applications of a forecasting methodology based on a mode decomposition performed through a continuous wavelet transform. The idea is comparable to the Fourier series decomposition but where the amplitudes of the components are not constant anymore: the signal is written as a sum of periodic components with smooth time-varying amplitudes. This leads to a drastic decrease in the number of terms needed to decompose and rebuild the original signal without loss of precision. Once the decomposition is performed, the components are separately extrapolated, which leads to an extrapolation of the reconstructed signal that stands for a forecast of the original one. The quality of the forecast is assessed through a hindcast procedure (running retroactive probing forecasts) and Pearson correlations and root mean square errors are computed as functions of the lead time. This technique is first illustrated in details with a toy example, then with the El Niño Southern Oscillation (ENSO) time series. This signal consists of monthly-sampled sea surface temperature (SST) anomalies in the Eastern Pacific Ocean and is well-known to be one of the most influential climate patterns on the planet, inducing many consequences worldwide (hurricanes, droughts, flooding,…) and affecting human activities. Therefore, short-term predictions are of first importance in order to plan actions before the occurrence of these phenomena. As far as the ENSO time series is concerned, the wavelet-based mode decomposition leads to four components corresponding to periods of about 20, 31, 43 and 61 months respectively and the reconstruction recovers 97% of the El Niño/La Niña events (anomalous warming/cooling of the SST) of the last 65 years. Also, it turns out that more than 78% of these extreme events can be retrieved up to three years in advance. Finally, a forecast of the ENSO index is issued: the next La Niña event should start early in 2018 and should be followed soon after by a strong El Niño event in the second semester of 2019.

Forecasting Maximum Daily River Temperatures: Evaluation of Forecast Combination Schemes
Mario Giacomazzo, Arizona State University; Yiannis Kamarianakis, Arizona State University

Forecasting the daily maximum water temperature in rivers is critical since many species have a higher mortality rate when temperatures are above certain (species' specific) thresholds. Accurate forecasts would allow managers of the aquatic environment to take preventative measures. This work analyzes daily measurements from 30 pairs of air-water temperature measurement locations in Spain. Location-specific models based on seasonal and air-to-water association profiles are estimated and horizon-specific forecast combination schemes are developed, aiming to improve accuracy, especially for relatively long horizons (eg. 1 week). Forecast combination schemes pertaining to fixed weights, smooth transition models, and threshold regressions are evaluated in terms of RMSE and MAPE.

A Multi-Decadal Temperature Forecast Grounded in the Observational Record
Kevin W. Murphy, Arizona State University

Decision makers across many sectors of the economy are presented with a wide span of uncertain climate model projections as they work to incorporate anticipated warming into their planning processes. Analyses indicate that "recent observed global warming is significantly less than that simulated by climate models". A pause or 'hiatus' in warming since the turn of the century has contributed to the divergence. For surface air temperatures to reach levels suggested by the Intergovernmental Panel on Climate Change (IPCC), its increase would need to resume immediately at rates in excess of 0.25oC/decade on a sustained basis for the

next 35 years and beyond. An analysis of historical warming rate durations reveals no such precedent within the long-term trend of 0.07oC/decade (1895-2014). Similar doubts arise for temperature projections at regional levels where adaptation planning takes place. In the interest of providing decision makers with an alternative and pragmatic way forward, this paper presents an approach to temperature forecast modeling that incorporates current research findings for the key components of the temperature record: climate sensitivity to anthropogenic forcing and natural internal variability. The recent warming hiatus has motivated a re-examination of internal variability by the climate research community. Its primary 60-70 year cycle that has been operating over centuries has been incorporated to the forecast model. Once that cyclicality is accounted for, the underlying climate sensitivity to a doubling of atmospheric CO2 concentration is identifiable for long-term trend parameterization. Increasing atmospheric CO2 can be projected with a logistic formulation; and a most-likely CO2 forecast falls mid-range amid IPCC scenarios. All temperature model elements are predictable on decadal time scales and support the proposed methodology that is applicable at regional to global scales utilizing observed data records. Expected forecast error is readily calculated through validation analyses employing hold-out forecasts measured against historical outcomes and in comparison to other forecasting methods. Findings show that the temperature record displays a modulation of the anthropogenic trend by internal variability that is likely to continue into the future. Historical periods of warming and cooling are reconciled, including the 1970s cooling period and the current hiatus. Results indicate the hiatus is likely to continue for the next two decades, followed by another warming period similar to the 1980s-90s. Most-likely temperature forecasts, regionally and globally, lie at the low end of the ranges suggested by IPCC climate model simulations, both at mid-century and at end-century.

11:15am-12:30pm RS Volatility forecasting (Room: MR8)
Chair: Xin Zheng

Volatility Forecasting Model Selection with Robust Information Criteria
Wei-Chong Choo, Universiti Putra Malaysia

The main focus of this study is the use of robust information criterion for volatility forecasting. We proposed and implemented a new robust Bayesian information criterion (BIC) using median, namely MedBIC, since median is a more robust estimator than the mean. Since trimming, as an approach to circumvent the problems caused by outliers, has been advocated by many researchers, we propose and implement this simple trimming based on the unconditional quantile to the log likelihood measure of fit for the BIC and name this new robust information criterion as UncondTrimBIC. We also propose and implement a conditional quantile approach to BIC and name this new robust information criterion as CondTrimBIC. Employing the stock market indices data, a comparison study of the robust criteria against BIC has been carried out for four pairs of competitive volatility forecasting methods, including simple exponential smoothing (ES), smooth transition exponential smoothing (STES) (extended ES), generalised autoregressive conditional heteroscedasticity (GARCH) and GJRGARCH. The overall results show that selection performance based on the robust IC, such as CondTrimBIC or MedBIC, has some potential compared to the selection performance based on the standard BIC.

Forecasting returns, volatilities and risk measures in GARCH models: A robust bootstrap procedure.
Carlos Trucios, University of Campinas.; Luiz K. Hotta, University of Campinas; Esther Ruiz, University Carlos III de Madrid

GARCH models are widely used to forecast the volatility and can be used to construct forecast densities for financial returns. These densities can be useful to obtain forecast intervals and quantiles of interest as, for example, the Value-at-Risk (VaR). In this context, bootstrap procedures can be useful as they allow obtaining forecast densities for returns and volatilities that incorporate the parameter uncertainty without assuming any particular error distribution. In this paper, we analyze the effect of outliers on the construction of bootstrap forecast densities for returns and volatilities when they are based on both standard maximum likelihood and robust procedures. The results have implications on the construction of forecast

intervals for returns and volatilities and on VaR forecasts. Finally, we propose a robust modification with good finite sample properties.

Bayesian Estimation with Informative Priors for GARCH Models-Forecasting Stock Market Volatility
Xin Zheng, University of Sydney

This paper applies quasi-maximum likelihood algorithm and Bayesian algorithm to estimate the GARCH, GJR-GARCH and EGARCH models with Gaussian, skewed Gaussian, student-t, skewed student-t, generalized error and skewed generalized error innovations. The data ranges from January 1992 to February 2014 with daily frequency and originates from North America, Australia, Europe and Asia. The Bayesian algorithm formulates informative priors of GARCH models' autoregressive, moving average, shape and skewness parameters by integrating interest rates and exchange rates' parametric structure into specifying priors, which update the likelihoods to generate the posteriors. Bayesian estimation with informative priors generally improves out-of-sample forecasting performance based on RMSE; however, Bayesian estimation does not necessarily improve in-sample forecasting performance based on AIC, BIC information criterion and Kolmogorov-Smirnov statistics. Bayesian estimation with informative priors normally attenuates the difference of RMSE in out-of-sample forecasting while it does not attenuates the difference of AIC and BIC information criterion in in-sample forecasting.

Sunday, June 21, 1:00-4:00pm
Workshop #3: State Space Modeling of Sequence Data, Presenter: Rajesh Selukar, SAS

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The International Institute of Forecasters (IIF), a non-profit organization founded in 1981, is dedicated to developing and furthering the generation, distribution, and use of knowledge on forecasting through the following objectives:

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- Contribute to the **professional development** of analysts, managers, and policy makers with responsibilities for making and using forecasts in business and government.
- Bridge the gap between **theory and practice**, with practice helping to set the research agenda and research providing useful results.
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- **Access to on-going research**

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