International Institute of Forecasters presents:

The 36th International Symposium on Forecasting

Santander, Spain | 19-22 June 2016

Program and Abstracts
The 36th International Symposium on Forecasting (ISF 2016)
19 - 22 June | Santander, Spain
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Contents

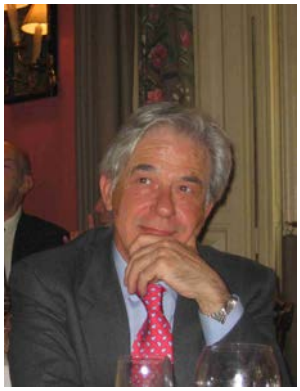
Welcome to Santander!

On behalf of ISF 2016 and the International Institute of Forecasters, I welcome you to the 36th International Symposium on Forecasting. And on behalf of the City Hall, the Cantabria Government and the Universidad Internacional Menendez y Pelayo, I welcome you to Santander and to Spain. This is the second time that ISF is taking place in Spain. So, when I accepted the challenge to organize this event, I have no doubt in my mind that given the experience of my previous ISF 2006, the idea of choosing again Santander and the Magdalena Palace was a safe bet. As I previously found, Cantabria is one of Spain's hidden jewels, with a breath taking array of landscapes ranging from spectacular mountains bedecked with flower filled meadows to lush green valleys and dense forests which provide a safe haven for some of the country's few remaining wolves and bears.

If you're thinking of planning a getaway to Cantabria in what is known as Green Spain, you can look forward to enjoying a trip full of natural landscapes, excellent gastronomy and a unique artistic and architectural heritage. This northern part of Spain is home to various prehistoric caves, of which the most famous of all is Altamira, awarded the World Heritage designation and known as the "Sistine Chapel of Prehistoric Art". Cantabria also lies on the famous Way of Saint James pilgrim route, and its towns and villages contain a wealth of beautiful monuments such as the monastery of Santo Toribio de Liébana or Gaudí's "Capricho" monument in Comillas. You'll also marvel at the spectacular landscapes, as the coast of Cantabria offers over 60 beaches with fine white sand in holiday resorts such as Laredo and San Vicente de la Barquera. And further inland, as well as its various nature reserves, nobody should miss a visit to the Picos de Europa National Park, the ideal place for adventure sports. An additional attraction when visiting this area is its first-rate gastronomy. You'll be able to sample typical dishes such as the bean stew known as "cocido montañés", "sobaos" (sponge cakes) and the "quesada pasiega" cheesecake. And to relax, what could be better than one of its famous spa resorts?

Such a splendid site deserved a truly outstanding scientific program. High quality, and well known, keynote and featured speakers were invited to cover different fields of interest within the IIF and our call for papers included more than twenty different areas of research. We received 375 abstracts and the scientific committee faced a top job of selection and including them into the 93 regular, invited and practitioner track sessions that constitutes the program that you are about to see. Honoring its name, ISF continues to be a truly international event with more than 350 delegates from 38 different countries covering all five continents. Also, 130 new delegates registered for the first time at ISF this year. I hope that this new "breed" will stay with us in future symposia and will be an important driving force in shaping the future of the institute. To them and to all of you my sincere gratitude for thinking that ISF 2016 was worth it.

Organizing an ISF is not a one man's job. Since I started planning ISF2016 in 2012, many people and organizations who have helped me, I am very grateful. To all our academic and professional sponsors for their generous financial help, to my fellow members of the IIF's Board for supporting Santander 2016, and to the Program Chair, Pilar Poncela, and our Business Director, Pam Stroud, for their dedication and devotion in preparing the program.



Antonio Garcia-Ferrer
General Chair, ISF 2016

Welcome from the IIF President

On behalf of the International Institute of Forecasters and its Board of Directors, I welcome you to the 36th International Symposium on Forecasting in Santander, Spain, a magnificent city in the northern region of Cantabria. This is the second time that the Symposium takes place in the Magdalena Palace, a majestic site hosting once more a truly international gathering of academic and industry forecasters. My special welcome to the 130 new delegates registered for the first time at the ISF. The Symposium provides excellent opportunities to interact with the world leading researchers and practitioners, and to learn about new developments and industry practices in the many fields of forecasting. I hope that you actively participate in the many sessions, enjoy the dialogue, and have fun. As a member of the IIF, you will receive the International Journal of Forecasting, the premier forecasting journal; Foresight: the International Journal of Applied Forecasting; and The Oracle, our newsletter. Please consider submitting your work to one of more of these outlets. If you are not an IIF member yet, I would like to invite you to visit our website http://forecasters.org to familiarize yourself with the activities of the Institute or visit our registration desk in the premises.

Being faithful to our educational mission, the IIF sponsors several initiatives to promote research in forecasting with the highest scientific standards. The generous support of SAS Corporation has allowed us to offer competitive annual awards in the areas of forecasting methodology and applications. We also contribute to the professional development of practitioners through alternative certification programs. To encourage attendance to the ISF, we continue to offer a limited number of travel awards to young researchers and Ph.D. students. Since 2003, we have been sponsoring small-scale specialized workshops on various topics. In this past year 2015, we sponsored three workshops: ICT and Innovation Forecasting in Paris, Tourism Forecasting in Hong Kong, and Advances in Time Series and Forecasting in Paris, and we also organized a summer school "Forecasting in a Changing Environment" in Santander. For detailed information on these activities and forthcoming workshops in 2016, please visit our website https://forecasters.org/conferences/iif-sponsored-workshops/. I invite you to attend the IIF members meeting, which will be held on Monday June 20th at 6:10 pm. The IIF Directors and I will be happy to share with you the highlights of the current and future activities of the Institute and listen to your questions and suggestions.

The organization and management of the Institute depends heavily on volunteers. New directors are elected annually to serve a three-year term and the president is elected among the directors. It is my pleasure to welcome two new elected directors, Nuno Crato and Fotios Petropoulos, and I wish them well in their duties. The outgoing directors, Haiyan Song and Eric Stellwagen, deserve my most sincere gratitude for their contributions to the Institute and their work over the years. Finally, my warmest thanks to Antonio García-Ferrer, the General Chair of the Symposium, Pilar Poncela, Program Chair, and Len Tashman, Chair of the Forecasting in Practice track, for their energy and dedication to make this Symposium a most memorable event. I am also grateful to our business director, Pam Stroud, who with her usual diligence has kept everybody on track, and to our sponsors who strongly support our mission.

To all delegates, my best wishes for a productive and enjoyable symposium and a nice stay in Santander!

Gloria Gonzalez-Rivera
President, *International Institute of Forecasters*

We would like to thank our Sponsors and Exhibitors

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Schedule

- Registration will be at Caballerizas & Paraninfo and at the Main Entrance of the Palacio de la Magdalena
- Tickets for the Gala Event will be available on Sunday, 19 June at the registration desk.
- Registration Hours

Sun, 19 June	8:30 - 9:00**,** 15:00 - 17:30
Mon-Tue, 20-21 June	8:00 - 17:00 (closed during lunch session)
Wed, 22 June	8:00 - 10:00

Saturday 18 June

10:00-16:00 **IIF Directors Meeting**

Sunday 19 June

10:00-16:00 **IIF Directors Meeting**

9:00-16:00 **Workshop 1: Using Time Series and Regression Techniques to Improve Forecast Accuracy in Business Applications (Santo Mauro)**
Eric Stellwagen, Business Forecast Systems, Inc.

9:00-16:00 **Workshop 2: Forecasting with R (Infantes)**
Fotios Petropoulos, Cardiff University and Nikolaos Kourentzes, Lancaster University

9:00-12:00 **Workshop 3: Forecasting to meet demand (Bringas)**
Roland Martin, SAP AG

13:00-16:00 **Workshop 4: Mining Transactional and Time Series Data (Biblioteca)**
Michael Leonard, Advanced Analytics R&D, SAS Institute, Inc.

9:00-12:00 **Workshop 5: Time Series Modeling with Unobserved Components (Biblioteca)**
Rajesh Selukar, SAS Institute, Inc.

13:00-17:00 **Workshop 6: The Learning of Neural Networks (Bringas)**
Hans-Georg Zimmerman, Siemens AG

16:30-17:15 **IJF Editor's Meeting, (Comedor De Infantes)**

18:30-20:00 **Welcome Reception – Palacio de la Magdalena, Hall Room**

Monday 20 June

8:45-9:00	**Welcome Address** Rodrigo Martinez-Val, Vice Chancellor, UIMP	**Paraninfo**
9:00-10:00	**Keynote Address, Edward Leamer**	**Paraninfo**
10:15-11:15	**FPT Speaker, Aris Syntetos**	**Rector Ernest Lluch**
10:15-11:35	Energy Forecasting 1	Infantes
	Forecast Evaluation 1	Comedor de Infantes
	Forecasting Methods 1	Pedro Salinas 2
	Inflation	Pedro Salinas 1
	Judgemental Forecasting	Bringas
	Predictability in financial markets	Santo Mauro
	Recent advances in distributional forecasting	Biblioteca
	Signal extraction 1	Paraninfo
11:35-12:00	**Break**	Terrace-outdoors
12:00-13:00	**FPT Speaker, Daniel Barrett**	Rector Ernest Lluch

12:00-13:20	Business Cycle	Santo Mauro
	Data for Forecasting in Education	Pedro Salinas 1
	Forecasting in industry	Comedor de Infantes
	Forecasting inflation	Infantes
	Load forecasting: research progress and challenges	Bringas
	Macroeconomic Uncertainty and Forecasting	Paraninfo
	Multivariate time series models in economics and finance	Biblioteca
	Seasonal Adjustment 1	Pedro Salinas 2
13:20-14:30	**LUNCH**	Terrace-outdoors
14:30-15:30	**Featured Speaker, Todd Clark**	Paraninfo
	Demand-supply forecasting	Santo Mauro
	Health Forecasting	Biblioteca
	Judgemental Forecasting and disagreement	Bringas
	Time Series	Infantes
15:40 – 16:40	**FPT Speaker, Bram Desmet**	Rector Ernest Lluch
	Early warnings	Santo Mauro
	Energy prices	Pedro Salinas 1
	Fiscal forecasting when fiscal policies are uncertain	Bringas
	Forecast Evaluation 2	Paraninfo
	Forecasting applications	Infantes
	Forecasting turning points	Biblioteca
	Macro Forecasting	Comedor de Infantes
	Signal Extraction 2	Pedro Salinas 2
16:40-17:00	**Break**	Terrace-outdoors
17:00-18:00	**FPT Speaker, Greg Parlier**	Rector Ernest Lluch
	Demand Forecasting	Pedro Salinas 2
	Energy Forecasting 2	Pedro Salinas 1
	Forecast Evaluation 3	Santo Mauro
	Forecasting in economics and society	Infantes
	Forecasting methods 2	Comedor de Infantes
	Forecasting using Common Features	Bringas
	Nowcasting and Forecasting 1	Paraninfo
	Risk forecasting	Biblioteca
18:10-18:30	**IIF Members Meeting**	INFANTES

Tuesday 21 June

9:00-10:00	**Keynote Address, Greg Allenby**	**Paraninfo**
10:15-11:15	**FPT Speaker, Dilek Onkal**	**Rector Ernest Lluch**
10:15-11:35	**Featured Speaker, José Duato**	**Paraninfo**
	Energy Forecasting 3	Bringas
	Forecast combination 1	Biblioteca
	Forecasting with big data	Santo Mauro
	Learning forecasting methods	Pedro Salinas 1
	Macroeconometrics and Forecasting	Infantes
11:35-12:00	**Break**	Terrace-outdoors
12:00-13:00	**FPT Speaker, Stephan Kolassa**	Rector Ernest Lluch
12:00-13:20	Applications in Engineering and Finance	Pedro Salinas 2
	Climate modeling and forecasting I	Biblioteca
	Demographic Forecasting in Diverse World	Santo Mauro
	Economics and Finance	Comedor de Infantes

	Expectations and Uncertainty in Survey Forecasts	Bringas
	Forecast combination 2	Infantes
	Forecasting Methods and Applications 1	Pedro Salinas 1
	The role of forecasting in climate change	Paraninfo
13:20-14:30	**LUNCH**	Terrace-outdoors
14:30-15:30	**Keynote Address, Henrik Madsen**	Paraninfo
15:40 – 16:40	**FPT Speaker, Christian Schäfer**	Rector Ernest Lluch
	Bayesian Methods 1	Infantes
	Business cycle analysis 1	Paraninfo
	Financial forecasting	Comedor de Infantes
	Forecast combination 3	Santo Mauro
	Forecast Evaluation	Biblioteca
	Forecasting in Practice	Bringas
	Forecasting methods with applications	Pedro Salinas 1
	Prices and inflation	Pedro Salinas 2
16:40-17:00	**Break**	Terrace-outdoors
17:00-18:00	**FPT Speaker, Eric Stellwagen**	Rector Ernest Lluch
	Applied forecasting methods	Biblioteca
	Bayesian methods 2	Pedro Salinas 1
	Business cycle analysis 2	Paraninfo
	Clustering and other Bayesian methods	Santo Mauro
	Energy Forecasting 4	Bringas
	Financial forecasting	Pedro Salinas 2
	Forecasting Systems	Comedor de Infantes
	Sources of forecasting uncertainty	Infantes

Wednesday 22 June

9:00-10:00	**Keynote Address, Adrian Raftery**	Paraninfo
10:15-11:35	Climate modeling and forecasting II	Biblioteca
	Density forecasting	Bringas
	Forecasting methods in economics and finance	Infantes
	Forecasting Performance	Santo Mauro
	Forecasting, Uncertainty and Risk	Pedro Salinas 2
	Seasonal Adjustment 2	Pedro Salinas 1
	The role of forecasts in policy	Paraninfo
	Time series and econometrics	Comedor de Infantes
11:35-12:00	**Break**	Terrace-outdoors
12:00-13:00	**FPT Speaker, Nikolaos Kourentzes**	Rector Ernest Lluch
12:00-13:20	**Featured Speaker, Robert Fildes**	**Paraninfo**
12:00-13:20	Big data, nowcasting and forecasting	Biblioteca
	Forecasting Applications	Infantes
	Forecasting in tourism and sports	Bringas
	Forecasting Methods and Applications 2	Santo Mauro
13:20-14:30	**LUNCH**	Terrace-outdoors

List of Sessions by Topic Area

Keynote talks [*All Keynote Talks in* Paraninfo]

K1	Edward Leamer	Monday, 9:00-10:00
	Measures of Model Ambiguity for Autoregressive Forecasting	
K2	Greg Allenby	Tuesday, 9:00-10:00
	Structuring Limited-Information Data for Marketing Forecasts	
K3	Henrik Madsen	Tuesday, 14:30-15:30
	State-of-the-art in Probabilistic Forecasting of Wind and Solar Power Generation	
K4	Adrian Raftery	Wednesday, 9:00-10:00
	Probabilistic Population Projections with Migration Uncertainty	

Featured Speakers [*All Featured Talks in* Paraninfo]

F1	Todd Clark	Monday, 14:30-15:30
	Time-Varying Volatility and Macroeconomic Forecasting	
F2	José Duato	Tuesday, 10:15-11:15
	Speeding up the execution of numerical computations and simulations	
F2	Robert Fildes	Wednesday, 12:00-13:00
	Research in Practice	

Forecasting in Practice Track [*All FPT Talks in* Rector Ernest Lluch]

Chair and Organizer: Len Tashman, Editor in Chief, Foresight

FPT1	Aris Syntetos	Monday, 10:15-11:15
	Forecasting and Inventory Control: Mind the Gap	
FPT2	Christian Schäfer	Monday, 12:00-13:00
	Challenges in Strategic Pharmaceutical Forecasting	
FPT3	Bram Desmet	Monday, 15:40-16:40
	Forecasting and Supply Chain Performance	
FPT4	Greg Parlier	Monday, 17:00-18:00
	Demand Planning for Military Operations	
FPT5	Dilek Onkal	Tuesday, 10:15-11:15
	Trust in Forecasting	
FPT6	Stephan Kolassa	Tuesday, 12:00-13:00
	Simplicity in Forecasting	
FPT7	Daniel Barrett	Tuesday, 15:40-16:40
	Demand Planning: Lessons from LEGO	
FPT8	Eric Stellwagen	Tuesday, 17:00-18:00
	Beyond Exponential Smoothing: How to Proceed when Extrapolation Doesn't Work	
FPT9	Nikolaos Kourentzes	Wednesday, 12:00-13:00
	Forecasting Temporal Hierarchies	

Regular sessions

Applications

Contributed	Forecasting applications	Infantes, Mon, 15:40-16:40
Contributed	Applied forecasting methods	Biblioteca, Tue, 17:00-18:00
Contributed	Learning forecasting methods	Pedro Salinas 1, Tue, 10:15-11:35
Invited	Applications in Engineering and Finance	Pedro Salinas 2, Tue, 12:00-13:20
Contributed	Forecasting Applications	Infantes, Wed, 12:00-13:20
Contributed	Forecasting Methods and Applications 2	Santo Mauro, Wed, 12:00-13:20
Invited	Forecasting, Uncertainty and Risk	Pedro Salinas 2, Wed, 12:00-13:20

Bayesian

Invited	Clustering and other Bayesian methods	Santo Mauro, Tue, 17:00-18:00
Contributed	Bayesian methods 2	Pedro Salinas 1, Tue, 17:00-18:00
Contributed	Bayesian Methods 1	Infantes, Tue, 15:40-16:40

Business Cycle

Contributed	Business Cycle	Santo Mauro, Mon, 12:00-13:20
Invited	Forecasting turning points	Biblioteca, Mon, 15:40-16:40
Invited	Business cycle analysis 2	Parainfo, Tue, 17:00-18:00
Invited	Business cycle analysis 1	Parainfo, Tue, 15:40-16:40

Climate

Invited	Climate modeling and forecasting I	Biblioteca, Tue, 12:00-13:20
Invited	The role of forecasting in climate change	Parainfo, Tue, 12:00-13:20
Invited	Climate modeling and forecasting II	Biblioteca, Wed, 12:00-13:20

Combination Forecasts

Contributed	Forecast combination 1	Biblioteca, Tue, 10:15-11:35
Contributed	Forecast combination 3	Santo Mauro, Tue, 15:40-16:40

Demand

Contributed	Demand-supply forecasting	Santo Mauro, Mon, 12:00-13:20
Contributed	Demand Forecasting	Pedro Salinas 2, Mon, 17:00-18:00

Economic Finance

Invited	Inflation	Pedro Salinas 1, Mon, 10:15-11:35
Invited	Multivariate time series models in economics and finance	Biblioteca, Mon, 12:00-13:20
Contributed	Forecasting inflation	Infantes, Mon, 12:00-13:20
Invited	Early warnings	Santo Mauro, Mon, 15:40-16:40
Invited	Forecasting using Common Features	Bringas, Mon, 17:00-18:00
Invited	Risk forecasting	Biblioteca, Mon, 17:00-18:00
Contributed	Forecasting in economics and society	Infantes, Mon, 17:00-18:00
Invited	Expectations and Uncertainty in Survey Forecasts	Bringas, Tue, 12:00-13:20
Contributed	Economics and Finance	Comedor de Infantes, Tue, 12:00-13:20
Contributed	Financial forecasting	Comedor de Infantes, Tue, 15:40-16:40
Contributed	Prices and inflation	Pedro Salinas 2, Tue, 15:40-16:40

Econometrics

Invited	Macroeconometrics and Forecasting	Infantes, Tue, 10:15-11:35

Energy

Contributed	Energy Forecasting 1	Infantes, Mon, 10:15-11:35
Invited	Load forecasting: research progress and challenges	Bringas, Mon, 12:00-13:20
Contributed	Energy prices	Pedro Salinas 1, Mon, 15:40-16:40
Contributed	Energy Forecasting 2	Pedro Salinas 1, Mon, 17:00-18:00
Contributed	Energy Forecasting 4	Bringas, Tue, 17:00-18:00
Contributed	Energy Forecasting 3	Bringas, Tue, 10:15-11:35

Evaluation

Contributed	Forecast Evaluation 1	Comedor de Infantes, Mon, 10:15-11:35
Contributed	Forecast Evaluation 2	Parainfo, Mon, 15:40-16:40
Contributed	Forecast Evaluation 3	Santo Mauro, Mon, 17:00-18:00
Contributed	Sources of forecasting uncertainty	Infantes, Tue, 17:00-18:00
Invited	Forecast Evaluation	Biblioteca, Tue, 15:40-16:40
Contributed	Forecasting Performance	Santo Mauro, Wed, 12:00-13:20

Finance

Invited	Predictability in financial markets	Santo Mauro, Mon, 10:15-11:35
Contributed	Financial forecasting	Pedro Salinas 2, Tue, 17:00-18:00

Government

Invited	Fiscal forecasting when fiscal policies are uncertain	Bringas, Mon, 15:40-16:40

Health

Contributed	Health Forecasting	Biblioteca, Mon, 12:00-13:20

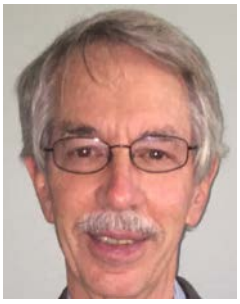
Judgemental		
Invited	Judgemental Forecasting	Bringas, Mon, 10:15-11:35
Contributed	Judgemental Forecasting and disagreement	Bringas, Mon, 12:00-13:20
Macroeconomics		
Invited	Macroeconomic Uncertainty and Forecasting	Parainfo, Mon, 12:00-13:20
Contributed	Macro Forecasting	Comedor de Infantes, Mon, 15:40-16:40
Methodology		
Contributed	Forecasting Methods 1	Pedro Salinas 2, Mon, 10:15-11:35
Contributed	Signal Extraction 2	Pedro Salinas 2, Mon, 15:40-16:40
Contributed	Forecasting methods 2	Comedor de Infantes, Mon, 17:00-18:00
Invited	Forecasting with big data	Santo Mauro, Tue, 10:15-11:35
Contributed	Forecasting Methods and Applications 1	Pedro Salinas 1, Tue, 12:00-13:20
Contributed	Forecasting methods with applications	Pedro Salinas 1, Tue, 15:40-16:40
Contributed	Density forecasting	Bringas, Wed, 12:00-13:20
Nowcasting		
Invited	Nowcasting and Forecasting 1	Parainfo, Mon, 17:00-18:00
Invited	Big data, nowcasting and forecasting	Biblioteca, Wed, 12:00-13:20
Demographics		
Invited	Demographic Forecasting in Diverse World	Santo Mauro, Tue, 12:00-13:20
Policy		
Invited	The role of forecasts in policy	Parainfo, Wed, 12:00-13:20
Prediction		
Contributed	Signal extraction 1	Parainfo, Mon, 10:15-11:35
Contributed	Forecast combination 2	Infantes, Tue, 12:00-13:20
Seasonality		
Invited	Seasonal Adjustment 1	Pedro Salinas 2, Mon, 12:00-13:20
Invited	Seasonal Adjustment 2	Pedro Salinas 1, Wed, 12:00-13:20
Tourism		
Contributed	Forecasting in tourism and sports	Bringas, Wed, 12:00-13:20
Time Series		
Contributed	Time Series	Infantes, Mon, 12:00-13:20
Contributed	Forecasting methods in economics and finance	Infantes, Wed, 12:00-13:20
Contributed	Time series and econometrics	Comedor de Infantes, Wed, 12:00-13:20
Other		
Invited	Recent advances in distributional forecasting	Biblioteca, Mon, 10:15-11:35
Invited	Data for Forecasting in Education	Pedro Salinas 1, Mon, 12:00-13:20
Contributed	Forecasting in industry	Comedor de Infantes, Mon, 12:00-13:20
Contributed	Forecasting Systems	Comedor de Infantes, Tue, 17:00-18:00
Contributed	Forecasting in Practice	Bringas, Tue, 15:40-16:40

ABSTRACTS

The IIF will publish electronic proceedings of this symposium (ISSN 1997-4124). Please submit your paper or presentation at forecasters.org/ISF.

Monday, 20 June

8:45 – 10:00
Keynote Session I (Paraninfo)
Chairperson: Antonio Garcia-Ferrer, Universidad Autonoma de Madrid



Edward Leamer

Chauncey J. Medberry Professor of Management, Professor of Economics, Professor of Statistics, and Director of the UCLA/Anderson Business Forecast Project, USA

Professor Leamer received a B.A. degree in mathematics from Princeton University and a Ph.D. degree in economics and an M.A. degree in mathematics from the University of Michigan. After serving as Assistant and Associate Professor at Harvard University, he joined the University of California at Los Angeles in 1975 as Professor of Economics and served as Chair from 1983 to 1987. In 1990 he moved to the Anderson Graduate School of Management and was appointed to the Chauncey J. Medberry Chair. Professor Leamer is a Fellow of the American Academy of Arts and Sciences, and a Fellow of the Econometric Society. In 2014 he won the award for "Outstanding Antitrust Litigation Achievement in Economics." awarded annually by the American Antitrust Institute.

Arnold Zellner Memorial Keynote Address: Measures of Model Ambiguity for Autoregressive Forecasting
Measures of statistical uncertainty presume certain or probabilistic knowledge regarding the time series model or mixture of models that generates the data, but actual forecasting usually begins with an exploratory phase in which the model is discovered. Forecasts are typically less accurate than the final model promises because both model uncertainty and model ambiguity are ignored sources of inaccuracy.

10:15 – 11:15 Forecasting Practitioner Track 1 (Rector Ernest Lluch)

Aris Syntetos, Chaired Professor in Operational Research and Operations Management, Cardiff University

Forecasting and Inventory Control: Mind the Gap
Demand forecasters often assume that forecasting is an end in itself. Conversely, inventory planners often assume no preceding stages of computation, i.e. that demand and its parameters are known. However: i) demand forecasts are merely inputs into a stock control model; ii) demand parameters (typically the mean and variance) are not known but rather they have to be estimated. The performance of the whole system can be judged only on the basis of the resulting inventory investments and the service levels we offer to our customers. In this presentation, the interactions between forecasting and stock control are discussed and common shortfalls, resulting from a lack of appreciation of such interactions, are demonstrated through practical examples for both fast and slow moving products, as well as cases where judgemental adjustments occur. We then present an assessment of the extent to which the lack of integration between forecasting and stock control can be harmful. We close with research based suggestions for addressing the gap under concern, and we emphasise the importance of this issue for any practical inventory forecasting application.

10:15 - 11:35 Energy Forecasting 1 (Infantes)
Chair: Jonathan Farland, DNV GL

Modelling of extreme non-winter peak electricity demand: An application to South African data
Caston Sigauke, University of Venda

In this paper we present an application of both xed and time varying thresholds in the modelling of extreme non-winter peak electricity demand using South African data for the period 2007 to 2013. It is during the non-winter period that Eskom, South Africa's power utility company usually carries out its maintenance of power plants. Extreme peak loads together with high unplanned and planned outages usually cause disruptions to the power plants' maintenance programmes during this period. If not properly managed this may result in negative economic impacts as electricity is one of the major drivers of any economy. Initially the data is made stationary by using a nonlinear detrending model. We then obtain an optimum xed threshold using extremal mixture models and threshold stability plots after which we decluster the exceedances and t the generalized Pareto distribution (GPD) to cluster maxima. Empirical results show that the developed modelling approach provides a good t of the GPD to cluster maxima. Most of the cluster maxima during the sampling period, years 2007 to 2013, are experienced in January, April and August. This modelling approach helps in the planning of maintenance programmes of South Africa's power plants.

Technology Foresight Scenarios for Solar Photovoltaic (Pv) In India
Deepak Singh, Jawaharlal Nehru University; Eugen Panaitescu, Northeastern University; Pranav Desai, Jawaharlal Nehru University; Marc Meyer, Northeastern University; Latika Menon, Northeastern University

India is a rising economic power and with a large population its energy hunger translates exponential demand trajectories. A lot has been talked and written about the potential role of abundant solar energy through Solar Photovoltaics (SPV) in quenching India’s energy hunger. This research can be broadly divided into two segments. In the first segment an attempt is been made to explore (SPV technologies, actors and their policy objectives/actions) the Indian energy technology innovations system (ETIS). In the second segment an attempt is made through a primary survey to capture the space for absorption for various SPV technologies in the urban and rural areas in India. The scope of the work is for both energy security and adoption of appropriate SPV technologies to address climate change policy of India. Methodology: Based on technology foresight analysis combining both qualitative and quantitative tools. This comprises of literature review, consumer survey, SPV technological assessment through expert interview, iterative Delphi rounds for consensus building. Data and Analysis: Primary data was collected from the consumers through a questionnaire, apart from secondary data available from various ministries. Results: Futures scenario are projected in the from of a priority matrix which can be used by policy makers to enhance the space of SPV in India’s ETIS in short, medium and long term futures.

Analysis of Electricity Demand and Price patterns of the United States Electricity Sector
Suman Gautam, DNV GL; Robert D. Weaver, The Pennsylvania State University

This paper uses extreme value theory (EVT), a widely used concept in the financial market, to analyze demand and price patterns and to predict future extreme events in the United States electricity market. We create a panel dataset using publicly available hourly demand and electricity marginal cost (lambda) information from the Federal Electric Regulatory Commission’s Form 714 and other geographic databases. The final dataset consists of 5.38 million observations of hourly electricity load of 54 unique utilities in the United States from the year 2000 to 2012. Similarly, the study contains 2.88 million observations of hourly electricity marginal costs of 48 different balancing authorizes for the period of 2006 to 2012. For each year’s hourly data of electric entities, we estimate generalized extreme value (GEV) distribution parameters with the goal of comparing how they have changed over time and market regions. We also account for the time dependencies, seasonality, and near-time clustering present in electricity load and prices due to distinctive features of non-storability and highly correlated observations with the help of autoregressive conditional heteroskedastic models. The results show that the distributions of hourly demand and lambda distributions are fat tailed. Hourly lambda values have more extreme values generating fatter tails than hourly electricity load. We also find that utilities from West and Northeast census regions have heavier hourly load tail distributions those of the Midwest and South regions. Similarly, hourly lambda values of West region’s balancing authorities

have larger extreme values compared with other regions' hourly lambda values. We also estimate single-point extreme tail quantiles with the help of generalized Pareto distribution parameters with the goal of using similar method in predicting extreme occurrences. The results show that unconditional extreme quantiles estimated using the GEV parameters are very similar to the actual observed load at both 95 and 99 percentile levels. The conditional quantiles, estimated after accounting for time dependencies, are also quite comparable for hourly load values. However, hourly lambda extreme quantile calculated after correcting for time dependencies overestimates the quantiles when compared with the actual hourly lambda values. The next step is to estimate tail quantiles by using hourly electricity price changes rather than using actual hourly values. Utilities and risk managers are also interested in estimating the extreme changes to reduce the price risks.

Load Forecasting for Distributed Energy Resources
Jonathan Farland, DNV GL; Farnaz Farzan, DNV GL; Rob Hyndman, Monash University

The advent of distributed energy resources (DER), such as photovoltaic cells, energy storage, electric vehicles and smart grids, are causing utilities and electricity providers to consider how the continued adoption of these technologies will impact future load as well as financial investment. As with any emerging or disruptive technology, employing statistical models may not be appropriate to forecast the future behavior of load as historical data is inherently limited or non-existent. With the exception of photovoltaic systems, few technologies associated with DER have sufficient history to measure and forecast their contribution to system load as saturation levels continue to vary across energy markets. This paper proposes a methodology that combines stochastic forecasting techniques to account for historical load patterns with engineering-based simulation techniques to model the impact of emerging technologies on hourly load profiles.

10:15 - 11:35 Forecast Evaluation 1 (Comedor de Infantes)
Chair: Carlos Diaz Vela, University of Leicester

Mixed-frequency models for tracking short-term economic developments in Switzerland
Alain Galli, Swiss National Bank; Christian Hepenstrick, Swiss National Bank; Rolf Scheufele, Swiss National Bank

We compare several methods to monitor short-term economic developments in Switzerland. Based on a large mixed-frequency dataset the following approaches are presented and discussed: a large scale dynamic factor model, a version using the three-pass regression filter and a model combination approach resting on MIDAS regression models. In an out of sample GDP forecasting exercise, we show that the three approaches clearly beat the relevant benchmarks that work with one or a small number of indicators. This suggests that a large dataset is an important ingredient to successful real-time monitoring of the Swiss economy. This particularly helps during and after the crisis. Comparing the three approaches we find that the dynamic factor model outperforms slightly. We conclude by discussing the three approaches relative merits and giving some guidance to the applied economist.

Effect of Data Frequency on Forecast Accuracy
Anupama Lakshmanan, Indian Institute of Management; Shubhabrata Das, Indian Institute of Management

We look at the impact of data frequency on forecast accuracy in this study. In order to forecast a variable at a particular frequency, obtaining the data at higher frequency may be costly or needlessly involve high computing power. However, if the data is aggregated, or collected only at the desired frequency and then used for prediction, we might be losing out on vital information leading to a possible reduction in forecast accuracy. Using New York electricity load data, and models for forecasting time series with multiple seasonality, like TBATS, we check if data collected at higher frequency implies better forecast accuracy than data collected at lower frequency. The purpose of the study is to understand and attempt to characterize when and how data at higher frequency may be used. The general answer may depend on the method and model adopted. Here we use the TBATS model (reference) and a new class of two-stage methods for forecasting. Subsequently, using a simulation framework, we build intuition for when we need to collect data at high frequency. The simulation study is undertaken to assess validity of possible generalization of the findings in terms of trade-off between signal and noise at the different frequencies. We analyse which of the two methods is better, method

one where we collect data at low frequency (or aggregate high frequency data) and predict at low frequency or method two where we collect and predict at high frequency and then aggregate to get low frequency data. In addition, we also check the extent by which the time at which data is recorded matters (for example, if we are interested in hourly forecasts, does it matter whether data is recorded at the beginning, middle or end of the hour).

Importance of the real-time data for forecasting Polish economy
Paulina Ziembinska, University of Warsaw

Recent literature stresses the importance of the inclusion of the revision processes in the macroeconomic research. Starting with its summary we gather stylized facts stemming from the empirical research based mainly on the American data and extend some ideas common in the forecasting literature, but not addressed before in the real-time setting i.e. expectation formation processes and some of the evaluation criteria, which we settle in a simple demonstrative model. We especially address the question on how to interpret forecasts when it is unclear which vintage had been predicted. Under fairly unrestrictive assumptions we estimate the relation between the unobservable forecast errors and revisions, which appears to highly depend on the variable. Moreover, we introduce two new datasets for Poland: a real-time dataset constructed from the monthly Statistical Bulletins published by the Central Statistical Office and a comprehensive dataset of the publicly available Polish macroeconomic and financial forecasts, which includes 77 variables from 9 sources. In the panel analysis we find significant variability of the forecasts accuracy (i.e. unbiasedness, efficiency) across forecasting horizons, sources and variables. We also find in- and out-of-sample predictability of the forecast errors with simple linear models and the well-documented in the literature co-movement of the errors with the business cycle. We provide one-equation test for the four expectations formation processes (i.e. extrapolative, naïve, adaptive and reversive). Its analysis reveals that even if we do not reject a certain scheme, residuals are still predictable by the business cycle related variables i.e. unemployment and interest rates. To assess quality of the forecasts we compare their accuracy with the ARIMA class models in the repeated observation (compare Stark and Croushore [2002]) and real-time experiments. We corroborate hypothesis known from the literature that the best results (in terms of the MSE loss) are obtained with models using first releases, which surprisingly often outperform Polish professional forecasts. Finally, we prove that the commonly used statistical procedures e.g. unit root and stationarity tests, autocorrelation tests and model selection criteria, depend on the vintage used in the analysis. Our study aims to present quantitative and qualitative summary of the forecasts for the Polish economy with some recommendations on the importance of the revision processes and their influence on the modelling and forecasting.

An Evaluation of the Bank of England Inflation Density Forecasts
Carlos Diaz Vela, University of Leicester

This paper shows how to extract the density of the shock of information perceived by the Bank of England between two consecutive releases of its inflation density forecasts. This information provides a tool to trace back the evolution of the assessment of risks perceived by the Bank at different forecast horizons, and construct a new measure of inflation uncertainty. It also allows to test the efficiency in the incorporation of new information to subsequent density forecasts.

10:15 - 11:35 Forecasting Methods 1 (Pedro Salinas 2)

Chair: Javier Arroyo, Universidad Complutense de Madrid

Modified Holt's Linear Trend Method
Hanife Taylan Selamlar, Dokuz Eylül University; Güçkan Yapar, Dokuz Eylül University; Sedat Çapar, Dokuz Eylül University; İdil Yavuz, Dokuz Eylül University
In this study, a new extrapolative forecasting framework will be introduced as an alternative to all major extrapolative techniques. This new framework will be called modified exponential smoothing since it is obtained by modifying the smoothing parameter of a traditional exponential smoothing model. The performance of the proposed method is compared empirically with the most popular forecasting algorithms based on the exponential smoothing and Box- Jenkins ARIMA using the M-Competition and the M3-Competition data sets.

Beta Forecasting at Long Horizons
Tolga Cenesizoglu, Alliance Manchester Business School; Fabio de Oliveira Ferrazoli Ribeiro, UNSW Business School; Jonathan Reeves, UNSW Business School

Systematic (CAPM beta) risk forecasting for long horizons, such as six months and one year, play an important role in financial management. This paper evaluates a variety of beta forecasting procedures for these long forecast horizons. The widely utilized Fama-MacBeth approach based on five years of monthly returns is found to be unreliable in terms of mean absolute (and squared) forecast error and statistical bias. The most accurate forecasts are found to be generated from an autoregressive model of realized beta. In addition to analyzing the statistical properties of these forecasts, the economic significance between the different approaches is demonstrated through evaluating investment projects.

Forecasting time series of distributions with kernel regression: Applications to renewable energy forecasting
Albert Meco, Universidad Complutense de Madrid; **Javier Arroyo**, Universidad Complutense de Madrid

The origin of an observed time series of distributions usually is the result of an aggregation of observed values. In the case of renewable energies, a time series of distributions can be obtained, for example, by the aggregation of the power production at a given frequency (say hourly) of individual wind turbines of a given wind farm to obtain the (hourly) distribution of the power production of the whole wind farm through time. Another example of time series of distributions would be the temporal aggregation of the solar irradiance observations in a solar power plant at each second to obtain the time series of the hourly distributions of the irradiance observations in that plant. In these cases, distributions provide a summary of the individual data that is more informative than those provided by other aggregates such as the mean or the total. In renewable energies, the variability of such non-aggregated values is higher and more difficult to forecast than that of the aggregated values and such unpredictability affects negatively electric power system reliability and market efficiency. The diminished variability in this field of the aggregated output is well understood and documented (Letendre et al, 2014). We propose the use of time series of distributions as an effective way of representing energy variability through time and the forecast of distributions as a tool for planning that should be useful for energy producers and balancing authorities. We propose the adaptation of kernel regression to forecast time series of distributions. Kernel regression is a locally weighted learning algorithm (Atkenson et al, 1999) where, given a new instance, all training instances are averaged to estimate the output using, a kernel as a weighting function. In our case, the 'new instance' is the most recent sequence of observed distributions, the training instances are the past sequences, while the 'solution' is the forecast of next distribution in the sequence. The kernel regression algorithm proposed here is an extension of the k-Nearest Neighbors method proposed by Arroyo and Maté (2009). Locally-weighted methods are useful to forecast time series that may exhibit complex patterns as is the case of renewable energy time series. We will illustrate the performance of the proposed approach with real-life data.

Alternative Density Forecast Evaluation Methods with Disaggregated Macroeconomic Random Variables
Roberto Morales-Arsenal, CUNEF; José Javier Nuñez-Velázquez, Universidad de Alcalá; Pablo Alonso-González, Universidad de Alcalá

The evaluation step is crucial in any forecast process. This allows us to evaluate or determine whether our theoretical model is useful for the purpose of forecasting our variable of interest. The techniques used in the evaluation of a single forecast are not applicable to the case of density forecast because this incorporates additional pitfalls and constraints that must be taken into account. Traditionally, the different methods used to evaluate density forecast have focused mainly on statistical procedures that somehow assess the closeness of the theoretical distribution to the empirical distribution. However, and from the work of Pesaran and Granger (2000), the density function evaluation process was complemented with the assessment in economic or monetary terms. In this paper, we extend the procedures implemented by these authors to a set of evaluation techniques from the field of the Decision Theory as: 1) The expected monetary value, 2) the Bayesian methodology, 2) stochastic dominance, 3) the mean-variance approach and 4) game theory. All of them in the context of forecasting disaggregated macroeconomic random variable. That is, we compare the density function obtained directly from the aggregated variable against the density function obtained by aggregating the

individuals density forecast of the different components that form the aggregated variable. The findings are derived from a decision matrix whose payoffs are, at the same time, probability distribution functions obtained through simulation. We show that the disaggregated approach is more accurate than the aggregated approach and that there is a consistency or coherence between the statistical approach of assessment and the monetary approach of assessment, in most cases. We show our results working with the Harmonized Consumer Price Index in the Eurozone (HCPI) using two levels of disaggregation: 1) a minimum level of disaggregation (with five components) and 2) a maximum level of disaggregation (with seventy components). This index is used to compute the level of inflation in the Eurozone, the main monetary target for the European Central Bank.

10:15 - 11:35 Inflation (Pedro Salinas 1)
Chair: Luis Nunes, Nova School of Business and Economics

The Dynamics of Inflation Expectations: Evidence from a Structural VAR Analysis
Till Strohsal, Freie Universität Berlin; Dieter Nautz, Freie Universität Berlin; Aleksei Netsunajev, Freie Universität Berlin

This paper introduces a structural VAR analysis as a tool for investigating the anchoring of inflation expectations. We show that U.S. consumers inflation expectations are anchored in the long-run because macro-news shocks are long-run neutral for long-term inflation expectations. The identification of structural shocks helps to explain why inflation expectations deviate from the central banks target in the short run. Counterfactual analysis suggests that the recent decline of long-term inflation expectations can be attributed to downward adjustments of the consumers perceived inflation target.

Inflation Forecasts, Inattentiveness and Uncertainty
Joshy Easaw, Cardiff University Business School; Roberto Golinelli, Department of Economics, University of Bologna; **Saeed Heravi**, Cardiff Universty Business School

The purpose of the current paper is to examine the role of uncertainty when professional forecasters form inflation forecast. Recent literature has considered professional forecasts inattentiveness. They identify two possible source of inattentiveness: ‘sticky information’ or ‘imperfect information’. The former is the result of transactions costs when acquiring relevant information while the latter focusing on noisy information and inattentiveness is depicted by ‘signal extraction’. In this paper we development a novel theoretical model which identifies the different rate of updating or inattentiveness when professionals form inflation forecasts. Using a Generalized State-Dependent Model (GSDM) we are able to empirically assess the effect of economic uncertainty on professional forecasters’ inattentiveness and, thereby, identifying the most likely source of the inattentiveness.

Comparing Alternative Methods of Combining Density Forecasts - with an Application to US Inflation and GDP Growth
Ana Galvao, University of Warwick; Anthony Garratt, University of Warwick; James Mitchell, University of Warwick

This paper explores the performance of a wide range of alternative density forecast combination or pooling methods proposed in the econometric and management science literatures. We evaluate how expertise and diversity/disagreement, among forecasters, affect the different types of combination. In particular, we contrast combinations over a small and a large number of models and consider the role of cross-sectional dependencies. A Monte Carlo exercise and two empirical applications help us establish which types of combination method work and when. The first application analyses density forecasts of US output growth and inflation using the large number of macroeconomic predictors in the Stock and Watson data set; and a second application uses probability forecast data of individual survey participants from the US Survey of Professional Forecasters to assess how the alternative combination methods work in practice.

Anchoring of inflation expectations in the euro area: recent evidence based on survey data
Tomasz Lyziak, National Bank of Poland; Maritta Paloviita, Bank of Finland

The paper analyses the anchoring of inflation expectations of professional forecasters and consumers in the euro area. We study anchoring, defined as the central bank's ability to manage expectations, by paying special attention to the impact of the ECB inflation target and ECB inflation projections on inflation expectations. Our analysis indicates that longer-term inflation forecasts have become somewhat more sensitive to shorter-term forecasts and to actual HICP inflation in the post-crisis period. We also find that the ECB inflation projections have recently become more important for short- and medium-term professional forecasts and at the same time the role of the ECB inflation target for those expectations has diminished. Overall, our analysis suggests that in recent years inflation expectations in the euro area have shown some signs of de-anchoring.

10:15 - 11:35 Judgemental Forecasting (Bringas)
Chair: Dilek Onkal, Bilkent University

Taking account of the effects of promotions: A comparison of unaided judgmental forecasting and judgmental adjustment of statistical forecasts
Nigel Harvey, University College London; Shari De Baets, Vlerick Business School

Sales forecasts may be made by unaided judgment or be based on statistical forecasts. Statistical forecasts are derived from the time series of past sales but generally do not incorporate information about the effects of exogenous sporadic events, such as sales promotions. Judgmental adjustment of statistical forecasts is therefore needed to allow for the effects of these events. We ask a) how forecasting is affected by the proportion of periods in a data series that are influenced by promotions, b) whether there is an overall advantage of using judgmentally adjusted statistical forecasts over using unaided judgmental forecasts, and c) whether any such advantage is affected by the proportion of promotional periods in the data series . To examine these issues experimentally, we used a mixed design in which type of task (unaided judgmental forecasting versus judgmental adjustment of statistical forecasts) was varied between subjects and both proportion of promotions in the presented data and forecasting for promotional versus non-promotional periods were varied within subjects. Analyses of Mean Absolute Error showed that a lower proportion of promotions in the data series facilitated forecasting of both types on non-promotional periods (but not on promotional ones). This may have been because there was relatively more data on which to base forecasts. In addition, the advantage of judgmentally adjusted forecasts over unaided judgmental forecasts was greater when the proportion of promotional to non-promotional periods was low (0.1) than when it was high (0.4). Many promotional periods appear to disrupt statistical forecasts and reduce their value. Analyses of Mean Error showed strong anchoring effects for all types of forecasts. People appear to anchor on the mean of the series and under-adjust upwards on promotional periods (to produce under-forecasting) and under-adjust downwards on non-promotional periods (to produce over-forecasting. With a high proportion of promotional periods (0.4), downward under-adjustment on non-promotional periods was the greater effect but, with a low proportion (0.1), upward under-adjustment on promotional periods was. It is possible that the need to adjust downwards on non-promotional periods is less salient than the need to adjust upwards on promotional ones: this matters when the proportion of promotions is high because the mean of the series as a whole is well above the mean of the non-promotional periods; it matters less when that proportion is low because these two means lie relatively close to one another.

Guru: a judgmental forecasting platform
Niki Kontoe, National Technical University of Athens;Fotios Petropoulos, Cardiff University; Vassilios Assimakopoulos, National Technical University of Athens

While managerial judgment has proved to be invaluable in many practical settings, it is still argued that state-of-the-art forecasting support systems do not offer the support to successfully integrate expertise into the forecasting process. The primary objective of this research is to offer the grounds for structured support when a judgmental forecast is needed. We discuss the design aspects of a judgmental forecasting system that will allow practitioners to integrate judgment in decision-making processes in a systematic way. We propose the integration of such systems with innovative information sources, such as social media and Google trends. We demonstrate such features through an open web-based

forecasting platform that acts as a tool for producing forecasts using Unaided Judgment, the Delphi method, Structured Analogies or a combination of the latter two. Finally, we focus in bridging the gap between theory and practice. To this end, the platform is completed with step-by-step feedback and best-practice advice, providing direct links with the findings of the academic literature. Such provision of feedback is crucial for both the back-end (facilitators) and the front-end (forecasting experts) users.

Presumed and experienced credibility for evaluating expert advice: Professionals' responses and insights from their debriefing sessions
Esra Öz, Bilkent University; Dilek Önkal, Bilkent University; Sinan Gönül, Middle East Technical University; Paul Goodwin, University Of Bath; Mary Thomson, Northumbria University

Incorporating experts' knowledge and judgments into the forecasting processes involves various challenges. Users of judgments confront challenges in selection or aggregation of expert judgments where forecast accuracy is mainly determined by the errors made at this stage. The credibility level of experts affects, to an important degree, how much users are influenced by their judgments. An expert's track record of accuracy (i.e., experienced level of credibility) and an expert's status (i.e., presumed credibility) are identified as two separate attributes which may influence the credibility of an expert's forecasts. This raises a question for both academics and practitioner
s: What happens if both an evidence of presumed credibility and an evidence of experienced credibility are available to the professional users of expert judgments? Which one is predominant in the case of conflicting indications, an expert holding a low experienced credibility but a high presumed credibility or an expert holding a high experienced credibility along with a low presumed credibility? This research also compares the findings from professional users of expert judgments with those obtained from non-professional users for evaluating presumed credibility versus experienced credibility. After the relevant data collection, a set of debriefing sessions were conducted with professionals in two phases, first immediately after the experiment, and secondly, after sharing the results of the experiment. In addition to discussing the experimental findings, this presentation will discuss what these debriefing sessions reveal and implications for further research.

Forecast adjustments in response to scenario tone
Dilek Onkal, Bilkent University; Paul Goodwin, University Of Bath; M. Sinan Gonul, Middle East Technical University; K. Zeynep Sayim, Hotelschool The Hague

Forecasts are important elements of decision making processes in organizations. When presented with external forecasts, users/decision-makers typically respond by judgmentally adjusting these predictions to incorporate their experience, intuition, and informational asymmetries. However, such adjustments may not always improve forecast accuracy; hence the need for support tools to improve communication and information sharing between providers and users of forecasts. Scenarios may provide effective mechanisms in this regard. This research outlines a series of experiments that focus on the effects of providing differently (i.e., weakly vs strongly and optimistic vs pessimistic) toned scenarios as forecast advice on individual and group-based judgmental predictions. Observed differences in adjustments suggest important directions for designing and implementing effective forecast support systems to aid both the providers and users of forecasts.

10:15 - 11:35 Predictability in financial markets (Santo Mauro)
Chair: Valerio Poti, University College Dublin

Do Supply Forecasts Matter? The Case of Wheat
Angi Roesch, FOM University of Applied Sciences; Harald Schmidbauer, FOM University of Applied Sciences; Ruben Simon, FOM University of Applied Sciences

Each year in May, the U.S. Department of Agriculture (USDA) releases its new "Outlook on World Wheat Supply and Use" in the upcoming biennial season. Forecasts of wheat ending stocks are revised from month to month. The USDA announcements are awaited by market participants, who draw conclusions on supply and demand fundamentals. The purpose of our study is to investigate the role of monthly USDA forecasts as determinants of expectation and volatility of daily wheat price changes. A dummy variable indicates the days on which a release is made. We then use an ARIMA-GARCH specification which contains the dummy variable, suitably modified to reflect a certain impact and market perception pattern of USDA forecasts. This methodology can thus differentiate between pre-

and post-release effects, distinguish between new and revised forecasts, including the relative magnitude and sign of deviation. Our study reveals that revisions of forecasts are anticipated by the market such that a negative (positive) change in supply forecast is accompanied by an increase (decrease) in wheat price expectation and higher volatility.

Multivariate Portfolio Optimization: The Relationship Between In-Sample Optimality and Out-Of-Sample Performance
Harald Schmidbauer, FOM University of Applied Sciences; Vehbi Sinan Tunalioglu, University of Genoa; Tolga Sezer, University of Genoa; Angi Roesch, FOM University of Applied Sciences

Multivariate portfolio optimization and its relationship to out-of-sample performances has been widely studied in the context of competing allocation strategies ranging from mean-variance portfolios to a naive equally-weighted policy. However, a very fundamental question has been largely neglected: To which degree does optimality help to improve out-of-sample performance? Using a range of financial portfolios and utility functions, we investigate the relationship between varying degrees (achieved through varying run lengths of evolutionary algorithms) of in-sample optimality and out-of-sample utility. We shed light on whether portfolio optimization in the absence of any forward-looking expectation, i.e. with the realized returns only, has any merit. More specifically, we investigate the monotonicity of this relationship and show to which degree optimality is a useful objective with respect to the out-of-sample performance. The presence of a non-monotonic relationship may indicate the problem of over-fitting. We further investigate the relationship by attempting to curb the over-fitting problem by introducing perturbations to the original in-sample data.

Predictability of predictability: Time-varying momentum and reversal across assets and over time
Valerio Poti, University College Dublin; Richard Levich, New York University; Tom Conlon, University College Dublin
In this paper, we investigate predictability of predictability. Our emphasis is on how the distinct components of predictability, namely momentum and reversals, arise and on their variation over time and across assets. 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. This is consistent with asset pricing models with slow moving capital since, during recessions (expansions), risk capital flows out of risky assets (safe heavens) and into safe havens (risky assets), thus allowing (forcing) the former to deviate from (converge to) its efficient price.

Predictability and Diversification Benefits of Investing in Commodity and Currency Futures
Emmanuel Eyiah-Donkor, University College Dublin; John Cotter, University College Dublin; Valerio Poti, University College Dublin

We re-examine diversification benefits of investing in commodities and currencies by considering a risk-averse investor with mean-variance preferences who exploits the possibility of predictable time variation in asset return means, variances, and covariances. We implement unconditional and conditional efficient portfolio strategies designed to exploit predictability, together with more traditional ones hitherto explored in this context (including the equally weighted, fixed weight, volatility timing, and reward-to-risk timing strategies). We find that, for all portfolio strategies, commodity and currency futures do not improve the risk-return trade-off of an investor with an existing portfolio of traditional assets (stocks and bonds), and an investment horizon of one-month. Our findings, which reverse the conclusions of previous studies that focus on static portfolio strategies, are robust across several performance metrics.

10:15 - 11:35 Recent advances in distributional forecasting (Biblioteca)
Chair: Gael Martin, Monash University

Real Time Surveillance for Abnormal Events: the Case of Influenza Outbreaks
Brendan McCabe, University of Liverpool; Yao Rao, University of Liverpool

This paper introduces a method of surveillance using deviations from probabilistic forecasts. Realised observations are compared with probabilistic forecasts and the "deviation" metric is based on low probability events. If an alert is declared, the algorithm continues to monitor until an all-clear is

announced. Specifically, this article address the problem of syndromic surveillance for influenza (flu) with the intention of detecting outbreaks, due to new strains of viruses, over and above the normal seasonal pattern. The syndrome is hospital admissions for flu like illness and hence the data are low counts. In accordance with the count properties of the observations, an integer valued autoregressive process is used to model flu occurrences. Monte Carlo evidence suggests the method works well in stylised but somewhat realistic situations. An application to real flu data indicates that the ideas may have promise. The model estimated on a short run of training data, did not declare false alarms, when used with new observations deemed in control, ex post. The model easily detected the 2009 H1N1 outbreak.

Probabilistic Forecasting and Predictive Model Assessment based on MCMC Output
Fabian Krüger, Heidelberg Institute for Theoretical Studies; Sebastian Lerch, Karlsruhe Institute of Technology; Thordis Thorarinsdottir, Norwegian Computing Center; Tilmann Gneiting, Karlsruhe Institute of Technology

A rapidly growing literature uses Bayesian methods to produce probabilistic forecasts of economic, financial or meteorological variables. Thereby, the posterior predictive distribution of interest attains the form of a simulated sample, typically generated by a Markov chain Monte Carlo (MCMC) algorithm. We conduct a systematic analysis of how to make and evaluate probabilistic forecast distributions based on such MCMC output. Utilizing the mathematical framework provided by the theory of proper scoring rules, we develop a notion of consistency that allows for assessing the adequacy of methods for estimating the stationary distribution underlying the MCMC output. We then review asymptotic results that account for the salient features of Bayesian posterior simulators, and derive conditions under which choices from the literature satisfy this notion of consistency. Importantly, these conditions depend on the scoring rule being used, such that the choices of approximation method and scoring rule are intertwined. While the popular logarithmic scoring rule often requires fairly stringent conditions, the continuous ranked probability score can be used under mild assumptions. These results are illustrated in a simulation study and an economic case study. A mixture of parameters estimator that efficiently exploits the parametric structure of the model performs well in these examples. By contrast, fully nonparametric kernel density estimation techniques prove to be problematic, particularly when used in conjunction with the logarithmic scoring rule.

Measuring sampling variation in frequentist distributional forecasts
David Harris, University of Melbourne; Gael Martin, Monash University; Indee Perera, Monash University; Don Poskitt, Monash University

The focus of his paper is on the quantification of frequentist sampling variation of probabilistic forecasts in time series models. We propose a method of constructing optimal confidence sets that respects the functional nature of the forecast distribution, and provide different ways of quantifying and visualizing the role played by estimation uncertainty in the forecasting exercise. A range of linear and non-linear models are used to demonstrate the procedure using artificially generated data, with the wide variation in distributional location and shape that can arise from parameter variation highlighted. An empirical example in which distributional forecasts of financial returns are used to construct optimal portfolios is then used to illustrate the practical importance of accommodating estimation uncertainty in the proposed manner.

10:15 - 11:35 Signal extraction 1 (Paraninfo)
Chair: Tommaso Proietti, Università di Roma

Automatic Signal Extraction for Stationary and Non-Stationary Time Series by Circulant SSA
Juan Bogalo, Universidad de Alcala; **Pilar Poncela**, European Commission, Joint Research Centre; Eva Senra, Universidad de Alcala

Singular Spectrum Analysis (SSA) is a nonparametric, and therefore model free, tecnique for signal extraction in time series. However, it requires the intervention of the analyst to identify the frequencies associated to the underlying components. We propose an automatic version of SSA based on the properties of circulant matrices. We extend our new variant of SSA, Circulant SSA, to the nonstationary case. Through several sets of simulations, we show the good properties of our approach: it is fast, automatic and produces strongly separable elementary components by frequency. Finally, we

apply Circulant SSA to the Industrial Production of six countries. We use it to deseasonalize the series and illustrate that it also reproduces a cycle in accordance to the dated recessions from the OECD.

A wavelet-based multivariate multiscale approach for forecasting
António Rua, Bank of Portugal

In an increasingly data rich environment, factor models have become the workhorse approach for modelling and forecasting purposes. However, factors are non-observable and have to be estimated. In particular, the space spanned by the unkown factors is typically estimated via principal components. Herein, we propose a novel procedure to estimate the factor space resorting to a wavelet based multiscale principal component analysis. Through a Monte Carlo simulation study, we show that such an approach allows to improve factor model estimation and consequently may boost forecasting performance. In the empirical application, we illustrate its usefulness for forecasting GDP growth and inflation in the United States. We find that it delivers noteworthy forecasting gains vis-à-vis the current practice in the literature and among practitioners.

Identification of Canonical Models for Vectors of Time Series: a Subspace Approach
Alfredo Garcia-Hiernaux, Universidad Complutense de Madrid; Jose Casals, Universidad Complutense de Madrid; Miguel Jerez, Universidad Complutense de Madrid

We propose a new method to specify linear models for vectors of time series with some convenient properties: First, it provides a unified modeling approach for single and multiple time series, as the same decisions are required in both cases. Second, it is scalable, meaning that it provides quickly a preliminary model, which can be refined in further modeling phases if required. Third, it is optionally automatic, because the specification depends on a few key parameters which can be determined either, automatically or by human decision. And last it is parsimonious, as it allows one to choose and impose a canonical structure by a novel procedure. Several examples with simulated and real data illustrate its application in practice and a MATLAB implementation is freely provided.

Exponential Smoothing, Long Memory and Volatility Prediction
Tommaso Proietti, Università di Roma "Tor Vergata"

Extracting and forecasting the volatility of financial markets is an important empirical problem. The paper provides a time series characterization of the volatility components arising when the volatility process is fractionally integrated, and proposes a new predictor that can be seen as extension of the very popular and successful forecasting and signal extraction scheme, known as exponential smoothing (ES). First, we derive a generalization of the Beveridge-Nelson result, decomposing the series into the sum of fractional noise processes with decreasing orders of integration. Secondly, we consider three models that are natural extensions of ES: the fractionally integrated first order moving average (FIMA) model, a new integrated moving average model formulated in terms of the fractional lag operator (FLagIMA), and a fractional equal root integrated moving average (FerIMA) model, proposed originally by Hosking. We investigate the properties of the volatility components and the forecasts arising from these specification, which depend uniquely on the memory and the moving average parameters. For statistical inference we show that, under mild regularity conditions, the Whittle pseudo-maximum likelihood estimator is consistent and asymptotically normal. The estimation results show that the log-realized variance series are mean reverting but nonstationary. An out-of-sample rolling forecast exercise illustrates that the three generalized ES predictors improve significantly upon commonly used methods for forecasting realized volatility, and that the estimated model confidence sets include the newly proposed fractional lag predictor in all occurrences.

12:00 - 13:00 Forecasting Practitioner Track 2 (Rector Ernest Lluch)

Christian Schäfer, Professor of Quantitative Management,
BW Cooperative State University, Mannheim

Challenges in Strategic Pharmaceutical Forecasting

In a decade of shrinking public healthcare budgets and cost-containment pressure on pharmaceuticals in mature markets, accurate prediction of drug demand is critical. When creating a first strategic forecast for a potential new pharmaceutical product, the launch of this product is often still 10-15 years away. Many developmental and regulatory hurdles will have to be overcome over the next decade. Modeling the competitive situation at launch must reflect the uncertainties and risks over the upcoming years. The industry faces high risks of product failure while having to take important investment decisions at very early stage. Within a pharmaceutical company, there are usually many different products at different development stages and different therapy areas compete to get funding for the next development stages. This mixture of early investment decisions, high failure risk, a very competitive industry landscape, and shrinking healthcare budgets makes strategic forecasting within the pharmaceutical industry particularly challenging. My talk with provide an application-oriented overview about the techniques and processes that pharmaceuticals have developed to overcome these challenges.

12:00 - 13:20 Business Cycle (Santo Mauro)
Chair: Kajal Lahiri, University at Albany

An outer space view of the business cycles
Jaqueson K. Galimberti, ETH Zurich

Real-time measures of economic activity are crucial to the decision-making process of policymakers and market participants in general. Unfortunately the process of collection and publication of macroeconomic data is not instantaneous; many measures of economic activity become publicly available only within months, or even quarters, of lags. The real-time decision-maker is then continuously faced with an intricate forecasting (or now-casting) challenge of finding leading indicators to the variables that are relevant to her business. In this paper we propose an evaluation of the use of satellite data on nightlights to improve the real-time measurement of countries and regions business cycles. High-resolution data on nighttime lights visible from the outer space have recently found interesting applications to issues of economic measurement. Most of these applications have focused on the construction of comparative measures of living standards across countries and regions, hence taking advantage mainly of the geographical dimension of luminosity data variability. Here, in contrast, we evaluate the usefulness of time variations in the intensity of nightlights within different countries and regions to improve the accuracy of early estimates of the overall economic activity in those geographic locations. Consistent to our interest on the business cycles, often observed at the quarterly frequency, another contribution of this paper is that we also use nightlights data at a higher frequency (monthly) than the standard series adopted in the previous literature (annual). The recent launch of a new sensoring instrument has made possible the production of improved imagery of nighttime lights radiance, which are also processed at a higher frequency than the previous instrument. Nevertheless, the annual average composites are still the longest continuous time series of nightlights data available, covering the period from 1992 to 2013, and should hence be informative on the short run relationship between changes in economic activity and the emission of nighttime lights. Therefore, our approach is geared towards the use of different frequencies of time series data in the estimation and computation of measures of economic activity. Preliminary results indicate a high degree of heterogeneity in the relationship between nighttime lights emission and short term economic growth across countries. That is particularly the case when considering traditional measures of luminosity, such as the sum of lights measured within a country's borders. We propose alternative indicators that go beyond the aggregate geographic view to focus instead on the identification of clusters of luminosity with the property of leading indicators.

Assessing the Impact of Qualitative Surveys for Nowcasting Real Economic Activity in the Euro Area
Raïsa Basselier, National Bank of Belgium; David De Antonio Liedo, National Bank of Belgium; Geert Langenus, National Bank of Belgium

This paper analyses the contribution of survey data, in particular various sentiment indicators, to nowcasts of quarterly euro area GDP. We transform the real-time dataflow into an interpretable flow of news, taking into account only the first data vintage based upon the original press releases. The news is defined in our particular example as the difference between the released values and the prediction of a mixed-frequency dynamic factor model along the lines of Banbura and Modugno (2010) or Camacho and Perez-Quiros (2010). More concretely, we specify a number of factors that is large enough to synthesize all relevant information from the data. Our purpose is twofold. First, we aim to quantify the specific value added for nowcasting of a set of heterogeneous data releases including not only sentiment indicators constructed by Eurostat, Markit, the National Bank of Belgium, IFO, ZEW, GfK or Sentix, but also hard data regarding industrial production or sales in both the euro area and Germany. Second, we provide a ranking of these indicators, taking into account their predictive character for GDP, as well as their timeliness. We do this on the basis of the Kalman filter gains. Among the survey indicators, we find the strongest contribution for the Markit euro area manufacturing PMI. In general, hard data contribute less to the nowcasts: they may be more closely correlated with GDP but their relatively late availability implies that they can to a large extent be anticipated by nowcasting models and, hence, their `news' component is smaller. Nevertheless, German industrial production turns out to have a larger impact on euro area GDP than euro area industrial production itself, and is actually the third most important indicator in the overall ranking. Finally, we also show that the NBB's own business confidence indicator is useful to predict euro area GDP, confirming previous results.

Evaluating a Leading Indicator: An Application: the Term Spread
Herman Stekler, George Washington University; Tianyu Ye, George Washington University

This paper analyzes the procedures that have previously been used to evaluate indicators. These methods determine whether the indicator correctly classifies periods when there was (not) a recession. These approaches do not show whether or not an indicator signaled a turn or failed to predict it. This paper then presents a new approach and applies it to the term spread series. The results are mixed because the indicator predicts every recession but also generates a large number of false signals. This result may explain why economists do not always place great weight on this series.

Construction of Leading Economic Index using Vine Copulas
Kajal Lahiri, University at Albany; Liu Yang, Nanjing University

The paper constructs a composite leading index for business cycle prediction based on vine copulas that capture the complex pattern of dependence among individual predictors across regimes.This approach is optimal in the sense that the resulting index possesses the highest discriminatory power as measured by the receiver operating characteristic (ROC) curve. The model specification is semi-parametric in nature, suggesting a two-step estimation procedure, with the second-step finite dimensional parameter being estimated by QMLE given the first-step non-parametric estimate. To illustrate its usefulness, we apply this methodology to optimally aggregate the ten leading indicators selected by The Conference Board (TCB) to predict economic recessions in the United States.

12:00 - 13:20 Data for Forecasting in Education (Pedro Salinas 1)
Chair: Nuno Crato, European Commission, Joint Research Centre

How test scores, cognitive and non-cognitive skills may help in forecasting youth unemployment
Margarida Rodrigues, Institute for Employment Research

Youth unemployment has been moving up in the policy agenda at both European and national levels, given its sharp increase in the aftermath of the Great Recession and the unprecedented levels reached in some European countries. The relatively scarce literature examining the determinants of aggregate youth unemployment has focused on factors related with economic conditions, demographic factors and labor market institutions, ignoring the potential role of the human capital of the correspondent

cohorts. Our research question is mainly two-fold. First, we assess the extent to which the human capital of youth cohorts drives country's youth unemployment levels. This follows the spirit of several papers by Hanushek and Woessman (e.g. Hanusek and Woessmann, 2008), who use cognitive skills to explain aggregate outcomes, in their case economic growth. We proxy human capital using international test scores, in particular the standardized assessments of reading achievement from several Programme for International Student Assessment (PISA) cycles. Second, we decompose the performance on the PISA tests into two components, one related with cognitive skills and other related with non-cognitive skills. This is accomplished by exploring the random allocation of questions to students. We then test which of the two components is more related with youth unemployment. In short, we study how test scores, cognitive and non-cognitive skills measured at age 15 may help in forecasting the evolution of youth unemployment at country level some years later. This may help reducing the uncertainty of future youth unemployment levels' evolution. We combine data from several PISA waves with Eurostat data on youth unemployment. Using a fixed effects panel data approach we are able to eliminate all time-invariant country-specific factors and isolate the association between PISA scores and youth unemployment. The paper also discusses further issues, namely, potential mechanisms through which test scores at the age 15 could drive later youth unemployment and heterogeneous effects with respect to age, gender, country's economic situation and country's characteristics related with the labor market institutions and the education system.

Predicting Life-Cycles Critical Points with Age-Dependent Mortality and Endogenous Leisure, Labor and Learning

Manuel Guerra, ISEG – University of Lisbon; **João Pereira**, ISEG - University of Lisbon; Miguel St. Aubyn, UECE/ISEG - University of Lisbon

This paper has two major goals. The first one, is to derive the optimal life-cycle planning of individuals that make decisions on the allocation of time between leisure, human capital accumulation, work and retirement explicitly allowing for the existence of on-the-job-training in a context in which they face an age dependent mortality. The second goal addresses the fact that once we introduce in the model a demographic process with a memory, individuals have to continuously revise their previous plans, in light of the new information regarding the non realization of the event of death. We discuss these implications to the life cycle hypothesis of Modigliani and Brumberg. We show how life cycle assumptions will help predict periods of training and periods of leisure for individuals. Our main findings are that planned life cycles present a hump shaped pattern in labour supply and labour income and a U shaped pattern in leisure. Also, the consumer reacts to increased longevity by planning to work more and by investing more in human capital which will counteract an unfavourable demography.

Is retention beneficial to low-achieving students? Evidence from Portugal

Luis Nunes, Nova School of Business and Economics; Ana Balcão Reis, Nova School of Business and Economics; Carmo Seabra, Nova School of Business and Economics

Approximately 12% of all 15-year-old students across OECD countries repeated a grade at least once during their compulsory schooling. The impact of retention/promotion decisions on the academic, professional and/or social trajectory of low-achieving students is a controversial issue and has been the subject of a very large number of empirical studies; yet, the conclusions remain unclear. The purpose of this paper is to contribute to this discussion. Our sample includes students from the 4th grade of the public education system in Portugal that obtained negative scores in their final exams. The data allow for a detailed matching between retained and promoted students, according to demographic and socioeconomic variables and according to the score attained at the end of the 4th grade, with the objective of establishing a causal relationship between retention and student achievement. We also propose an instrumental variables approach to check if there is indeed a causal effect. Our results suggest that early retention improves achievement at the 6th grade level exam. However, the overall effect of retention on the length of the cycle of studies is negative: although progression for the retained in the following years is a little faster than for the promoted this effect is not sufficiently strong to compensate for the initial year lost with the retention. These results are important to correctly predict the impact of changes in educational policies on the students' future performance. Our work makes a contribution to forecast the path of students over time and hence to forecast the resources required by educational services.

Predicting the number of students in the Portuguese education system after extending to twelve years the compulsory education
Luísa Canto e Castro Loura, DGEEC; Pedro Antas Martins, DGEEC

The evolution of Portuguese society and, consequently, the profound changes which occurred in their educational system, had as one of the main effects the passage of compulsory education of four and three years in 1956 (for men and women, respectively) to nine years, through the base law of the education system in 1986 and, more recently, in 2009, to twelve years of schooling. Because of the greater impact on a fringe of the school population aged 16 to 18 with retention history and tendency to abandonment of this latest enlargement, it became important to quantify this impact in order to organize the network of school offers and safeguard the funds necessary to the implementation of more practical / vocational student oriented pathways. The adopted prediction model was based on: the gradual implementation of compulsory education; demographic constraints arising from the births and migration; maintenance of the transition and retention rates, reflected in the model through the proportions of the population in fixed age group that attends each scholar grade. Thus, the proposed model was founded on census data and on the most recent data on the age distribution in each grade and in each type of education program.

12:00 - 13:20 Forecasting in industry (Comedor de Infantes)
Chair: Maria Rosa Nieto Delfin, Universidad Anahuac Mexico Norte

Forecasting model selection for industry data by applying meta-learning with different feature sets
Mirko Kück, BIBA-University of Bremen; Sven F. Crone, Lancaster University Management School; Michael Freitag, University of Bremen

Demand planning is an important task for manufacturing companies because it is the main basis for all following steps of production planning. Typically, the future demand per stock-keeping-unit has to be forecasted for a large number of items based on univariate time series of past customer orders. For this purpose, diverse different forecasting models can be applied, which all have different strengths and weaknesses. While statistical models like exponential smoothing variants performed best in some studies, methods of computational intelligence, such as neural networks have shown promising performance in more recent studies. Unfortunately, the no-free-lunch theorem states that there is no universally best model outperforming all others for a broad problem domain. This theoretical statement has been confirmed in several empirical studies. Hence, a suitable model selection method is needed in order to find appropriate forecasting models for each case of different time series evolution. This problem was formulated as the algorithm-selection problem. In this context, meta-learning is a promising approach for model selection. This approach, describes how to deploy knowledge from past tasks in order to select predictive models for new tasks with certain characteristics. While meta-learning is most often applied for selecting classification algorithms, fewer applications exist for selecting models for univariate or multivariate time series forecasting. Moreover, in the area of time series forecasting, all different studies deployed different meta-feature sets. In particular, the meta-learning approaches neglected error-based features as normally used in model selection for time series forecasting. This raises the questions whether error-based features are appropriate for meta-learning and which features are most applicable for the selection of time series forecasting models. The paper at hand studies the impact of different feature sets for a meta-learning approach conducting a neural network as meta-learner to select one of four forecasting models often used in industry. For this purpose, the impact of seven different feature sets on the performance of model selection is studied. These are the feature sets used in a meta-learning approach by Wang et al., features of recurrent quantification analysis used in a meta-learning approach by Scholz-Reiter et al., several statistical measures as well as four different sets based on training or validation errors of the four forecasting models. The impact of the different feature sets as well as the general applicability of the meta-learning approach is evaluated within an empirical study conducted on the univariate industry time series of the NN3-competition.

Practical approach to new products demand forecasting
Agata Chorowska, Prologistica Soft

In our research we study a problem of forecasting demand for new products. Main difficulty associated with this problem is lack of historical data. Indeed, many business decisions, as those related to inventory management, marketing or financial strategies, need to be made when sales history of a product is very short or even before it starts. Moreover, demand for new products is often very dynamic and has a complex structure depending on many factors like not yet stable price or intensive marketing. In our research we compare two methods of approaching this problem. First of all we propose a new technique based on modeling demand for products' features. We treat products as a combination of features and use the product sales history to model demand for specific features. Finally, we use these models to forecast demand for new products. We present an application of this approach for assortment choice decisions and show how it can be used to determine a combination of features which would be the most desirable for customers. Second of all we study the use of known models for new products demand (distribution models and decision models). Although the models themselves are well described in the literature, it is not clear how to determine their parameters especially with lack or very limited historical data. We study methods of determining the parameters basing on products similarities as well as other factors such as moment of products introduction (we observed different demand profiles for products introduced in high or low season), intensity of marketing or price. We use a combination of regression and clustering methods to determine the models' parameters. For both presented approaches we propose techniques of determining forecast confidence intervals. Profiting from our experience as a business intelligence software provider we compare those two techniques in context of their potential application to facilitate companies making business decisions related to new products. We study the quality of the results in the light of inventory management, sales planning and assortment choice decisions. We compare the availability of necessary input information. Finally, we analyze computational complexity of presented methods in context of their use in real time applications such as what-if scenarios analysis and simulations. All our research is based on sales data of several distribution companies across different business areas.

Increasing the Innovation Succes Rate by using the Power of Superforecasting
Binne Heida, Blauw Research; Anke Bergmans, Blauw Research; Christian De Jong, Blauw Research

The importance of good forecasting at an early stage - In a world that is changing ever faster, innovation is of crucial importance: Innovate or go under. However, there are so many ideas and opportunities. It's important to know whether something is going to be success at an early stage. But it is also extremely difficult to effectively forecast the potential success in this early design phase. In this paper, we will tell you how we involve the right forecasters in market research in order to arrive at a realistic assessment. Forecasting by marketers - An experienced marketer knows what is happening in 'his' market better than anyone. Unfortunately, in practice, it often turns out that knowledge and experience of the market have the opposite effect, because: • Experts are bad forecasters. In his book, Tetlock1 says that experts that have developed their own vision have difficulty in deviating from it. • Marketers have a vested interest in a positive forecast. They want their idea to be a success and are thus no longer objective. Forecasting by market researchers - Market research is carried out to provide marketers with objective information. Traditionally, this is done by presenting a concept to the target group and then asking them about their purchasing intention. However, based on behavioural economics, we know that people are bad at predicting their own behaviour. Respondents will try to answer as rationally as possible, while in real life their behaviour comes down to pure routine and emotion. Superforecasters as the solution - So who can help us to forecast? In collaboration with the Royal Dutch Touring Club (ANWB), an experiment was performed based on Tetlock's book Superforecasting. He has shown that forecasts are more accurate if you use superforecasters. The scientific personal characteristics found by Tetlock were used to identify superforecasters through self-assessment. These superforecasters and the general public produced forecasts on the success of various products. The first results are encouraging: - The forecasts made by superforecasters seem to be more realistic. Superforecasters make different (more conservative) forecasts than the 'average' ANWB member. - The difference between the two groups is larger in the case of more complex propositions. Due to his ability to analyse and to be decisive, the superforecaster seems better able to deal with complicated issues. How do we help organisations with this? - Superforecasters help organisations to build a more realistic business case. The most promising innovations can be developed more efficient and faster.

Econometric model to forecast the unmet demand applied to the airline industry
Maria Rosa Nieto Delfin, Universidad Anahuac Mexico Norte; Rafael Bernardo Carmona Benitez, Universidad Anahuac Mexico Norte

This paper analyzes the concept of unmet demand, or the demand that has not been satisfied, for passenger transportation applied to the airline industry. The unmet demand may exist because of the economic effects of supply and demand. In literature, there are evidences of studies and analysis that tackle the problem of calculating the unmet demand. The identification of unmet demand has been mainly studied from the point of view of human needs, such as family planning or emotional needs, economic and financial needs. The proposed methodologies for the calculation of needs are analyzed and studied for forecasting unmet demands. For the first time, we develop an approach to forecast the unmet demand for passenger transportation applied to the airline industry. In this paper, the market size per route is assumed to be equal to the sum of the known demand and the unmet demand. This research proposes the ARIMA-GARCH-Bootstrap method to forecast the market size per distance block and then use it for forecasting the possible passenger unmet demand. The model does not assume any specific distribution from the analysis of the behaviour of the air transportation market instead the bootstrap methodology is applied. The econometric model is set up by analyzing The United States domestic air transport market (Bureau of Transportation Statistics, 1991-2016)

12:00 - 13:20 Forecasting Inflation (Infantes)
Chair: Antoni Espasa, Universidad Carlos III

Improving inflation forecasts with survey-based expectations
Travis Berge, Board of Governors of the Federal Reserve

Expectations are a fundamental ingredient to modern macroeconomic models, both theoretical and empirical. Macroeconomic models typically assume that inflation expectations are model-consistent, whereas empirical models typically condition on survey-based measures of inflation expectations instead. Yet simple econometric tests typically reveal biases in survey-based measures of inflation expectations---in short, little is known of how expectations are formulated. This paper produces an empirical model of inflation expectations, obtained with a principled search for predictors of inflation expectations. The method selects regressors from a large dataset that includes subcomponents of the consumer price index and a large panel of real-time macroeconomic indicators. The indicators that best forecast surveys of household inflation expectations are different than those that predict surveys of professional forecasters. A forecasting horserace among several simple variants of the New Keynesian Phillips Curve highlights the importance of including inflation expectations for predicting future inflation.

Estimating a Time-Varying Phillips Curve for South Africa
Alain Kabundi, South African Reserve Bank; Eric Schaling, Wits University; Modeste Some, World Bank

In this paper we estimate a Phillips curve for South Africa. The slope of the Phillips curve, the inflation persistence, the natural rate of unemployment and the central bank's inflation target band are time-varying. We find that the slope of the Phillips curve has flattened since the mid 2000s - particularly after the Great Recession - which is in line with the findings in most advanced countries. Our results indicate that inflation persistence increased from 1994 to 2001, remained constant from 2001 to 2008, and eventually decreased around 2008. This pattern is different from that of advanced countries where expectations became better anchored relatively early in the inflation targeting (IT) regime and stayed there. Finally, we suggest that the increased stability of inflation expectations after 2008 -- which coincides with the Great Financial crisis - may be a result of "good luck" not just a good policy framework.

Forecasting Inflation: Phillips Curve Effects on Services Price Measures
Saeed Zaman, Federal Reserve Bank of Cleveland; Ellis Tallman, Federal Reserve Bank of Cleveland
We estimate an empirical model of inflation that exploits a Phillips Curve relationship between a measure of unemployment and a sub-aggregate measure of inflation (services). We generate an aggregate inflation forecast from forecasts of the goods sub-component separate from the services sub-component, and compare the aggregated forecast to the leading time-series univariate and standard

Phillips curve forecasting models. Our results indicate notable improvements in forecasting accuracy statistics for models that exploit relationships between services inflation and the unemployment rate. In addition, models of services inflation using the short-term unemployment rate (less than 27 weeks) as the real economic indicator display additional modest forecast accuracy improvements.

22 Years Of Inflation Forecasting Experience at the Bulletin of EU & US Inflation and Macroeconomic Analysis
Antoni Espasa, Universidad Carlos III

The forecasting procedure in this publication, subjected to continuous updates, is based on monthly single-equation econometric models for the components of a price index. These components show big differences in their behaviour which are mainly due to the fact that prices are affected distinctively by factors like technological changes, changes in preferences, changes in international prices, seasonal factors, etc. Then, the paper argues that in forecasting inflation a breakdown in different components is of interest because gives component results, provides a better understanding of the aggregate useful for diagnosis and increases the forecast accuracy of the headline inflation. This improvement in accuracy is attained by a modelling strategy which exploits the particular stationary and non-stationary properties of the components, some of the restrictions existing between some of them, the inclusion of specific leading indicators, the formulation of non-linear models for the components which could require them and the use in nowcasting of the most recent information. Exploiting the disaggregation results the procedure can provide hints for a causal interpretation of the headline forecast. Additionally, it also considers how to provide causal explanation of the forecasts by linking time series forecasts with those from congruent econometric models. Two approaches can be considered in looking for the breakdown of a particular CPI. One is relatively subjective based on exploiting empirically the important differences present in the data for the components. This is the approach usually followed in the BIAM, see Espasa and Albacete (2007). Another one consists in using rigorous statistical methods to identify common features in the components.

12:00 - 13:20 Load forecasting: research progress and challenges (Bringas)
Chair: Tao Hong, University of North Carolina

Analysis of ex-ante probabilistic load forecasts at the low voltage substation level
Stephen Haben, University of Oxford; Siddharth Arora, University of Oxford; Georgios Giasemidis, CountingLab Ltd.; Tamsin Lee, University of Oxford

Probabilistic load forecasts have significant financial and operational implications for energy demand systems. With the increasing uptake of low carbon technologies, probabilistic load forecasts could play a vital role in planning and managing of the electricity distribution network, particularly at the low voltage (LV) level. In this study, we present different multivariate techniques for generating short term probabilistic load forecasts at the LV substation level. We consider horizons ranging from an hour to a day ahead, and generate probabilistic forecasts by conditioning load on lagged load observations and weather forecasts, using data for temperature, wind speed, etc.. The models are evaluated using a range of different performance scores that quantify the point, quantile, and probabilistic forecast accuracy. We also investigate the impact of total number of consumers at the feeder level and the consumer types (residential/SME) on the accuracy of our forecasts, which can be important for informing monitoring and modelling requirements at different aggregation levels.

GEFCom2014 probabilistic electric load forecasting: An integrated solution with forecast combination and residual simulation
Jingrui Xie, University of North Carolina at Charlotte

We present an integrated solution for probabilistic load forecasting. The proposed solution was the basis for Jingrui Xie's submission to the probabilistic load forecasting track of the Global Energy Forecasting Competition 2014 (GEFCom2014), and consists of three components: pre-processing, forecasting, and post-processing. The pre-processing component includes data cleansing and temperature station selection. The forecasting component involves the development of point forecasting models, forecast combination, and temperature scenario based probabilistic forecasting. The post-processing component embodies residual simulation for probabilistic forecasting. In addition, we also discuss several other variations that were implemented during the competition.

Load Forecasting Using Lasso Based Time Series Methods
Florian Ziel, European University Viadrina Frankfurt

A new methodology for probabilistic electric load forecasting using high-dimensional time series techniques is presented. The approach is based on a bivariate autoregressive process for electric load and temperature. The heart of the methodology is the considered lasso (least absolute shrinkage and selection operator) estimation method. It allows to estimate models with very large parametrizations without having over-fitting concerns. The large parametrization allows to capture several stylized facts like annual, weekly and daily seasonalities, non-linear effects (esp. from temperature on load) and public holidays effects. Applications to GEFCom2014 data are shown.

Aggregate consistent forecasting algorithms for hierarchical electricity demand data
Souhaib Ben Taieb, Monash University; James W. Taylor, University of Oxford; Rob J. Hyndman, Monash University
Forecasting electricity demand is critical for electric utilities in order to undertake appropriate planning of generation and distribution. Recently, the large-scale deployment of smart electricity meters has made available a large amount of time series data representing household electricity demand at intervals from 1 minute to one hour. Electricity demand forecasts at the household level can be particularly useful for evaluating demand response programs as well as for improving forecasts at aggregated levels. Time series of electricity demand can often be represented in a hierarchical or grouped structure. For example, the electricity demand for a whole country can be disaggregated by states, cities, regions and homes. In order to allow consistent decisions over different levels of the hierarchy, the forecasts for the disaggregated series are usually required to add up exactly to the forecasts of the aggregated series, a constraint known as aggregate consistency. The aggregate consistent forecasts can be computed by first forecasting all series at all levels of the hierarchy. Then a regression procedure is used to reconcile these forecasts, where the estimated coefficients represent the aggregate consistent forecasts. However, since electricity demand is positive, the reconciliation procedure must guarantee the non-negativity of the estimated coefficients. We will present and compare the performance of different point forecasting algorithms using a smart meter dataset collected from 8000 households in the United Kingdom at 30-minute intervals over a period of 1.3 years. Finally, we will also discuss some challenges in reconciling probabilistic forecasts.

12:00 - 13:20 Macroeconomic Uncertainty and Forecasting (Paraninfo)
Chair: Ana Galvao, University of Warwick

An inflation predicting measure of the output gap for the euro area
Marek Jarocinski, European Central Bank; **Michele Lenza**, European Central Bank

Using a small Bayesian dynamic factor model of the euro area we estimate the deviations of output from its trend that are consistent with the behavior of inflation. We label these deviations the output gap. In order to pin-down the features of the model, we evaluate the accuracy of real-time inflation forecasts from different model specifications. The version that forecasts inflation best implies that, after the 2011 sovereign debt crisis, the output gap in the euro area has been much larger than the official estimates. Versions featuring a secular-stagnation-like slowdown in trend growth, and hence a small output gap after 2011, do not adequately capture the inflation developments.

Are Macroeconomic Density Forecasts Informative?
Michael Clements, ICMA Centre, University of Reading

We consider whether survey density forecasts (such as the inflation and output growth histograms of the US Survey of Professional Forecasters) are superior to unconditional density forecasts. The unconditional forecasts, by construction, do not make use of information available at the forecast origin. The SPF forecasts might be expected to outperform the unconditional densities at the shortest horizons, but this does not transpire to be the case, for either the aggregate or individual respondents' forecasts.

Predicting the Relative Forecasting Performance of the Models: Conditional Predictive Ability Approach
Tatevik Sekhposyan, Texas A&M University; Eleonora Granziera, Bank of Canada

The relative performance of forecasting models is known to be unstable over time. However, it is not well understood why the forecasting performance of economic models change. We propose to address this question by evaluating the predictive ability of a wide range of economic variables for U.S. output growth. We take a conditional view on this issue, identifying situations where particular kind of models perform better than simple benchmarks. We, therefore, test whether the relative forecasting performance of models depend on the state of the business cycle, financial conditions, uncertainty or measures of past relative performance. We then investigate whether the conditioning variables help us predict the more accurate forecasting model for a specific future date. Further, we investigate whether using the conditional performance as a model selection or model averaging criteria can improve the accuracy of the predictions.

Macro Uncertainty and Time Varying Heteroscedasticity when Data are subject to Revisions
Michael Clements, University of Reading; **Ana Galvao**, University of Warwick
Data revisions may have a significant impact on measuring macroeconomic uncertainty. Clements (2015) argue that by estimating the forecasting model using the vintage of data available at the forecast origin, our assessment of the macroeconomic uncertainty for variables subject to data revisions may be inaccurate, in particular if we target early-vintage estimates. This paper addresses the impact of data revisions on measuring macroeconomic uncertainty when the conditional variance of the underlying true process changes over time. We evaluate the impact of news and noise revisions on measures of macroeconomic uncertainty computed with forecasting models that use either the vintage of data available at the forecast origin or a time series of snapshots of real-time data. We employ a simulation study and an empirical exercise with quarterly and monthly macroeconomic time series subject to revisions to evaluate the implication of our results.

12:00 - 13:20 Multivariate time series models in economics and finance (Biblioteca)
Chair: Gianluca Cubadda, University of Rome Tor Vergata

Testing for Noncausal Common Features in Multivariate Time Series
Alain Hecq, Maastricht University; Gianluca Cubadda, University Of Roma Tor Vergata; Sean Telg, Maastricht University; Lenard Lieb, Maastricht University

This paper introduces the notion of common noncausal feature and proposes tools to be added to the usual testing procedure for detecting the presence co-movements in stationary economic and financial time series. For purely noncausal, i.e., forward looking, VARs of lead order p, we estimate reduced rank regressions in reverse time in order to highlight the potential presence of such noncausal co-movements. For more than one lead or lag, we are able to determine whether the VAR is better represented by purely causal or purely noncausal models. Using both sets of lag and lead instruments within a canonical correlation or a GMM framework, additional relationships are discovered between series, both in the Monte Carlo simulations and in an empirical illustration with price data. For mixed causal-noncausal models though, an approximate maximum likelihood estimator assuming non Gaussian disturbances is needed.

A dynamic component model for forecasting high-dimensional realized covariance matrices
Luc Bauwens, CORE - Université Catholique de Louvain; Manuela Braione, CORE - Université Catholique de Louvain; **Giuseppe Storti**, Università di Salerno

The Multiplicative MIDAS Realized DCC (MMReDCC) model of Bauwens et al. (2016) decomposes the dynamics of the realized covariance matrix of returns into short-run transitory and long-run secular components where the latter reflects the effect of the continuously changing economic conditions. The model allows to obtain positive-definite forecasts of the realized covariance matrices but, due to the high number of parameters involved, estimation becomes unfeasible for large cross-sectional dimensions. Our contribution in this paper is twofold. First, in order to obtain a computationally feasible estimation procedure, we propose an algorithm that relies on the maximization of an iteratively re-computed moment-based profile likelihood function. We assess the finite sample properties of the proposed algorithm via a simulation study. Second, we propose a bootstrap procedure for generating

multi-step ahead forecasts from the MMReDCC model. In an empirical application on realized covariance matrices for fifty equities, we find that the MMReDCC not only statistically outperforms the selected benchmarks in-sample, but also improves the out-of-sample ability to generate accurate multi-step ahead forecasts of the realized covariances.

Forecasting Stock Returns With Large Dimensional Factor Models
Alessandro Giovannelli, Universita di Roma Tor Vergata; Daniele Massacci, Bank of England; Stefano Soccorsi, ECARES, Universite Libre de Bruxelles

We study the performance of time series forecasts of the equity premium using large dimensional information sets. Time domain and frequency domain factor models are used to summarize the information content of a large macroeconomic dataset. Using standard evaluation criteria, we show that large dimensional factor models produce more accurate equity premium forecasts than valid alternative approaches commonly used in the literature. Frequency domain models also provide an hedge over the time domain counterparts.

Forecasting Inflation Densities Using Disaggregate Commodity Spot Prices and Convenience Yields
Anthony Garratt, University of Warwick; Ivan Petrella, Bank of England

In this paper we examine the ability of different commodity groups to generate well calibrated h-step ahead US consumer price inflation predictive densities. Using a model averaging approach, in constrast to the existing literature which often adopts a factor based approach, we combine a large number of simple linear models which explain h-step ahead inflation. The models use either a single commodity spot price or a single commodity convenience yield, defined over different lag lengths of the commodity variable and inflation. Two methods of pooling are examined, the Linear Opinion Pool and the Log Linear opinion pool, where in each case (time-varying) weighted averages are constructed using both log score (LS) and continuous rank probability score (CRPS) weights. Averages over N models are examined and two additional weighted averages are constructed, using a two step approach. The first allows the contribution of each commodity group, and the second for the effects of spot prices versus convenience yields, to be examined. The general features of the results are (i) there are significant roles for most commodity group considered and for models containing both spot prices or convenience yields (ii) where a single commodity group does take a more dominant role, this is most often Grain group (containing Soybean Oil, Corn, Oats, Soybean, Soybean Meal, Wheat), but the degree of dominance is modest and varies over the forecast horizon being considered (iii) time variation is a feature of the weightings, particularly in the second half of the evaluation period, from around 2005 onwards. Finally we construct commodities inflation indices which examine moving-averages of the LOP average densities LS and CRPS relative to the LS and CRPS of an AR(p) benchmark for inflation.

12:00 - 13:20 Seasonal Adjustment 1 (Pedro Salinas 2)
Chair: Daniel Ollech, Deutsche Bundesbank

Variance Estimation for Weekly Seasonally Adjusted National UI Claims Series
Thomas Evans, Bureau of Labor Statistics; Michael Sverchkov, Bureau of Labor Statistics

Two of the timeliest U.S. economic indicators are initial claims and continuing claims from the Unemployment Insurance (UI) program. These series are collected and processed weekly by the states, and are seasonally and calendar adjusted by the Bureau of Labor Statistics for release by the Department of Labor. Weekly data are difficult to seasonally adjust as the series do not have constant periodicity. Seasonal adjustment is carried out utilizing a locally-weighted regression approach originally described in Cleveland (1993). Week-to-week changes can be both relatively large and variable, so the changes can be difficult to interpret. To account for this problem, we utilize the impulse response method to calculate the observation weights. Once the weights are available, variances are calculated in a similar manner as shown in Pfeffermann and Sverchkov (2014). Standard errors for week-to-week changes from this method are analyzed for both initial claims and continuing claims series.

Modelling multiple seasonalities across hierarchical aggregation levels
Daniel Waller, Lancaster University; John Boylan, Lancaster University; Nikolaos Kourentzes, Lancaster University

Forecasting product demand is an important issue for retail businesses in every sector for supply chain management, marketing strategy development and financial planning. A prominent feature of retail sales series is often the presence of one or more seasonal patterns. Furthermore, as a time series is viewed from different levels of aggregation over products, time, and other hierarchies, different features of the series can become more pronounced, and different seasonalities can be revealed. Depending on the level of investigation, multiple seasonal cycles may appear and the nature of seasonality can change. Higher levels of aggregation can mask seasonal effects, and at lower levels the signal may be distorted by increased noise, making estimation difficult. The question of which level to choose can also be approached from a causal viewpoint; some seasonal effects may be driven by localised variables, whilst some may have more overarching drivers. Hence, it is desirable to have a forecasting approach which estimates each seasonal pattern at the level of aggregation that is most effective. Using real demand data from a fuel retailer, we assess how various methods capture seasonality at different aggregation levels and how this information is carried over across levels of aggregation. We propose methods to produce forecasts which combine these multiple seasonalities from different levels, comparing the accuracy of our forecasts against known univariate procedures for handling multiple seasonalities, as well as classic forecast benchmarks.

Analysing Daily Time Series: Adjusting Seasonal and Moving Holiday Effects
Daniel Ollech, Deutsche Bundesbank

The methods for seasonal adjustment of official data explicitly supported by Eurostat are X-11 and SEATS. Both methods do not allow for adjustment of data with a higher than monthly frequency, though an increasing number of time series is available with a weekly or daily periodicity. Possible examples range from data on air pollution, web-search keywords, and traffic jam data to economic variables such as exchange rates, online prices, and the amount of Euro banknotes in circulation. The aim of this research is the development of a procedure that makes it possible to estimate and adjust for regularly and periodically reoccurring systematic effects and the influence of moving holidays and trading days in time series with daily observations. To this end, an STL (Seasonal and Trend Decomposition using Loess) based seasonal adjustment routine is combined with a regression model with ARIMA errors for the estimation of calendar and outlier effects. The latter will also be used for forecasting of the original time series, so as to be able to compute forecasted seasonal factors. The seasonal adjustment procedure successively estimates and adjusts intra-weekly, intra-monthly and intra-annual periodic movements. The prediction of the original series is based on the regARIMA model which uses trigonometric functions to incorporate monthly and annual seasonality. In addition, the intra-weekly seasonal factors are extrapolated using exponential smoothing. The procedure is evaluated empirically using a set of economic time series.

14:30 - 15:30
Featured Speaker I (Paraninfo)
Chairperson: Esther Ruiz, University Carlos III

Todd Clark

Federal Reserve Bank of Cleveland, USA

Todd Clark is a Vice President and Economist at the Federal Reserve Bank of Cleveland, where he leads the Research Department's macroeconomics group. Dr. Clark began his career as an economist with the Federal Reserve Bank of Kansas City. In 2010, he joined the Cleveland Reserve Bank and assumed his current position. He specializes in research related to monetary policy and macroeconomics and has published on a variety of topics, including the measurement of inflation, forecasting methods, and the evaluation of forecasts. He currently serves as co-editor of the Journal of Business and Economic Statistics and as an associate editor with the Journal of Money, Credit, and Banking.

Time-Varying Volatility and Macroeconomic Forecasting
The evidence of time variation in macroeconomic volatility is now well established. For example, volatility fell sharply with the Great Moderation and rose during the Great Recession. Recent research has shown that macroeconomic forecast accuracy can be improved significantly by incorporating time-varying volatility in common time series and structural models. After documenting volatility shifts and the basic benefits of modeling them for the purpose of macroeconomic forecasting, this talk will review the time series models currently available, including some approaches that can be used with relatively large models, as well as alternative approaches. The talk will then review challenges and topics for further research, including the treatment of fat tails and outliers and medium-horizon forecasts of volatility.

14:30 - 15:30 Demand-supply forecasting (Santo Mauro)
Chair: George Athanasopoulos, Monash University

SKU retail sales forecasting and promotions optimization by integrating cross-item promotional information
Shaohui Ma, JiangSu University of Science and Technology; Robert Fildes, Lancaster Centre for Forecasting; Tao Huang, Kent Business School

SKU level retail store sales are affected by inter and intra category effects which potentially need to be considered when deciding on promotional strategy and producing operational forecasts. But no research has yet put this well accepted concept into forecasting practice: an obvious obstacle is the ultra-high dimensionality of the variable space. This paper develops a four steps methodological framework to overcome the problem. It is illustrated by investigating the value of both intra- and inter-category SKU level promotional information in improving forecast accuracy. The method consists of the identification of potentially influential categories, the building of the explanatory variable space, variable selection and model estimation by a multistage LASSO regression, and the use of a rolling scheme to generate forecasts. The success of this new method for dealing with high dimensionality is demonstrated by improvements in forecasting accuracy compared to alternative methods of simplifying the variable space. Based on the demand model, we then build a nonlinear integer programming model to maximize the retailer's category profits over a planning horizon under constraints that model important business rules. The output of the model provides optimized prices, display and feature advertising planning together with sales and profit forecasts. The new model delivers an optimizing promotional schedule at SKU level which maximizes multi-period category level profit under the constraints of business rules typically applied in practice. The empirical results show that models integrating more information perform significantly better than the baseline model when using the proposed methodology framework. In general, we can improve the forecasting accuracy by 12.6 percent over the model using only the SKU's own predictors. But of the improvements achieved, 95 percent of it comes from the intra-category information, and only 5 percent from the inter-category information. The optimization tests over a number of stores and categories using supermarket data suggest that our model increases category profits by approximately 17% and that including cross-item and cross-period effects is also valuable.

Improving Forecasting and Inventory Management in a Small to Medium Size Enterprise Food Production Company.
Christian Davies, Bangor University; Kostas Nikolopoulos, Bangor University; Siwan Mitchelmore, Bangor University

We were invited to assess a company's forecasting models and inventory control systems. The company is a cooked food producer supplying a wide range of customers. Its demand pattern is intermittent with variable volumes being ordered, and some products have a seasonal variation also. Lead times are variable across products and the products shelf life is short. The company wanted to have the input of current academic theory and best practice in developing an alternative forecasting and inventory control system. A range of forecasting models (SES, Regression, ARIMA, moving averages etc.) were competed against each other on the company's historic data to establish which fitted the data best. These measures were used to assess the forecasting accuracy; Symmetric MAPE, average ranking, median symmetric APE, percentage better, median RAE, and MASE. The best fitting model was then run alongside the current system to establish if it improved forecast accuracy. Its inventory system was assessed also. The influence of different aggregation methods and bullwhip effects were investigated as well as its supply chain. Advice, based on current academic theory, on how to improve the inventory system was passed on to the company.

Forecasting restaurant bookings
George Athanasopoulos, Monash University; Nicholas Harrington-Johnson, Monash University; Rob J Hyndman, Monash University

Accurate forecasts of bookings are important for hotels, airlines and restaurants among other operators within the tourism industry. In this paper we focus on forecasting bookings for restaurants. The accuracy of such forecasts is important for management to better plan for staffing and supplies. We use daily data provided by the EZTABLE booking system for the most popular restaurants across Taiwan and forecast 1 to 14 days ahead. We propose semi-parametric models which model past bookings information using regression splines, account for public holidays and observances, and include ARIMA errors. We find significant gains in forecast accuracy when we compare these against methods typically used for bookings data such as the pick-up method, pure time series models and other naïve benchmarks.

14:30 - 15:30 Health Forecasting (Biblioteca)
Chair: Reinaldo Castro Souza, Pontifical Catholic University of Rio de Janeiro

Australian cancer incidence projections, 2002 to 2011, revisited
Ian McDermid, The Australian National University

In a 2005 report (AIHW, AACR & NCSG: McDermid 2005) the Australian Institute of Health and Welfare (AIHW) published projections of Australian national cancer incidence from 2002 to 2011 for 60 cancer sites and groups of cancers. These projections were designed to support planning of cancer services and used the then most recently available Australian national cancer incidence data, from 1982 to 2001. The methods chosen at the time to project the age-specific cancer incidence rates were based on the functional data analysis (FDA) approach introduced by Ramsey and Silverman (1997, 2001). Research at the time (Booth et al 2002, Hyndman & Ullah 2005) showed that FDA methods could be used to generalise the Lee–Carter approach (Lee & Miller 2001, Lee 2000, Lee & Carter 1992) to demographic forecasting. Australian national cancer incidence data has recently become available on the AIHW website (AIHW 2016) for almost the entire projection period. In this paper, we use the new data to evaluate the 2005 projections.

Predicting the Annual Total Claim Amount of Individuals by Introducing Heterogeneity into Aggregate Loss Models
Aslihan Senturk Acar, Hacettepe University; Ugur Karabey, Hacettepe University; Dario Gregori, University of Padova

The theory of aggregate loss models is one of the cornerstones of actuarial science. Both claim frequency and claim severity components are modeled in aggregate claims process to estimate total loss amount of individuals. Aggregate loss approach is used to model cross-sectional data that is

collected in a specific policy period. Especially for health insurance, policyholders have a tendency to utilize medical service more than once in a policy period. In this case, there may be a correlation structure between the repeated claims of the same policyholder. Ignoring correlation may cause invalid inferences. Main source of variability that induce correlation between repeated measures of the same individual is the between-individual heterogeneity. In this study, our aim is to get marginal predictions by taking into account heterogeneity between individuals. For this purpose, we use random effects model to estimate mean claim amount per claim of policyholders to take into account heterogeneity. Then, we marginalize random effects model by averaging over the distribution of random effects. We get closed-form predictors of individual total claim amounts. For the application part, we use a private health insurance data set of a Turkish insurance company. Different statistical models are fitted to both claim frequency and claim severity data. Predictive accuracy of purposed model is compared with alternative models by using cross validation method. Results are discussed.

Brazilian health insurance premium forecasting with a new forecast combination approach
Juliana Christina Carvalho de Araújo, Pontifical Catholic University of Rio de Janeiro; Bruno Quaresma Bastos, Pontifical Catholic University of Rio de Janeiro; **Reinaldo Castro Souza**, Pontifical Catholic University of Rio de Janeiro

Health insurance premium forecasting is essential to insurers. It provides support to business strategies and provides guidelines for portfolio planning. Despite the importance to the market, insurance forecasting literature is very limited. As a result, we do not have indications of a reference model that best represents the generating process of health insurance premium series. Thus, we do not have reference of which modeling approach provides the best forecasts for the series. In order to overcome this issue, we apply a new forecast combination approach to improve monthly individual forecasts of Brazilian health insurance premium forecasts. We make use of five modeling approaches to obtain individual health insurance premium forecasts: Box and Jenkins (B&J), Exponential Smoothing (ES), Mamdani Fuzzy Logic System (M-FLS) and Naïve. Each one of these approaches (expect the latter) has one particular process for model building and selection, which we adopt. After obtaining individual forecasts, we apply different and simple forecast combination methods (e.g. simple average, constrained least squares), considering different combination schemes, to produce combined forecasts. The combination schemes comprehend all possible combinations of forecasts. (For example: one scheme is the combination of B&J and ES forecasts; another scheme is the combination of B&J and M-FLS forecasts; another scheme is the combination of forecasts obtained from all models; and so on.) After producing forecasts for all combination schemes, we select the results of the combination scheme that presents the best in-sample forecasts, based on accuracy measures. The presented approach is not restricted to health insurance premium forecasting, and can be applied to different problems and areas where uncertainty over model performance exists or where improvements on forecast accuracy are needed. The limitations of the approach are basically two: as we adopt more and more forecasts, (i) the number of combination schemes increases without restraint (and so does the computational effort) and (ii) the information obtained from different forecasts is lost. The work predicted four time series with the proposed approach: medical insurance (co-operative), odontological insurance (co-operative), ondotological insurance (group), health insurance (group). We made 12-step forecasts and used the Mean Absolute Percentage Error (MAPE) as forecast accuracy measure. The data were acquired from the Brazilian Private Insurance Superintendency (SUSEP). To the authors' knowledge, this is the first combined forecast application to improve Brazilian health insurance time series forecasting.

14:30 - 15:30 Judgemental Forecasting and disagreement (Bringas)
Chair: Paul Goodwin, University of Bath

Approximating Fixed-Horizon Forecasts Using Fixed-Event Forecasts
Malte Knüppel, Deutsche Bundesbank; Andreea Vladu, Deutsche Bundesbank

In recent years, survey-based measures of expectations and disagreement have received increasing attention in economic research. Many forecast surveys ask their participants for fixed-event forecasts. Since fixed-event forecasts have seasonal properties which hamper many types of empirical analyses, researchers often use an ad-hoc approach in order to construct fixed-horizon forecasts from fixed-event forecasts. In this work, we derive the optimal approximation for the fixed-horizon forecasts by minimizing the mean-squared approximation error. Like the approximation based on the ad-hoc approach, our approximation is constructed as a weighted sum of the fixed-event forecasts, with easily

computable weights. The optimal weights tend to differ substantially from those of the ad-hoc approach. In an empirical application, it turns out that the optimal-weights approach yields a lower mean-squared approximation error than the ad-hoc approach in all cases considered, and that the gains from using optimal weights are very pronounced. Our results also show that the optimal approximation is preferable to the ad-hoc approach when trying to capture cross-sectional disagreement prevailing among forecasters.

What if your judgmental forecasts are not Bayesian? The consequences for decisions involving risk
Paul Goodwin, University of Bath; Dilek Onkal, Bilkent University; Herman Stekler, George Washington University

Many studies have examined the extent to which individuals' judgmental probability forecasts depart from Bayes' theorem when these are revised in the light of new information. Generally, these studies have not considered the implications of such departures for decisions involving risk. We identify when two common types of decisions are likely to be sensitive to these departures. We then report on two experiments where people were asked to revise their own prior probabilities of a forthcoming economic recession in the light of new information. When the reliability of the new information was independent of the state of nature, people tended to overreact to it when their prior probability was low and underreact when it was high. When it was not independent, they tended to display conservatism. We identify the circumstances where discrepancies in decisions arising from a failure to use Bayes' theorem are most likely to occur. However, we find that these discrepancies will be relatively rare and will typically not be serious. Our findings therefore suggest that models that aim to predict individuals' decisions assuming a Bayesian updating procedure are likely to produce results that are robust and accurate in most circumstances.

Cross-cultural variations in overconfidence in judgmental forecasting: Difference in risk-taking attitude?
Summer Xia Meng, University of Bath; Paul Goodwin, University of Bath; Sheik Meeran, University of Bath
This paper reports on a study designed to explore the relationship between cross-cultural variations found in judgmental interval forecasting and cultural variations in risk-taking attitudes. Our prior study found that, in a time-series forecasting context, Chinese participants exhibited higher degrees of overconfidence than their British counterparts. That is, judgmental prediction intervals of the former group were significantly narrower than the latter's. A lack of familiarity with probabilistic thinking partially explained such variations. However, existing literature has established that there are cross-cultural variations in risk-taking attitudes: Chinese participants have been found to be more risk-seeking than Western participants. Such cultural differences can also potentially have an impact on one's judgment in forecasting, in that risk-seeking individuals may be more likely to provide overly-narrow prediction intervals and hence reveal overconfidence. Stemming from the above, we hypothesised that people's risk-taking behaviour is another explanation for the cross-cultural variations in overconfidence in judgmental interval forecasting. The study comprised of two experiments that examined the hypothesis. They enabled an assessment to be made as to which of the two explanations (risk-taking behaviours and familiarity with probabilistic thinking) is more strongly associated with cultural differences in interval forecasts.

14:30 - 15:30 Time Series (Infantes)
Chair: Robertas Gabrys, University of Southern California

High-frequency time series analysis tools for forecasting
Robertas Gabrys, University of Southern California

Advancements in computer technology, data recording and storage have made high-frequency business, economic and financial data more and more accessible to academicians and practitioners and have driven the data frequency to the limit. A natural way to view and analyze such data is to treat them as random continues curves. The Functional time series analysis tools for forecasting and their applications to business, economic and financial data sets are presented in the talk.

Classification of cointegrated series
Marcos Bujosa, Universidad Complutense de Madrid; Alfredo Garcia-Hiernaux, Universidad Complutense de Madrid

We present a new, simple and fast algorithm to classify stochastic processes by means of a reflexive, symmetric and transitive relation, R (e.g., equal mean, equal variance, pairwise cointegration, etc.). The procedure has two steps. A) the refinement process: it makes pairwise comparisons among all the processes to identify those related by R. Then, these relations are extended by transitivity. Hence, an equivalence relation is defined, and therefore a partition of the set (a quotient set) is defined. This spliting step is iteratively repeated on each sub-group (equivalence class) until no more sub-groups are formed. B) the merging process: an aggregate that summarizes the common feature of the group is assigned to each sub-group, and then an equivalence relation is defined on the set of aggregates (through R like in step A). The union of sub-groups whose aggregates are related form a new classification of stochastic processes. This merging step is iteratively repeated until no more merging is possible. Steps A) and B) are iteratively repeated until convergence in the classification (in the quotient set) is reached. The result is a classification of stochastic processes in groups that share a common feature (equal mean, equal variance, etc). We apply this algorithm to the specific case of pairewise cointegration, and we present the advantages of the algorithm in terms of computational efficiency, convergence and robustness.

Forecasting Aggregated Power Consumption for a Water Supply System
David Raz, Holon Institute of Technology, Management of Technology Faculty; Ariel Daliot, mPrest LTD
Bar Amit

In the special case presented, the aggregated power consumption of a national water supply system is forecasted. In order to achieve energetic efficiency, two types of energy consumption forecasts are required: The first is used in producing a day-ahead consumption plan for the next 24-72 hours (depending on weekday and holidays), which is part of the contractual obligation. Deviating from this consumption plan incurs fines. The second is an online forecast executing every hour with a horizon of 168 hours which is used as part of the operational procedure, attempting not to deviate from the aforementioned consumption plan. Both forecasts are in 30 minute time slots. The special challenge in this setting stems from two major factors: The first is an inherent inaccuracy in the data. The second, and more important, is an abundance of hidden variables, mostly linked to the fact that the consumption represents operational decisions of the different water supply centers which are not independent and relies heavily on operational procedures and on the state of the system, both of which are unknown, for the future as well as the past. This introduces very strong interdependencies between the different sub areas and the hours of the day, which we present and discuss. Seasonal changes in the energy cost structure, which in turn change operational policies in an unknown manner, further deteriorate this, making forecasts in the seasonal change period especially challenging. On the other hand, the consumption pattern relies heavily on the energy cost structure which is exploited in the presented method. For cleansing the data we rely on well tested outlier removing procedures. Since a very strong cost-determined daily consumption pattern is present, we use an adaptive Holt-Winters exponential smoothing forecaster for the day-ahead forecast. The forecaster seeks to predict the daily average and pattern. The forecaster parameters are optimized using a hill-climbing search algorithm. For the online forecaster we use a similar mechanism with different parameters. Surprisingly, we find that the consumption within the first few hours of the day is a very good indication of the daily average and pattern for rest of the day, so much so, that weather information has little effect on the results. This is especially useful for the online forecasts which become very accurate already before the first working hours of the day.

15:40-16:40 Forecasting Practitioner Track 3 (Rector Ernest Lluch)

Bram Desmet, Managing Director of Solventure

How Strategy Impacts Forecasting and How Forecasting Improves Supply Chain and Financial Performance

My overall goal is to explain why I believe that the forecasting domain is affected by the strategic context of a company, and why forecasting is crucial for improving the supply chain and more generally the financial performance of a company! I will build this discussion in 3 steps. First I introduce my recent work on the Supply Chain Triangl'. That triangle captures the struggle in many companies to balance service, cost, and cash. I will show how improving that supply chain balance is the same as improving the financial performance of a company. I will also show how the balancing act in that supply chain is linked to the chosen company strategy. In a second step I introduce a supply-chain-metrics framework based on that triangle. The framework starts from the SCOR model and adds a customer value dimension based on work by Crawford and Matthews. Finally, I use that metrics framework to show how forecasting impacts the overall supply chain and financial performance of a company, and how the 'complexity of the forecasting job' will depend on the chosen strategy of the company.

15:40 - 16:40 Early warnings (Santo Mauro)
Chair: Margarida Rodrigues, Institute for Employment Research

Optimal Investment Strategies Derived from Financial Crisis Indicators Based on Random Matrix Theory
Antoine Kornprobst, Paris I Panthéon-Sorbonne University

The main objective of this study is to build successful investment strategies and devise optimal portfolio structures by exploiting the power of forecast of our financial crisis indicators based on random matrix theory. While using daily data constituted of the components of a major equity index like the Standard & Poor 500 (SP500) or the Shanghai-Shenzhen CSI 300 (SHSZ300), the financial crisis indicators used in this paper are of two kinds. Firstly we consider the financial crisis indicators that are based on measuring the Hellinger distance between the empirical distribution of the eigenvalues of the correlation matrix of those components of the index and a distribution of reference built to either reflect a calm or agitated market situation. Secondly, we consider the financial crisis indicators based on the study of the spectral radius of the correlation matrix of the components of the index where the coefficients have been weighted in order to give more importance to the stock components that satisfy a chosen characteristic related to the structure of the index, market conditions or the nature of the companies which are part of the index. For example, we will attempt to give more importance in the computation of the indicators to the most traded stocks, the stocks that represent the companies with the highest market capitalization or the stocks which represent companies with an optimal debt to capital ratio. Our optimal investment strategies exploit the forecasting power of the financial crisis indicators described above in order to produce a “buy”, “sell” or “stay put” signal every day that is able to anticipate most of the market downturns while keeping the number of false positives at an acceptable level. Such tools are very valuable for investors who can use them to anticipate market evolution in order to maximize their profit and limit their losses as well as for market regulators who can use those tools to anticipate systemic events and therefore attempt to mitigate their effects.

Use of unit root methods in early warning of financial crises
Eero Tölö, Bank of Finland; Katja Taipalus, Bank of Finland; Matti Virén, Bank of Finland and University of Turku; Timo Virtanen, Bank of Finland and University of Turku

This paper introduces a new time-series method based early warning indicator of financial crises and provides cross-country evidence of its performance in EMU countries. The method is based on unit root tests of relevant time series as in Taipalus (2006). The main advantage of the method is that, unlike in conventional logit models, the early warning signals do not depend on signaling thresholds estimated based on historical data. Hence the signals can be constructed for all countries irrespective of existence of historical data or history of financial crises. Even in the absence of free parameters, the

early warning signals have quite high relative usefulness. To further improve the crisis prediction, the signals from multiple time series can be combined into a composite indicator. It is also possible to use a mix of data with different frequencies, which can be useful for providing more timely warning signals. The results suggest that this approach has a place in the toolkit of financial stability supervision.

RiskRank: Measuring interconnected risk
Jozsef Mezei, Åbo Akademi University; **Peter Sarlin**, Hanken School of Economics and RiskLab Finland

This paper proposes RiskRank as a joint measure of cyclical and cross-sectional systemic risk. RiskRank is a general-purpose aggregation operator that concurrently accounts for risk levels for individual entities and their interconnectedness. The measure relies on the decomposition of systemic risk into sub-components that are in turn assessed using a set of risk measures and their relationships. For this purpose, motivated by the dpevelopment of the Choquet integral, we employ the RiskRank function to aggregate risk measures, allowing for the integration of the interrelation of different factors in the aggregation process. The use of RiskRank is illustrated through a real-world case in a European setting, in which we show that it performs well in out-of-sample analysis. In the example, we provide an estimation of systemic risk from country-level risk and cross-border linkages.

15:40 - 16:40 Energy prices (Pedro Salinas 1)
Chair: Jethro Browell, University of Strathclyde

Forecasting Electricity Prices and Market Length for Trading Stochastic Generation in Markets with a Single-price Balancing Mechanism
Jethro Browell, University of Strathclyde

This paper presents the problem facing stochastic generators who are required to participate in electricity markets with a single-price balancing mechanism. The solution to this problem requires forecasts of multiple processes: weather-dependent generation, electricity and balancing prices, and the sign of the system length. By formulating the problem from a probabilistic perspective, it is demonstrated that a combination of well known and understood forecasting techniques can support market participants in both increasing revenue and reducing risk. Probabilistic forecasts of system length are produced using logistic regression on data widely available to market participants, and electricity prices are forecast using ARMAX models with automated fitting. Wind power forecasts are provided by a wind farm operator for a case study based on wind participating in the UK electricity market. It is shown that the proposed approach can be employed to increase revenue, by over 10% in the most extreme case, and to reduce risk.

On the importance of the long-term seasonal component in day-ahead electricity price forecasting
Jakub Nowotarski, Wrocław University of Technology; Rafal Weron, Wrocław University of Technology

We examine the importance of the long-term seasonal component (LTSC) in day-ahead electricity price forecasting (EPF). In short-term EPF the daily and weekly seasonalities are always taken into account, but the LTSC is believed to add unnecessary complexity to the already parameter-rich models and is generally ignored. The aim of this paper to conduct an empirical study to verify if the LTSC should be included in day-ahead EPF models, contrary to a common belief that it is redundant in the short-term. Although the study focuses on energy markets, the methodology may be found universal and applied in other forecasting problems.

Real time electricity price forecasting, comparative assessment of some computationally intelligence algorithms
Atom Mirakyan, European Institute for Energy Research; Andreas Koch, European Institute for Energy Research

Day-ahead electricity price forecasting is very important among others for balancing power markets, where accurate forecast values of the electricity prices for next 24 hours are required. Electricity price

has high volatility, price spikes, seasonal or calendar effects. Computationally intelligence algorithms have been successfully implemented to cope with such a kind complex, volatile data sets. However, there are restrictions in everyday forecasting praxis like required time or knowledge for forecasting. This study asses the performance of different methods such artificial neural networks, support vector regression or ridge regression in such restricted forecasting conditions using different data sets. Empirical results show that the predictive power of support vector regression outperform other methods according to different error measures. However, in certain restricted conditions rigid regression might provide satisfactory results.

15:40 - 16:40 Fiscal forecasting when fiscal policies are uncertain (Bringas)
Chair: Javier Pérez, Banco de España

Now-casting the Italian budget deficit: a mixed frequency BVAR approach

Jacopo Cimadomo, European Central Bank; Domenico Giannone, Federal reserve Bank of New York; Michele Lenza, European Central Bank

Budget balance data are only available at quarterly frequency and their release is particularly delayed coming, in general, later than national quarterly accounts. However, monthly data are available on cash flows from government, with a very limited delay (two days after the end of the reference month, in the case of Italy). Though very timely, due to a different accounting methodology compared to the one for assessing the budget balance, monthly cash flows are a noisy indicator of the budget balance. In order to extract information on the budget balance while, at the same time, discounting the noisy content of monthly cash-flows, this paper proposes a Bayesian Mixed VAR approach to now-cast the Italian budget balance.

Forecasting fiscal aggregates in an emerging market economy: the role of macro variables and fiscal plans

Javier J Perez, Bank of Spain; A. Jesus Sanchez-Fuentes, University Complutense of Madrid; Engin Yilmaz, Ministry of Finance

In this paper we develop a comprehensive short-term fiscal forecasting system specifically designed for the Turkish case, an interesting case study for several reasons. First, Turkey is one the most relevant emerging countries. Second, this issue has not been systematically analised in the scarce related literature. Third, UE adhesion seems to be speeded up in the incoming months and fiscal surveillance will need of stronger supervision tools. The system is made of a suite of models, with different levels of disaggregation and composition (including or not macroeconomic indicators). The models are time-series, mixed-frequencies models along the lines of Harvey and Chung (2000), Moauro and Savio (2005), Proietti and Moauro (2006), and Pedregal and Pérez (2010), for which the starting point of the modeling approach is to consider a multivariate Unobserved Components Model known as the Basic Structural Model (Harvey, 1989), suitable to deal with non-stationary time series. These papers use a temporal aggregation method that relies on the information contained on related indicators observed at the desired higher frequency. The statistical treatment of structural time series models is based on the state space form and the Kalman Filter. Our tools are instrumental for ex-ante detection of risks to targets fulfilment, and thus can help in reducing the ex-post reputational costs of budgetary deviation. All in all, our results will allow official monitoring bodies to expand their toolkit to evaluate regular adherence to targets and improve their communication policies as regards sources of risks of (ex-ante) compliance.

Fiscal targets. A guide to forecasters?

Joan Paredes Lodeiro, European Central Bank; Gabriel Pérez Quirós, Banco de España; Javier J. Pérez, Banco de España

Should rational agents take into consideration government policy announcements? A skilled agent (an econometrician) could set up a model to combine the following two pieces of information in order to anticipate the future course of fiscal policy in real-time: (i) the ex-ante path of policy as published/announced by the government; (ii) incoming, observed data on the actual degree of implementation of ongoing plans. We formulate and estimate empirical models for a number of EU countries (Germany, France, Italy, and Spain) to show that government (consumption) targets convey

useful information about ex-post policy developments when policy changes significantly (even if past credibility is low) and when there is limited information about the implementation of plans (e.g. at the beginning of a fiscal year). In addition, our models are instrumental to unveil the current course of policy in real-time. Our approach complements a well-established branch of the literature that finds politically-motivated biases in policy targets.

15:40 - 16:40 Forecast Evaluation 2 (Paraninfo)
Chair: Rob J Hyndman, Monash University

The Stochastic Order of Forecast Error Losses
Wilmer Martinez, Banco de la Republica; Manuel Hernandez, Banco de la Republica; Juan Julio, Banco de la Republica

A simulation study of the small-sample power and size of stochastic order tests applied to the evaluation of a set of $k \geq 2$ forecast procedures is presented, and their results are compared to those of widely known alternatives. Given a forecast error loss function, stochastic loss order tests are proposed instead of loss moment order in two complementary circumstances; when a strict (but unknown) joint forecast performance order exists among all k forecast alternatives, and when order happens only in subsets of alternative procedures. Despite of the fact that stochastic order is stronger than moment order, it may reveal undesirable local forecast error loss distribution features not identified otherwise. We found that stochastic loss order tests are at least as powerful as competing tests and are robust to correlation, autocorrelation and heteroscedasticity, specially in small sample sizes.

Testing Forecast Rationality Under Asymmetric Loss: Evidence for EMU countries
Alessandro Giovannelli, University of Rome Tor Vergata; Filippo Maria Pericoli, European Commission, Joint Research Centre

We investigate the rationality of GDP growth forecasts issued by governments of EMU countries in the years 1999-2013. The paper is motivated by the policy relevance of GDP in macroeconomic forecasting and by the belief that the comprehension of past forecasting behaviors can help improving the reliability of future forecasting exercises. In order to take into account the peculiarity of governmental forecasts, we depart from the standard quadratic loss function. Thus, following the method proposed by Elliott et al. (2005), we test the hypothesis of rationality by adopting a flexible loss function where the shape parameter driving the extent of asymmetry is unknown and estimated from the empirical distribution of forecast errors. In detail, we assume a loss function of the lin-lin type, which is potentially capable of approximating even more general classes of loss functions. Our results confirm that within the traditional RMSE framework the rationality hypothesis - tested by means of the regression-based Mincer-Zarnovitz approach is generally rejected, and this is particularly true in the case of governments' forecasts. However, allowing for a flexible and potentially asymmetric loss functions identified by letting the data speak for themselves, the hypothesis of forecast rationality is no longer rejected in a wide number of cases.

Exploring time series collections used for forecast evaluation
Rob Hyndman, Monash University; Yanfei Kang, Baidu; Kate Smith-Miles, Monash University

It is common practice to evaluate the strength of forecasting methods using collections of well-studied time series datasets, such as the M3 data. But how diverse are these time series, how challenging, and do they enable us to study the unique strengths and weaknesses of different forecasting methods? In this paper we propose a visualisation method for a collection of time series that enables a time series to be represented as a point in a 2-dimensional feature space. The effectiveness of different forecasting methods can be visualised easily across this space, and the diversity of the time series in an existing collection can be assessed. Noting that the M3 dataset is not as diverse as we would ideally like, this paper also proposes a method for generating new time series with controllable characteristics to fill in and spread out the instance space, making generalisations of forecasting method performance as robust as possible.

15:40 - 16:40 Forecasting applications (Infantes)
Chair: Konstantinos Nikolopoulos, Bangor University

Forecasting Branded and Generic Pharmaceutical Life Cycles When the Branded Drug is Out Performing the Generic Drug
Samantha Buxton, Swansea University; Marwan Khammash, University of Sussex; Konstantinos Nikolopoulos, Bangor University; Philip Stern, Exeter University

Branded and generic pharmaceuticals have until recently competed in virtually distinct worlds. This world is separated by the patent protection of branded products. There was also a wide discrepancy in the prices of branded pharmaceuticals as compared with their generic counterparts. Over the past decade these worlds have collided creating a new term known as "braneric competition". Comparing the life cycles of branded and generic drugs that are no longer patent protected, it can be seen that a new pharmaceutical life cycle has started to emerge and is inextricably associated with the new environment. This research shows now that branded drugs even many years after patent expiration are still actively competing with and often outperforming the generic equivalents. The research is being undertaken in two stages. Stage 1 saw the Bass diffusion model, repeat purchase diffusion model (RPDM), moving average, exponential smoothing, Naïve and Naïve with trend models applied to the data. There is competing literature suggesting that complex models are better able to forecast pharmaceutical life cycles. While other research supports the conclusion that simple models are often better. When stage 1 had been completed it was noted that none of the complex models were able to outperform the simple models. The second stage will see the Holt winters exponential smoothing model, autoregressive integrated moving average (ARIMA) model, robust regression, and regression over t, regression over t-1 all applied to the data. The empirical evidence linked to stage 1 shows that for the branded life cycle the Naïve with 50% trend would perform the best. For the generic equivalents the empirical evidence suggests that the Naïve model with the addition of a 10% trend would provide the most accurate and robust modelling and forecasting method.

Forecasting Branded and Generic Pharmaceuticals with Lotka-Voltera survival equations
Konstantinos Nikolopoulos, Prifysgol Bangor University; Fotios Petropoulos, Cardiff University; Dimitrios D. Thomakos, University of Peloponnese; Phil Stern, University of Exeter

In this paper we forecast simultaneously the demand for the total market, branded and generic pharmaceuticals with univariate, bivariate, hierarchical and simultaneous survival equations (Lotka - Voltera models). The empirical evaluation is performed in annaly and monthly (seasonal) data from UK over a period of 20 years.

Forecasting blood donations with Google Trends
Tine Van Calster, KU Leuven; Michael Reusens, KU Leuven; Bart Baesens, KU Leuven; Wilfried Lemahieu, KU Leuven

In recent years, Google Trends data has been applied in many applications, from the well-known Google Flu to forecasting the ups and downs of the housing market. In this paper, we propose an entirely new application for this type of data: blood donation forecasting. The turn-out for blood donations is exceedingly important in the day-to-day planning of donation centres. This forecast does not only impact the logistical preparation of anticipating the number of spots for donors and providing a sufficient amount of employees, but it also has an effect on the foreseeable blood supply per blood type. This in turn affects the number of people that need to be contacted, either by extending their marketing campaigns or by directly getting into touch with specific donors. Future research will also include the forecast of donations of plasma and blood platelets, but in this presentation, we will focus on the case of blood donations alone. Our research is conducted in cooperation with the Belgian Red Cross - Flanders. The main two goals of this project consist of assessing the exact turn-out of blood donors in their donor centres for all blood types, while also giving an indication of how successful their marketing campaigns were. In order to achieve this goal, we turn to time series models that capture the ongoing trend and expected seasonality due to the holidays and include available external factors, such as the amount of visitors on certain web pages of the Red Cross website and data about marketing campaigns. Additionally, we add relevant Google search terms, which are limited to the Flanders region, as we expect them to give an indication of the amount of people that are interested in blood donations. We compare our results to several benchmarks, such as naïve forecasts and Seasonal ARIMA models, in order to assess the exact impact of the addition of the external factors.

15:40 - 16:40 Forecasting turning points (Biblioteca)
Chair: Eva Ortega, Bank of Spain

Dating Business Cycles: The new dating of the Spanish Economic Association
Eva Ortega, Bank of Spain

In April 2015, the Spanish Economic Association launched the first dating of the Spanish Business Cycle, through its Dating Committee. It followed the spirit of the dating of the US business cycle by the NBER or that of the euro area by the CEPR. Its web page http://asesec.org/CFCweb/archivo_e.htm gives access to the data and methodology used, the precise turning points and an explanation for each of them, among other things. The historical dating of the Spanish Economic Association identifies the turning points by analyzing a number of quarterly series since the early 70s, most prominently the GDP. In addition to this, and in order to provide the public with a tool to assess the current economic conditions, the Dating Committee built and maintains an updated index of economic activity, which combines monthly and quarterly information from several data sources to extract the latent level of economic activity in real time.

Comparing alternative models to match and forecast the official dating of the Spanish business cycles
Antonio Garcia-Ferrer, Universidad Autónoma de Madrid; Marcos Bujosa, Universidad Complutense, Madrid; Aranzazu de Juan, Universidad Autónoma de Madrid

Last year, the Spanish Economic Association (SEA) appointed a group of well known experts to create the Dating Committee for the official Spanish business cycle dates. This achievement meant an important milestone for researchers and policy makers trying to analyze and compare alternative business cycle specifications. As it happens with the NBER for the US data, we now have a yardstick to compare historical and future results. In this paper, we compare our UAM-UCM coincident index, CI (based on the low frequency components of a few monthly economic variables) and other alternatives with the SEA dating. Additionally, we present empirical of how our leading indicator index (LI) provides considerable aid in forecasting annual and quarterly GDP growth rates during the last recession and recovery. Using only real data at the beginning of each forecast period, our LI forecasts compares favorably with other alternatives.

Hyper-Parameterized Dynamic Regressions for Nowcasting Spanish GDP Growth
David de Antonio Liedo, National Bank of Belgium; Elena Fernandez, I.E.S. Brianda de Mendoza

Monitoring the on-going developments in the Spanish business cycle requires the use of accurate forecasting tools that can handle an heterogeneous number of economic indicators. This paper analyzes the nowcasting performance of hyper-parameterized dynamic regression models with all variables in levels and compares it with the state-of-the-art. Our method requires the estimation of many parameters if we wish to construct projections conditional on a large information set. The so-called curse of dimensionality is overcome here with prior information originating in the Bayesian VAR literature. The real-time forecast simulation conducted over the most severe phase of the Great Recession shows that our method yields reliable real GDP growth predictions almost one and a half months before the official figures are published. The usefulness of our approach is confirmed in an genuine out-of-sample evaluation that considers the period of the European sovereign debt crisis and the subsequent recovery.

Early warning indicators of private credit imbalance. Application for financial crisis detection
Marcin Lupinski, National Bank of Poland

The Great Depression and the Great Financial Crisis negatively tested the classical and neoclassical hypotheses of the credit to private sector neutrality for the real economy. Explosion of the private debt spent on the non-productive spending (like buying residential real-estates) and deflation of the credit-financed assets' prices are perceived as single-one most important causes of both events. Fluctuations of the private credit indicators are now closely observed by authorities (central banks and supervisors) responsible for macroprudential policy-making. In this paper we analyse private credit time-series (with the special concern of the credit to non-financial corporates and households) from the group of developed and catching-up European economies to assess their cyclical characteristics. We check similarities and dissimilarities of the private credit evolution across time and survey the degree of harmonization of the credit cycles among surveyed countries. Knowing key features of the surveyed

private credit time-series we investigate group of the potential variables, that can be used as univariate or as an input to multivariate early warning indicators. We analyse the group of time-series from different domains (private credit formation, debt service series, financial markets variables, real-estate prices, macroeconomic variables, external imbalances, banks' financial situation) and then construct the group of early warning indicators (EWIs) that can be used to identify in advance bank credit to private sector imbalances. The constructed EWIs are based on linear methods (logistic regression) and non-linear ones (Markov switching models). In the last part of the paper we formulate some guidance for using constructed EWIs as the tool for detecting of the forthcoming financial crises.

15:40 - 16:40 Macro Forecasting (Comedor de Infantes)
Chair: Marcin Kolasa, Warsaw School of Economics and National Bank of Poland

Exchange rate forecasting with DSGE models
Michal Rubaszek, Narodowy Bank Polski; Marcin Kolasa, Narodowy Bank Polski; Michele Ca'Zorzi, European Central Bank

We run a comprehensive real exchange rate forecasting horse race for Australia, Canada, UK, euro area, US. We evaluate 2 DSGE models, 3 BVAR models and 2 simple bechmarks (RW and "fixed AR" model). We highlight that two principles hold. First, prudence is a virtue: forecasts should not replicate the high volatility of exchange rates observed in-sample. Second, models should exploit the mean reversion of the real exchange rate over long horizons. Abiding by these principles, an open-economy DSGE model performs well in real exchange rate forecasting. It predicts instead poorly nominal exchange rates, since it fails to correctly anticipate the relative adjustment of domestic and foreign prices. This failure points to simpler ways to beat the random walk.

Variability of Macroeconomic Forecasts: The Other Dimension
Nathan Goldstein, Bar-Ilan University; Ben-Zion Zilberfarb, Bar-Ilan University

We consider the variation in expectations under models of information rigidities. While many studies concentrate on forecast disagreement, which corresponds to the cross-sectional variability of forecasts, this study focuses on a dimension that was quite overlooked in the literature – the time variability of forecast series. We derive from several leading models of information rigidities the same pattern of variability, for which the time variance of the average forecast series should increase as the forecast horizon is getting shorter. However, models disagree on whether the actual series should vary more than the forecast series. We propose a bootstrap method to test the hypothesis of the variability pattern across forecast horizons, and apply it to a unique Israeli survey of inflation and exchange rates forecasts, taking advantage of the vast changes in inflation and exchange rate processes during the sample period. The survey period can be divided to three distinct sub-periods: a first sub-period of high inflation and rapid devaluation, which ended abruptly by a successful stabilization program; a second sub-period of moderate and declining inflation accompanied by special exchange rate policies; and a third sub-period of steady low inflation and fully-floated exchange rate. By breaking the sample to the distinct regimes, our evidence demonstrate that the predicted variability pattern across forecast horizons holds only when ruling out periods where special policy interventions bring on non-stationarity to the processes of the variables, as in the second sub-period of the sample, for which we get the precise reverse variability pattern. A possible implication of our results is that one should investigate the underlying process of macroeconomic series before drawing conclusions on the expectations formation process.

Does foreign sector help forecast domestic variables in DSGE models?
Marcin Kolasa, Warsaw School of Economics and National Bank of Poland; Michal Rubaszek, Warsaw School of Economics and National Bank of Poland

This paper evaluates the forecasting performance of several variants of a state-of-the-art small open economy DSGE model relative to its associated closed economy benchmark. We find that point and density forecasts for domestic variables obtained from the open economy models are statistically indistinguishable from, and in most cases even significantly less accurate than, those produced by the closed economy setup. We argue that this disappointing performance of the open economy DSGE model is due to important misspecification of the underlying theoretical structure rather than to large estimation error related to an increased number of parameters. This claim is supported by demonstraing

that even the richly specified estimated open economy model generates several counterfactual predictions about the comovement between domestic and foreign sector variables.

15:40 - 16:40 Signal Extraction 2 (Pedro Salinas 2)
Chair: Diego J Pedregal, Universidad de Castilla-La Mancha

Continuous-Time Model Identification, Estimation and Forecasting
Peter C. Young, University of Lancaster

A perusal of the time-series analysis, econometric and forecasting literature quickly reveals the almost universal dominance of discrete-time models for characterizing the input-output behaviour of dynamic systems. Yet this is in stark contrast to the modeling of dynamic systems in the scientific world, where most causative models are in the form of continuous-time, ordinary or partial differential equations. This paper will argue that Continuous-Time (CT) models often have theoretical and practical advantages over their discrete-time equivalents. It will also show how it is straightforward to identify and optimally estimate such models from noisy sampled data. Some of the advantages of CT models are rather obvious. For instance, most scientific laws, such as the conservation equations (mass, energy, momentum etc.) are posed in terms of CT equations that can be interpreted directly in physically meaningful terms. The parameters of the CT model are unique: unlike the DT model, they are not a function of the sampling interval. In addition, should the user require a DT model (e.g. for control or forecasting system design), the DT model at any selected sampling interval can be generated straightforwardly by transformation from the estimated CT model. Moreover, this yields good results when direct DT estimation would prove problematical; e.g. when the sampling interval is fast and the eigenvalues of the DT model approach the unit circle. But there are other advantages of CT model estimation: CT models can be estimated from non-uniformly sampled data; estimation is straightforward even if the system is 'stiff' , i.e. it has a combination of widely separated slow and fast dynamic modes; 'fractional' time-delay systems with time delays less than the sampling interval present no problems; large initial conditions that could prove problematical if they are not accounted for, can be handled easily; and, finally, CT model identification and estimation preserves a priori knowledge and identifies more parsimonious models. Despite these advantages, there seems to be a view that CT models are difficult to estimate, perhaps because this is often associated with the estimation of 'stochastic differential equation' models of fully stochastic, univariate or multivariate systems. In the case of stochastic input-output models, however, estimation is straightforward and algorithms for their identification and estimation are freely available in the CAPTAIN Toolbox for Matlab. A practical example of CT modeling using CAPTAIN tools is given is a paper for the Climate Modeling and Forecasting Session.

Pi weights for the state space model
Blyth Archibald, Dalhousie University

π weights for state space models - The π weights for a forecast are the implicit weights given to past values of a time series in the one period ahead forecast. Box-Jenkins describes them and their calculation for an infinite series. We use the Kalman gains for a state space model to determine them for a finite series. They are more complex, as they depend on the length of the series and change with each new observation. Still, given modern computers, they are easily calculated. They can be used to measure the sensitivity of a forecast to an observation. We use them to show that the estimate of a fixed trend from the Kalman filter is the same as obtained with generalized least squares.

Flexible time series modelling with SSpace
Diego J Pedregal, Universidad de Castilla-La Mancha (UCLM); Marco A Villegas, UCLM; José I Castillo-Manzano, Universidad de Sevilla (US); Lourdes López-Valpuesta, US; M. Mercedes Castro-Nuño, US

SSpace is a library for State Space modelling. State Space is in itself a powerful and flexible framework for dynamic system modelling, and SSpace is conceived in a way that try to enhance such flexibility to its maximum. In this sense, the toolbox incorporates a number of powerful features, some of them standard but some others not so standard. Most of them having to do with the algorithmic power of the library, e.g. exact, diffuse or ad-hoc initialisation of recursive algorithms is possible; univariate treatment of multivariate systems is implemented; different objective functions are included,

like (concentrated) Maximum Likelihood, forecast errors several steps ahead, etc. The most salient feature of SSpace is that users implement their models by coding a function. In this way, the user has complete flexibility when specifying the systems, having absolute control on parameterisations, constraints among parameters, etc. Besides, the library allows for some ways to implement models in a rather non-standard fashion, like using arbitrary non-linear relations with inputs, transfer functions without using the State Space form, etc. The toolbox may be used on the basis of scratch State Space systems, but is supplied with a number of templates for standard models. A full help system and documentation is provided individually for each function and also in html format. The way the toolbox is conceived allows for extension in many ways, surely some of them the authors have not imagined. In order to fuel such extensions and discussions a forum has been launched. SSpace is being exploited successfully currently in different applications, like transport logistics, traffic casualties, energy forecasting, supply chain forecasting, etc.

17:00 – 18:00 Forecasting Practitioner Track 4 (Rector Ernest Lluch)

Greg Parlier, US Army retired and adjunct research staff at the Institute for Defense Analyses

Demand Planning for Military Operations

This presentation offers a practical approach for improving the US Army's complex global logistics system. It is a seemingly intractable strategic challenge to effectively integrate production planning, inventory systems, and distribution policies given the usage histories and consumption patterns exhibited by tactical military forces – in other words, to align supply to real customer demand. I will introduce the new concept of mission-based forecasting (MBF) for demand planning. MBF is can support military operations more effectively and can sustain essential readiness levels more efficiently. We can also capitalize on "big data" opportunities and recent advances in sensor and information technologies, including the Internet of Things (IoT), to harness the complementary powers of operations research, advanced analytics, and management innovation to achieve order-of-magnitude reductions in forecast error and many billions of dollars in cost savings.. I provide a summary of recent research from the ongoing Project to Transform US Army Supply Chains, along with an overview of previous evaluations published in the text Transforming US Army Supply Chains: Strategies for Management Innovation.

17:00 - 18:00 Demand Forecasting (Pedro Salinas 2)
Chair: Huijing Chen, University of Portsmouth

Forecasting demand with internet searches and social media shares
Oliver Schaer, Lancaster University Management School; Nikolaos Kourentzes, Lancaster University Management School; Robert Fildes, Lancaster University Management School

Rapid changes in consumer interests, major events and disruptive innovations lead to a competitive business environment. One possible way to identify demand changes is to incorporate information from publicly available online sources that reflect customer behaviour. Many customers nowadays research the product online prior to purchase, sharing behaviour on online social media platforms or search traffic popularity. This is potentially valuable information for demand forecasting. Although various studies reported increased forecast accuracy when incorporating such data, one of the main constraints is that even though accuracy might improve the lead time might be insufficient for any operational decisions. Furthermore, little is known about the causal direction of online data. We typically assume that search traffic leads to sales, but it could also be that once a product is sold, search traffic is caused by users looking for support or additional information. Thus, it remains questionable whether online data is equally beneficial during all stages of the product life-cycle. To investigate these questions we consider two distinct datasets: the first contains search traffic information from Google Trends and sales of video games. The second includes data of corporate video views and social media shares. In both cases the relatively short life-cycles permit us to study the relationship between demand and exogenous impact from online data sources over its entire life-cycle.We use a rolling Granger causality approach to test the effect of lead order changes. The aim is to provide guidelines to practitioners on how to best use data from online sources and provide possible new ways for future research in this emerging area.

Demand forecasting with dynamic hierarchies
Michał Kurcewicz, SAS Institute; Piotr Skarzyński, SAS Institute

Demand forecasting systems usually allow for expert adjustments of statistical forecasts. While the value added of these adjustments is debated in the literature, large organizations typically employ domain experts to verify and adjust business critical forecasts. We present an integrated demand forecasting system that structures the forecasting process. Statistical forecasts are automatically generated in a hierarchy that results in the best forecast quality possible. However such a hierarchy may not be the hierarchy that best reflects the business needs or the information available to the experts. Therefore the system allows business users to visualize and adjust forecasts using dynamic hierarchies which can be changed on the fly. Such an approach allows experts to easily include external information. For example a business user can change a typical hierarchy of Product – Customer – Location used to generate statistical forecasts to a Customer – Product – Location hierarchy and adjust the forecasts for a given customer based on his/hers expert information. The user can then proceed to change the hierarchy to Location – Product – Customer to add some location specific adjustments. The system support various types of adjustments (percentage, fixed, allocate value on a time interval using the forecast pattern) and includes expert rules that can automatically generate adjustment suggestions. The described system has been implemented using SAS software and is used in production mode at a large Polish oil&gas company. The value added of each forecasting step is measured using the FVA (Forecast Value Added) method. Preliminary results show that statistical forecasts are more accurate than naïve forecasts while expert adjustments improve statistical forecasts.

Temporal shrinkage approach to short-term seasonal demand forecasting
Huijing Chen, University of Portsmouth; John Boylan, Lancaster University

Accurate estimate of seasonal demand behaviour is critically important for organisations for inventory and replenishment planning purposes and can contribute to significant cost reductions. However it is often a very challenging task because of short data history and each season occurring only once a year. Traditionally seasonal indices are estimated individually from the SKU's history by using classical decomposition. In this paper we propose a shrinkage approach that shrinks individually estimated seasonal indices across the seasons towards zero. The motivation behind this proposal is to improve forecasting accuracy by balancing the trade-off between unbiasedness and efficiency. This approach is then compared to the individual seasonal indices (ISI) approach. Theoretical results and properties of the approach will be presented. And we show conditions under which it performs better than the ISI approach. A James-Stein type of estimator is used for estimating the unknown parameters and the theory is validated by simulations and empirical analysis using the M3 competition data. Although simple models are assumed in this paper, the major contribution is to provide a greater theoretical understanding of how shrinkage works in the seasonal demand forecasting context. Insights are gained to bridge some of the gaps in the literature and provide practical guidelines on implementation.

17:00 - 18:00 Energy Forecasting 2 (Pedro Salinas 1)
Chair: Antonio Munoz, Universidad Pontificia Comillas

Forecasting residual demand curves of the day-ahead electricity market with a Hilbertian ARMAX model
José Portela, Universidad Pontificia Comillas; **Antonio Muñoz**, Universidad Pontificia Comillas; Estrella Alonso, Universidad Pontificia Comillas
The offering or bidding strategy of an agent operating in a day-ahead electricity market may be optimized by modeling the competitive behavior of its competitors. This can be done using residual demand curves. For every auction, the residual demand is defined as the clearing price of the market expressed as a function of the amount of energy the agent is able to buy or sell. Forecasting residual demand curves is the first and essential step in the design of optimal bidding strategies. Residual demand curves can be considered as a functional time series defined as the realization of a stochastic process where each observation is a continuous function defined on a finite interval. In order to forecast these curves, a functional Hilbertian ARMAX model is presented in this paper using functional integral operators in the L2 space. The kernels of the operators are modeled as linear combinations of sigmoid functions, where the parameters of each sigmoid are estimated using a Quasi-Newton algorithm which minimizes the sum of squared functional errors. This functional model allows forecasting the time series of hourly residual demand curves taking into account time dependencies,

seasonality as well as exogenous variables. An empirical study is presented for the hourly residual demand curves of the Spanish day-ahead electricity market.

Expectations of Natural Gas Prices using Dynamic Models in two Alternative Approaches
Andre Assis de Salles, Federal University of Rio de Janeiro

The crude oil and natural gas prices are important and often decisive variables for the economic policy makers as well as for the international financial market investors. The oil and gas prices volatility implies on uncertainties for the world economy and national economies. Thereby the oil and natural gas price expectations are fundamental for the economic agents. Therefore, despite the difficulties and complexities to obtain an oil and gas price forecast models, studies have been carry out by academic and market professionals to build these forecast models. Many studies have been developed in order to establish a stochastic process that can represent the movements or the returns of crude oil and natural gas prices, price returns or variations of such prices time series to obtain price expectations. This study used two dynamic models described in the statistical inference literature as alternative approaches to forecast crude oil and natural gas prices. This work aims to propose an alternative methodology in two appraches. First a dynamic model Bayesian and second a classical model based of an ARDL model for building forecast models of oil and natural gas prices. These models consider the conditional heteroskedasticity and non normality of returns. Furthermore this study investigate if the influence hypothesis of crude oil price is present on gas natural price returns or if crude oil prices are relevant for developing methods to forecast natural gas price returns. Furthermore this work investigate if the influence of crude oil price returns hypothesis still present on gas natural price returns or if crude oil prices are relevant for developing methods to forecast natural gas price returns. To reach the objectives of this work crude oil such as WTI and Brent types and natural gas benchmark such as Henry Hub and NBP weekly prices time series traded in the international market were collected. All crude oil prices information collected were in US$ per barrel and natural gas price were converted into U.S. dollars per U.S. dollars per million BTU. The data covers the period from September 2007 to January 2016. This information adds up to time series with 336 observations.

Box & Jenkins with transfer function in R: a case study to Natural Inflow Energy series from the Brazilian southwest subsystem
Pedro Ferreira, Instituto Brasileiro de Economia; **Reinaldo Souza**, Pontifícia Universidade Católica do Rio de Janeiro; Daiane Mattos, Instituto Brasileiro de Economia

The use of auxiliary variables in univariate models of Box & Jenkins through transfer function can improve the modeling and time series forecasting. This article aims to present this methodology using the R software, a fact not yet addressed in international literature. Furthermore, a study using the Sunspot and Southern Oscillation Index (SOI) series for modeling the Natural Inflow Energy (NIE) time series from the Brazilian southwest subsystem showed superior results when compared with ARIMA model.

17:00 - 18:00 Forecast Evaluation 3 (Santo Mauro)
Chair: Robinson Kruse, CREATES, Aarhus University

A Note on the Validity of Cross-Validation for Evaluating Time Series Prediction
Christoph Bergmeir, Monash University; Rob J Hyndman, Monash University; Bonsoo Koo, Monash University

One of the most widely used standard procedures for model evaluation in classification and regression is K-fold cross-validation (CV). However, when it comes to time series forecasting, because of the inherent serial correlation and potential non-stationarity of the data, its application is not straightforward and often omitted by practitioners in favor of an out-of-sample (OOS) evaluation. In this paper, we show that the particular setup in which time series forecasting is usually performed using Machine Learning methods renders the use of standard K-fold CV possible. We present theoretical insights supporting our arguments. Furthermore, we present a simulation study where we show empirically that K-fold CV performs favorably compared to both OOS evaluation and other time-series-specific techniques such as non-dependent cross-validation.

Qualitative evaluation of the Federal Reserve's multihorizon forecasts: Do they predict turning points?
Yoichi Tsuchiya, Tokyo University of Science

This study examines whether multi-horizon forecasts in the US Federal Reserve's Greenbook predict turning points of the economy. This study also examines those forecasts in the Survey of Professional Forecasters (SPF) and compares their relative performances. To evaluate those forecasts qualitatively, this study applies market-timing tests that have been often used in finance literature. In addition to widely used tests to evaluate qualitative performances of various forecasts, this study uses a new market-timing test. That test has an advantage to take into consideration of serial correlation that is often observed in economic variables although the previous studies has overlooked. Many studies have examined and evaluated various multi-horizon forecasts owing to their fundamental difference from single-horizon forecasts. However, researchers have rarely examined their qualitative accuracy, that is, in terms of direction, unlike other areas in forecast evaluation. This study fills the gap in the literature by extending the market-timing tests to jointly evaluate the Greenbook forecasts and SPF with two pairs of different forecast horizons. In other words, this study focus on 4×4 cases by extending the market-timing tests used to examine 2×2 cases. The joint evaluation of the Greenbook forecasts shows that simultaneous forecasts in real GDP, industrial production, and unemployment rate are broadly useful in predicting increase/decrease and acceleration/deceleration up to two quarters ahead. In contrast, joint forecasts of GDP deflator are not useful. These findings suggest that the Federal Reserve can broadly predict qualitative conditions of the US economy. Our results reveal the advantage of the new test method. The joint evaluation of the SPF forecasts yields similar results with those of the Greenbook.

Comparing Predictive Accuracy under Long Memory - With an Application to Volatility Forecasting
Robinson Kruse, CREATES, Aarhus University; Christian Leschinski, UNi Hannover; Michael Will, UNi Hannover

This paper extends the popular Diebold-Mariano test to situations when the forecast error loss differential exhibits long memory. It is shown that this situation can arise frequently, since long memory can be transmitted from forecasts and the forecast objective to forecast error loss differentials. The nature of this transmission mainly depends on the (un)biasedness of the forecasts and whether the involved series share common long memory. Further results show that the conventional Diebold-Mariano test is invalidated under these circumstances. Robust statistics based on a memory and autocorrelation consistent estimator and an extended fixed-bandwidth approach are considered. The subsequent Monte Carlo study provides a novel comparison of these robust statistics. As an empirical application, we conduct forecast comparison tests among recent extensions of the heterogeneous autoregressive model for realized volatility of the Standard and Poors 500 index. While we find that forecasts improve significantly if jumps in the log-price process are considered separately from continuous components, improvements achieved by the inclusion of implied volatility turn out to be insignificant.

17:00 - 18:00 Forecasting in economics and society (Infantes)
Chair: Rocio Sanchez-Mangas, Universidad Autonoma de Madrid

Forecasting the USD/CNY Exchange Rate under Different Policy Regimes
Yuxuan Huang, George Washington University

The USD/CNY exchange rate exhibits very different pattern in different periods as it changes wildly from one period to another according to the economic reforms and policies. This paper compares the performance of six different forecasting models of USD/CNY exchange rate under three different forecast scenarios from 2005-2015. In particular, the paper focuses in answering the following questions. (i) Do models' forecast performance change when the marketization level changes? (ii) Which model has the best forecast when the regimes change? (iii) Can forecasting robustifications help? The forecast results show that models incorporates economic fundamentals perform better in less regulated periods when the exchange rate can oat more freely. For the forecast experiments with breaks in the forecast origin, the exchange rate CVAR model perform the best before robustifications. In most cases, the intercept-correction and double-difference device improve the forecast performance in both

dynamic forecast and one-step forecast. Different models seem to do well under different forecast scenario after applying the robust devices.

The 5th science & technology foresight in South Korea: Identifying future main societal issues using network analysis
Jonghwa Park, KISTEP; Seung Ryong Lee, KISTEP

Korea establishes science & technology (S&T) policies by engaging in S&T planning activities at the national strategy level. S&T Foresight is one of these S&T planning activities. The 1st S&T Foresight was conducted in 1994, and the 4th S&T Foresight results were published in 2012. According to provision of the S&T Framework Law, S&T Foresight should be conducted every five years and the results should be reflected in the Science and Technology Basic Plan. The 5th S&T Foresight is performing for 2 years between 2015 and 2016, and it is conducted to discover future technologies that might be developed by 2040. Its goal is to provide basic data for the establishment of national S&T policy. Last year, we studied on prospects of future Korean society up to the year of 2040 and investigated megatrend, trend, and main issues, in stages. Firstly, we gathered global future trends from reliable future trend books which are domestic and international. We adjusted the trends using STEEP(Society, Technology, Economy, Ecology and Politics) frame and derived 5 megatrends, which are human empowerment, innovation by hyper-connection, anger of the earth, evolution of complicated society and reorganization of economic system. Based on the trends, we derived future issues which may highly affect the South Korean society. We defined future issues as controversial topics or worrying problems due to corresponding future trends. As a results we derived total 100 issues with short-(~10 years) and long-term(11~25 years) perspectives. To draw 40 main future issues, which we have to pay attention more among 100 issues, we analysed each issue by citizens and expert committee applying 3 evaluation criteria – likelihood, societal impact and possibility to solve the issues by S&T. Also, we performed network analysis among 40 main future issues based on social big data to reveal relation between the issues. We analysed over 26 million news articles for recent 4 years in South Korea. We studied on amount of reference of each issue, time series network analysis and technological keyword analysis, etc. In this presentation, we will introduce background, purpose and progress of S&T Foresight performed by our institute, KISTEP. Each process of 5th S&T Foresight and what has been improved compared to prior foresight results will be presented. In addition we will also introduce following process to derive future technologies which are doing on this year.

A dynamic structural model of investment decisions at the firm level
Rocío Sánchez-Mangas, Universidad Autónoma de Madrid

This paper investigates fixed capital investment decisions at the firm level using a dynamic behavioral model. We focus on the role of irreversibility and nonconvexities in the investment decision, posing a general specification of the adjustment cost function that includes both convex and nonconvex components. The dynamic structural model is estimated using a longitudinal sample of Spanish manufacturing firms, for which we find evidence of inaction and lumpy investment episodes. The estimation approach is based on the existence of a one-to-one mapping from the conditional choice value functions to the conditional choice probabilities. We use the estimated structural model to predict the effect of some counterfactual experiments on firms' investment behavior.

17:00 - 18:00 Forecasting methods 2 (Comedor de Infantes)
Chair: Elliott Mandelman, Kinaxis Inc.

Augmenting Statistical Time Series Models with Machine Learning Techniques
Slawek Smyl, Microsoft; Karthik Kuber, Microsoft

The talk will report on our attempts to improve forecasting performance of statistical time series algorithms (in particular an extension of Exponential Smoothing) by applying Machine Learning algorithms. This approach has several advantages as it makes use of the best of both worlds - statistical and ML: 1. From a statistics perspective, as in the case of classical statistical time series algorithms, it allows us to forecast for large horizons (in comparison to the length of past data). 2. The ML value-add is that it adjusts the statistical time series algorithms' forecast with the power and complexity of a modern black-box ML algorithms. However, it still leaves the base model comparatively simple and

understandable. We apply this combination of techniques and test them on a standard benchmark set of prediction problems, viz. the M3 datasets.

Taming volatile high frequency data with long lag structure: An optimal filtering approach
Stefan Neuwirth, KOF / ETH Zurich; Dirk Drechsel, KOF / ETH Zurich
We propose a Bayesian optimal filtering setup for improving out-sample forecasting performance when using volatile high frequency data with long lag structure for forecasting low-frequency data. We test this setup by using real-time Swiss construction investment and permit data. We compare our approach to different filtering techniques and show that our proposed filter outperforms those techniques in terms of extracting the more relevant signal of the indicator series for forecasting. This result is robust for various other mixed-frequency forecasting methods, such as standard MIDAS, U-MIDAS or bridge models.

Identifying the Appropriate Forecasting Time Lag for Error Metric Computation
Elliott Mandelman, Kinaxis Inc.

This paper addresses an often ignored factor that can be pivotal in supporting profitable uses of forecasts; namely the appropriate computation of forecast error. Good decisions controlling the size of safety stock component in inventories all depend on good estimates of the size of the errors we should expect in our forecasts. Forecast error is directly linked to the levels of inventory; specifically, to the computation of safety stock. The safety stock component of total inventory is a quantity of stock that protects against service failures. Yet, many companies state that their forecast error is within reasonable bounds but that actual service levels are far below expectations and, frequently, below the industry average as well. The cause of the service problem may be the manner in which the forecast error metric is computed. If the error component of safety stock, standard deviation of forecast error, is computed incorrectly, the result will be an inappropriate value that will impact service levels. The subject of this paper addresses the determination of the appropriate time lag period; the time between the actual demand and the time period when the forecast was generated for the time period of the actual. For example, a forecast error based on a lag period of 3 is the actual for March based on the March forecast made in December.

17:00 - 18:00 Forecasting using Common Features (Bringas)
Chair: Joao Issler, Graduate School of Economics, EPGE

The Role of Demand Factors in Predicting Oil Prices
Angelo Duarte, BIS / Central Bank of Brazil; Joao Issler, Graduate School of Economics, EPGE; Guillen Osmani, Central Bank of Brazil; Roberto Branco

The purpose of this paper is twofold. The first is to improve our understanding of oil price variation either in the long run or in the short run by using standard time-series techniques. We rely on the common-trend and common-cycle approach. Here, non-stationary economic series are decomposed into an integrated trend component and a stationary and ergodic cyclical component, where their properties can be jointly investigated in a unified multivariate setting based on vector autoregressive (VAR) models. Trends and cycles can be common to a group of series being modelled, and these common features can be removed by independent linear combinations. Focusing on the period from 1990 onwards, and using these techniques outlined above applied to oil-price data, we show empirically that there is an important role for demand factors in explaining their behavior. The importance of demand factors had been stressed at least since the influential paper of Deaton and Laroque (1996). Despite that, as far as we know, we are the first authors to investigate and find the synchronicity of oil prices and output cycles, accounting for theory and empirics. Much of our setup relies on the previous effort of Issler et al. (2014), who successfully modeled the behavior of metal-commodity prices, showing the importance of demand factors for their out-of-sample forecasting as well. Our second objective is to improve on current forecasts of oil prices. Instead of relying on a specific model to forecast oil prices, we diversify out the risk of large forecast errors (and increase the information set used in forecasting) by combining forecasts of different models. This approach, first put forward by Bates and Granger (1969), has been shown to reduce forecast uncertainty in a variety of studies. Recently, Issler and Lima (2009) and Gaglianone and Issler (2015) have developed an optimal forecast-combination framework, in a panel-data setting, where forecasts of different models (or survey results) comprise the cross-sectional dimension. In their context, the optimal forecast using a mean-

squared error (MSE) risk function can be consistently estimated by employing bias corrections to the consensus forecasts, identifying the conditional expectation, which is a common feature of all forecast models.

Forecasting Liquidity in Emerging Markets
Osmani Guillen, BCB and Ibmec

For a Central Bank in an Emerging Market it is important to predict liquidity in order to perform optimal monetary policy. The objective of this paper is to propose and evaluate several time-series models that could potentially predict liquidity. Some of them are within the ARIMA class and some are state-space models estimated using the kalman filter. We also entertain multivariate models. All these models are estimated at different frequencies, daily, weekly, and monthly, and different horizons. Initial results show that ARIMA models work well at short horizons and state-space models work well at longer hoizons.

Consumption-Wealth Ratio and Expected Stock Returns: Evidence from Panel Data on G7 Countries
Joao Issler, Getulio Vargas Foundation; Andressa Castro, Getulio Vargas Foundation

Using the theoretical framework of Lettau and Ludvigson (2001), we perform an empirical investigation on how widespread is the predictability of cay { a modified consumption-wealth ratio { once we consider a set of important countries from a global perspective. We chose to work with the set of G7 countries, which represent more than 64% of net global wealth and 46% of global GDP at market exchange rates. We evaluate the forecasting performance of cay using a panel-data approach, since applying cointegration and other time-series techniques is now standard practice in the panel-data literature. Hence, we generalize Lettau and Ludvigson's tests for a panel of important countries. We employ macroeconomic and financial quarterly data for the group of G7 countries, forming an unbalanced panel. For most countries, data is available from the early 1990s until 2014Q1, but for the U.S. economy it is available from 1981Q1 through 2014Q1. Results of an exhaustive empirical investigation are overwhelmingly in favor of the predictive power of cay in forecasting future stock returns and excess returns.

17:00 - 18:00 Nowcasting and Forecasting 1 (Paraninfo)
Chair: Pablo Pincheira, Adolfo Ibanez University

Short-term forecasting of GDP via evolutionary algorithms using survey-based expectations
Oscar Claveria, University of Barcelona; Enric Monte, Polytechnic University of Catalunya; Salvador Torra, Riskcenter-IREA, University of Barcelona

Business and consumer surveys are the main source of agents' expectations. In this study we use survey expectations about a wide range of economic variables to forecast GDP growth. We propose a symbolic regression (SR) via genetic programming (GP) approach to derive mathematical functional forms that link survey-based expectations to economic growth. The set of empirically-generated indicators are used as building blocks to forecast economic activity in a set of European economies. We find that in most countries the survey-based predictions outperform the forecasts generated by a baseline model.

The Evasive Predictive Ability of Core Inflation
Pablo Pincheira, Adolfo Ibáñez University; Jorge Selaive, University of Chile; Jose Luis Nolazco, University of Lima

We explore the ability of traditional core inflation –consumer prices excluding food and energy– to predict headline CPI annual inflation. We analyze a sample of OECD and non-OECD economies using monthly data from January 1994 to March 2015. Our results indicate that sizable predictability emerges for a small subset of countries. For the rest of our economies predictability is either subtle or undetectable. These results hold true even when implementing an out-of-sample test of Granger causality especially designed to compare forecasts from nested models. Our findings partially challenge the common wisdom about the ability of core inflation to forecast headline inflation, and

suggest a careful weighting of the traditional exclusion of food and energy prices when assessing the size of the monetary stimulus.

State-Space Methods for Nowcasting with Large BVAR models
Jean Palate, National Bank of Belgium; **David de Antonio Liedo**, National Bank of Belgium

Bayesian estimation methods are widely applied in dynamic econometric models due to advances in computer power and on-going efforts in the development of computational techniques. Those techniques often rely on state-space methods, the implementation of which is often disregarded. In this paper, we describe the JDemetra+ implementation of large mixed-frequency Bayesian VAR models, which will be at the core of our nowcasting plugin together with dynamic factor models. We show that the object-oriented used in our general state-space framework is more efficient than procedures based on matrix algebra. We illustrate the usefulness of our approach by reproduce the results of Schorfheide and Song (2014), based on eleven macroeconomic variables, and compare them with a model that exploits a larger information set. Second, we propose in this paper a straightforward empirical Bayes method that relies on the marginal likelihood of a given target variable to automatically determine the priors for VAR parameters.

17:00 - 18:00 Risk forecasting (Biblioteca)
Chair: Marcin Lupinski, National Bank of Poland

Early warning models of banking crises applicable to non-crisis countries
Piotr Banbula, National Bank of Poland and Warsaw School of Economics; Marcin Pietrzak, National Bank of Poland

We built Early Warning Indicator (EWI) of banking crises, which can guide the optimal moment for build-up phase of countercyclical capital buffer. For this purpose we estimate number of early warning models based on the widest panel of countries in the literature. We test many potential variables from the early 1970s until 2014, their combinations, and the stability of their signals. Our setting includes country-specific-information without using country-specific effects, which allows to directly apply the EWI we obtain to any country, including these that have not experienced a banking crisis. The probability of extracting a correct signal from our synthetic EWI exceeds 0.9. We find that VIX has very high predictive qualities concerning banking crises and its signal is stable. Variables that generate signals with the highest accuracy and stability are those associated with credit, property prices and contribution of financial sector to GDP growth. The use of indicator that combines information from more than one variable greatly increases the quality of signals. The fact that growth in the contribution of financial sector to the value added usually precedes banking crises corroborates hypotheses that the measured value added often includes systemic risk taken by the financial sector, rather than the value added itself.

Real time identification of credit cycle phases in emerging markets
Elena Deryugina, Bank of Russia; Alexey Ponomarenko, Bank of Russia

Basel III uses the gap between the credit-to-GDP ratio and its long-term trend as a measure of credit cycle phase and a guide for setting countercyclical capital buffers. Criticism of this choice centers on several areas. The main concern is practical measurement and the end-point problems. Recent studies find that several indicators (e.g. non-core liabilities ration and debt service ratio) that do not require de-trending may be successful in predicting banking crises. The interest in such supplementary indicators is also driven by the demand for a system that could provide a signal that is early enough to account for the 12 month implementation period for raising the capital buffers specified in the CRD IV regulation. The aim of this paper is to develop such system. We will contribute to the existing literature in several ways. Firstly, we will concentrate on the applicability of our analysis to the cross-section consisting exclusively of emerging market economies (25 in total). Secondly, instead of trying to predict banking crises we will look for indictors that are useful for predicting the turning points of the credit cycle as measured by ex-post credit gap fluctuations (we check the robustness of this measure by examining alternative credit cycle indicators) in real time. For this purpose, we apply the state of the art signaling and secrete choice models.

Forecasting optimal countercyclical capital buffers for the banking sectors of the selected UE countries

Marcin Lupinski, National Bank of Poland

The excessive growth of private credit was perceived as one of the key factors of the Great Financial Crisis 2007+. Noticing importance of this problem Basel Committee of Banking Supervision (BCBS) recommended introduction of countercyclical-capital buffer, which could be imposed on the financial institutions to accumulate financial base in the time of credit boom and use it during recession to assure business continuity. In Europe mentioned BCBS recommendation was included to the last verion of the capital requirements directive (CRD IV) as one of the crucial instruments of the general macroprudential policy frameworks. However, the responsibility for the appropriate countercyclical-capital buffer operationalization was ceded to domestic supervisors raising the questions about its optimal size and timing of introduction/release. Some answers to this question based on early warning indicators approach could be found in the papers of Schularick and Taylor (2012), Detken et al. (2013) and Detken et al. (2014). There is also a lot of consultative and working papers issued by local institutions (co-)responsible for countercyclical buffer introduction in their jurisdictions (e.g. Sveriges Bank, 2011; Swiss National Bank, 2013; National Bank of Poland, 2016). In this paper we tried to augment solutions proposed in the available literature applying early warning approach to advanced and catching-up countries European countries and catching-up countries. First we added group of additional variables (e.g. CDS of host countries, share of wholesale financing) trying to capture differentia specifica of the analysed countries' banking sectors. We also confronted results of the logistic regression analysis used broadly in the literature with the output of the multivariate Markov switching model (MMSM) estimation. Moreover, we experimented with different time windows and weighting schemes to emphasise importance of the latest data in the early signal extraction models. Quality of the gained results (financial crisis signals) was checked with the ROC evaluation method. In the conclusions we formulated some recommendations for the counter-cyclical buffer operationalization in the catching-up countries.

Tuesday, 21 June

9:00 – 10:00
Keynote Session II (Paraninfo)
Chairperson: Philip Hans Franses, Erasmus School of Economics

Greg Allenby

Professor of Marketing and Statistics, Ohio State University, USA

Greg Allenby is the Kurtz Chair in Marketing at Ohio State University. He is a Fellow of the INFORMS Society for Marketing Science and the American Statistical Association. He is also the 2012 recipient of the AMA Parlin Award for his contributions to the field of marketing research and also a recipient of the ISMS Long-Term Impact award. He is past editor of Quantitative Marketing and Economics, and past area/associate editor for Marketing Science, Journal of Marketing Research, the Journal of Business and Economic Statistics.

Structuring Limited-Information Data for Marketing Forecasts
Data in marketing is typically characterized by many units of analysis with each having relatively short histories. Respondents in consumer surveys are limited in the time and attention they provide to survey questions before fatigue and boredom set in, household shopper panels frequently contain less than a dozen observed purchases in a particular product category, and the analysis of customer reviews is challenged by short narratives of experiences with a product or service. Moreover, the field of marketing embraces the notion of consumer heterogeneity, where differences among individuals drives segmentation, product development, pricing and promotional strategies. Forecasts of customer demand and satisfaction in a heterogeneous environment must therefore looks for ways of obtaining additional information in ways other than simple data pooling and aggregation. This presentation examines successful strategies for improving marketing forecasts by employing assumptions that successfully impart greater model structure and parsimony.

10:15 – 11:15
Feature Speaker II (Paraninfo)
Chairperson: Mohsen Hamoudia, France Telecom Group

José Duato, Professor, Polytechnic University of Valencia, Spain

Jose Duato is Professor in the Department of Computer Engineering (DISCA) at the Technical University of Valencia, Spain. His current research interests include interconnection networks, on-chip networks, and multicore and multiprocessor architectures. He published over 500 refereed papers. According to Google Scholar, his publications received more than 12,000 citations. He proposed a theory of deadlock-free adaptive routing that has been used in the design of the routing algorithms for the Cray T3E supercomputer, the on-chip router of the Alpha 21364 microprocessor, and the IBM BlueGene/L supercomputer. He also developed RECN, a scalable congestion management technique, and a very efficient routing algorithm for fat trees that has been incorporated into Sun Microsystem's 3456-port InfiniBand Magnum switch. Prof. Duato led the Advanced Technology Group in the HyperTransport Consortium, and was the main contributor to the High Node Count HyperTransport Specification 1.0. He also led the development of rCUDA, which enables remote virtualized access to GP-GPU accelerators using a CUDA interface.

Speeding up the execution of numerical computations and simulations
Speeding up the execution of numerical computations and simulations
This keynote will present some techniques to speed up the execution of numerical computations and simulations, with special emphasis on the use of hardware accelerators. The talk will present the architecture of the most popular accelerators currently in use, the implications for the programmers, and the main limitations of the current commercial implementations. The talk will also describe a recent technology for virtualizing accelerators that dramatically improves the utilization and effective computing power of those accelerators while reducing power consumption. Finally, the measured benefits in some real computing installations will be shown.

10:15 – 11:15 Forecasting Practitioner Track 5 (Rector Ernest Lluch)

Dilek Onkal
Professor of Decision Sciences, Bilkent University

Trust in Forecasting
Forecasting academics and practitioners focus on improving forecast performance with the ultimate goal of supporting decision-making processes. All this effort could easily be wasted if decision-makers do not trust the forecasts, and thus, either modify the given predictions or discard them completely. This talk will address the issue of trust in forecasts and forecasting processes. It will present our findings from questionnaires and interviews with professionals to explore preliminary answers to the following questions: What does trust in forecasting mean to decision-makers? How much do forecast users really trust the predictions put in front of them? What do users need to build-up their trust? What are the key factors that affect users' trust in forecasts? What can forecasters do to boost trust? What can organizations do to enhance trust in forecasting?

10:15 - 11:35 Energy Forecasting 3 (Bringas)
Chair: Tao Hong, University of North Carolina at Charlotte

Causality between sunspot number and global temperature: evidences from novel non-parametric dynamic causality detection methods
Xu Huang, Bournemouth University

The causality between sunspot number (SS) and global temperature (GT) has been explored by many scholars with different causality detection techniques to date. However, due to the existence of complex dynamic fluctuations and the difficulties on modelling the data with highly possible non-

stationary features, most of the conducted researches already lost the advantages for providing convincing analyses because of the parametric techniques that are adopted. We here evaluate the causal relationship between SS and GT by two novel non-parametric dynamic causality detection techniques: Singular Spectrum Analysis (SSA) based causality and Convergent Cross Mapping (CCM). The significant advantages of these two novel non-parametric techniques are that no prior linear model assumptions are made and both techniques are designed for adopting complex time series that may contain nonlinear or complex dynamic fluctuations. Both methods confirm the unidirectional causal relationship from SS to GT. More importantly, both non-parametric techniques prove the increasing significance of causal effect from SS to GT since 1880 to recent years, which provide solid evidences that may contribute on explaining the escalating global tendency of warming up recent decades.

What's new in load forecasting since 2010?
Tao Hong, University of North Carolina at Charlotte

The load forecasting community has been quite busy since 2010: more than 1000 papers have been published; 4 international forecasting competitions have been organized and completed; several important problems were brought to the academic literature; many methodological breakthroughs were accomplished. This presentation will offer a brief review of the load forecasting literature in the recent 5 years, with the emphasis on the probabilistic load forecasting track of the Global Energy Forecasting Competition 2014.

Electricity consumption scenarios for Brazilian Tertiary Sector via techno-economic bottom-up model
Fernando Luiz Cyrino Oliveira, Pontifical Catholic University of Rio de Janeiro; Bruno Quaresma Bastos, Pontifical Catholic University of Rio de Janeiro; Reinaldo Castro Souza, Pontifical Catholic University of Rio de Janeiro; Rodrigo Flora Calili, Pontifical Catholic University of Rio de Janeiro; Gheisa Roberta Telles Esteves, Pontifical Catholic University of Rio de Janeiro

Brazil is under profound political and economic crisis; as a result, economic perspectives are continuously changing, what motivate us to propose scenarios of electricity consumption based on optimistic, base and pessimistic macroeconomic scenarios. In this work, we apply a techno-economic bottom-up energy model to produce the electricity consumption scenarios for Brazilian tertiary sector. The model was adapted from Europe, and is novel for Brazil. The model represents the electricity consumption in a disaggregated manner, detailed by five regions, eight subsectors and fourteen energy services, such as lighting, air-conditioning, and others. The main drivers of the model are (i) number of employees per subsector, (ii) specific floor area per subsector, and (iii) energy services' diffusion. The strong features of the model are related to its ability of modeling policies and technological changes, what is performed via diffusion of energy services and of energy efficiency measures. Within the model, the electricity consumption is calculated, for a given year, by adding and multiplying global drivers (e.g. number of employees per square meter), specific drivers related to energy services (e.g. number of computers per employee), and specific drivers related to energy consumption (e.g. installed power per computer). The approach is very data-intensive, and the input data were obtained in a major effort of consolidating a database for Brazil, which now contains highly disaggregated technical and macroeconomic information for the country. We adopt, in this work, macroeconomic predictions obtained from the Brazilian Central Bank (BACEN) to produce number of employees scenarios for tertiary subsectors per region. Moreover, we create forecasts for input variables. We produce scenarios of electricity consumption from 2013 until 2023, and compare them with official government forecasts. The results show that, for 2023, the official electricity forecast is 5.1% higher than our optimistic scenario, 10.4% higher than our base scenario, and 15.8% higher than the our pessimistic scenario. Moreover, we see that the pessimistic scenario proposes a great reduction of electricity consumption in the mid-term. The regional results are very much aligned with observed values (until the beginning of 2016) and official forecasts (after the beginning of 2016).

Solar Power Forecasting with High-dimensional Time Series
Laura Cavalcante, INESC TEC - INESC Technology and Science; Ricardo Bessa, INESC TEC - INESC Technology and Science

The increasing levels of solar power generation in distribution grids are complemented by the installation of smart grid equipment. In this scenario, the access to real-time time series information spatially distributed is technically viable and can be used to improve forecasting skill in the very short-

term time horizon. Forecasted information can be embedded in smart grid management functions, such as voltage control and congestion management. The Vector Autoregression (VAR) framework can be applied to combine information from solar power time-series distributed in space, collected by the advanced metering infrastructure. The application of a VAR model to this problem will benefit from the following improvements: (a) inclusion of different LASSO penalties in order to perform variable selection and obtain different sparse solutions, which is known to lead to lower forecast error [1]; (b) coefficients' fitting algorithm with high scalability to handle hundreds or thousands of solar power time series in a single statistical model. This paper describes a forecasting methodology that explores a set of different sparse structures for the VAR model using the LASSO framework, presenting the following original contributions: (a) proposes several sparse structures for the VAR model using the LASSO framework; (b) explores the advantages of applying the Alternating Direction Method of Multipliers (ADMM) to fit the different sparse VAR variants; (c) applies this framework to the solar power forecasting problem. A test case was performed to predict hourly values of solar power for horizons up to six-hour-ahead. The production data used corresponds to hourly averaged solar power, collected over 2 years, from 44 microgeneration units time-series located in a city in Portugal. The suggested method is implemented in two phases. First, a statistical normalization of the solar power is obtained through a clear sky model in order to remove the seasonality of the solar power time series. Then, forecasts of the normalized solar power are computed using the sparse VAR structures proposed. The forecasting skill was evaluated computing the root-mean squared error. A comparison was made with the conventional Autoregressive (AR) forecasting Model leading to an improvement up to 7%.

10:15 - 11:35 Forecast combination 1 (Biblioteca)
Chair: Aranzazu de Juan Fernandez, Universidad Autonoma de Madrid

Adaptive Combination Schemes for Point and Density Forecasts
Leopoldo Catania, University of Rome, Tor Vergata; Tommaso Proietti, University of Rome, "Tor Vergata" and CREATES

Point and density forecast combinations based on some optimality measure are becoming increasingly popular for pooling information coming from different sources. We propose a new way of combining point and density forecasts allowing for time varying weights. Our method allows for model misspecification and do not require that the true data generating process belongs to the available set. Concerning the density combination schemes, our combined predictive density dynamically approximate the true density in a Kullback-Leibler sense using a recursion based on the score of the implied mixture conditional density. Similarly, for the point forecast combination schemes we propose, the weights are updated using the gradient of the user defined loss function. The relevance of the new combination techniques is illustrated by several Monte Carlo experiments and an empirical application in time series econometrics.

Combining forecasts or combining information: A comparative assessment to nowcast world GDP growth
Laurent Ferrara, Banque de France; Katja Heinisch, Halle Institute for Economic Research; Clément Marsilli, Banque de France

Evaluating the current state of the business cycle and forecasting global economic growth is a key element for many economic decisions such as those of international financial institutions, governments, central banks and export oriented firms. The paper focuses on the nowcasting performance of IMFs World Economic Outlook world GDP when using selected global or country-specific leading indicators. The IMF updates its forecasts for the current year (nowcasts) and the year after (one-year-ahead forecasts) twice a year – in April and October. However, during the year much more information is available which should be used to improve the accuracy of the forecasts. Using a large monthly database, we apply two approaches, namely forecast combination and dynamic factor models. In both cases, mixed-frequency data sampling (MIDAS) will be applied to nowcast annual GDP growth rates by monthly indicators. First, we nowcast world GDP growth by estimating univariate MIDAS regressions for each variable in the database, then we combine those forecasts by using various aggregation schemes. Second, we estimate a dynamic factor model, then we compute GDP growth nowcasts using a factor-augmented approach. We compare both nowcasting approaches and analyze whether factor models will outperform forecast combination results based on individual indicators. We

find that both approaches produces lower forecast errors at the beginning of the year compared to IMF forecasts and forecast errors decreases with increasing forecast rounds during a year. However, the results show that it is ambiguous whether indicator forecasts or indicator information should be combined, mainly depending on the evaluation sample.

Combining Value-at-Risk Forecasts using Lasso Quantile Regression
Sebastian Bayer, University of Konstanz

This paper proposes combining Value-at-Risk (VaR) forecasts using lasso penalized quantile regression. The proposed combination approach allows for the combination of a large number of VaR forecasts due to the shrinkage and automatic variable selection properties of the lasso penalty. Pre-selecting a small number of models is not required. The lasso quantile regression combination method is applied to 30 current and former constituents of the Dow Jones Index. The lasso combined forecasts are less often rejected by backtests and achieve lower tick losses than the forecasts of competing combination approaches and the standalone models. This holds in particular for the time of the 2007 global financial crisis, a period where precise VaR forecasts are needed most.

Combinaton and selection of forecasters via the simplex
Antonio S.M. Arroyo, Universidad Autónoma de Madrid; Aránzazu de Juan Fernández, Universidad Autónoma de Madrid

This paper explores the general use of the simplex as the natural way to combine experts' forecasts expressed by relative Split-Then-Combine (STC) weights; in particular, when a dimensionality problem does not allow the use of regression or Principal Component Analysis (PCA) procedures. Simplex-based procedures such as Mean, Variation, Scaled, Projection, PCA, and Cluster combinations and subcombinations have been used to forecast several stock and flow economic variables with different samples and number of forecasters.

10:15 - 11:35 Forecasting with big data (Santo Mauro)
Chair: Michela Nardo, European Commission - Joint Research Centre

Forecasting Tourist Arrivals with the Help of Web Sentiment: A Mixed-Frequency Modeling Approach for Big Data
Irem Önder, MODUL University Vienna; Ulrich Gunter, MODUL University Vienna

The internet is the hub of all information and online news media can be the first point where the potential traveler starts thinking about traveling to a destination. Thus, news coverage of a destination can affect destination image and in return can influence the number of tourist arrivals. Online news media coverage is a form of big data and can be crawled and collected in various ways. In addition, big data and analytics can be a solution, especially for the timeliness of the data. Destination image can change before and after an online browsing session (Li et. al., 2009) such as reading news related to a destination. Marchiori et al. (2013) investigate the importance of different messages that are involved in online conversations as proxies of public opinions and conclude that message sidedness, consistency, overall argument, strength of the message, and the attitude of users (i.e. to be reputation seekers) have a significant influence on the dominant opinion about a destination, which is expressed online. Sentiment analysis extracts web sentiment by rating a segment of text as either positive (favorable) or negative (unfavorable), which shows the perception of the author about the topic in discussion and can be used to enhance management decisions such as measuring the impact of customer reviews on purchasing decisions (Weichselbraun et al., 2010). The goal of this article is to investigate whether web sentiment data, which is based on online news coverage of Vienna as a tourist destination, possesses informative content able to predict actual tourist arrivals to Vienna. To achieve this goal, online news media coverage was collected and sentiment analysis was conducted using the automated semantic routines of the portal webLyzard. Due to different data frequencies of tourist arrivals (monthly) and web sentiment indicators (daily), the mixed-data sampling (MIDAS) modeling approach was applied. The results show that MIDAS models employing various types of web sentiment indicators as explanatory variables in addition to own lags of tourist arrivals, in particular total, negative, and mean sentiment, are able to outperform purely autoregressive and naïve benchmarks in terms of the accuracy measure MSE, MAPE, and MASE. This result holds across

various Exponential Almon and Beta polynomial MIDAS weight specifications as well as across estimation window types (fixed, recursive, and rolling).

Outlier Detection in Large Sets of Multivariate Time Series
Daniel Peña, Universidad Carlos III de Madrid; Pedro Galeano, Universidad Carlos III de Madrid
This article presents a procedure based on projections to find outliers in a large set of multivariate time series. It is assumed that the data have been generated by a Dynamic Factor Model and two types of outliers are considered. Common outliers, generated by the factors, which affect several or all of the time series, and specific or idiosyncratic outliers, which are generated by the specific components and affect a single time series. Common outliers are allowed to be innovative, additive or level shifts, whereas specific outliers are assumed to be additive outiers. The outliers are identified by projecting the vector of time series into directions with some optimality properties and searching for univariate outliers in this directions. The procedure is fast to apply and does not require to specify a multivariate model for the data.

Predicting financial market behavior with web mining
Michela Nardo, European Commission, Joint Research Centre; Nathalie Ndacyayisenga, European Commission, Joint Research Centre; Ronal Muresano, European Commission, Joint Research Centre; Andrea Pagano, European Commission, Joint Research Centre

Is web buzz capable of predicting financial market behavior for a set of systemically important banks? From December 2013 to February 2016, we retrieve daily articles related to two dozen of European banks by scraping 4000 world media websites in more than twenty languages. This allows us computing a sentiment analysis from these news. We aim at detecting which mood (tonality) is predominant on a given day for a given bank. By putting in relation this information with financial market (bank's equity and CDS) we explore how much of the future market's shift can be anticipated. In particular, we investigate whether CDS or equity's markets are sensitive to web-buzz. Our research puts itself in the growing area of on-line sentiment analysis and text mining for financial market prediction. By combining techniques from machine-learning, linguistics and behavioral economics for selecting and modelling web-news about a bank, we propose to link unstructured textual information to the real economy. We are able to assess the importance of news not only in English but also bank's 'home local' language. We also test how machine-learning techniques allow to select news relevant for market prediction by improving the quality of our experimental data.

Forecasting UK GDP growth using large survey panels
Nikoleta Anesti, Bank Of England; George Kapetanios, King's College London, University of London

Recently, there has been increasing interest in forecasting methods that utilise large data sets, mainly motivated by the fact that policymaking institutions need to process a large number of indicators to assess the state of the business cycle. This paper considers the task of forecasting UK GDP growth using variable reduction and selection methods in an extensive dataset that consists of disaggregated survey balances and other macroeconomic variables for the UK economy. The variable reduction methods include Principal Components and Partial Least Squares. The variable selection methods are focused on penalised regressions and multiple testing. We evaluate the predictive content of Lasso, Ridge regressions and a new approach based on Multiple Testing (MT) as discussed in Chudik, Kapetanios and Pesaran (2015) against standard benchmarks like Autoregressive processes (AR(1)) and the Random Walk (RW). We provide empirical evidence on the performance of these techniques for the GDP growth nowcasting and forecasting. We analyse how their predictive ability changes with the forecasting horizon and which set of variables appears to be most informative for forecasting UK GDP growth.

10:15 - 11:35 Learning forecasting methods (Pedro Salinas 1)
Chair: Luísa Canto e Castro Loura, General Directorate for Education and Science Statistics

Developing Intelligent Tutoring Support for Teaching Business Forecasting: The Forecasting Intelligent Tutoring System
Devon Barrow, Coventry University; Antonija Mitrovic, University of Canterbury; Jay Holland, University of Canterbury; Nikolaos Kourentzes, Lancaster University; Mohammad Ali, Coventry University

Forecasting plays a key role in the management of supply chain and business operations, yet relatively little is known about how individuals learn to forecast and even less formal support is provided in terms of developing better forecasters. Current business forecasters are trained through either expensive specialist forecasting training courses only available offline through scheduled classes, or are self-taught using text books and/or a combination of ad hoc web-based content and online tutorials. Additionally, only a handful of universities provide a module on Business Forecasting at the Undergraduate or Masters Level. The limited opportunities for formal training in Business Forecasting also places a strain on teaching which recognises the need for personalised learning whilst catering for the increase in demand for such training. As a remedy Intelligent Tutoring Systems (ITSs) offer an innovative solution in that they provide one-on-one tutoring, delivered through computer based online learning, with the benefits of relatively low cost, and added flexibility with regard timing, location and degree of learning support and guidance. This paper presents the conceptual design and development of the first Forecasting Intelligent Tutoring System (FITS), designed to assist students on Undergraduate Level 3 and Masters Level business forecasting modules. The system provides tutoring support to students in the application of classical time series decomposition and its use in improving forecasts. The paper provides a detailed description of the context in which the study takes place, the ITS environment, the creation of the tutoring system including problem design and motivation, problem construction and user interface design. The systems impact on learning is assessed through a pre- and post-test evaluation study and responses to a purpose-built questionnaire. Practical reflections on the design and development of FITS provides important lessons for improving the understanding of how such systems as well as other forecasting support software, can facilitate and improve forecasting performance through user modelling, pedagogical development and performance tracking.

Forecasting eSchool: from training to superforecasting
Nikoletta Zampeta Legaki, National Technical University of Athens; Konstantinos Nikolopoulos, Bangor University; Fotios Petropoulos, Cardiff University; Dimitrios Thomakos, University of Peloponnese; Vassilios Assimakopoulos, National Technical University of Athens

Forecasting eSchool (FeS) envisages the advance of the educational process via introducing gamification in teaching forecasting techniques courses. This study examines the application of gamified ideas in teaching forecasting principles aiming at amplifying the learning effect and attracting students' interest. FeS is composed of three different applications (games) linked to respective well–known academic published works. The first application (Horses for Courses, based on the paper "'Horses for Courses' in demand forecasting" by Petropoulos et al., 2014, EJOR) focuses on the model selection across a set of widely practiced statistical methods. The second application (JudgIT, based on the paper "Judgment under Uncertainty: Heuristics and biases" by Tversky & Kahneman, 1974, Science) puts the emphasis on the judgmental aspects of forecasting and the associated heuristics and biases. The third application (Metrics to escape, based on the paper "Another look at measures of forecast accuracy" by Hyndman & Koehler, 2006, IJF) intends to demonstrate the importance of using the appropriate metrics in forecasting evaluation exercises. Preliminary results have illustrated the positive effects of FeS on the learning process and students' engagement. In order to build on these effects, FeS integrates a Super Forecasters platform, an innovative free web based application aiming to identify super forecasters from a set of trained forecasters.

Communications Forecast Compendium
Lawrence Vanston, Technology Futures, Inc.

We review the myriad of communications and computing technologies that are combining to drive rapid change in both industries. These technolgies include Big Data, Fast Data, Cloud Computing, Cognitive Computing, Internet of Things, Gigibit Networks, 5G Mobile, and SDN/NFV. We show how these inter-related technologies encourage each other. Finally, we present selected technology and

market forecasts that indicate that the exhilarating pace of technological progress of the last two decades is far from slowing down.

Measuring forecasting performance: a complex task
Nikolaos Kourentzes, Lancaster Centre for Forecasting; Ivan Svetunkov, Lancaster Centre for Forecasting; Juan Ramon Trapero, Universidad de Castilla-La Mancha

Forecasting plays a crucial role in decision making and accurate forecasts can bring important benefits for organisations. Predictive performance is often separated into accuracy and bias, for which different metrics have been developed and used to varying degrees in research and practice. Exploring the literature one can conclude that forecast accuracy metrics have received more attention than bias metrics, even though the latter are very important for practice. One can also observe that the choice of metric can change the findings of an analysis. For example, this has been very pronounced in the judgemental forecasting literature, which we will use as a case study in our investigation. Typically judgemental forecasts and adjustments can enhance accuracy under certain circumstances, although they are biased given the nature of human behaviour. Researchers have been actively looking into possible causes and remedies of human bias; however we argue that their investigation has been hindered by the lack of adequate metrics. Motivated by this we develop a novel metric that overcomes the aforementioned limitations by using an innovative application of complex numbers theory. The new metric is successfully applied to analyse the judgemental forecasts of a household products manufacturer. We proceed to explore the properties of the metric and its general use in assessing the performance of forecasts.

10:15 - 11:35 Macroeconometrics and Forecasting (Infantes)
Chair: Robert Kunst, University of Vienna

Evaluation of Economic Forecasts for Austria
Klaus Weyerstrass, Institute for Advanced Studies; Ines Fortin, Institute for Advanced Studies; Sebastian Koch, Institute for Advanced Studies

Economic forecasts are important foundations for economic policy, but also for strategic planning of companies and private households. On the European level, the Stability Programmes which the EU member countries have to submit regularly are asked to be based on realistic and careful projections. In order to be a useful tool for the support of political and strategic decision-making, economic forecasts should be as precise as possible. In particular, good projections are unbiased, and they exploit the available information in the best possible way. In Austria, two research institutes, the Institute for Advanced Studies (IHS) and the Austrian Institute of Economic Research (WIFO) have a long tradition in producing economic forecasts. This paper focuses on the evaluation of the IHS forecasts, but also compares them to the WIFO forecasts and to naïve forecasts. At the end of each quarter, IHS publishes forecasts of GDP, its demand components, the labour market, and inflation for the current and the following year. The forecast evaluation in this paper is based on quarterly forecasts of the last 25 years. We base our forecast evaluation on both traditional and more modern approaches. The traditional evaluation methods include the mean absolute error, the root mean squared error, and Theil's inequality coefficient. These traditional measures, which examine each forecast variable separately, are complemented by methods which assess important variables jointly. The multi-dimensional evaluation should take the interdependencies between variables into account. Thus, a forecast which is too optimistic regarding the growth rates of GDP as well as investment and exports should be evaluated better in the sense of being more consistent than a forecast which is too optimistic regarding GDP growth, but underestimates investment and export growth. These correlations are considered by the Mahalanobis distance. In addition, we test for unbiasedness of the forecasts.

Seasonal prediction of agricultural product prices: Are energy prices relevant?
Adusei Jumah, Central University; Robert Kunst, University of Vienna

Both energy and agricultural prices have the inclination to exhibit seasonal behaviour. While seasonal variation in agricultural prices originates from the supply side, seasonal tendencies in energy prices originate essentially from the demand side. Although energy is an important input in agricultural production and marketing, total final energy consumption used directly in the agriculture sector is relatively small so that a causal seasonal effect is expected from energy to agriculture. We use seasonal

time series models to investigate whether energy prices could be used to improve the forecasting ability of food, beverage and agricultural raw materials' prices.

What forecasters believe – Waht do their forecats tell us?
Roland Döhrn, RWI
When publishing short term forecasts, economists have to reveal their beliefs, e.g. on duration, shape, and driving forces of business cycles. In this paper we try to identify some of these beliefs by evaluating a broad range of forecast for Germany. The empirical base is a rather detailed data bank containing the results of 38 regularly published forecasts which were produced by 15 national and international institutions. The data include the main national account demand side aggregates, but also some international variables such as world trade and US GDP. Since also the date the forecast was published is included, the data allow us to trace the change of forecast for a given year over time, and to investigate relations between the several variables forecasted. With respect to the forecast horizon, the study distinguishes between more theory driven forecasts and predictions which are strongly data-driven, since they rely at least partially on data already published for the year forecasted. In particular the theory-driven forecasts hint at the forecasters beliefs. It is one result of the study that a vast majority of forecasters believe that the next year will show a better economic performance than the current on. Another common feature of many forecasts is that future growth will be determined by internal demand instead of net exports. These views are compared to empirical facts about the German business cycle, which show, e.g., that the chance that the next year will be better than the current one is far below 50%. Taking these findings as a starting point, it is furthermore scrutinized, whether domestic institutions share views that differ from those of international institutions.

Visualization of distance measures implied by forecast evaluation criteria
Robert Kunst, University of Vienna

Traditional moment-based measures of predictive accuracy, such as the mean squared error (MSE) and the mean absolute error (MAE), assess the precision of forecasts in the framework of widely accepted metric spaces. Many researchers, however, pursue more complex targets, such as the mean absolute percentage error (MAPE), often motivated by an attempt to reduce the influence of scaling. We argue that most of these measures are characterized by asymmetry in the sense that moving the actual closer to the forecast has a quite different effect from moving the forecast, and also by non-convexity of the implied environments. For some of them, even paradox effects can be generated, such as a deterioration of accuracy as the actual approaches the forecast. We illustrate all effects using contour plots. Our warning against the careless usage of relative asymmetric criteria adds to the recent argument that these criteria may be hampered by the non-existence of moments.
Robert Kunst, University of Vienna

12:00 - 13:00 Forecasting Practitioner Track 6 (Rector Ernest Lluch)

Stephan Kolassa
Research Expert at SAP AG Switzerland

Simplicity in Forecasting
Sometimes our forecasts are bad because we forget to include an important driver of our time series, such as seasonality, trend, or marketing activities. Sometimes, however, it's the other way around: inclusion of an important driver makes things worse. How can this be? We'll walk through a simulation example, discuss the practical implications for demand forecasting, and consider possible ways forward.

12:00 - 13:20 Applications in Engineering and Finance (Pedro Salinas 2)
Chair: Maria Jesus Sanchez, ETS Ingenieros Industriales, Universidad Politecnica de Madrid

Measuring Financial Cycles with a Model-Based Filter: Empirical Evidence for the United States and the Euro Area
Gabriele Galati, De Nederlandsche Bank; **Irma Hindrayanto**, De Nederlandsche Bank; Siem Jan Koopman, Vrije Universiteit Amsterdam; Marente Vlekke, Centraal Planbureau

The financial cycle captures systematic patterns in the financial system and is closely related to the concept of procyclicality of systemic risk. This paper investigates the characteristics of financial cycles using a multivariate model-based filter. We extract cycles using an unobserved components time series model and applying state space methods. We estimate financial cycles for the United States, Germany, France, Italy, Spain and the Netherlands, using data from 1970 to 2014. For these countries, we find that the individual financial variables we examine have medium-term cycles which share a few common statistical properties. We therefore refer to these cycles as `similar'. We find that overall financial cycles are longer than business cycles and have a higher amplitude. Moreover, such behaviour varies over time and across countries. Our results suggest that estimates of the financial cycle can be a useful monitoring tool for policymakers as they may provide a broad indication about when risks to financial stability increase, remain stable, or decrease.

Short-term electric load forecasting with regression-spline models
Eduardo Caro, Technical University of Madrid; Jesús Juan, Technical University of Madrid; F. Javier Cara, Technical University of Madrid

In this work, a short-term electric load forecasting method is devel-oped, using as explanatory variable the temperature forecasts from an external agent. A regression-spline model has been designed to implement the relationship between temperature and energy demand. The proposed method is general and can be implemented in any real-time electricity energy system. To check the method's performance, a real data set from the Spanish electricity market has been used and the developed algorithm has been tested employing the MSE as the performance metric. Results denote that the forecasting method is both accurate and computationally efficient.

Multivariate forecasting of price and demand of electricity based on Random Forest Models.
Camino González, Technical University of Madrid; José Mira-McWilliams, Technical University of Madrid; José Alejandro Ojeda, Technical University of Madrid

Short-term demand and price forecasting allows energy producers to adjust their production to meet demand and to know in advance an estimate of the price at which their energy will be purchased. The same applies to consumers viz. the price they will pay for the energy they use and adapt their consumption accordingly. The main objective of this work is to predict jointly (multivariate modeling) the price and demand of electricity in the Spanish market and compare the results with those obtained individually (univariate modeling). Both univariate and multivariate predictions are obtained using data mining models, in particular regression tree models and the ensemble of trees named Random Forests. Multivariate modeling is able to a) jointly predict price and demand and b) find those electricity market variables which explain the evolution of both. In general, if the two response variables to predict are correlated, as is the case of the this work, it is expected that multivariate analysis may be able to get better predictions that two univariate analysis. To implement the multivariate model, Random Forest based on Conditional Inference trees (RF-CI) have been used. RF-CI evaluates the recursive binary cuts by using hypothesis tests on the independence between the response variable or variables and the possible explanatory variables. The prediction errors have been measured in terms of the Mean Absolute Percentage Error and Mean Squared Error. It is worthwhile mentioning that one of the critical aspects of multivariate modeling is the definition of a function error to evaluate the error in predicting jointly both variables. In this work a new metric is proposed. Different scenarios have been used to evaluate the models providing predictions for both variables. The results have been compared with those obtained with similar but univariate models in terms of prediction error and computation time. The fitted models have been: • Multivariate RF- CI. • Univariate RF- CI and RF- CART. The results indicate that multivariate RF-CI is able to obtain virtually identical predictions for demand and better for price than its univariate counterparts, as well as almost halving running times. The average joint prediction error is 6.6%, with 3,8% for demand and 6.6% for price. As main conclusion it should pointed out that multivariate models are emerging as a valid and accurate tool capable of

complementing existing univariate prediction techniques for price and demand and even surpassing them.

Modelling and forecasting common and specific components in multivariate time series
Carolina Garcia-Martos, ETS Ingenieros Industriales, Universidad Politecnica de Madrid; Julio Rodriguez, Universidad Autonoma de Madrid; Maria Jesus Sanchez, Universidad Politecnica de Madrid

When dealing with vectors of series an interesting problem is to extract common and specific components. It is usually assumed that the specific factors does not present a dynamic structure (or just a slight one), but when handling real data this does not hold. In this work, we propose a joint estimation procedure that is able to extract both dynamic common and specific component from a vector of series. We show that this joint estimation procedure outperforms the results of the two-stage estimation procedure that can be found in the literature. The influence on the results of the number of series of the observed vector of series is also studied. We present an real data example using energy market data.

12:00 - 13:20 Climate modeling and forecasting I (Biblioteca)
Chair: Peter C. Young, University of Lancaster

Atmospheric CO2 and global temperatures: The strength and nature of their dependence.
Granville Tunnicliffe Wilson, Lancaster University

Statistical proof of the causal dependence of one trending time series upon another is challenging. In this analysis we demonstrate the strong statistical dependence between the trend corrected annual series from 1959 of Mauna Loa atmospheric carbon dioxide concentration, mean global sea and land surface temperatures and the southern oscillation index. We use both spectral and structural autoregressive modelling to investigate causal relationships between these series and present a plausible interpretation of their interdependence.

Bias in decadal global temperature forecasts
Geoffrey Allen, University of Massachusetts; Robert Fildes, Lancaster University Centre for Forecasting; Nikolaos Kourentzes, Lancaster University Centre for Forecasting

Decadal forecasts (or "hindcasts") for surface temperature are a specific goal of the 5th Climate Model Intercomparison Project (CMIP5). Starting from observed initial conditions, forecasts tend towards the model's preferred climatology, which generally tracks observed temperatures though with either positive, or more often, negative bias. On a 10-year horizon, the bias often exceeds the observed temperature change. This problem has generated a growing literature in the meteorological journals, with several correction mechanisms proposed. Without exception, the focus is to use all information to correct model biases, not to improve forecasts. We examine whether using past model biases as information to adjust raw forecasts improves climate model performance enough to beat the forecasts from simple statistical models.

Historic Tracking of Climate Change Models
Michael Beenstock, Hebrew University; Yaniv Reingewertz, Haifa University; Nathan Paldor, Hebrew University

Monthly hindcast data for global surface temperature (GST) generated by 22 climate change models are used to study their ability to track GST during 1880-2010. Since GST and model hindcasts are nonstationary and seasonal, the methodology of seasonal cointegration at the annual frequency is used to tests the relation between GST and its hindcasts. Despite the high correlations between GST and the hindcasts, these correlations turn out to be spurious in all 22 models. Since these models do not meaningfully track GST since 1880, they are unlikely to provide reliable projections of climate change in the future.

12:00 - 13:20 Demographic Forecasting in Diverse World (Santo Mauro)
Chair: Juha Alho, University of Helsinki

A two-sex model for first marriage
Nico Keilman, University of Oslo

We formulate a two-sex model for first marriage of men and women. The model is based on Alho's coherent nuptiality model. Exposure times of unmarried men and women are decomposed into one part for never-married persons and one part for those who have been married earlier. This allows us to estimate a coherent indicator for the level of first marriage when both partners marry for the first time. Extensions to the case of remarriage are discussed. We apply the model to Norwegian data for the years 1995-2014.

An Integrated Framework for Bayesian Population Forecasting
Jason Hilton, University of Southampton; Jakub Bijak, University of Southampton; Erengul Dodd, University of Southampton; Jonathon Forster, University of Southampton; Peter Smith, University of Southampton

We develop a fully integrated and dynamic Bayesian approach to forecast populations by age and sex. The approach combines models for age- and sex-specific fertility, mortality, immigration and emigration within a cohort-component projection framework. This allows coherent population forecasts by age and sex to be made with associated measures of uncertainty. The methodology may be adapted to handle different data types and sources of information. To illustrate, we analyse historic data for the United Kingdom and forecast the components of population change, and hence the overall future population size and structure. We also compare the results obtained from different forecast models for age-specific fertility, mortality, and migration. In doing so, we demonstrate the flexibility and advantages of adopting the Bayesian approach for population forecasting and highlight areas where this work could be extended.

Studying the economics of demographic transition with stochastic population projections: How to add insight to quantification?
Jukka Lassila, The Research Institute of the Finnish Economy

Using stochastic population projections jointly with economic models offers great possibilities to analyse the economics of population ageing and to design policy strategies and specific policy instruments to enhance fiscal sustainability. However, results and projections based on stochastic simulations are often difficult to explain and require more time and attention from the users. Insight about the reasons and mechanisms behind the results may not always be obtained. We discuss an approach of studying the effects of mortality, fertility and migration separately with stochastic simulations, aiming at giving up as little as possible on quantitative realism while gaining on pedagogic aspects and intuition.

Statistical Evidence on the Convergence of Female and Male Mortalities in Retirement Age
Juha Alho, University of Helsinki

Statistical evidence about the past trends of female and male mortality in retirement ages is presented, for 20+ EU countries. The data show that this process has developed differently in different regions. This poses challenges to any attempt at forecasting the future of the gender gap. Models related to the bilinear models introduced by Lee and Carter are used to illustrate the phenomenon. The choice of data period and scale in which the analysis is carried out has an impact on estimates and forecasts.

12:00 - 13:20 Economics and Finance (Comedor de Infantes)
Chair: Yoshinori Kawasaki, The Institute of Statistical Mathematics

Volatility forecasting with empirical similarity: Japanese stock market case
Takayuki Morimoto, Kwansei Gakuin University; **Yoshinori Kawasaki**, The Institute of Statistical Mathematics

In this research, we compare the forecasting ability of various volatility models through within-sample and out-of-sample forecasting simulations. Models considered here are heterogeneous auto regression models (HAR), 1/3 model where the weight coefficients are all set to 1/3 in HAR model (ES0), and HAR model of which weight coefficients are determined by empirical similarity. We also try AR(1), ARCH/GARCH and their variants. As stock data, we pick 6 index series in Tokyo Stock Exchange, and 24 individual stock series all of which had enough liquidity from April 1st 1999 to December 30th 2013. Minute-by-minute data were created based on high frequency data. Forecasting evaluation depends on what kind of evaluation function we employ. We make use of Patton's error function. Changing the length of estimation period and forecasting period, and also the parameter of Patton's error function, we try 27,000 patterns of forecasting simulations. We find ES1 and HAR are almost comparative in within-sample forecasting, whereas ES0 is outstanding in out-of-sample forecasting experiments. We also tried model comparison based on pair-wise testing procedure proposed by Hansen et al. We see the similar results but the details are a little bit different in index series and in individual stock series.

The Volatility Index Performance in Non-derivatives Southeastern Asian Market: Cross-Sectional Volatility Index Approach
Futeri Jazeilya Md Fadzil, University of Essex; John G.O'Hara, University of Essex; Jianyong Sun, University of Essex

The Cross-Sectional Volatility Index (CSVI) is an index proposed as an alternative to the VIX. It is a new form of volatility index based on observable and model-free volatility measures. This approach is particular appropriate when a country's financial market does not trade local options. Suggesting that the CSVI should intimately related to option-based implied volatility measures is by providing some interpretation of the CSVI as a proxy for aggregate economic uncertainty. As to strengthen the performance of CSVI, this paper utilizes the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) and Heterogenous Autoregressive Realized Volatility (HAR-RV) model to explore the predictive power of CSVI in some Southeastern Asian market namely, Kuala Lumpur Composite Index (KLCI) of Malaysia, Jakarta Stock Exchange Composite Index (JKSE) of Indonesia, Philippine Stock Exchange Index (PSEi) of Philippine and The Stock Exchange of Thailand (SET). This study adopts the GARCH, E-GARCH,GJR-GARCH and HAR-RV model to forecast the CSVI. The performance of the prediction is measured by Normalized Root Mean Square Root (NMSE) and the Squared Return (R2). The period of the data is from 3rd January 2000 until 2nd November 2015. The results capture symmetric and asymmetric effects on the volatility and yields for better predictive performance.

Modelling and Forecasting Inflation Rate Volatility
Christoph Weiss, University of Cambridge; Paul Kattuman, University of Cambridge

The adverse effects of inflation volatility on economic growth and welfare are well known. The generating process that underlies inflation volatility is not as well understood as it should be. Using monthly data that underlies the Retail Price Index for the U.K., for the period since inflation targeting was introduced, we analyse the drivers of the inflation rate and its volatility. We explore patterns in the time varying covariation among product inflation rates that aggregate up to category inflation rates that in turn aggregate up to the overall inflation rate. We find that aggregate inflation volatility closely tracks the time paths of covariation, which turns out to be mainly driven by the variances of common shocks shared by all products, and the covariances of idiosyncratic, product-level shocks. Using a forecasting system that comprises of models for the mean and the variance, following the disaggregated approach of the hierarchical time series forecasting framework, we exploit the index structure of the aggregate inflation rate and obtain forecasts that are between 16 and 108% more accurate than a GARCH(1,1) benchmark for the aggregate inflation rate/volatility.

Forecasting Financial Market Indices Using Computational Intensive Analytical Methods
Azzam Alroomi, Bangor Univirsity; Kostas Nikolopoulos, Bangor Univirsity; Ru Xie, Bangor Univirsity

The proposed study aims at undertaking a comparative investigation to ascertain whether artificial intelligence can outperform statistical methods, with data ranging from 1995 to 2016 for the top 20 most capitalized companies in the FTSE 100. The data consists of daily, weekly, monthly, quarterly and yearly prices of opening, closing, high, low, trading volume and adjusted closing. Specifically, the study tests which of these methods if they yield a more accurate and significant outcome under the aforementioned frequencies and under the working environment of such index and timeframe. Furthermore the study is data driven, which thrives on developing and outcome that is based on a large complex data set. In contrast to the free parallel parameters of the artificial intelligence, the statistical methods are tested in an equal and fair environment to ensure that both artificial intelligence and the statistical methods be tested as equal methods. The study undergoes and test a variety of a wide range of frequencies to develop a compelled outcome over the different ranges of the aforementioned frequencies.The proposed study aims at undertaking a comparative investigation to ascertain whether artificial intelligence can outperform statistical methods, with data ranging from 1995 to 2016 for the top 20 most capitalized companies in the FTSE 100. The data consists of daily, weekly, monthly, quarterly and yearly prices of opening, closing, high, low, trading volume and adjusted closing. Specifically, the study tests which of these methods if they yield a more accurate and significant outcome under the aforementioned frequencies and under the working environment of such index and timeframe. Furthermore the study is data driven, which thrives on developing and outcome that is based on a large complex data set. In contrast to the free parallel parameters of the artificial intelligence, the statistical methods are tested in an equal and fair environment to ensure that both artificial intelligence and the statistical methods be tested as equal methods. The study undergoes and test a variety of a wide range of frequencies to develop a compelled outcome over the different ranges of the aforementioned frequencies.

12:00 - 13:20 Expectations and Uncertainty in Survey Forecasts (Bringas)
Chair: Eva Senra, Universidad de Alcala

Does Uncertainty Affect Participation in the European Central Bank's Survey of Professional Forecasters?
Víctor López-Pérez, Universidad Politécnica de Cartagena

This paper explores how changes in macroeconomic uncertainty have affected the decision to participate in the European Central Bank's Survey of Professional Forecasters (ECB's SPF). The results suggest that higher (lower) aggregate uncertainty reduces (increases) participation in the survey. This effect is statistically and economically significant. Therefore, the assumption that individual ECB's SPF data are missing at random may not be appropriate. Moreover, forecasters that perceive more individual uncertainty seem to exhibit lower likelihood of replying to the survey. Consequently, measures of uncertainty computed from individual ECB's SPF data could be biased downwards.

Inflation uncertainty, disagreement and monetary policy: Evidence from the ECB Survey of Professional Forecasters
Alexander Glas, Heidelberg University; Matthias Hartmann, Heidelberg University

We analyze the determinants of average individual inflation uncertainty and disagreement based on data from the European Central Bank's Survey of Professional Forecasters. We empirically confirm the implication from a theoretical decomposition of inflation uncertainty that disagreement is an incomplete approximation to overall uncertainty. Both measures are associated with macroeconomic conditions and indicators of monetary policy, but the relations differ qualitatively. In particular, average individual inflation uncertainty is higher during periods of expansionary monetary policy, whereas disagreement rises during contractionary periods.

Understanding the role of uncertainty in the Euro area business cycle
Geoff Kenny, European Central Bank; Cecilia Melo Fernandes

We propose parametric and non-parametric measures of economic uncertainty extracted from the density forecasts of professional forecasters. The properties of different aggregate uncertainty measures are compared also with reference to other proxies for uncertainty commonly used in the literature. We exploit the timing of the survey in order to identify an exogenous uncertainty shock in a Bayesian Vector AutoRegression (BVAR). The relevance of uncertainty shocks during the Great Recession and subsequent sovereign debt crisis in the euro area is then assessed both in sample and also in terms of out-of-sample predictive content.

Measuring uncertainty and assessing its predictive power in the euro area
Pilar Poncela, European Commission, Joint Research Centre; Eva Senra, Universidad de Alcalá

Expectations and uncertainty play a key role in economic behaviour. This paper deals with both, expectations and uncertainty derived from the European Central Bank Survey of Professional Forecasters. Given the strong turbulences that the euro area macroeconomic indicators observe since 2007, the aim of the paper is to check whether there is any room for improvement of the consensus forecast accuracy for GDP growth and inflation when accounting for uncertainty. We propose a new measure of uncertainty, alternative to the ad-hoc equal weights commonly used, based on principal components. We test the role of uncertainty in forecasting macroeconomic performance in the euro area between 2005-2015. We also check the role of surprises in the considered forecasting sample.

12:00 - 13:20 Forecast combination 2 (Infantes)
Chair: Philip Hans Franses, Erasmus School of Economics

Optimal combination of volatility forecasts to enhance solar irradiation prediction intervals estimation
Juan R. Trapero, University of Castilla-La Mancha; Alberto Martín, Agencia Estatal de Metereorología – AEMET

Solar power generation has been steadily increasing worldwide as a response to environmental concerns. Unfortunately, the integration of solar energy into the energy mix of a country brings new challenges. The main problem is due to the variability of the solar energy, which is not available ``on demand''. In Spain, forecasts of production have to be provided to the transmission system operator (TSO). In case of deviations from the scheduled production, the TSO applies a cost penalty. If the forecast is higher than the real production, the TSO charges falling penalties, and conversely, charges rising penalties for a production dispatch above the forecasted value. In general terms, most of the published literature on solar energy forecasting is based on the application of different techniques in order to provide point forecasts. Nevertheless, the need of the users of such forecast (or stakeholders) require more information apart from the point forecast. In particular, they require uncertainty forecasts that they can be even more useful than typical point forecasts in order to optimize the risk policies of energy traders. The aim of this work is twofold. Firstly, to bridge the gap in the solar energy forecasting literature by focusing on uncertainty forecasting, which has remained overlooked in comparison with point forecasting. Secondly, to use such uncertainty forecasts to compute prediction intervals on the basis of a novel methodology that combines them in an optimal manner. In this work, we will analyse non-parametric approaches as kernel density estimators and parametric approaches as exponential smoothing and Generalized AutoRegressive Conditional Heteroskedasticity Models (GARCH) to forecast volatility. The optimal combination will be carried out by maximizing the conditional coverage Christoffersen test p-value. The results show that such an optimal combination can achieve the desired confidence level/target with a lower average interval width. Data from a facility located in Spain are used to illustrate our methodology.

Combining Forecasts: Consistency Levels and Performance in Inflation Rate Forecasting
Andrew Pollock, Glasgow Caledonian University; Mary Thomson, Northumbria University; Sinan Gonul; Dilek Onkal, Bilkent University

There is general agreement that a final forecast should be produced by combining individual forecasts. The relative reduction in error in a combined forecast is dependent upon the degree to which the

component forecasts contain independent information or are inconsistent with one another. It is usually the case, however, that forecast errors are positively correlated and, as such, analysts attempt to generate independence by combining different types of forecasts (i.e., statistical and judgmental) or combing forecasts using a variety of different forecasting methods. Unfortunately, in many contexts creating independence is difficult as the same statistical models are typically used by the individual forecasters, or judgmental forecasts are made by individuals who use similar criteria. Using UK, Q4, Retail Prices Index inflation forecasts for the period 1998 to 2014, the present study demonstrates an alternative, more direct approach to this problem by incorporating a measure of consistency into an analytic evaluation framework so that the most independent forecasts can easily be selected for combination. The framework also decomposes performance scores to illustrate the underlying aspects that are responsible for error reduction evidenced in composite forecasts.

Moving Beyond Bayes: On the Combination of Probabilistic Forecasts Given Imperfect Models
Edward Wheatcroft, London School of Economics; Leonard Smith, London School of Economics

A variety of different models are often available from which to form probabilistic forecasts for a given target. It is widely understood that a weighted average can sometimes outperform each of the models individually in terms of probabilistic forecast peformance. One question then is how best to select the weightings placed on each model forecast. A common approach is Bayesian Model Averaging (BMA) in which some set of prior weights is chosen, and then updated as new data become available. BMA, however, makes the assumption that exactly one of the models is perfect, that is it can describe the dynamics of the system exactly. In the real world, at best, this is highly unlikely; the assumption is violated. In practice, the weight placed on the model with the highest likelihood always tends to one as the number of data points used to update the prior is increased and thus the information in the other models is ignored asymptotically. In fact, BMA should not be considered a method for finding the optimal combination of models at all, but rather to account for the uncertainty in selection of the best model when only limited data is available. An alternative approach to forming probabilistic forecasts with multiple models is to blend the models. With this method, the model weightings are chosen to be those that optimise forecast performance over a forecast-outcome archive with respect to some particular scoring rule. The weights are expected to tend towards the optimal weights as the size of the forecast-outcome archive increases. Models from nonlinear dynamical systems are used to show how, whilst BMA outperforms blending when one of the models is indeed perfect, the opposite is true in the more realistic case that each of the models contain some structural model error. These results prove, by demonstration, that using BMA with multiple models is a suboptimal approach to probabilistic forecasting.

Combining Expert-Adjusted Forecasts
Philip Hans Franses, Erasmus School of Economics; Dick van Dijk, Erasmus School of Economics

It is well known that a combination of two model-based forecasts can improve on the individual forecasts. Most forecasts available in practice are however not purely based on econometric models but entail adjusted model-based forecasts, where experts with domain-specific knowledge modify the original model forecasts. In this paper we show that combined expert-adjusted model forecasts can improve on the combined model forecasts, even in the case when the individual expert-adjusted forecasts are not better than their associated model-based forecasts. We discuss various implications of this finding.

12:00 - 13:20 Forecasting Methods and Applications 1 (Pedro Salinas 1)
Chair: Reinaldo Castro Souza, Pontifical Catholic University of Rio de Janeiro

Forecasting Sales of Consumer Devices Using Search Query Data
Mayank Shrivastava, Microsoft; Konstantin Golyaev, Microsoft; Gagan Bansal, Microsoft; **Matt Conners**, Microsoft; Shahar Ronen, Microsoft; Walter Sun, Microsoft

Most businesses require accurate revenue forecasts for efficient operations. This problem is front and center for manufacturers of consumer devices who face the need to coordinate supply chain operations over the course of months if not quarters. At the same time, forecasting sales of consumer devices, such as Xbox and Surface, is challenging for the business, partially due to lack of forecasting expertise, but also due to short sales history and strong holiday-driven seasonality. To alleviate the challenges for our

consumer device business, we turned to Bing query logs, anonymized and aggregated and processed by Bing Predicts algorithms. These days, people frequently do research on products before choosing what to purchase, e.g. comparing Xbox One against PlayStation 4 or Nintendo Wii U. Capturing and quantifying such research activities that typically precede purchases allowed us to construct much more accurate forecasts using machine learning techniques. We employed two separate approaches, one that models weekly data and aggregates weekly predictions to produce a quarterly forecast and the other that models monthly data and aggregates monthly predictions in a similar fashion. We modeled weekly data with a Random Forest regression that had two groups of features. First, we used date-based features, such as week, month, quarter, and year. Second, we used the weekly query counts grouped by intent that were constructed by Bing Predicts. Our best model improved the mean absolute percentage errors for 2015 by 88 percent relative to an internal benchmark. We resorted to monthly models for devices and markets where reliable weekly data were unobtainable. A similar set of features was employed, but the learning algorithm had to be changed since complex nonlinear models suffered from severe underfitting due to lack of data. Instead, we trained a large number of linear regressions with random subsets of all possible features and combined the top ten percent of them as measured by out-of-sample RMSEs into the final ensemble. This approach generated a range of improvements between 44 and 68 percent, depending on the device and market forecasted. To sum up, by using consumer intent features engineered from Bing query logs as part of a machine learning workflow, we were able to improve the mean absolute percentage errors for quarterly revenue forecasts by anywhere between 44 and 88 percent relative to the baseline forecast provided by the business.

Scenarios simulation with causal PAR(p): Studying the influence of climate variables in Brazilian reservoir inflow

Paula Medina Maçaira, Pontifical Catholic University of Rio de Janeiro; Fernando Luiz Cyrino Oliveira, Pontifical Catholic University of Rio de Janeiro; Fernanda Villa Nova de Almeida, Pontifical Catholic University of Rio de Janeiro; Pedro Guilherme Costa Ferreira, Getulio Vargas Foundation; Reinaldo Castro Souza, Pontifical Catholic University of Rio de Janeiro

Actually, the Brazilian power sector uses an univariate process to generate scenarios for hydrological inflows based on Periodic Autoregressive model, PAR(p), which corresponds to a particular structure of the Box & Jenkins family. This approach is used to estimate the operational costs of the Brazilian hydro-thermal optimal dispatch, and does not consider any exogenous information that may affect hydrological regimes and as a consequence the power production. Recent study has shown that the introduction of climatic events to model and forecast water inflow has improved the models' performance. This is the main reason why this paper focuses on the definition of a PAR(p) approach which considers exogenous variables, here entitled causal PAR(p). The purpose of this study is the application of a causal PAR(p), using exogenous variables such as El Niño and Sunspots, to generate scenarios for some Brazilian reservoirs inflow. Through the results is possible to conclude that the model improves the in-sample errors measurement when compared to the traditional PAR(p).

Probabilistic forecasting for airborne pollution: a case study

José L. Aznarte, Universidad Nacional de Educación a Distancia (UNED)

With more and more problematic pollution levels in cities around the world, and given the scientific consensus about their adverse effects on health, many cities are imposing traffic restrictions when high pollution episodes occur. For example, Madrid has enforced a new protocol which includes reducing speed limits and other restrictions to the circulation to vehicles when NO2 concentrations reach certain threshold during a certain period. Anticipating the activation of such measures is critical both for the decision makers (which need to disseminate information about the measures in advance) and for the vehicle owners (which need to plan their transport alternatives in advance). However, research on forecasting extreme pollution events is meagre in general and, in particular, to our knowledge, probabilistic forecasting has never been put in practice to deal with NO2 concentrations. Obviously, forecasting the central tendencies of the data distribution, i.e. the conditional mean, is not the best approach if the main interest is to predict possible exceedances of thresholds that lie on the tails of the distribution. In this study, we investigate the feasibility and convenience of probabilistic forecasting to predict extreme concentrations of NO2. Data from the Atmospheric Pollution Monitoring System in Madrid, including pollutant concentrations as well as meteorological measures are analyzed. Different quantile regression approaches will be used and compared, and different ways to use the probabilistic forecasts in order to maximize their usefulness will be explored.

Performance of clusterwise linear regression model for rainfall prediction in Australia
Arshad Mahmood, Federation University Australia; Adil Bagirov, Federation University Australia; Andrew Barton, GWMWater

In this paper, the Clusterwise Linear Regression (CLR) technique is applied for prediction of monthly rainfall in Australia. The CLR method is a combination of clustering and regression techniques to discover trends within data, when more than one trend is likely to exist. An algorithm for solving the CLR is described. Then the CLR method is applied to predict monthly rainfall in Australia using rainfall data with five input climatic variables over the period of 1970 - 2014 from 24 geographically diverse weather stations. The forecasting performance of the CLR model is evaluated by comparing observed and predicted rainfall values using the Root Mean Squared Error and Nash-Sutcliffe Coefficient of Efficiency. The proposed method is compared with the artificial neural network model using computational results. The results demonstrate that the CLR method is capable of finding the patterns and trends of the observations in monthly rainfall forecasting and has the ability to forecast extreme rainfall values with high accuracy.

12:00 - 13:20 The role of forecasting in climate change (Paraninfo)
Chair: David Hendry, Oxford University

Seasonal Changes in Central England Temperatures
Tommaso Proietti, Univeristy of Rome Tor Vergata; Eric Hillebrand, Aarhus University and CREATES

The aim of this paper is to assess how climate change is reflected in the variation of the seasonal patterns of the monthly Central England Temperature time series between 1772 and 2013. In particular, we model changes in the amplitude and phase of the seasonal cycle. Starting from the seminal work of Thomson (1995), a number of studies have documented a shift in the phase of the annual cycle implying an earlier onset of the spring season at various European locations. A significant reduction in the amplitude of the seasonal cycle is also documented. The literature so far has concentrated on the measurement of this phenomenon by various methods, among which complex demodulation and wavelet decompositions are prominent. We offer new insight by considering a model that allows for seasonally varying deterministic and stochastic trends, as well as seasonally varying autocorrelation and residual variances. The model can be summarized as containing a permanent and a transitory component, where global warming is captured in the permanent component, on which the seasons load differentially. The phase of the seasonal cycle, on the other hand, seems to be following the trend that was identified in Thomson (1995) with Earth's precession in a stable manner. We identify the reported fluctuations as transitory.

Forecasting sea-level rise in the 21st century
Luke Jackson, Oxford University; Svetlana Jevrejeva, National Oceanography Centre
How sea-level change will vary in the future is a pertinent social, economic and political issue with significant implications for coastal protection and adaptation. Sea-level change is an integrated response to the climate system due to changes in radiative forcing. The total sea level can be considered as the sum of various components, which vary in time as climate changes and in space so the ocean conforms to an equipotential surface. We present relative sea-level (RSL) projections at Santander for three climate change scenarios. In a world where global surface temperature increases reach 2°C, 4°C and 4°C with unprecedented Antarctic ice-losses by 2100, median (5-95th percentile) RSL rise is 49 cm (30-68 cm), 65 cm (41-88 cm) and 79 cm (40-185 cm) respectively. These forecasts are probabilistic in the sense that we aggregate realisations derived from individual sea-level components and extract quantiles from their sum. We outline how this local forecast is reached from a methodological point of view and discuss the uncertainties associated with individual sea-level components and the total uncertainty, which varies through time and is geographically non-uniform.

Improved Forecasting of El Niño-Southern Oscillation with a Novel Structural Time Series Model

Desislava Petrova, Catalan Institute for Climate Science; Siem Jan Koopman, VU Amsterdam; Joan Ballester, Catalan Institute of Climate Science; Xavier Rodo, Catalan Institute for Climate Science

El Niño-Southern Oscillation (ENSO) is one of the most important climatic phenomena. Its positive phase, El Niño, manifests as an anomalous warming of the eastern tropical Pacific Ocean, but its consequences are far-reaching as the ocean warming shifts the area of convection and heats the atmosphere directly above it. This heat triggers various atmospheric teleconnections and alters the normal weather patterns in many parts of the world. These changes could severely damage crop yields, and cause natural hazards such as storms, flash floods, and landslides among many other disasters. Therefore, ENSO forecasting has long been an active area of research, and nowadays predictions and warnings are issued by many climate science institutions worldwide. However, even after several decades of intensive research, the long-lead prediction of ENSO on the order of more than one year in advance remains yet a serious and unsolved challenge. In the present study we have explored the problem of long-lead forecasting using a state space structural time series model. It consists of a trend and 6 cycle components, along with a number of explanatory regression covariates, and an irregular term. A fixed seasonal component was initially included in the model, but it was found to be inadequate to properly account for the modulation of seasonality in the tropical Pacific, especially during El Niño years. Thus, two cycles were added instead with the purpose of modeling more accurately the seasonal effect in the time series. Their periods are initially prescribed and restricted to about 6 and 12 months, respectively. Another interesting feature of the scheme is that different regression variables are included at every lead-lag time with the aim of capturing specific dynamical processes associated with the evolution of El Niño. These variables could also be used to detect and study the effect of subsurface ocean warming not only due to normal El Niño dynamics, but also due to climate change. To assess the skill of the model major El Niño events were forecast at long lead times of at least 2 years before the peak of the anomaly in the winter months of the Northern Hemisphere. Forecasting results place the model among the few top performing ENSO prediction models. Our findings also offer some new insights in the ENSO theory.

Detecting Volcanic Eruptions in Temperature Reconstructions by Designed Break-Indicator Saturation

Felix Pretis, Oxford University; Lea Schneider, Johannes Gutenberg University; Jason Smerdon, Columbia University; **David Hendry**, Oxford University

We present a methodology for detecting breaks at any point in time-series regression models using an indicator saturation approach applied to modelling climate change. Building on recent developments in econometric model selection for more variables than observations, we saturate a regression model with a full set of designed break functions. By selecting over these break functions using an extended general-to-specific algorithm, we obtain unbiased estimates of the break date and magnitude. Monte Carlo simulations confirm the approximate properties of the approach. We assess the methodology by detecting volcanic eruptions in a time series of Northern Hemisphere mean temperature spanning roughly 1200 years, derived from a fully-coupled global climate model simulation. Our technique demonstrates that historic volcanic eruptions can be statistically detected without prior knowledge of their occurrence or magnitude- and hence may prove useful in estimating the past impact of volcanic events using proxy-reconstructions of hemispheric or global mean temperature, leading to an improved understanding of the effect of stratospheric aerosols on temperatures. The break detection procedure can be applied to evaluate policy impacts as well as act as a robust forecasting device.

14:30 - 15:30
Keynote Session III (Paraninfo)
Chairperson: Daniel Peña, Universidad Carlos III de Madrid

Henrik Madsen

Professor, Head of Center Department of Applied Mathematics and Computer Science, Technical University of Denmark

Henrik Madsen got a PhD in Statistics at the Technical University of Denmark in 1986. He was appointed Ass. Prof. in Statistics in 1986, Assoc. Prof. in 1989, and Professor in Mathematical Statistics with a special focus on Stochastic Dynamical Systems in 1999. His main research interest is related to analysis and modelling of stochastic systems. This includes time series analysis, estimation, grey-box modelling, forecasting, optimization and control. He has authored or co-authored approximately 500 papers and 12 books. The most recent books are Time Series Analysis (2008); General and Generalized Linear Models (2011);Integrating Renewables in Electricity Markets (2013), and Statistics for Finance (2015). For more information please see http://henrikmadsen.org

State-of-the-art in Probabilistic Forecasting of Wind and Solar Power Generation
This talk describes state-of-the-art methods for probabilistic forecasting of wind and solar power generation. In Denmark on average of 43 % of the total electricity load was covered by wind power in 2015. The key to a successful integration of such a high share of fluctuating renewable power is to take advantage of reliable methods for probabilistic forecasting in the operational dispatch of power generation and in market bidding. This talk describes how the information from meteorological forecasts is combined with information in local data to obtain suitable point forecasts for the relevant time horizons. Several methods for generating full probabilistic forecasts will be outlined, including the use of adaptive quantile regression and stochastic differential equations. Methods for taking spatio-temporal dependencies into account are also described.

15:40 – 16:40
Forecasting Practitioner Track 7 (Rector Ernest Lluch)

Daniel Barrett, Director of Global Demand Planning Center-of-Excellence at LEGO

Demand Planning: Lessons from LEGO
Planning is becoming increasingly more complicated with organizations finding it difficult to accurately identify issues in process performance and then implement meaningful improvements that add long-term value. Process standards are important and allow for benefits across the organization such as clear transparency on how processes perform, enable better collaboration to improve these processes, and create a stronger foundation for capability and network building. This talk will share some insights into the journey The LEGO Group has been on globally aligning and implementing process standards in demand planning. This can be a difficult journey with many challenges to navigate!

15:40 – 16:40 Bayesian Methods 1 (Infantes)
Chair: Richard Peck, Innovations for Poverty Action & Columbia University

Model Identification Through Heteroscedasticity within the Network Connectedness Framework: The "Systemic Five" Stock Markets
Erhan Uluceviz, Koç University

Our focus in this research is a particular network connectedness framework developed through decomposing the forecast error variance that results from a vector auto regressive (VAR) model. The

model is estimated using daily returns on stock indices, yielding a spillover table which can be interpreted as a network structure and summarized in a measure called spillover index. Departing from a sequence of spillover tables, this framework has recently been enhanced in several directions with concepts to quantify: (i) a market's potential to spread information, (ii) the amount of information gained from day to day and (iii) the speed of information processing and the degree of network stability. We evaluate the performance of the extant identification approaches, and show that they are arbitrarily misestimating with respect to the above-mentioned network measures. As an alternative, we propose the use of identification through heteroscedasticity (ITH) which utilizes heteroscedasticity in the data to identify structural VARs. As an empirical example, we analyze the "Systemic Five" system of markets representing stock indices DJIA, FTSE, EuroStoxx-50, Nikkei-225 and SSEC. ITH uncovers that at prosperous and stable times, eastern markets' relative importance with respect to the western ones' increase significantly, and during times of trouble their importance decrease drastically. In terms of network stability, we observe that the system stability increases linearly with increasing spillovers followed by temporary decreases and then linear increases again. We conclude that ITH could be proposed as a viable identification approach candidate in the network connectedness framework to investigate richer sets of network dynamics.

Transforming the theta model into a flexible decomposition method by considering nonlinear trends
Evangelos Spiliotis, National Technical University of Athens; Vassilios Assimakopoulos, National Technical University of Athens

The Theta model, well known for its performance in the M3 competition, proposes the decomposition of the seasonally adjusted series in two or more so-called Theta-lines of the same mean and slope with the original data. Given a parameter θ, the local curves of the series are modified based on the linear correlation coefficient of the data and a forecasting model is then used for extrapolating the created lines. The final forecasts of the model are produced by combining the individual forecasts of the Theta lines. Although a lot of work has been done in the direction of generalizing the Theta model, the research is mainly focused into selecting appropriate lines and combining them effectively limiting that way the benefits that the decomposition framework of Theta can offer. In this respect we further expand its original approach by considering both linear and curved functions for estimating the Theta lines. The approach improves the goodness of fit and enables the model to produce nonlinear forecasts making it more flexible and generic. We finally prove that, given a smoothed series, the forecasts of the model are a linear combination of the running level and the trend of the data, simplifying that way its parameterization and enhancing its performance. The approach is evaluated across the M3 competition data with encouraging results.

Predicting Violent Events in Indonesia
Samuel Bazzi, Boston University; Robert Blair, Brown University; Christopher Blattman, Columbia University; Matthew Gudgeon, Boston University; **Richard Peck**, Innovations for Poverty Action & Columbia University

Using conflict data coded from newspaper reports, nine other datasets of sub-district and village level characteristics, and six popular machine learning techniques, we generate year-ahead sub-district level forecasts of violence in Indonesia over the period 2005 to 2009. Our preferred model, an ensemble of the other five, improves on previous attempts to predict local level violence, with an area under the ROC curve of 0.82. We find that lagged conflict measures, demographic variables and natural disasters are the most important predictors of future conflict. Although economic variables such as rainfall shocks and commodity price movements feature prominently in the conflict literature, their inclusion here generates no improvement in model performance.

15:40 – 16:40 Business cycle analysis 1 (Paraninfo)
Chair: Danilo Leiva-Leon, Central Bank of Chile

Index-Augmented Autoregressive Models: Representation, Estimation, and Forecasting
Gianluca Cubadda, University of Rome Tor Vergata; Elisa Scambelloni, University of Rome Tor Vergata

We examine the conditions under which each individual series that is generated by a vector autoregressive model can be represented as an autoregressive model that is augmented with the lags of

few linear combinations of all the variables in the system. We call this modelling Index-Augmented Autoregression (IAAR). We show that the parameters of the IAAR can be estimated by a switching algorithm that increases the Gaussian likelihood at each iteration. Since maximum likelihood estimation is known to perform poorly when the number of parameters approaches the sample size, we propose a regularized version of our algorithm to handle a medium-large number of time series. We illustrate the usefulness of the IAAR modelling both by empirical applications and simulations.

The Evolution of Regional Economic Interlinkages in Europe
Danilo Leiva-Leon, Central Bank of Chile; Maria Dolores Gadea-Rivas, University of Zaragoza; Ana Gomez-Loscos, Bank of Spain

This paper analyzes changes, across time and space, in the synchronization of European regional business cycles and investigates the role that the sectoral composition has played in explaining such changes. Motivated by the lack of high frequency data at the regional level, we propose a new method to measure time-varying synchronization in small samples that combines regime-switching models and dynamic model averaging. Our main findings can be summarized as follows: (i) in only two years the Great Recession synchronized Europe twice more than what the European Union process did in decades, (ii) Ile de France is the region acting as main channel in the transmission of business cycles shocks in Europe, (iii) increases in regional sectoral composition similarity have a positive effect on business cycles synchronization, only for regions that already experience high levels of similarity in their productive structure, and in particular, after the Great Recession.

Measuring the Financial Cycle with Dynamic Factor Models
Christian Menden, University of Bamberg; Christian R. Proaño, University of Bamberg

The analysis of the financial cycle has become a central topic since the 2007-08 financial crisis. So far, the great majority of studies has analyzed the cyclical properties of the financial cycle by means of a small number of financial risk indicators at a rather aggregated level. This paper proposes an empirical approach to extract information about the financial cycle from a large data set of macroeconomic and financial variables for the US. Using a dynamic factor model we estimate three synthetic financial cycle components that account for the majority of the variation in the complete data set. Along the lines of the existing literature we provide statistical evidence for an average cycle length of eight years across all factors. Further, peaks in our synthetic financial cycle components coincide with economic recessions giving rise to potential properties as early warning indicators for financial and economic distress. Additionally, we investigate whether our financial cycle components have significant predictive power for GDP growth by means of Granger causality tests both in the time- and frequency domain.

15:40 – 16:40 Financial forecasting (Comedor de Infantes)
Chair: Antonio S.M. Arroyo, Universidad Autonoma de Madrid

Forecasting Foreign Exchange Rate as Group Experiment: The Wisdom of Crowds' Effect and the Social Influence Effect
Haruo Horaguchi, Hosei University

Social psychologists, cognitive scientists, economists and managerial scientists recognize the existence of the wisdom of crowds' effect: estimations that are made by a large number of people coincide with the true values. It is also pointed out that the estimations by the crowds tend to have certain biases, which are called social influence effect. This article explains why the wisdom of crowds' effect exists and inquires to what extent crowds have biases. To answer these questions, we show simulation results, give mathematical proofs and examine the data from forecasted foreign exchange rates. The data are provided by Nikkei, which holds a forecasting competition by a group of students. The participants consist of 3,657 groups over a period of eight years in Japan. The participants recorded 1.43 percent as the average absolute deviation during an eight-year period. They show some evidences that the social influence effect exists in this data set.

Investing in Global Equity Markets with Particular Emphasis on Chinese Stocks
John Guerard, McKinley Capital Mgt, LLC; Shijie Deng, Georgia Institue of Technology; Harry Markowitz, McKinley Capital Mgt, LLC.; Ganlin Xu, McKinley Capital Mgt, LLC.; Ziwei (Elaine) Wang, McKinley Capital Mgt, LLC.

In this analysis of the risk and return of stocks in global markets, we build several models of stock selection and create optimized portfolios to outperform a global benchmark. We apply several applications of robust regression techniques in producing stock selection models and several Markowitz-based optimization techniques in portfolio construction in various global stock universes. We test separate Japanese and Chinese stock selection models because they are large markets, with large global benchmark weights or are frequently in the news. We find that (1) that robust regression applications are appropriate for modeling stock returns in global markets; and (2) mean-variance techniques continue to produce portfolios capable of generating excess returns above transactions costs; and (3) our models pass data mining tests such that the models produce statistically significant asset selection. We estimate expected return models in a global equity markets using a given stock selection model and generate statistically significant active returns from various portfolio construction techniques.

Forecasting the Market Risk Premium with Artificial Neural Networks
Leoni Eleni Oikonomikou, Georg-August Universität Göttingen

This paper aims to forecast the Market Risk premium (MRP) by applying machine learning techniques, namely the Multilayer Perceptron Network (MLP), the Elman Network (EN) and the Higher Order Neural Network (HONN). Furthermore, Univariate ARMA and Exponential Smoothing models are also tested. The Market Risk Premium is defined as the historical differential between the return of the benchmark stock index over a short-term interest rate. Data are taken in daily frequency from January 2007 through December 2014. All these models outperform a Naive benchmark model. The Elman network outperforms all the other models during the insample period, whereas the MLP network provides superior results in the out-of-sample period. The contribution of this paper to the existing literature is twofold. First, it is the first study that attempts to forecast the Market Risk Premium in a daily basis using Artificial Neural Networks (ANNs). Second, it is not based on a theoretical model but is mainly data driven. The chosen calculation approach fits quite well with the characteristics of ANNs. The forecasting model is tested with data from the US stock market. The proposed model-based forecasting method aims to capture patterns in the data that improve the forecasting accuracy of the Market Risk Premium in the tested market and indicates potential key metrics for investment and trading purposes for short time horizons.
Antonio S.M. Arroyo, Universidad Autonoma de Madrid

15:40 – 16:40 Forecast combination 3 (Santo Mauro)
Chair: Eva Senra, Universidad de Alcala

Combine to compete improving fiscal forecast accuracy over time
Laura Carabotta, Ministry Of Economy And Finance; Peter Claeys, Université libre de Bruxelles

Budget forecasts have become increasingly important as a tool of fiscal management to influence expectations of bond markets and the public at large. The inherent difficulty in projecting macroeconomic variables – together with political bias – thwart the accuracy of budget forecasts. We improve accuracy by combining the forecasts of both private and public agencies for Italy over the period 1993-2012. A weighted combined forecast of the deficit/ ratio is superior to any single forecast. Deficits are hard to predict due to shifting economic conditions and political events. We test and compare predictive accuracy over time and although a weighted combined forecast is robust to breaks, there is no significant improvement over a simple RW model.

Looking for the best forecasts on mortality rates: better combining models than selecting just one
Pablo Alonso-González, Universidad de Alcalá; Eva Senra Díaz, Universidad de Alcalá

Forecasting mortality is a relevant issue in demographic and actuarial areas. The most common models in the literature are based in one or more non-observable factors, such as those proposed by Lee and Carter (1992), Cairns, Blake and Dowd (2006) and its extensions, or in the use of splines, such as

Currie et al (2004). However, there is no consensus in the literature on the best model to forecast mortality rates, and also, the forecasting accuracy of the different models can vary across the age structure. Combination of forecasts has proven as a useful tool to improve forecast accuracy since the seminal work of Bates and Granger (1996). And it is also known that the simple average of point forecasts is usually a benchmark difficult to beat. In this paper we check whether the use of a principal component approach to combine forecasts produces a more reliable results than the original forecasts obtained by single models and the usual benchmark. Data are taken from the Human Mortality Database and they are referred to English and Welsh population amongst 50 and 100 years old from 1950 to 2013.

Improving times series forecasting: an approach combining Bagging, Clusters and Exponential Smoothing
Tiago Dantas, PUC-RIO; Fernando Oliveira, PUC-RIO
Some recent papers have demonstrated that the combination of Bootstrapping Aggregating (Bagging) and Exponential Smoothing can produce highly accurate forecasts and improve forecast accuracy when compared with traditional methods. Inspired by this idea, we propose a new approach that combines Bagging, Exponential Smoothing and clustering methods to improve forecasting accuracy. Existing methods improve forecast accuracy using Bagging to generate and aggregate a group of forecasts and reduce variance. However, none of them consider the effect of covariance among the group of forecasts, even though it can drastically impact the variance of the group and, therefore, the forecast accuracy. The proposed method aims to reduce the covariance effect using clustering methods to create clusters of similar forecasts and, subsequently, select some forecasts from each cluster to form a group with reduced variance. This approach was tested considering different time series sets and the empirical results demonstrated a substantial reduction on the forecast error, considering MAPE, MASE and RMSE.

15:40 – 16:40 Forecast Evaluation (Biblioteca)
Chair: Joerg Breitung, University of Cologne, Institut of Econometrics and Statistics

Comparing predictive accuracy in small samples
Laura Coroneo, University of York; Fabrizio Iacone, University of York

We consider fixed-b and fixed-m asymptotics for the Diebold and Mariano (1995) test of predictive accuracy. We show that this approach allows to obtain predictive accuracy tests that are correctly sized even in small samples. We apply the alternative asympotics for the Diebold and Mariano (1995) test to evaluate the predictive accuracy of the Survey of Professional Forecasters (SPF) against a simple random walk. Our results show that the predictive ability of the SPF was partially spurious, especially in the last decade.

Order Invariant Evaluation of Multivariate Density Forecasts
Hans Manner, University of Cologne; Jonas Dovern, University of Heidelberg

We derive new tests for proper calibration of multivariate density forecasts based on Rosenblatt probability integral transforms. These tests have the advantage that they i) do not depend on the ordering of variables in the forecasting model, ii) are applicable to densities of arbitrary dimensions, and iii) have superior power relative to existing approaches. We furthermore develop adjusted tests that allow for estimated parameters and, consequently, can be used as in-sample specification tests. We demonstrate the problems of existing tests and how our new approaches can overcome those using Monte Carlo Simulation as well as two applications based on multivariate GARCH-based models for stock market returns and on a macroeconomic Bayesian vectorautoregressive model.

How far can we forecast? Statistical tests of the predictive content
Joerg Breitung, University of Cologne; Malte Knueppel, Deutsche Bundesbank

Forecasts are useless whenever the forecast error variance fails to be smaller than the unconditional variance of the target variable. This paper proposes tests for the null hypothesis that the forecast becomes uninformative beyond some limiting forecast horizon h*. Following Diebold and Mariano (DM, 1995) we propose a test based on the comparison of the mean-square error of the model forecast and the sample variance. It is shown however that the resulting test has a degenerate limiting

distribution. We therefore suggest a simple modification of the DM test that results in a chi-squared distributed test statistic. Furthermore, a forecast encompassing test is developed that outperforms the modified DM test. In our empirical analysis we apply our tests to macroeconomic forecasts of some key variables from the survey of professional forecasters.

15:40 – 16:40 Forecasting in Practice (Bringas)
Chair: Robert Nau, Duke University

Forecasting Americans' Long-Term Adoption of Connected and Autonomous Vehicle Technologies
Prateek Bansal, Cornell University; Kara Kockelman, The University of Texas at Austin

Automobile enterprises, researchers, and policymakers are interested in knowing the future of connected and autonomous vehicles (CAVs). To this end, this study proposes a new discrete choice modeling-based simulation framework to forecast Americans' long-term (year 2015 to 2045) adoption levels of CAV technologies under eight different scenarios based on: 5% and 10% annual drops in technology prices; 0%, 5%, and 10% annual increments in Americans' willingness to pay (WTP); and changes in government regulations (e.g., mandatory adoption of connectivity on new vehicles). This fleet evolution framework was calibrated with the data obtained from a survey of 2,167 Americans. In order to obtain Americans' preferences for CAV technologies (e.g., WTP), the survey investigated each respondent's household's current vehicle inventory, technology adoption, future vehicle transaction decisions, WTP for and interest in CAV technologies, autonomous vehicle (AV) use based on trip types, travel patterns, and demographics. Respondents' home locations were also geocoded to account for the impact of built-environment factors (e.g., population density) and subsequently, person- and household-level weights were calculated and used to obtain relatively unbiased estimates of model estimates, and technology adoption rates. Long-term fleet evolution suggests that the privately held light-duty vehicle fleet will have 24.8% Level 4 AV penetration by 2045 if one assumes an annual 5% price drop and constant WTP values (from 2015 forward). This share jumps to 87.2% if one uses a 10% annual rate of decline in prices and a 10% annual rise in WTP values. Among Level 1 technologies, traffic sign recognition is currently the least adopted (2.1%), and is anticipated to remain least adopted, with adoption rates of 38.1% in 2045 at 5% tech-price reduction and constant WTP. Blind-spot monitoring and emergency automatic braking are the two most interesting Level 1 technologies for Americans; they are anticipated to be the most and second-most adopted Level 1 technologies (excluding ESC) in 2045 at 5% tech-price reduction and constant WTP, with adoption rates of 53.5% and 51.2%. In all scenarios with at least a10% annual increase in consumer WTP or at least a 10% annual price reduction, all Level 1 technologies exceed 90% adoption rates by 2045. Overall, simulations suggest that, without a rise in most people's WTP, or policies that promote or even require technologies, or unusually rapid reductions in technology costs, it is unlikely that the U.S. light-duty vehicle fleet's technology mix will be anywhere near homogeneous by the year 2045.

The inventory performance of forecasting methods: a reanalysis of the M3-competition monthly industry data
Fotios Petropoulos, Cardiff University; Xun Wang, Cardiff University; Stephen Disney, Cardiff University; Aris Syntetos, Cardiff University

Forecasting competitions have been a major drive not only for improving the performance of forecasting methods but also for the development of new forecasting approaches. M and M3 are the largest to date forecasting competitions, involving more than 4,000 time series combined and evaluation of the forecasts produced by more than 30 different methods. Despite the tremendous value and impact of these competitions (the respective studies have been cited more than 1,800 times so far), a limitation is that the performance of each method is measured only in terms of forecast accuracy and bias, lacking utility metrics including inventory evaluations. In this study we empirically explore the inventory performance of widely used forecasting techniques, including exponential smoothing and ARIMA models as well as the Theta method. Using the monthly industry series of the M3-competition, we employ a rolling simulation approach and analyse the results for the order-up-to policy and various lead times.

Visualization of Logistic Regression Models
Robert Nau, Duke University

The assumptions of logistic regression are in many ways more subtle and strained than those of ordinary linear regression. In both teaching and in applications, an understanding of the properties of a logistic regression model's confidence bands, error distribution, classification performance, and out-of-sample predictions can be greatly aided by visualization. However, the graphical output for logistic regression models that is provided by typical software packages or in code written by typical users is very uneven in scope and quality. This talk will discuss the advantages of interactive graphics in logistic regression analysis, illustrated by RegressIt, a free Excel add-in.

15:40 – 16:40 Forecasting methods with applications (Pedro Salinas 1)
Chair: Nuno Crato, European Commission, Joint Research Centre

Temporal aggregation and model selection: an empirical evaluation with promotional indicators
Matt Weller, Lancaster Centre for Forecasting; Sven Crone, Lancaster Centre for Forecasting; Robert Fildes, Lancaster Centre for Forecasting

Forecasts are of critical importance to retailers and manufacturers in a supply chain as they plan for inventory and operations. A range of business decisions are based on forecasts, these decisions span horizons, hierarchies and temporal frequencies. This adds complexity to the forecasting task and the question of how to produce the most accurate set of forecasts reconciled for the organisational S&OP process. Further complexity is added by the use of promotions to drive consumer demand at the retail level. Such events can produce huge uplifts relative to the baseline demand. In practice, demand planners favour monthly data and basic univariate models augmented with human judgement (Weller & Crone, 2012). This choice is driven by time constraints, the smoothing effects of aggregation and, not least, the suitability of monthly data for the family of exponential smoothing routines commonly implemented in commercial forecasting software. These system forecasts are broken into weeks by naïve means and judgemental adjustments may be applied before or after the split, e.g. for promotions and other demand drivers. This study focuses on the twin forecasting challenges of method selection and temporal aggregation, using item-level POS data and promotional variables for 1800 SKUs in 20 product categories. To make use of price and promotional information in forecasting, we implement multivariate techniques such as stepwise regression and ARIMAX models. These are compared to industry-standard benchmarks, generated with a range of univariate (ETS, ARIMA, naïve) methods via the R forecast package. We subsequently consider the temporal aggregation and disaggregation of the weekly and monthly forecasts, evaluating at both frequencies. The robust experimental design consists of two years of rolling origin forecasting and multiple error measures calculated to evaluate performance. Results show that complex methods perform significantly better than simple methods when evaluating weekly errors, however this result does not replicate with monthly forecasting where the simpler methods typically perform better. Interestingly, we note that weekly ARIMAX forecasts aggregated to monthly buckets become optimal, overtaking the univariate forecasts from monthly data. We do not find consistent improvement through aggregation and disaggregation: benefits do not generalise across methods. To provide further insight, some potential explanatory factors are investigated, testing across multiple categories for consistency and reliability. The research contributes to the empirical evaluation of univariate and multivariate forecast methods on weekly data. The study also adds to temporal aggregation research, particularly in the specific case of weekly and monthly forecasting with promotions.

Variable selection for long-term forecasting using temporal aggregation
Yves R. Sagaert, Ghent University; Nikolaos Kourentzes, Lancaster Centre for Forecasting; El-Houssaine Aghezzaf, Ghent University; Bram Desmet, Solventure

Producing long-term forecasts is typically done by extrapolating past tendencies to the future, often adjusted with managerial insights. In several sectors such as credit insurance, investments and supply chain management tactical-strategic decisions are made based on these forecasts. External relevant market information has the potential to improve forecast accuracy. However, long-term movements can be overwhelmed by the short-term dynamics. This makes it very hard to identify relevant external variables. Focusing specifically on long-term forecasts, we propose to identify long-term dynamics via temporal aggregation. High frequency information is filtered out on high temporal aggregation levels

(e.g. quarterly, yearly), thus capturing long term dynamics, such as trend and cycle, more easily. Even though temporal aggregation will reduce the available fitting sample, high-frequency variability is filtered due to the aggregation and any of the long-term co-movements between the target and explanatory variables become more apparent. This can make the selection of leading indicators for long-term forecasting easier. In this work we investigate different ways we can use temporal aggregation to enhance variable selection in a regression context. We compare the selection of variables through temporal aggregation against the conventional selection solely on the original (high frequency) information. We empirically evaluate the proposed variable selection methodology using demand data from a global tire manufacturer that needs forecasts for tactical level supply chain management.

Revenue Forecasting for Enterprise Products
Amita Gajewar, Microsoft Corp.; Gagan Bansal, Microsoft Corp.; **Jocelyn Barker**, Microsoft Corp.

For any business, planning is a continuous process, and typically business-owners focus on making both long-term planning aligned with a particular strategy as well as short-term planning that accommodates the dynamic market situations. An ability to perform an accurate financial forecast is crucial for effective planning. In this paper, we focus on providing an intelligent and efficient solution that will help in forecasting revenue using machine learning technologies. We experiment with three different revenue forecasting models, and here we provide detailed insights into the methodology and their relative performance measured on real finance data. As a real-world application of our models, we partner with Microsoft's Finance organization (department that reports Microsoft's finances) to provide them a guidance on the projected revenue for upcoming quarters. Our first algorithm, Algo1, is a linear model that includes forecasts obtained from time series models (ARIMA, ETS, and STL) as one of the input features along with the information corresponding to the launch of certain Microsoft products. Our second algorithm, Algo2, uses richer feature-set, is extensible to include external data easily into the model, and forecasts revenue up to h_max quarters into the future. For our experiments we set h_max=4. To illustrate this method, assume that we want to forecast revenue for geographical-area geo1 at quarter (q + h), where q is the current quarter. Then, we construct the feature-set as: horizon=h, geographical-area=geo1, forecasts at horizon h computed using time series models (ARIMA, ETS, and STL) trained on revenue data up to quarter q for geo1, derived features constructed using these forecasts, and lag-features constructed using historical revenue for geo1. Once we construct a feature-set corresponding to all geographical-areas and for horizons 1 to 4, we train RandomForest model on this dataset. We use this RandomForest model to obtain final forecasts of quarterly revenue at various horizons. In our third algorithm, Algo3, we enhance the feature-set of Algo2 by including the macro-economic indicators (e.g., Share Prices and Gross Domestic Product) to incorporate the trend in global market. Initial experiments suggest that the models developed using machine learning algorithms can forecast quarterly revenue with reasonable accuracy. We believe that using machine learning algorithms for revenue forecasting will be very helpful for finance organizations as it will be free of human judgements and computed in an efficient manner. Further, our methodology can incorporate social-economic information and key business drivers easily, and scale well with relevant big data.

15:40 – 16:40 Prices and inflation (Pedro Salinas 2)
Chair: James Reade, University of Reading

Forecasting U.K. House Prices during Turbulent Periods
Alisa Yusupova, Lancaster University Management School; Efthymios Pavlidis, Lancaster University Management School

The latest boom and bust in housing markets and its role in the Great Recession has generated a vast interest in the dynamics of house prices. International organizations and central banks have become increasingly concerned about monitoring the developments in housing markets across the world (e.g., the IMF established the Global Housing Watch), and policy makers have attached a larger weight on the importance of these markets in financial stability and the real economy (see, e.g., the 2014 U.K. stress testing exercise of the Bank of England). At the same time, a substantial empirical literature has developed that deals with predicting future house price movements. This literature concentrates almost entirely on the US, leaving national and regional markets of other countries, where housing has also played a central role, mostly unexplored. In this paper, we contribute to this literature by conducting an extensive investigation of the ability of a battery of econometric models to forecast UK national and

regional housing prices over the last two decades. The econometric models considered include Autoregressive Distributed Lag (ARDL), Bayesian VAR (BVAR), Factor Augmented BVAR (FABVAR), Time-Varying Parameter VAR (TVP-VAR), Dynamic Model Averaging (DMA), Dynamic Model Selection (DMS), and the Dynamic Stochastic General Equilibrium (DSGE) model proposed by Iacoviello and Neri (2008). In summary, our findings suggest that models that allow both the underlying specification and the parameter estimates to vary over time, i.e. DMA and DMS, produce more (and, in some cases, dramatically more) accurate forecasts than methods where the number of predictors is kept fixed. The DMS, in particular, performs remarkably well. First, it uniformly outperforms the benchmark model for the national and all the regional housing markets and, second, it captures particularly well the housing boom up to 2004 and the price collapse of 2008. The superiority of dynamic over static models is consistent with recent evidence that suggests that the relationship between real estate valuations and conditioning macro and financial variables, such as domestic credit, displayed a complex of time-varying patterns over the last decades (Aizenman and Jinjarak, 2014). Our results also reveal large differences in predictability across regional housing markets. Specifically, accurate forecasts are found to be more difficult to obtain in regions with high volatility, such as Northern Ireland, the North and Wales. We demonstrate that, for these regions, the gains in predictive accuracy obtained from allowing for parameter shifts and model changes are the largest.

Forecasting Day-Ahead Electricity Prices: Exploiting Intra-Day Information
Jan-Willem Engelen, Erasmus University Rotterdam; Jeroen van Halteren, Erasmus University Rotterdam; Mike Hooymans, Erasmus University Rotterdam; **Dick van Dijk**, Erasmus University Rotterdam

The daily average electricity price represents the simple arithmetic mean of hourly prices of electricity to be delivered throughout the course of the next day. It serves as a key reference price in the electricity market, and a better understanding of its dynamics can ultimately lead to increased profitability and risk control for electricity companies. In this paper we scrutinize the daily average electricity price at the Nord Pool Spot exchange over the period May 1992 - July 2015. Recent research suggests that the disaggregated hourly prices contain useful predictive information for the daily average price. However, models for the full panel of hourly prices suffer from the 'curse of dimensionality' as a result of the large number of parameters that need to be estimated. In an attempt to mitigate the issue of overfitting while maintaining the usefulness of intraday information, we demonstrate that the hours in a day may be grouped into five subintervals according to common characteristics. We show that multivariate models for these subintervals deliver substantially more accurate one-day ahead forecasts of the daily average price, compared to models
for the full panel of hourly prices as well as univariate models for the daily average price itself, with reductions in the Mean Squared Prediction Error of up to 15%.

Forecasting and Forecast Narratives: The Bank of England Quarterly Inflation Reports
Michael Clements, Unviersity of Reading; **James Reade**, University of Reading

We analyze the narratives that accompany the numerical inflation forecasts in the Bank of England's Inflation Reports. We focus on the whether the narratives contain useful information about the future course of inflation over and above the point predictions, in terms of whether the narratives can be used to enhance the accuracy of the numerical forecasts. We find that sentiment related to specific aspects of the economic outlook (say, demand conditions, or supply conditions) carries useful information for point prediction.

17:00 - 18:00
Forecasting Practitioner Track 8 (Rector Ernest Lluch)

Eric Stellwagen, CEO and Co-Founder, Business Forecast Systems

Beyond Exponential Smoothing: How to Proceed when Extrapolation Doesn't Work
Many organizations rely heavily on extrapolation-based forecasting algorithms such as exponential smoothing. In this session, I will discuss practical ways to improve your forecasts when extrapolation from the past "just won't cut it." We will examine pragmatic forecasting approaches such as creating forecast histories, adding judgmental adjustments to baseline forecasts, and establishing an S&OP or other collaborative process. In addition, we will review more quantitative approaches including new product forecasting models, event models, and causal forecasting. You will gain an understanding of the strengths and weaknesses of the different approaches, learn about best practices for implementing these methods, and see how these approaches are applied to corporate data via several real-life examples.

17:00 - 18:00 Applied forecasting methods (Biblioteca)
Chair: Victor M. Guerrero, Instituto Tecnologico Autonomico de Mexico

The Assessment of Productivity of the Public Sector Services Across States within the United States
Miriam Scaglione, Institute of Tourism University of Applied Sciences and Arts; **Brian Sloboda**, University of Maryland, University College

This paper will examine the productivity of the public sectors in the US across the states. Because There is heterogeneity across states in terms of public services provided that could impact its productivity. In fact, there could be a convergence across the states. The services provided by the public sectors has come under increased scrutiny with the ongoing process of reform in recent years. The public sector unlike the private sector or in the absence of contestable markets, and the information and incentives provided by these markets, performance information, particularly measures of comparative performance, have been used to gauge the productivity of the public service sector. This paper will examine the productivity of the public sector across states throughout the United States. This analysis will assess productivity beyond the use of the standard data envelopment analysis (DEA) and stochastic production frontier panel models to assess the productivity in the public sector. This analysis will identify the leaders, those states that are catching up, and those states that are convergent. Given that there is a homogeneity across states in terms of the use of a standard currency, e.g., the dollar, it will be easy to identify the nature of the convergence process in the public sectors throughout the United States. The latter approach has been used in the assessment of total factor productivity (TFP) as delved by Batavia et al (2006).

Forecasting Russian Macroeconomic Indicators with BVAR
Oxana Malakhovskaya, National Research University Higher School of Economics; Boris Demeshev, National Research University Higher School of Economics

This paper evaluates the forecasting performance of BVARs on Russian data. We estimate BVARs of different sizes and compare the accuracy of their out-of-sample forecasts with those obtained with unrestricted VARs and random walk. Our sample consists of 23 variables and we forecast at five different horizons up to twelve months. For each variable and each forecasting horizon we compare 60 specifications. The hyperparameter of the overall tightness in BVARs is determined endogenously according to the approach introduced by Banbura et al. (2010). We show that for the majority of the variables, BVARs outperform the competing models in terms of forecasting accuracy. However, we cannot confirm the conclusion drawn in some other studies where Bayesian methods were applied to data from developed countries, claiming that high-dimensional BVARs forecast better than low-dimensional models. Our results imply that a 23-variable BVAR performs most accurately in only about a half of cases where a BVAR is considered as a better forecasting tool with respect to its competitors. For the rest of those cases a BVAR with a relatively small size (6 or 7 variables in our case) can outperform a 23-variable BVAR in terms of forecasting accuracy. As a robustness check, we

implement the Model confidence set (MCS) procedure (Hansen et al. (2011)) and for each variable we choose the sets of forecasting models for which the hypothesis of equal predictive ability cannot be rejected.

Forecasting remittances to Mexico with a Multi-State Markov-Switching model applied to the trend with controlled smoothness
Alejandro Islas-Camargo, Instituto Tecnológico Autónomo de México; **Victor M. Guerrero**, Instituto Tecnológico Autónomo de México; Eliud Silva, Universidad Anáhuac del Norte

In this work we apply a statistical methodology to forecast remittance flows to Mexico based on the Multi-State Markov-Switching model with three different specifications. The model is applied to the trend of the data instead of the original observations, in order to avoid the effect of outliers and transitory blips. The filtering technique employed to estimate the trend allows us to control the amount of smoothness in the trend as well as to take into account an implicit adjustment of the data at both extremes of the time series. Thus, the Markov-Switching approach captures more precisely the trend persistence in remittances and the forecasts generated with the model are shown to be better than some other alternatives entertained.

17:00 - 18:00 Bayesian methods 2 (Pedro Salinas 1)
Chair: Shari De Baets, Vlerick Business School

Enhanced anchoring effects produced by the presence of statistical forecasts: Effects on judgmental forecasting
Shari De Baets, Vlerick Business School; Nigel Harvey, University College London

Are judgmentally adjusted statistical forecasts better or worse than unaided judgmental forecasts? We investigated this issue in a series of sales-forecasting experiments in which the presence or absence of statistical forecasts was manipulated as a within-subjects factor. In Experiment 1, graphs with statistical forecasts displayed them for past periods as well as for future ones. We found that forecasts were too low when promotions were present but too high when they were not. This suggests that the mean of the series acted as a judgment anchor. This effect increased when a statistical forecast was present and, as a result, Mean Absolute Error (MAE) was higher when a statistical forecast was present than when it was not. To test whether this effect arose because the additional line joining past statistical forecasts produced a visually enhanced anchor on the graph, Experiment 2 included statistical forecasts only for the future periods that were to be predicted. However, the detrimental effect of the presence of a statistical forecast was maintained. In both Experiments 1 and 2, 40% of past sales periods contained promotions. With fewer promotions, the statistical forecasts would be much closer to sales level of the periods without promotions in the displayed series. As a result, forecasting errors due to anchoring should be much smaller on non-promotional periods – and the enhanced anchoring effects produced by the presence of a statistical forecast should matter less. To test this, Experiment 3 was identical to Experiment 1, except that the number of promotions in the sales history was reduced from 20 to five. An overall reduction in MAE was obtained but it was still higher for series with statistical forecasts than for those without them.

A new bio-inspired forecasting algorithm based on genomic evolution
Zara Ghodsi, Bournemouth University

Many scientific fields consider accurate and reliable forecasting methods as important decision-making tools in the modern age amidst increasing volatility and uncertainty. As such there exists an opportune demand for theoretical developments which can result in more accurate forecasts. Inspired by Colonial Theory, this paper seeks to bring about considerable improvements to the field of time series analysis and forecasting by identifying certain core characteristics of Colonial Theory which are subsequently exploited in introducing a novel approach for the grouping step of subspace based methods. The proposed algorithm shows promising results in terms of improved performances in noise filtering and forecasting of time series. The reliability and validity of the proposed algorithm is evaluated and compared with popular forecasting models with the results being thoroughly evaluated for statistical significance and thereby adding more confidence and value to the findings of this research.

A Bayesian Model for Forecasting Hierarchically Structured Time Series
Julie Novak, IBM Research; Scott McGarvie, Bank of England; Beatriz Etchegaray Garcia, IBM Reserach

An important task for any large-scale business is to prepare forecasts of business metrics, such as revenue, cost, and event occurrences, at different time horizons (e.g. weekly or quarterly intervals). Often these business organizations are structured in a hierarchical manner by line of business, division, geography, product line or a combination thereof. In many situations projections for these business metrics may have been obtained independently and for each level of the hierarchy. The problem with forecasts produced in this way is that there is no guarantee that forecasts are aggregate consistent according to the hierarchical structure of the business, while remaining as accurate as possible. A similar problem has been examined by Hyndman et. al. (2011) in which they find revised forecasts using a least squares approach. However, for an organization it is often also important to achieve accurate forecasts at certain levels of the hierarchy according to the needs of users. We propose a Bayesian hierarchical method that will treat the ``base'' forecasts (those which were initially provided) as observed data which are then updated and obey the hierarchical organizational structure. In addition, by leveraging the prior covariance matrix, we are able to set up a heterogeneous loss function to obtain higher accuracy at the levels prescribed by the user. We develop a novel approach to hierarchical forecasting that provides an organization with optimal forecasts that reflect their preferred levels of accuracy while maintaining the proper additive structure of the business.

17:00 - 18:00 Business cycle analysis 2 (Paraninfo)
Chair: Laurent Ferrara, Banque de France

A multivariate system of turning points detection for all euro area countries
Rosa Ruggeri Cannata, European Commission – Eurostat; Monica Billio, University of Venice; Leonardo Carati, Greta
The recent 2008-2009 financial and economic crises, as well as the 2012-2013 recessions, have shown the importance of having an accurate system able to detect, almost in real-time, the occurrence of turning points. At the euro area level, such a system has been developed by Eurostat in the last years and then extended to the largest euro area economies. Nevertheless, the increasing idiosyncratic behaviour among the euro area economies, started around 2008, does not guarantee that concentrating our attention to the euro area as a whole, or to its largest economies, provides a reliable picture of the cyclical situation. For this reason, we have decided to extend our turning points detection system to all euro area countries starting from the same multivariate Markov-Switching based model. The paper discusses in details the main problems and challenges encountered when extending our system to all euro area countries. In particular, we are focusing here on data availability problems, on the complexity of properly identifying cyclical movements for small and very open economies, as well as on the short span of available data, at least for some countries.

The Role of Credit in Predicting US Recessions
Harri Pönkä, University of Helsinki

We study the role of credit in forecasting US recession periods with factor-augmented probit models. We employ both classical recession predictors and common factors based on a large panel of financial and macroeconomic variables as control variables. Our findings suggest that a number of credit variables are useful predictors of US recessions over and above the control variables both in and out of sample. Especially the excess bond premium, capturing the cyclical changes in the relationship between default risk and credit spreads, is found to be a powerful predictor. Overall, models that combine credit variables, common factors, and classic recession predictors, are found to have the best forecasting performance.

Common factors of commodity prices
Laurent Ferrara, Banque de France; Simona Delle Chiaie, ECB; Domenico Giannone, New York Fed

The high level of co-movement among commodity prices indicates that a few common forces could drive the bulk of commodity price fluctuations. In this paper, we estimate common factors from a large cross-section of commodity prices. We distinguish between global factors, category-specific factors and commodity-specific components. We find that the bulk of the fluctuations in commodity prices is

well summarized by a single global factor. However, while the variations in crude oil are explained to a greater extent by block-specific shocks, the role of global sources has increased markedly since the late 1990s. The factor is partly predictable and its predictability increases substantially during periods of high commonality. Looking at historical episodes of major commodity price changes, we find strong evidence that this single factor is associated with global demand shock

17:00 - 18:00 Clustering and other Bayesian methods (Santo Mauro)
Chair: Elias Moreno, University of Granada

Variational Bayes Inference for Large Vector Autoregressions
Gholamreza Hajargasht, University of Melbourne; **Tomasz Wozniak**, University of Melbourne
Variational Bayes (VB) provides an approximation to the joint posterior distribution of parameters of a model. The VB approximate posterior is derived subject to some simplifying assumptions and is usually accurate and of a tractable form. We show that when applied to large Bayesian Vector Autoregressions, proven to have an excellent performance in economic forecasting, VB allows for fast and accurate computations of posterior distributions. The algorithms for the VB estimation of VAR models for a wide class of prior distributions including conjugate and independent prior structures are derived. Models estimated with the VB approximate algorithms are shown to have the forecasting performance indistinguishable from those estimated with exact Bayesian methods. We also derive analytical solutions of a VB lower bound for the logarithm of the marginal data density (MDD), a VB measure of the in-sample fit of the model, that is optimal with respect to the Kullback-Leibler divergence distance. We show that for a given dataset and for VAR models the VB in-sample fit measure includes the same information content as the MDD. This measure is further used in a novel procedure of choosing the optimal hyper-parameters of the prior distributions. The optimal hyper-parameters obtained in such a way are shown to improve the forecasting performance of the models in the same way as the hyper-parameters optimal with respect to the MDD. Our procedure, however, allows for fast computations for models for which the analytical solutions for the MDD are not available. Finally, a new estimator of the MDD based on the output from both the MCMC and the Variational Bayes estimation is shown to have superior numerical efficiency compared to other known estimators within the class of generalized harmonic mean estimators.

Change-Point detection in multivariate time series: A Bayesian approach
F. Javier Girón, University of Málaga

Detection of change-points in multivariate time series has become an important problem in the analysis of complex multivariate series, which has been analysed from different perspectives, including the Bayesian approach, and is an important tool for making short and medium term predictions. We approach the problem of change-point detection as a model selection problem when the data is ordered: this can be viewed as a particular case of cluster analysis for ordered data. We accomplished this by modeling the multivariate series as a set of multivariate piecewise linear models between consecutive change-points. The detection of simultaneous change-points in multivariate time series, in particular when the is correlation among the univariate series, has the advantage of detecting possible change-points with higher probabilities than those obtained when only the one-dimensional componentes of the series are considered. From the computational point of view we present two different but complementary approaches for locating change-points: one is a simple sequential procedure which produces a local optima of the positions of the change-points, and the second one is an on-line procedure for sequentially detecting the most influential change-points. Both are computationally inexpensise and produce similar results.

A statistical analysis of the between sample heterogeneity: Consistency
Elias Moreno, University of Granada

The detection of the between sample heterogeneity yields a more accurate model, and, consequently, a more sensible forecasting. Clustering k samples is focused here as a Bayesian statistical model selection problem. The class of sampling models is given by the product partition models approach by Hartigan (1990) and Barry and Hartigan (1992). As the dimension of the sampling models grows as the sample size n grows, it is assumed that k=O(n^{a}) for 0≤a≤1. The prior for the model parameters is the objective intrinsic prior for model comparison (Berger and Pericchi, 1996; Moreno, Bertolino and Racugno, 1998). The choice of the prior on model space is of utmost importance, almost

overshadowing the other parts of the clustering problem, and we examine the asymptotic behaviour of the model posterior probabilities based on two popular model priors, the hierarchical uniform prior (HU) (Casella, Moreno and Girón, 2014) and the Ewens-Pitman prior (EP). We give sufficient conditions on the rate of grow of k to ensure that as $n \to \infty$, posterior model consistency holds for both the HU prior and the EP prior. We find the rate of convergence to one of the posterior probability of the true model, and conclude that the HU model prior provides a faster rate of convergence than that of the EP model prior.

17:00 - 18:00 Energy Forecasting 4 (Bringas)
Chair: Reinaldo Castro Souza, Pontifical Catholic University of Rio de Janeiro

Electricity Forward Curves with Thin Granularity
Ruggero Caldana, Accenture spa; Gianluca Fusai, Università del Piemonte Orientale; Andrea Roncoroni, Essec Business School

We put forward a constructive definition of electricity forward price curve with thin granularity. This case encompasses timescales with hourly frequencies on, including half-hourly cross-sections. The resulting assessment is jointly consistent to both risk-neutral market information, as represented by baseload/peakload quotes, and historical market information, as mirrored by periodical patterns exhibited by time series of spot price records. Our method combines suitable nonparametric filtering with monotone convex interpolation in a way that the resulting curve is positive, stable, local, and monotonic. An empirical investigation in the EPEX spot market assesses effectiveness and representativeness of the resulting forward price estimates with hourly granularity.

Environmental Radioactivity and Weather Data: A Cross-Wavelet Analysis
Harald Schmidbauer, FOM University of Applied Sciences, Munich; Angi Roesch, FOM University of Applied Sciences, Munich

Understanding the pattern of environmental radioactivity is important for several reasons, for example for the detection of man-made radioactivity. Environmental radioactivity measurements are highly volatile, making the identification of patterns a challenging task. Analyzing time series of daily radioactivity measurements from eight places in Germany, we show that patterns become visible by means of wavelet analysis. In addition, frequency aspects of weather data, namely precipitation, relative humidity, and temperature, can be analyzed jointly with radioactivity measurements using cross-wavelet analysis. We show that even though environmental radioactivity does not follow an annual periodicity everywhere, temperature is in phase, and leading, radioactivity in a majority of the places investigated. Our analysis can potentially contribute to a location-specific definition of maximum permissible radioactivity levels.

Comparative analysis of statistical models and non-parametric approach to predict wind speed
Soraida Aguilar Vargas, Pontifical Catholic University of Rio de Janeiro; Reinaldo Castro Souza, Pontifical Catholic University of Rio de Janeiro; José Francisco Pessanha, Rio de Janeiro State University

The stochastic nature of the wind speed made its prediction a difficult task. However, wind speed forecasts are required to obtain wind power predictions. Reviews of the academic contributions to this field were completed by Soman et al. (2010), Wang et al. (2011), Zhao et al. (2011) e Foley et al. (2012). These reviews presented the different physical, statistical and some new hybrid approaches and takes into consideration the horizon forecast, highlighting statistical models to be used on short-time. This work reports a comparative analysis of statistical approach and non-parametric techniques to predict wind speed for a 24, 64 and 168-hours-ahead lead-time. The outcomes reveal a slight improvement in the predicted values for non-parametric techniques, although the remaining models performed well.

17:00 - 18:00 Financial forecasting (Pedro Salinas 2)
Chair: Trino-Manuel Niguez, University of Westminster & University of Alicante

Fusion of Multiple Diverse Predictors of Stock Returns and Risk
Sasan Barak, Technical University of Ostrava; Azadeh Arjmand, Alzahra University

Stock returns and risk prediction is one of the most important concerns of market practitioners who want to determine stock status. Although lots of studies have given a comprehensive attention to single classifier of stock returns and risk methods, fusion methods which just emerged in recent years need to be further studied in this area. The main aim of this paper is to propose a fusion model based on the use of multiple diverse base classifiers which operate on a common input and a meta-classifier which learns from base classifiers' outputs to obtain more precise stock return and risk predictions. A set of diversity methods including Bagging, Boosting and AdaBoost is applied for diversity creation in classifier combinations. Moreover, we determine the number of classifiers in fusion by dataset clustering and designing an algorithm for selecting base classifiers from candidate ones by consideration of the accuracy of fused classifiers. As a result of this analysis, Bagging displayed a far better performance with fusion scheme and could achieve maximum 83.6% accuracy with Decision Tree, LAD Tree and Rep Tree for return prediction and 88.2% accuracy with BF Tree, DTNB and LAD Tree in risk prediction. This paper aimed to help designers in the choice of the individual classifiers and combination methods of a fusion scheme. To illustrate the approach, we apply it to Tehran Stock Exchange (TSE) data from 2002 to 2012.

MGARCH models: Trade-off between feasibility and flexibility
Daniel Almeida, University Carlos III; Luiz Hotta, University of Campinas; Esther Ruiz, University Carlos III

Multivariate GARCH (MGARCH) models have attracted a great deal of attention due to several applications that require forecasts of conditional variances, covariances and correlations of multivariate time series. The largest number of implementations of MGARCH models appear in the context of systems of financial returns such as asset pricing, portfolio selection, risk management and future hedging applications. The original MGARCH models, which were direct generalizations from their univariate counterparts, were flexible allowing all volatilities and conditional covariances in the model to be related with each other. However, in practice, the empirical implementation of MGARCH models was limited due to two main limitations. First, due to the need of estimating a large number of parameters, their implementation was originally restricted to systems with very few series. Second, their parameters need to be restricted to guarantee covariance stationarity and positive definiteness of conditional covariance matrices. Consequently, numerous popular MGARCH models are restricted in a such way that parameter estimation is feasible and it is easy to guarantee covariance stationarity and positiveness.This paper analyze the potential biases incurred when the restricted models are fitted to systems with rich dynamics as those usually encountered in real data. We extend previous research by carrying out Monte Carlo experiments, including new models and very recently proposed new parameter estimators. In this way, we fit the restricted models and parameter estimators to systems simulated by the general VECH model to analyze the empirical implications on estimated conditional variances, covariances and correlations of the restrictions imposed on MGARCH models to reduce the number of parameters and/or to guarantee covariance stationarity and/or positiveness. These limitations are also illustrated using a five-dimensional system of exchange rate returns. We show that the restrictions imposed by the BEKK, O-GARCH and GO-GARCH models are very unrealistic generating potentially missleading forecasts of condicional correlations. We emphasize that although the BEKK model is as general as the VECH model in the bivariate case, it is strongly restricted when supposed to have just one factor, as usually considered in empirical applications. In this way, it is advisable to fit the restricted DBEKK or SBEKK models, or their rotated version. On the contrary, models based on the DCC specification provide appropriate forecasts. Finally, alternative estimators of the parameters are important to simplify the computations but do not have implications on the estimates of conditional correlations.

Hedge fund evaluation using performance measures distribution
Angel Leon, University of Alicante; **Trino-Manuel Niguez**, University of Westminster & University of Alicante; Javier Perote, University of Salamance

In this study we propose the use of the performance measure distribution rather than its punctual value to rank hedge funds. Generalized Sharpe Ratio and other similar measures that take into account the higher-order moments of portfolio return distributions are commonly used to evaluate hedge funds performance. The literature in this field has reported non-significant difference in ranking between performance measures that take, and those that do not take, into account higher moments of distribution. Our approach provides a much more powerful manner to differentiate between hedge funds performance. We use a non-semiparametric density based on Gram-Charlier expansions to forecast the conditional distribution of hedge fund returns and its corresponding performance measure distribution. Through a forecasting exercise we show the advantages of our technique in relation to using the more traditional punctual performance measures.

17:00 - 18:00 Forecasting Systems (Comedor de Infantes)
Chair: Rocio Sanchez-Mangas, Universidad Autonoma de Madrid

OMEN: Promoting forecasting support systems
Ilektra Skepetari, National Technical University of Athens; Evangelos Spiliotis, National Technical University of Athens; Achilleas Raptis, National Technical University of Athens; Vassilios Assimakopoulos, National Technical University of Athens

Nowadays, forecasting is of utmost importance when it comes to planning, which is the backbone of every successful company. In order to help companies in their forecasting and decision-making procedures, many Forecasting Support Systems have been developed through the years. While these systems can be proven quite helpful in general, it seems that they tend to be deficient both in technological and methodological aspect. In the present paper we indicate that the main vulnerabilities of typical 'off-the-shelf' solutions are their limited customizability, non web-based architecture and poor user interface, although outdated methods and lack of the judgmental component are also issues of significant importance. We also make some suggestions regarding the way a system can be involved and set open-source solutions as a key parameter for dealing with all the problems mentioned above. In this respect we present OMEN, a fully customizable web-based forecasting tool which uses exclusively open-source solutions and a modern interface to support companies and practitioners. The feautures of OMEN are used to demonstrate the advantages of its principles and structure and all its modules, including data mining, data pre-processing and forecasting, are exposed to promote changes in modern Forecasting Support Systems.

Producing "effective" scenarios: an evaluation of both the basic Intuitive Logics method and recent developments of that method.
George Wright, Strathclyde Business School; Ron Bradfield, Strathclyde Business School; George Cairns, Queensland University of Technology

In this paper, we establish the common objectives of scenario interventions within organizations and contextualize the well-established, but basic, "intuitive logics" scenario development methodology. We next consider if the basic intuitive logics method achieves these objectives. Then, we consider recent augmentations of the intuitive logics method and evaluate whether these augmentations enhance the basic method's capabilities. We find that there is a strong case for arguing that these scenario methods are designed to address two of the three objectives that we identified from the literature, namely: (i) enhancing understanding: of the causal processes, connections and logical sequences underlying events — thus uncovering how a future state of the world may unfold, and (ii) challenging conventional thinking in order to reframe perceptions and change the mind-sets of those within organizations. However, other than in the augmentation in which multi-attribute value analysis is applied, none of the recent developments that we detail address directly the third objective that we distil from the literature: (iii) improving decision making: to inform strategy development. We conclude by considering the new methodological development of "Scenario Improvisation" (Cairns, Wright and Fairbrother, 2015) and its use with time-poor decision makers.

Individual vs group: Advice Taking in Judgmental Forecasting Adjustments
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 group and individual's forecast adjustment behavior and performance when an advice is given. When individuals make decisions, especially that are exacting task like forecasting, they often feel anxious due to high responsibility on the outcome of the decisions they make. Yet, when groups make decisions, they feel less anxious due to the spread of responsibility. Using a controlled laboratory experiment, we test the influence of responsibility and anxiety in individual vs. group forecasting on advice taking and the ability to discern the quality of advice. Across seven different types of time series (i.e., constant mean, mean change, random walk, random walk with drift, ARIMA(0,1,1), ARIMA(1,1,0)), the weight of advice taking and one's ability discriminate the quality of advice are investigated. Individuals are found to be more reliable on advice than group, but the discrimination ability to discern depends on the nature of time series. For non-stationary time series, groups are found to be more receptive to good advice than bad advice while individuals fail to discriminate between good and bad advice. However, this behavior disappears when the time series is stationary (i.e. constant mean).

17:00 - 18:00 Sources of forecasting uncertainty (Infantes)
Chair: Fotios Petropoulos, Cardiff University

Aggregation in an Uncertain Production Environment: Secondary Forecasting to Align Production with Demand
Christina Phillips, Bangor University; Konstantinos Nikolopoulos, Bangor University

The following emerged from a project to align production with demand in a manufacturing facility which experiences a high degree of uncertainty across the value chain from demand through to pre-release testing. This is to be done by first running a participative simulation experiment to try different family groupings of products with different cycle schedules. This highly regulated semi-process industry produces a mature product with relatively flat demand on aggregate. However, at lower levels of detail customer batch rationing behaviour causes lumpy purchasing patterns. Since the product has shelf life constraints this causes problems throughout the forecast supply chain. There are further constraints due to validated batch sizing and post production testing with variable lead times. To allow production to be aligned with demand we must understand the best level and therefore time for the aggregation periods. If the periods are too long or batches too large we may hold excess inventory. Too short and we risk stock out and disruption to the smoothed schedules. The levels should be set such that noise is removed but in order to set effective buffers in production the probability and size of large signal patterns need to be quantified. Temporal aggregation of demand will allow schedule smoothing but too high an aggregation level will destroy important information. With batching and customer rationing there is an inclination in the system to bullwhip. Aggregation increases this effect, in part due to information loss. The analysis will use both rolling and non-rolling windows to quantify the uncertainty in each line. We will look at both the total lead time demand and the lead time demand from dating over different aggregation levels. We refer to methods used on intermittent demand data to see if they can be applied to this non-zero but lumpy demand to enable a best aggregation level forecast that can be trialed during the participative simulation workshop and verified through use.

Forecasting Volatility with Interacting Multiple Models
Jiri Svec, The University of Sydney; Xerxis Katrak, The University of Sydney

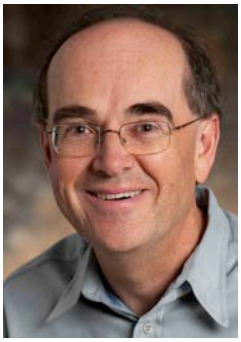
We examine the performance of Kalman Filter techniques in forecasting volatility. We find that the simple implementation of an online Kalman filtering procedure that combines commonly used time-series forecasting models with market-based option-implied volatility estimates improves the accuracy of volatility forecasts. Furthermore, we demonstrate that combining multiple volatility models with a market-based estimate using Multiple Model Adaptive Estimation yields further increases in forecast accuracy.

Exploring the sources of uncertainty: why does bagging work?
Fotios Petropoulos, Cardiff University; Rob Hyndman, Monash University; Christoph Bergmeir, Monash University

In a recent study, Bergmeir, Hyndman and Benitez (2016, IJF) successfully employed the bootstrap aggregation (bagging) technique for improving the performance of exponential smoothing. Each series is Box-Cox transformed, and decomposed using STL; then bootstrapping is applied on the remainder series before the trend and seasonality are added back, and the transformation reversed. Consequently, they apply automatic exponential smoothing on the original series and the bootstrapped versions of the series, with the final forecast being the equal-weight combination across all forecasts. In this study we attempt to address the question: why does bagging for time series forecasting work? We assume three sources of uncertainty (model uncertainty, data uncertainty, and parameter uncertainty) and we separately explore the benefits of bagging for time series forecasting for each one of them. Our analysis considers 4,004 time series (from the M- and M3-competitions) and two families of models (exponential smoothing and ARIMA). The results show that the benefits of bagging predominantly originate from the fact that different models might be selected as optimal. As such, a suitable weighted combination of the most suitable models should be preferred to selecting a single model.

Wednesday, 22 June

9:00 – 10:00
Keynote Session IV (Paraninfo)
Chairperson: Rob J Hyndman, Monash University



Adrian Raftery

Professor of Statistics and Sociology University of Washington, USA

Adrian E. Raftery is Professor of Statistics and Sociology at the University of Washington in Seattle. He was born in Dublin, Ireland, and obtained a B.A. in Mathematics (1976) and an M.Sc. in Statistics and Operations Research (1977) at Trinity College Dublin. He obtained a doctorate in mathematical statistics in 1980 from the Université Pierre et Marie Curie in Paris, France under the supervision of Paul Deheuvels. He was a lecturer in statistics at Trinity College Dublin from 1980 to 1986, and then an associate (1986-1990) and full (1990-present) professor of statistics and sociology at the University of Washington. He was the founding Director of the Center for Statistics and Social Sciences (1999-2009). Raftery has published over 170 refereed articles in statistical, sociological and other journals. His research focuses on Bayesian model selection and Bayesian model averaging, model-based clustering, inference for deterministic simulation models, and the development of new statistical methods for sociology, demography, and the environmental and health sciences.

***IJF Editor's Invited Paper*: Probabilistic Population Projections with Migration Uncertainty**
The United Nations recently issued official probabilistic population projections for all countries for the first time, using a Bayesian hierarchical modeling framework developed by our group at the University of Washington. These take account of uncertainty about future fertility and mortality, but not international migration. We propose a Bayesian hierarchical autoregressive model for obtaining joint probabilistic projections of migration rates for all countries, broken down by age and sex. Joint trajectories for all countries are constrained to satisfy the requirement of zero global net migration. We evaluate our model using out-of-sample validation and compare point projections to the projected migration rates from a persistence model similar to the UN's current method for projecting migration, and also to a state of the art gravity model. We also resolve an apparently paradoxical discrepancy between growth trends in the proportion of the world population migrating and the average absolute migration rate across countries. This is joint work with Jonathan Azose.

10:15 - 11:35 Climate modeling and forecasting II (Biblioteca)
Chair: Peter C. Young, University of Lancaster

A 7-Year Test Opportunity of Opposing Global Warming Forecast Methods
Kevin W Murphy, Arizona State University

A slowdown of global warming since the turn of the century, sometimes called 'the pause' or 'the hiatus', has contributed to a divergence of recent observations from climate model projections. It has only recently been accepted that the slowdown is due to natural internal variability which has offset increasing anthropogenic warming from greenhouse gas emissions (GHG), and that climate modeling methods do not capture those mechanisms. Additionally, energy budget analyses and empirical decomposition of the instrumental climate record reveal lower climate sensitivity to GHG than is embodied in climate models. Both near-term and long-term temperature forecasts are intimately dependent upon the interaction of natural variability and climate sensitivity to GHG. For surface air temperatures to now reach levels suggested by the Intergovernmental Panel on Climate Change (IPCC), accelerated warming would need to resume immediately at rates in excess of 0.25oC/decade

on a sustained basis for the rest of this century. An analysis of historical warming rate durations reveals no such precedent within the long-term trend of 0.07oC/decade (1895-2015). Nevertheless, research by the climate modeling community suggests that the current El Nino will trigger a phase reversal of the Interdecadal Pacific Oscillation (IPO) with sustained release of sequestered heat energy from the Pacific Ocean, resulting in 0.22oC/decade warming for 2013-2022 and thereafter. In contrast, empirical model analyses indicate that temporarily elevated El Nino temperatures are a transient which will pass. The warming slowdown will then persist for nearly two more decades, followed by a cyclical phase reversal of the Atlantic Multidecadal Oscillation (AMO). The IPO is believed to be a 16-year precursor to the AMO in this scenario. The AMO change with lower climate sensitivity results in delayed accelerated warming, but towards temperatures at the low end of mid-century and end-century IPCC expectations. If so, the broad and higher IPCC temperature projections will no longer be justifiable. The next seven years therefore provide an opportunity to place two opposing forecast methods to a test. Because comparative evaluations can be conducted over such a short time horizon and resolve the adequacy of methods for long-range predictions, this will be a unique opportunity for the forecasting and climate communities to engage constructively on a matter of major policy relevance. This paper reviews the opposing near-term and long-term forecasts and proposes the basis upon which comparative testing can be performed.

Data-Based Mechanistic Modelling and Forecasting Global Climate Data
Peter C. Young, University of Lancaster

This paper considers an inductive, Data-Based Mechanistic (DBM) approach to modeling the dynamic relationship between globally averaged measures of total radiative forcing and atmospheric temperature. The model, which is identified statistically in the form of an ordinary differential equation (ODE) model in its equivalent, Stochastic Transfer Function (STF) form, is inferred from the data without any prior assumptions about the order or structure of the STF model. The initial analysis, while confirming previous studies of the relationship between radiative forcing and temperature, also indicates the presence of another possible `quasi-periodic' input. The initial statistical identification analysis shows that the information content in the radiative forcing and temperature data alone can only support a first order STF model between these variables. This is despite the fact that climate models relating these same variables, including the simpler 'emulation' models, are normally of very much higher order. However, the residual error series of this first order model, which is very similar to those of the higher order climate models, is identified by Dynamic Harmonic Regression (DHR) analysis as a stochastic, quasi-periodic signal with a central period of approximately 52 years. The complete stochastic model estimated in this form, including the DHR model for the quasi-cycle, is then used to produce rolling 10-year-ahead forecasts over the historical data, including a successful prediction of the 'levelling out' observed in the temperature series over the last ten years; a prediction that is considerably enhanced from the effects of the quasi-cycle component over this period of time. It seems likely that this additional quasi-periodic component could be caused by the influence of other inputs or 'tele-connections' affecting the global climate system. In this regard, analysis shows that component has a fairly strong correlation with the Atlantic Multi-decadal Oscillation (AMO) index. Incorporation of AMO as an additional input effect then leads to a two input model that explains 92.5% of the changes in the Global temperature and produces comparable forecasts to those obtained by the initial, single input-DHR analysis. This model is in the convenient STF form that can be used for both forecasting and emission control studies, as well as providing a basis for additional modeling research aimed at explaining further the nature of the quasi-cycle, or other similar cycles, and their effect on changes in global temperature.

Prediction, Projection, and Probability: Quantifying Uncertain Scientific Insights Regarding the Far Future
Leonard Smith, LSE

Physical simulations models are often employed to gain useful insight, and at times quantitative prediction, of the world. Weather forecasts are perhaps the highest profile example, long the domain of statistically based forecasting, since the 1960's simulations modelling have provided superior, steadily improving predictive information. It is not clear, however, even in this paradigm example that actionable probabilities are produced, where an "actionable probability" can be rationally interpreted as "probability" in a risk management sense. The extension of the mechanisms of modern numerical weather prediction to the climate problem are discussed. While it is clear that physical simulation can teach us a great deal about the climate system, and equally clear that we hold a great deal of

longstanding understanding of the system without modern simulations, delimiting the boundaries between where quantitative interpretation of model simulations shift from high fidelity insights to biased but suggestive plausibility to systematically misleading and maladaptive misinformation, these boundaries are not well described. Given the central role simulation models plan in policy and planning, an outline in how these boundaries might be sketched is given, including proposals for necessary if not sufficient conditions for rationally interpreting simulation information quantitatively.

10:15 - 11:35 Density forecasting (Bringas)
Chair: Gloria Gonzalez-Rivera, University of California

Medium-term Density Forecasting of Web Page Views using a Hybrid Componentized Models Framework
Cole Sodja, Microsoft

Forecasts up to 1 year ahead of hourly views on Microsoft's retail store is required to drive medium-term capacity planning decisions. Particular attention is given toward ensuring that hardware provisioned supports the annual peak load. Given the fact that peak views can take on extreme values, and furthermore, no information is available in advance to help predict the magnitude of the peak, it's necessary to provide probabilistic forecasts so that this uncertainty can be reflected appropriately when trading off high customer service levels with cost. This talk will describe a new framework built that decomposes a univariate time series into different components, builds separate models to forecast level, multiple seasonal patterns, and peak lift, and combines forecasts together with simulation of peak timing to produce sample paths. Specifically, innovations state space models and additive models are estimated and combined in a unique way to exploit the characteristics of the time series across different time grains, bootstrapped errors of forecasts are then computed across different peak periods, and quantile regression is used to generate calibrated forecasts. This solution was operationalized in Microsoft Azure Machine Learning, forecasts were produced and evaluated for peak traffic in 2015, and results showed significant improvements in forecast accuracy compared to other benchmark time series and regression models applied. Although capacity was already provisioned in 2015, had the high scenario forecasts under this framework been used an estimated 14% in cost savings would have been achieved while still satisfying peak traffic.

Density forecasts of US inflation with dynamic conditional skewness: a scale-asymmetric Bayesian DCS model
Blazej Mazur, Cracow University of Economics, Narodowy Bank Polski

The problem of asymmetries in the structure of inflationary and deflationary shocks is considered here. In order to address the issue, a univariate time-series model that allows for three sources of asymmetry is developed. Firstly, its conditional distribution is assumed to be flexible enough to allow for shape (in particular tail) asymmetry and/or skewness. The distribution used here is a generalized asymmetric t applied by Harvey and Lange (2015), having the skew-normal, skew-t, skew-GED and the generalized asymmetric t of Zhu and Galbraith (2010) among its special cases. Secondly, the distribution is reparametrized in terms of two scale factors (corresponding to the left and the right part of the distribution) replacing the usual parametrization in terms of the conditional skewness and the (overall) conditional scale. Dynamic behavior of the conditional location, L-scale and R-scale parameters is assumed to follow the idea of Dynamic Conditional Score of Harvey (2013). Thirdly, the dynamic updating DCS scheme allows for different reactions to positive and negative shocks. The resulting model accounts for non-homogeneity of inflationary/deflationary impulses in terms of tail behavior and dynamic properties of the two scale coefficients therefore reflecting potential asymmetries in the balance of inflationary/deflationary risks. The specification is applied to the series of US PCE inflation used by Stock and Watson (2015). It turns out that only the R-scale coefficient displays noticeable persistence, therefore the usual pattern of conditional volatility reported for the US inflation is mostly due to the persistence in the scale of inflationary impulses. On the contrary, the conditional L-scale parameter seems to be rather constant over time, with a couple of one-time (deflationary) shocks having no permanent influence. Moreover, the left part of the conditional distribution has heavier tails, whereas the right part seems to be conditionally Gaussian. The model is estimated within the Bayesian approach. The density forecasting performance of the model is compared to a number of alternative symmetric specifications. Moreover, the model used here separates the influence of inflationary and disinflationary impulses which implies that the probability of inflation (or disinflation) is not directly

affected by disinflationary (inflationary) shocks. Therefore, the differences in predicted probability of deflation/inflation are also examined.

Forecasting densities of returns, volatilities, correlations and VaR in cDCC models using bootstrap procedures in the presence of outliers.
Carlos César Trucíos Maza, University of Campinas; Luiz K. Hotta, University of Campinas; Esther Ruiz, University Carlos III de Madrid

Forecasting densities of returns, volatilities and correlations are a key issue in finance; for example, in option pricing, portfolio choice and risk measures. On the other hand it is a stylized fact the presence of outliers in return finance series. These extreme observations may badly affect the estimate of the parameters, volatilities and correlations and, consequently, their forecast h-step-ahead prediction. In this work, we deal with forecast densities in presence of outliers in multivariate GARCH models (MGARCH), specifically in the corrected dynamic conditional correlation (cDCC). One way to construct forecast densities, which take into account the parameters estimation uncertainty without assuming any particular error distribution is through bootstrap procedures. We analyze the effect of outliers on the construction of forecast densities for returns, volatilities, correlations and also for the Value-at-Risk (VaR). Finally, we propose a robust bootstrap procedure that shows good finite sample properties, both for contaminated and uncontaminated time series returns.

A Bootstrap Approach for Generalized Autocontour Testing
Joao Henrique Gonçalves Mazzeu, Universidad Carlos III de Madrid; Gloria González-Rivera, University of California; Esther Ruiz, Universidad Carlos III de Madrid; Helena Veiga, Universidad Carlos III de Madrid

We propose an extension of the Generalized Autocontour (G-ACR) tests (González-Rivera and Sun, 2015) for dynamic specification of a density model (in-sample tests) and for evaluation of predictive densities (out-of-sample tests). These tests are based on the probability integral transform (PIT) variates. To retrieve the PITs, we need to assume a conditional density for the variable of interest. Our contribution lies on computing the PITs from a bootstrapped conditional density so that no assumption on the functional form of the density is needed. The proposed bootstrap procedure generates predictive densities that incorporate parameter uncertainty and model uncertainty. In addition, the bootstrapped G-ACR tests enjoy standard asymptotic distributions. This approach will be particularly useful to evaluate multi-step predictive densities whose functional form is unknown or difficult to obtain even in cases where the conditional density of the model is known.

10:15 - 11:35 Forecasting methods in economics and finance (Infantes)
Chair: Fabio H. Nieto, Universidad Nacional de Colombia

Determining the number of factors after stationary univariate transformations
Francisco Corona, Universidad Carlos III de Madrid; Pilar Poncela, European Commission, Joint Research Centre; Esther Ruiz, Universidad Carlos III de Madrid

A very common practice when extracting factors from non-stationary multivariate time series is to differentiate each variable in the system. As a consequence, the ratio between variances and the dynamic dependence of the common and idiosyncratic differentiated components may change with respect to the original components. In this paper, we analyze the effects of these changes on the finite sample properties of some popular procedures to determine the number of factors. In particular, we consider the information criteria of Bai and Ng (2002), the edge distribution of Onatski (2010) and the ratios of eigenvalues proposed by Ahn and Horenstein (2013). The performance of these procedures when implemented to differentiated variables depends on both the ratios between variances and dependencies of the differentiated factor and idiosyncratic noises. Furthermore, we also analyze the role of the number of factors in the original non-stationary system as well as of its temporal and cross-sectional dimensions.

Choosing a dynamic common factor as a coincident index
Wilmer Martínez, Banco de La República de Colombia; **Fabio H. Nieto**, Universidad Nacional de Colombia; Pilar Poncela, European Commission, Joint Research Centre

A methodology to compute a coincident index is presented. The procedure is based on the common factors of a set of indicator variables and a device that is termed coincident profile. Applications in economics and finance are included.

Transforming quarterly into monthly time series. An application to Swiss business tendency survey data
Michael Graff, ETH Zurich, KOF Swiss Economic Institute; Klaus Abberger, ETH Zurich, KOF Swiss Economic Institute

This paper documents strategies and algorithms to deal with two related problems: mixed frequency and ragged edge, applied to Swiss business tendency survey, which are collected both monthly and quarterly. Univariate temporal disaggregation methods range from equal distribution to interpolations and non-parametric approaches. At the right margin, univariate methods either hold the last observation fixed or try to exploit the momentum of the series. Even if some of these approaches are technically sophisticated, the inherent shortcoming lies in the fact that missing observations are generated without resorting to any information except for the series itself. Notably, they are informationally inefficient when other data are disregarded that could supply valid information on the true movement of the process at points that are unobserved. With variables or sets of variables that are directly or partially correlated with the lower frequency series, this information can be exploited if one of the following conditions is met: (1) they are observed at a higher frequency; (2) they exhibit a stable lead or a lag to the series of interest. In either case, the information reflected by these series or set of series will be correlated with the missing data points. We resort to different multivariate imputation algorithms and apply them to generate monthly series out of quarterly series from the KOF BTS in the Swiss manufacturing sector and compare the results. With no monthly reference at hand, there is no yardstick for the identification of the most appropriate transformation. We therefore make sure that we do possess adequate reference series for the model selection stage. To this end, we apply our procedures to series that are monthly, from which we create artificial quarterly data by deleting the same two out of three data points from each quarter. This procedure essentially replicates the results if the surveys were quarterly rather than monthly in the first place. We resort to all 17 items in the monthly survey, generate imputed monthly series and run the statistical results. These will allow to decide which algorithm to apply to the genuinely quarterly series. For the various temporal disaggregation results, we run standard tests of forecasting accuracy by comparing the imputed monthly series to the original monthly series. Descriptive statistics allow to rank the algorithms; statistical tests reveal whether the different methods are significantly superior/inferior.

10:15 - 11:35 Forecasting Performance (Santo Mauro)
Chair: John Boylan, Lancaster University

A comparison of automatic outlier detection methods on forecast performance
Duncan Elliott, Office for National Statistics; Jennifer Davies, Office for National Statistics; Tariq Aziz, Office for National Statistics; Cathy Jones, Office for National Statistics; Atanaska Nikolova, Office for National Statistics

The Office for National Statistics (ONS) is the UK's independent producer of official statistics and National Statistical Institute. Forecasting is used within ONS including in early estimates of Gross Domestic Product (GDP) for components where timely survey data are not available, and as part of the seasonal adjustment process. Forecasts are predominantly produced using ARIMA models with the capability of including external regression variables and are produced using X-13ARIMA-SEATS. The software allows automatic model identification which determines the order of the ARIMA model and the inclusion of outliers and level shifts. The approach of automatic model identification is typically used where large numbers of time series need to be forecast. This paper provides and empirical evaluation of the automatic outlier identification procedures available in X-13ARIMA-SEATS compared to alternative methods from an indicator saturation approach and changepoint methods.

Learning a Global Forecasting Models from the Sparse Representations of Time Series Data
Ahmed Helmi, Arab Academy for Science and Technology; Mohamed Waleed Fakhr, Arab Academy for Science and Technology; Amir F. Atiya, Cairo University

In this work, we propose using the sparse coding techniques for learning models for the purpose of time series forecasting. Training data are extracted from the input time series as a set of time-lagged predictors along with their correspondent targets. These time-lagged predictors are sparsely decomposed and transformed into the sparse domain. The sparse vectors are then fed to a training method to learn a global regression model. This method tries to exploit the fact that a sparse representation of the predictor will represents the hidden patterns of the predictor in terms of its basis vectors, which are selected from the dictionary used in the decomposition. Results of the experiments show that different types of the dictionary affect the performance greatly, and so different types and schemes of the dictionaries are tested such as discrete cosine transform (DCT), Gabor basis, and data vectors from the series itself. Also different combinations of these types are used, where two or more dictionaries are combined together to act as one whole dictionary. Also, dictionary learning is considered, where different initial dictionaries are used and a compact dictionary is learned by dictionary learning algorithms, namely, the K-SVD and the stochastic online dictionary learning algorithms. Initial dictionaries using data vectors as well as DCT and Gabor basis are used. For the learning of the global model, different learning techniques such as support vector regression, neural networks and simple least squares are used. Experiments performed confirm the effectiveness of the proposed approach.

Unbelievable balance sheets: Developing an out-of-sample procedure for forecasting the negative net worth in banking
Mikhail Mamonov, Institute for Economic Forecasting

This paper proposes an empirical framework for estimating the scope of negative net worth on banks' balance sheets. Banks operate with hidden negative capital in case they have too aggressive lending strategies to create sufficient amount of loan loss provisions (LLP). To satisfy the official requirements on capital adequacy such banks artificially increase their capital, but eventually they face with license withdrawal. Using the latest bank-level data on Russian banks, we show that this story really happens and attracts growing concern from monetary authorities. First, collecting the data from various issues of the Bulletin of the Central Bank of Russia over the 2014-2016, we show that the revealed size of hidden negative capital in a sample of 106 credit institutions, whose licenses were withdrawn during this period, amounts to about RUB 1450 bln (2% of Russia's GDP in 2015). Second, following the literature on the cost of banking failure developed on the basis of US banking by James (1991), Schaeck (2008), Bennet and Unal (2014) and Cole and White (2015), we first estimate a set of simple OLS-models showing that some factors affecting the cost of failure in Russia are very similar to that in US (bank size, capital, LLP, excessive asset growth). Next, we introduce a set of new hypotheses regarding the reasons of negative net worth accumulation on balance sheets, namely the high turnover and the low turnover hypotheses, and empirically test them within the OLS-models. Third, based on the previous step, we incorporate the determinants of negative net worth into a Tobit model built on the sample of 106 failed banks and the subsample of those banks that a-priori have minor incentives to falsify their balance sheets (largest government-owned banks and foreign banks). Using this Tobit model, we produce the out-of-sample forecasts for the other part of Russian banking system. Our estimations have shown that about 250 of still operating credit institutions in Russia falsify their balance sheets so far and the estimated out-of-sample forecast of their cumulative negative capital amounts to RUB 900 bln. Importantly, if these banks leave the credit market, the non-financial firms and households will lose approximately RUB 4500 bln of credit resources. To deal with possible sample selection bias in Tobit model, we check the robustness of our results by estimating Heckman selection model. We suppose these results might be useful for monetary authorities and contribute to the literature on banking stability.

Reproduction of Forecasting methods in the M Competitions
John Boylan, Lancaster University; 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 used in the M1 and M3 competitions, including the process of seasonal decomposition. We reported some initial results at last year's conference and will present new results and insights in this paper. The purpose of the study is threefold. Firstly, we wish to document carefully any assumptions which need to be made and 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.

10:15 - 11:35 Forecasting, Uncertainty and Risk (Pedro Salinas 2)
Chair: Spyros Makridakis, Neapolis University Pafos

Project Risk Management the link to ERM: A way of changing Project Culture
Maria Papadaki, University of Manchester; Richard Kirkham, The University of Manchester; A. W. Gale
Halim Boussabaine, The University of Manchester; Spyros Makridakis, Neapolis University Pafos

Project risk management is an important element of project, programme and portfolio (PPP) management and it is directly linked with organisational strategy. Recent industry examples shown that the not effective manage of project risks can lead on loss of organisation reputation which direct impacts profitability e.g. Volkswagen. Organisations, nowadays, are strongly recommended the use of effective risk management for ensuring successful delivery of PPP and the wider corporate objectives. Even though the use of risk management has increased in recent years, it could be argued that it has still not reached maturity. In order to achieve maturity, organisation need to face a lot of challenges such as organisational risk culture or the use of risk data in the decisions making process. Risk management goes beyond PPP management and includes the whole enterprise. This paper is based on findings from a research project done with a large Aerospace organisation and explores the benefits of changing practitioners' attitude towards a more effective use of project risk management in relation to the Enterprise Risk Management, which will allow them to take better decisions.

Brazilian insurance premium forecasting
Juliana Christina Carvalho de Araújo, Pontifical Catholic University of Rio de Janeiro; Reinaldo Castro Souza, Pontifical Catholic University of Rio de Janeiro; Rodrigo Flora Calili, Pontifical Catholic University of Rio de Janeiro; Fabiano Torrini, SulAmérica

Brazilian insurance market has experienced strong performance despite economical crisis. The Brazilian market accounts for nearly half of Latin America's gross premium, and has huge growth potential. It is, therefore, important to understand the tendencies and the development of this market. In order to achieve this understanding, we propose forecasts for different Brazilian insurance series. Insurance premium forecasting is essential to insurers. It provides support to business strategies and provides guidelines for portfolio planning. Despite the importance to the market, insurance forecasting literature is very limited. Bibliographical researches indicate lack of studies on insurance premium forecasting. When undertaking researches with words "insurance", "forecast", "premium" , "models", "risk", "insurance demand", most of the articles found are not within the desired scope. There are only few articles that address specifically insurance forecasting. Moreover, as a result of the limited literature, we do not have reference of which modeling approach provides the best forecasts for different insurance series. In order to overcome these issues, this work attempt to close the literature gap. We do so by proposing reference models for different Brazilian insurance premium series. We apply a methodology that comprehends: (i) descriptive analysis of the different time series, (ii) model building with four different model approaches (Box and Jenkins, Exponential Smoothing, Fuzzy Logic, and Naïve), (iii) model selection, and (iv) forecasting. We focus on three business lines: life, automotive and health. Together, they account for approximately 84% of the total premium revenues in Brazil. We use the database from Brazilian Private Insurance Superintendence (SUSEP). The accuracy measure chosen for comparison and evaluation of models was the Mean Absolute Percentage Error (MAPE). The work contributes to the literature, and provides analyses on the Brazilian Insurance Market.

Medical Uncertainty and Risks
Spyros Makridakis, Neapolis University Pafos

Unpredictability and uncertainty reigns over most of medicine. Should women be screened for mammography and men for prostate cancer? The answer is not obvious as a growing number of researchers and doctors assert that the harm of preventive measures is greater than the benefits. Can patients trust the diagnoses of their doctors? Awkwardly, research has shown that the chance of a correct diagnosis of difficult cases to be as low as 5.8% and worse that the doctors involved were 64% certain that they were right. Further, a new study estimates as many as 400,000 deaths a year in the USA caused by medical errors. In addition, assuming a correct diagnosis the wrong treatment can be applied, an inappropriate dosage of the prescribed medicine can be given, while patients may not consume the recommended dosages correctly. Moreover, there can be harmful side effects from medication, “never events” and infections by superbugs while in hospitals. These occurrences increase the chance that something can go wrong, enlarging uncertainty and decreasing the predictability that a cure will be successful. In medicine as in other fields, forecasts are needed to improve our decisions regarding future events and medical decisions are not exceptions. In the great majority of cases, the higher their accuracy and the lower their uncertainty the greater their value and the higher our confidence that our decisions will be correct. As most medical decisions require predictions about future, uncertain events, it is of interest to know their accuracy and correctly appreciate their level of uncertainty, or their reliability. This paper is organized in two parts. It uses a forecasting perspective and considers how accurately we can predict first the consequences of preventive and second those of curative medicine while also discussing the uncertainty involved when making such predictions. There is also a concluding section summarizing the findings and proposing some actions to improve the accuracy and reduce the uncertainty in medical decisions.

10:15 - 11:35 Seasonal Adjustment 2 (Pedro Salinas 1)
Chair: Dominique Ladiray, INSEE

Residual Seasonality in Economic Indicators
Keith Phillips, Federal Reserve Bank of Dallas; Jack Wang, Federal Reserve Bank of Dallas

Rudebush, Wilson and Pyle (2015) find the presence of residual seasonality in key U.S. macroeconomic measures of output and inflation. A common element is that the indicators are not seasonally adjusted directly but are constructed by adding up the seasonally adjusted component series. When they directly seasonally adjust official seasonally adjusted RGDP they find that an average upward adjustment of first quarter growth in the past several years of about 1.5 percentage points. The presence of residual seasonality can significantly distort current analysis of national and regional economies. In the U.S., the very weak estimates of first quarter RGDP growth in both 2014 and 2015 caused analysts at the time to hesitate on their forecasts for the year. Previous research such as Hood and Findley (2001) and Maravall (2006) have found both advantages and disadvantages of using the indirect seasonal adjustment method. In this paper we discuss some of the reasons that residual seasonality can occur and test for its presence across a host of international and regional data that are calculated by the indirect method of seasonal adjustment. We also discuss some potential issues that might arise when applying a direct seasonally adjustment to a series that was indirectly seasonally adjusted but still had residual seasonality.

The Direct versus Indirect Problem in Seasonal Adjustment
Dominique Ladiray, INSEE; GianLuigi Mazzi, Eurostat

Most of principal economic indicators are aggregates: a National Industrial Production Index (IPI) is for example computed from the NACE sub-sector indexes; the European IPI is constructed as a weighted sum of the Member states IPIs etc. In this case, the problem is to decide how the seasonally adjusted series can be computed: Should we adjust the aggregate (direct approach) or should we aggregate the adjusted series (indirect approach)? The choice between the 2 approaches is still an open question and few scientific paper exist on the subject. In practice, the choice is based on publication constraints, rule of thumb or "basic common sense" and scarcely on statistical considerations. The problem has in fact many faces and variants that make it quite complex: additive and non-additive aggregation, mixed strategies, mixed adjustment methods etc. Some descriptive statistics have already been proposed to choose between the two strategies and in this presentation we use multivariate

techniques, like principal component analysis, factor analysis and cluster analysis, to help the user making a sound choice.

Approach for Quality Assurance of Seasonal Adjustment for a Large System of Time Series
Steve Matthews, Statistics Canada; Susie Fortier, Statistics Canada

At Statistics Canada, many projects require ongoing seasonal adjustment of a large number of time series. The analysis required each period to validate the seasonal adjustment options used for each series is not manageable. Consequently, an approach has been developed for maintenance of the parameters, however these efforts have historically been focused on periodic reviews at predetermined time intervals (e.g. annual revisions). This presentation will outline a new initiative at Statistics Canada to impose more structure on the quality assurance and the maintenance of the seasonal adjustment parameters. A first step towards this goal was to outline the conditions that would be sufficient for unplanned modifications to the seasonal adjustment parameters which lead to a protocol for intervention in seasonal adjustment. Further, results of work to outline key diagnostics for quality assurance of the seasonal adjustment process will be summarized as well as the proposed approach to monitor these diagnostics on an ongoing basis. Finally, a dashboard tool developed to summarize the seasonally adjusted results for a specific series from an analytic point of view will be described.

10:15 - 11:35 The role of forecasts in policy (Paraninfo)
Chair: Jennifer Castle, Oxford University

Forecasting using a soft thresholding approach
Jennifer Castle, Oxford University; David Hendry, Oxford University

We propose a method for selecting models using a two-step procedure in which variables are selected using Autometrics, a tree-search algorithm that provides a hard threshold initially, and then a bias correction is applied to the estimated parameters of retained variables after model selection, downweighting marginally significant regressors, in the second soft-thresholding step. The benefits of using such an approach are demonstrated for both forecasting and policy. If there are structural breaks in included irrelevant variables, the bias correction dampens these effects, substantially improving both forecasts and the outcomes of policy intervention.

Evaluating Multi-Step System Forecasts with Relatively Few Forecast-Error Observations
David Hendry, University of Oxford; **Andrew Martinez**, University of Oxford

We develop a new approach for evaluating multi-step system forecasts when there are relatively few forecast-error observations. In doing so, we combine Clements and Hendry (1993) with Abadir et al. (2014) to allow for calculation of the general forecast-error second-moment (GFESM) when there are more variables times horizons than forecast-error observations. Simulations show that previous method deteriorates as observations decrease. The proposed approach compares well against alternative methods. We also show how to extend tests for differences in the GFESM proposed in Martinez (2016) to cases there are relatively few forecast-error observations. Simulations suggest that the test remains well sized. Finally we illustrate our results by evaluating forecasts of the US economy.

Extracting Implicit Forecasts from the FOMC's Minutes
Neil Ericsson, Federal Reserve Board

Stekler and Symington (2016) construct indexes that quantify the Federal Open Market Committee's views about the U.S. economy over 2006-2010, as expressed in the minutes of the FOMC's meetings. These indexes provide insights on the FOMC's deliberations, especially at the onset of the Great Recession. Ericsson (2016) complements Stekler and Symington's analysis by showing that these indexes reveal relatively minor bias in the FOMC's views when the indexes are reinterpreted as forecasts. Additionally, these indexes provide a proximate mechanism for inferring the Fed staff's Greenbook forecasts of the U.S. real GDP growth rate, years before the Greenbook's public release. The current paper evaluates Stekler and Symington's indexes against previously unreleased Greenbook forecasts, jointly analyzes the corresponding nowcasts and forecasts, and assesses the choice of forecast horizon. The current paper also develops an algorithm to mimic Stekler and Symington's

indexes, extends their indexes to pre-2006 and post-2010 FOMC meetings, and evaluates those indexes against Greenbook forecasts and growth outcomes.

Evaluating Forediction Failure
Jennifer Castle, Oxford University; **David Hendry**, Oxford University; Andrew Martinez, Oxford University

Economic-policy agencies make forecasts accompanied by `narratives', which we call foredictions, usually basing policy changes on the developments envisaged. Although forecast failure need not impugn a forecasting model, it almost inevitably entails forediction failure and policy invalidity. Most policy regime changes involve location shifts, and these can induce forediction failure unless the policy variable is super exogenous in the policy model. We consider an improved test for invariance to policy changes based on step-indicator saturation. Systematic forecast failure justified by `narratives' reveals such stories to be economic fiction, as does a lack of invariance.

10:15 - 11:35 Time series and econometrics (Comedor de Infantes)
Chair: Antonio Aznar, University of Zaragoza

Estimating Fiscal Policy Rules
Peter Claeys, Vrije Universiteit Brussel; Diederik Krumps, Vrije Universiteit Brussel

This paper develops a new procedure to test f0r the presence of the so-called “Omitted Variable Bias”. It is well known that if this bias is present then we cannot estimate consistently the parameter of interest and, so, a causal interpretation of the estimation of this parameter is not allowed. The test is based on the joint consideration of two regressions, the first one, only with the regressor of interest and the second one where the variable that might cause the omitted variable bias is added. Then, using the second model we test the null hypothesis that the parameter of interest equals the estimation of that parameter in the first model. We first assume a cross-section framework and, then we extent the results to a time series framework considering that the parameter of interest is the long-run effect of a given regressor on the dependent variable. In this dynamic setting we qre interested in both the inclusion of new regressors as well as how to determine the number of lagas. In the last part of the paper we apply the results previously obtained to two examples from the book “Introduction to Econometrics” of J. H. Stock and M. H. Watson.

Model parameter estimation with trace forecast likelihood
Ivan Svetunkov, Lancaster Centre for Forecasting; Nikolaos Kourentzes, Lancaster Centre for Forecasting

The conventional approach to forecasting models estimation implies the usage of likelihood function which is based on one-step-ahead forecast error. This approach is effective, but several empirical and theoretical studies showed that using multiple steps ahead forecast errors in the estimation leads to the decrease of bias and more robust estimators. Although it is intuitive that aligning the forecasting objective with the optimisation cost function is beneficial, no statistical rationale has been given for this estimation method. We propose a likelihood function that gives this rationale and explains what type of cost function should be used and why. We also prove that maximising trace forecast likelihood is equivalent to single-step-ahead optimisation with parameter shrinkage. Notably, our approach permits shrinkage of both autoregressive and moving average processes. Therefore, maximising the proposed likelihood both incorporates the forecasting objective in the estimation and overcomes estimation limitations due to sampling or model misspecification. We validate our theoretical findings by conducting experiments on real data and demonstrate the advantage of the proposed approach in comparison with the conventional objective functions.

Testing for multiple moving average unit roots in a general ARIMA model
José Luis Gallego, Universidad de Cantabria; **Cristina Mazas**, Parlamento de Cantabria

We propose a common parametric procedure to test for multiple moving average unit roots in a general ARIMA model. Our test statistics for noninvertibility are calculated from the exact residuals, and their corresponding critical values and p-values can be computed by numerical integration for each specific model. We conduct several Monte Carlo experiments to evaluate the empirical powers of the proposed

tests when the parameters of the model are unknown and must be estimated. These empirical powers are compared with those of other popular tests for overdifferencing. Finally, we study the usefulness of this kind of tests for unit roots on forecasting.

Testing for the presence of an "Omitted Variable Bias"
Antonio Aznar, University of Zaragoza

This paper develops a new procedure to test f0r the presence of the so-called “Omitted Variable Bias”. It is well known that if this bias is present then we cannot estimate consistently the parameter of interest and, so, a causal interpretation of the estimation of this parameter is not allowed. The test is based on the joint consideration of two regressions, the first one, only with the regressor of interest and the second one where the variable that might cause the omitted variable bias is added. Then, using the second model we test the null hypothesis that the parameter of interest equals the estimation of that parameter in the first model. We first assume a cross-section framework and, then we extent the results to a time series framework considering that the parameter of interest is the long-run effect of a given regressor on the dependent variable. In this dynamic setting we qre interested in both the inclusion of new regressors as well as how to determine the number of lagas. In the last part of the paper we apply the results previously obtained to two examples from the book “Introduction to Econometrics” of J. H. Stock and M. H. Watson.

12:00 - 13:00
Forecasting Pactitioner Track 9 (Rector Ernest Lluch)

Nikolaos Kourentzes, Senior Lecturer, Lancaster University and member, Lancaster Centre for Forecasting, UK

Forecasting Temporal Hierarchies
In forecasting we typically build our models and forecasts in the same frequency that our time series were collected (for example monthly or weekly). However, this is not always aligned with the decision making needs of organisations that may require even shorter term operational forecasts or longer term strategic forecasts at a quarterly or annual level. Furthermore, different planning needs and horizons should be aligned. Operational, tactical and strategic forecasts should be in agreement to avoid conflicting decision making. For example operational inventory decisions should be supported by mid-term production and procurement ones. Current forecast practice does not guarantee that, where independent predictions are produced at each level using various methods or human judgement. These may agree or not. A last point to consider in current forecasting practice is that from a modelling point of view, constructing forecasts using raw data at the original frequency that was collected may not be ideal from a statistical standpoint. Working at an aggregate or disaggregate level may help forecasting by revealing or filtering elements of the time series. Temporal hierarchies, a new development in time series modelling aims to address all the issues above. The principal idea is to model time series at multiple levels of temporal aggregation (for example: weekly, monthly, quarterly and annually) and combine the resulting predictions. There is a two-fold motivation for this. First, resulting forecasts are able to extract better the information captured in time series, as temporal aggregation allows attenuating or strengthening different components of the time series. Second, by modelling time series in this way we can ensure that short-term forecast (constructed at disaggregate levels, e.g. weekly) and long-term forecasts (constructed at aggregate levels, e.g. yearly) are aligned and can support decision making at all different levels. This provides a statistically sound way to achieve the so called `one-number’ forecast. This presentation will introduce temporal hierarchies, show how to build and use them and demonstrate their advantages with real case studies.

12:00 - 13:20 Big data, nowcasting and forecasting (Biblioteca)
Chair: Gian Luigi Mazzi, European Commission - Eurostat

A Nowcasting Model for Canada: Do U.S. Variables Matter?
Michele Modugno, Federal Reserve Board

We propose a dynamic factor model for nowcasting the growth rate of quarterly real Canadian gross domestic product. We show that the proposed model produces more accurate nowcasts than those produced by institutional forecasters, like the Bank of Canada, the Organization for Economic Co-operation and Development (OECD), and the survey collected by Bloomberg, which reflects the median forecast of market participants. We show that including U.S. data in a nowcasting model for Canada dramatically improves its predictive accuracy, mainly because of the absence of timely production data for Canada. Moreover, Statistics Canada produces a monthly real GDP measure along with the quarterly one, and we show how to modify the state space representation of our model to properly link the monthly GDP with its quarterly counterpart.

Lasso variable selection in predictive mixed-frequency model
Clément Marsilli, Banque de France

In short-term forecasting, it is essential to take into account all available information on the current state of the economic activity. Yet, the fact that various time series are sampled at different frequencies prevents an efficient use of available data. In this respect, the Mixed-Data Sampling (MIDAS) model has proved to outperform existing tools by combining data series of different frequencies. However, a major issue remain regarding the choice of explanatory variables. The paper addresses this point by developing MIDAS based dimension reduction techniques and by introducing a novel approach based on a method of penalized variable selection, the Lasso. This feature integrates a cross-validation procedure that allows auto- matic in-sample selection based on forecasting performances. Then the developed technique is assessed with regards to its forecasting power of US economic growth during the period 1990-2015 using an augmented version of the Stock and Watson database jointly involving daily, weekly, monthly, and quarterly data as the real-time economic data-flow. Our model succeeds in identifying leading indicators and constructing an objective variable selection with broad applicability.

Big data and nowcasting macroeconomic indicators
Gian Luigi Mazzi, European Commission – Eurostat; George Kapetanios, Kings College, University of London; Massimiliano Marcellino, Bocconi University

In the recent years, a lot of efforts have been made by statistical authorities and researchers to improve the timeliness of the key macroeconomic indicators, by means of flash estimates and nowcasting. Flash estimates and nowcasting constitute an essential part of a real-time monitoring system, which is considered one of the major priorities of statistical institutions. Traditional data sources and econometric techniques have been largely exploited to derive new and sophisticated nowcasting models with quite good results. Nevertheless, the data revolution which has characterised the recent years with the availability of very large amount of data, often unstructured and of very high frequency, constitute a new opportunity of constructing more advanced macroeconomic nowcasting. Big data also constitute a big challenge, both for official statisticians and econometricians because of their intrinsic nature and of their volume. This paper analyses the most relevant challenges in terms of identification of the most appropriate set of big data, the most appropriate modelling strategy in order to derive macroeconomic nowcasting, possibly to be updated on a weekly or even daily basis. An empirical application, based on Google Trends data, completes the paper.

12:00 - 13:20 Forecasting Applications (Infantes)
Chair: Neil Ericsson, Federal Reserve Board

Conditional forecasting with BVAR model for Russia: The role of oil prices, sanctions, and monetary policy
Anna Pestova, Center for Macroeconomic Analysis and Short-term Forecasting; Mikhail Mamonov, Center for Macroeconomic Analysis and Short-term Forecasting

In this paper we develop and provide an empirical test of Bayesian VAR model for Russian economy. Given the scarcity of literature on theoretically based forecasting models for Russia (DSGE) and generally lack of the consensus on DSGE modeling in emerging economies, data-driven VAR models provide viable and flexible alternative. While most of the literature is focused on unconditional forecasting with BVAR, showing that their forecasting accuracy is comparable to other nonstructural models, a limited attention has been paid to conditional forecasts. We fill this gap showing that Bayesian VAR framework is a useful tool for macroeconomic modeling and conditional forecasting in emerging market countries such as Russia. On the basis of Bayesian VAR forecasting model we estimate the impact of deteriorated external conditions (oil price drop and financial sanctions imposed by EU and US) as well as the effect of monetary policy tightening on the Russian economy in 2014-2015. In particular, we perform two counterfactual experiments with BVAR model for Russia: we estimate path of the key macroeconomic variables conditioning on realized external conditions of 2012-2013 ("quiet period") and 2014-2015 ("crisis period"). We show that the accuracy of conditional forecasts is higher than unconditional ones. In the "quiet period" BVAR model demonstrates a good approximation of the actual trajectories, while for the crisis period forecasting becomes complicated due to the monetary policy regime shift. We found that not only the fall in oil prices explains the depth of the current recession in the Russian economy, but the deleveraging on external corporate debt as a result of EU and US sanctions against Russian companies as well.

Forecasting and Foresight Oil Dependency Risk With Structured Analogies and Interaction Groups
Waleed Alghassab, Bangor University; Konstantinos Nikolopoulos, Bangor University

In this study we investigate the strategies of oil rich countries, presently focused on the oil sector. The case study of this paper will be about Saudi Arabia which heavily depends on the oil exports as the primary component of its GDP. This strategy is risky as the main consumers of this product are seeking cleaner forms of energy. To help Saudi decision-makers determine a vision for the future, we provide forecasts and scenarios per se. The study has four phases: Unaided Judgment, Structured Analogies, and Interaction Groups with Structured Analogies - all three on disguised data and finally work on the real case study over a significant amount of time. Adopting the judgmental methods attributed to three main reasons: attempting to derive forecasts and make decisions for the long term in order to change the current strategy, seeking comprehensive assessment of all the variables related to the Saudi case and reaching consensus in the insights to be considered a roadmap for resources rich countries.

Do Crude Oil Futures Reflect Asymmetric Market Preferences?
Julian Hoss, TU Darmstadt; Sebastian Ruths Sion, TU Darmstadt

Oil price fluctuations have been associated with U.S. and global business cycles. Since the first oil crises in the 1970s and 1980s, researchers have made great progress in understanding the mechanisms that drive and influence the interactions between oil prices and macroeconomic aggregates. In light of these developments, forward-looking macroeconomic models have focused on how to improve the quality of oil price forecasts. In this regard, researchers and policymakers have used oil futures as a measure of market expectations for the crude oil's spot price (see e.g. Baumeister and Kilian (2014)). However, spot price expectations and oil futures generally differ, as Hamilton and Wu (2014) note. They diverge by the time-varying risk premium, i.e. the traders' compensation for their exposure for unexpected future price risks. Consequently, Baumeister and Kilian (2015) conclude that in order to obtain accurate market expectations of the oil price, oil futures have to be adjusted by the risk premia. This increases their quality as oil price forecasts in terms of small mean squared errors. We propose an alternative way to represent these risk premia by treating futures as forecasts with an underlying loss function that is potentially asymmetric. Thus, high risk premia should be reflected by a loss function that indicates an aversion to overestimating the oil price (i.e. future prices exceeding the actual oil price). To quantify the asymmetry, we use the approach proposed by Elliott, Komunjer and

Timmermann (2005, 2008) that permits evaluating a series of forecast errors by estimating the degree of asymmetry from a family of loss functions and simultaneously testing for the forecasts' rationality. See e.g. Krüger and Hoss (2012) for an application to German business cycle forecasts. The approach presented in this paper is applied to the monthly WTI oil price between 1990:01 and 2015:12 and the corresponding futures traded at the New York Mercantile Exchange with a maturity between one and six months. First results obtained indicate that: (1) the futures can be interpreted as forecasts with an underlying asymmetric loss function, (2) the direction of asymmetry indicates the expected preference for underestimating the oil price, (3) the degree of asymmetry increases for larger maturities, (4) forecast rationality with respect to weak efficiency and lagged observations of the target variable can predominantly be rejected under symmetric loss, (5) allowing for asymmetry considerably reduces the number of rejections.

Detecting, Quantifying, and Forecasting Climate Change in Mauritanian Rainfall
Neil Ericsson, Federal Reserve Board
This paper analyzes time series on precipitation over 1919—1997 in Mauritania, a country within the Sahel region of Africa. Average precipitation shows a marked decline during this period, as indicated by estimated probability density functions of the rainfall data and by tests for structural change in the behavior of rainfall. These tests detect a decline in mean rainfall of approximately one third, beginning around 1970, thus providing statistical evidence on climate change. This finding is reinforced by an analysis of the Palmer Drought Severity Index for Mauritania. Because water is a scarce resource in Mauritania, this decline in precipitation–with adverse consequences on food production–could provide a basis for financial assistance from international organizations.

12:00 - 13:20 Forecasting in tourism and sports (Bringas)
Chair: Miriam Scaglione, Institute of Tourism University of Applied Sciences and Arts

Forecasting performance in tourism and varying demand elasticities
Egon Smeral, Modul University Vienna

This study highlights that accounting for the fact that tourism elasticities do not remain stable is crucial for forecasting situations subject to major economic fluctuations and changes in the macro-economic framework conditions. Therefore, approaches with constant elasticity assumptions might lead to substantial forecasting failures. In cases where the business cycle follows distinct upward or downward-directed trends, we have to take into account that different price and income effects are to be expected. The main reasons why income elasticity may vary across the business cycle include loss aversion, liquidity constraints, and precautionary saving. With the help of the time-varying parameter approach, it has been possible to be demonstrate that elasticities may vary due to gradual changes in consumer behavior and/or policy regime shifts. Income elasticities may also change in the medium term from growth period to growth period in line with the ongoing saturation process and the prevailing macro-economic framework conditions.

European tourism in times of economic stagnation
Ulrich Gunter, MODUL University Vienna; Egon Smeral, MODUL University Vienna

This study demonstrates that accounting for the fact that tourism income elasticities in the EU-15 have not remained stable since 2004 is crucial to forecasting situations. Estimations show that the income elasticities in the period from 2004 to 2014 were greater in slow growth periods (SGPs; above 1) than in fast growth periods (FGPs; below 1). Due to the gradual deterioration of the general economic situation since 2004, the small income improvements in the FGPs got used relatively more for satisfying the pent-up demand for necessary consumer goods or precautionary savings than for traveling abroad. In contrast to the periods before, travel budgets grew slower than incomes. The relatively high income elasticities in the SGPs were the result of negative adjustments due to the effects of the economic downturn. As a consequence, approaches relying on the constant elasticity assumption may lead to substantial forecasting errors.

PARX model for football matches prediction
Giovanni Angelini, University of Bologna; Luca De Angelis, University of Bologna

We propose an innovative approach to model and predict the outcome of football matches based on the Poisson Autoregression with eXogenous covariates (PARX) model recently proposed by Agosto, Cavaliere, Kristensen and Rahbek (2016). We show that this methodology is particularly suited to model the goals distribution of a football team and provides a good forecast performance. The main purpose of our paper is to develop an approach able to compute a set of probabilities associated with each possible result and use these probabilities to profit from the potential mispricing of the odds offered on the betting market. The odds proposed by the bookmakers often reflect the betting volumes rather than the true probability of the match outcomes. Indeed, the aim of the bookmakers is to encourage betters to subdivide their bets on each odd. In doing so, they minimise the risk and gain from the unfairness of the proposed odds. Therefore, the comparison between the true probabilities and the odds can be exploited to define a profitable betting strategy. The betting strategy is based on the idea that the odds proposed by the market do not reflect the true probability of the match because they may incorporate also the betting volumes. The out-of-sample performance of the PARX model is evaluated in a simple betting strategy which is applied to the English football Premier League data for the 2013/2014 and 2014/2015 seasons. The results show that the return from the betting strategy is larger than 35% in all the cases considered and may even exceed 100% if we consider an alternative strategy based on a predetermined threshold which allows to exploit the inefficiency of the betting market.

"Real time" tourism flows monitoring with mobile data for enriching flash indicators models
Miriam Scaglione, Institute of Tourism, University of Applied Sciences Western Switzerland; Pascal Favre, Institute of Tourism, University of Applied Sciences Western Switzerland; Jean-Philippe Trabichet, Institute of Business Computer Science, University of Applied Sciences Western Switzerland

Destination marketing and management has, since its inception in the early 1970s, been a major challenge for actors and organizations in the private and public sectors in tourist destinations. Lack of specific knowledge of what and when visitors do in a place and where they continue their trip is – among others – one of the major issues for the actors. Furthermore, they usually need to wait at least a month to have a concrete idea of the tourist frequentation in the area. By using mobile data from Swisscom which is the leader national provider, we built some routines to monitor on a weekly basis the touristic flows inside a destination. The goal is not only to know how many people stayed in a specific location but also the attractions visited before. From the forecasting point of view, the aim is to include this pseudo real-time data as a new explanatory variable in the estimation of our flash indicators models. Is it possible to build bridge equations from daily to monthly data in order to fulfill the later objective?

12:00 - 13:20 Forecasting Methods and Applications 2 (Santo Mauro)
Chair: Leonard Smith, London School of Economics, University of Oxford

Initialising neural network weights for time series prediction - an empirical evaluation of different methodologies
Sven Crone, Lancaster Cenre for Forecasting; Tobias Kempcke, iqast

Artificial neural networks require multiple initialisations of their starting weights for training, as the learning algorithms used for nonlinear parameter optimisation regularly converge into local minima. As the identification of suitable network weights is of preeminent importance in learning the classification or regression task at hand from a given dataset, a number of methodologies have been proposed to aid the learning process in setting initial starting weights. However, little attention has been given how many times a neural network needs to be initialised until a suitable local minimum for a given learning task is found (see, e.g., Crone, 2005), or which algorithm of estimating initial weights to apply for time series forecasting. In addition to the standard procedure, using starting values drawn at random from a uniform distribution constrained to a narrow interval around zero, e.g. [-1; 1], [-0.5; 0.5] or even smaller intervals as suggested by Sarle (2002), a number of alternative initialisation methodologies have been proposed by Nguyen and Widrow (1990), which is also the standard algorithm for weight initialisation in the Mathlab-Toolbox for Neural Networks, Drago and Ridella (1992), Wessels and Barnard (1992), Yam and Chow (2000) and LeCun et al. (1998), which promise

enhanced learning accuracy, efficiency and / or robustness. Although the discussion has recently received increasing attention due to the need to initialise a large number of weight-layers for architectures of deep neural networks and convolutional neural networks used in image recognition, much less attention to these methodologies has been given in their application for classification and regression tasks, nor the more widely used multilayer perceptron and extreme learning machine architectures. A review of the forecasting literature further indicates that none of these methodologies have been assessed on tasks of time series prediction and forecasting. This paper seeks to remedy this omission and assess the effect of different initialisation techniques in an empirical evaluation on real-world time series data, using a representative experimental design of fixed-horizon forecasts across multiple rolling time-origins, and using robust error metrics. The results suggest that the selection of an adequate initialisation methodology has a significant impact on forecast accuracy, robustness and efficiency, which is larger than that of other meta-parameters in neural network modelling.

Forecasting Dengue in Urban India
Siuli Mukhopadhyay, Indian Institute of Technology Bombay

Dengue is one of the most severe health problems faced by urban India even today. It is caused by four distinct dengue virus serotypes (DENV 1-4) transmitted primarily by the female Aedes aegypti mosquito, with Aedes albopictus as a secondary vector. Till date no vaccine or specific medical treatment is yet available for dengue, integrated vector control and surveillance are still the only strategies for disease prevention and control in endemic regions. Identifying the causative factors such as age, sex, social factors, climatic conditions etc. affecting the transmission of the disease is very important for epidemiological research on dengue and its eradication. In this work, the aim is to develop an early warning system for dengue in urban India (starting with Mumbai), which will aid the public health department to predict, prevent, and respond to future disease outbreaks. The main focus will be on successful forecasting of dengue cases in future years by incorporating environmental and epidemiological surveillance data, and other social ecological data in a dynamical model. The fitted model will forecast the disease risks for the future years and also generate seasonal risk maps for dengue. For fitting the model and predicting the number of disease cases, weekly data on number of dengue cases for the last seven years from various regions in Mumbai (one of the metro cities in India) have been collected. Preliminary analyses involving tests for non-stationarity, removal of seasonality will be done prior to model fitting. The response variable (disease counts) is count data in nature and there is a chance of presence of overdispersion. Thus the dynamical model fitted will be non-gaussian and possibly nonlinear in nature. Approximate Kalman filter techniques via mode estimation will be used by taking into account all complexities in the data and fitting a model to the disease data using climatic factors, social factors and epidemiological factors as the covariates.

Semiparametric Modelling of Quantiles and Expected Shortfall in a Variety of Applications
James Taylor, University of Oxford

In various applications, there is a need for predictions of both a conditional quantile and the corresponding expected shortfall (ES), which is the expectation of the exceedances beyond the quantile. In financial risk management, ES is receiving increased attention as a measure of market risk, due to the limitations of value at risk (VaR). In previous work, we focused on this application, and showed how VaR and ES can be jointly modelled using quasi-maximum likelihood based on an asymmetric Laplace (AL) density. Although this estimation framework uses an AL density, it does not rely on an assumption for the shape of the returns distribution. For forecast evaluation, we proposed the AL log-likelihood, and showed that it is strictly consistent for the joint evaluation of VaR and ES. In the current paper, we adapt these ideas for other applications. We consider wind power production in a deregulated electricity market, where the optimal bid is a quantile, and the resulting expected profit can be calculated from the corresponding ES. We also consider the classic newsvendor problem, for which the optimal order quantity is a quantile, and the expected profit is a simple function of ES.

Sculpted Ensembles: Exploiting A Modern Data Assimilation Technique to Enhance Early Warning of High Impact Events
Leonard Smith, LSE

Modern forecasting systems often employ ensemble approaches to aid in the quantification of the forecast sensitivity of simulation models to slight changes in initial conditions or in parameters. Traditionally, data assimilation has been deployed to determine (ensembles of) initial conditions for a forecast model given observations of the system. Modern data assimilation techniques, however, are sufficiently flexible that they can be applied to points in the future as well as those in the past. In this paper, pseudo-orbit data assimilation or PDA (see Du, H. and Smith, L.A. (2014) 'Pseudo-orbit data assimilation part II: assimilation with imperfect models', Journal of the Atmospheric Sciences, 71 (2), 483-495) is used to explore interesting potential futures, thereby clarifying the plausibility of high-impact events under a model's dynamics. This is achieved by sculpting a forward trajectory with the aim of allowing the model to produce events of interest (bigger storms, longer dry spells, …) and including additional ensemble members generated in this way. While it is not possible to assign probabilities to such trajectories, they provide insight in to developing conditions to look out for; note that is it not possible to assign probabilities to current ensemble members either. A second, related application useful for melding multiple models with different strengths, cross pollination in time, will also be noted.

12:00 - 13:20
Featured Speaker III (Paraninfo)
Chairperson: Spyros Makridakis, Neapolis University Pafos

Robert Fildes

Distinguished Professor of Management Science, Lancaster University, UK

Robert Fildes is Distinguished Professor of Management Science in the School of Management, Lancaster University and Director of the Lancaster Centre for Forecasting. He was co-founder in 1981 of the International Institute of Forecasters and in l985 of the International Journal of Forecasting. He has recently published on the validation of climate models. His current research interests are concerned with the comparative evaluation of different forecasting methods and the implementation of improved forecasting procedures and systems. His major concern is that despite all the research organisations still stay with old-fashioned systems and methods and do not validate their forecasts. The solution, he thinks, is better designed forecasting systems, better trained forecasters and even more optimistically, more discriminating consumers. In 2015 he was awarded the UK OR Society's Beale medal, its highest accolade.

Research in Practice
The forecasting journals, the symposia and the Institute were set up to "bridge the gap between theory and practice. The intention [was] to make forecasting useful and relevant to decision and policy makers who need forecasts." What is the evidence of success? This presentation overviews the limited research on organisational forecasting practices in the two main forecasting journals. Overall, researchers have paid little attention to issues of identifying limitations in current practice, as well as implementing improvements. It is too often assumed that a model or approach that research finds it performing well will automatically be adopted and found useful. But even now, 60 years after exponential smoothing was introduced, most of the developments we have seen are still not recognised by software developers and used in practice. This presentation will look at the question of what implementation focussed research needs to be done using examples of integrated approaches that attempt to 'bridge the gap'.

Guidelines for Speakers

At the ISF

- Arrive at the room at least 10 minutes before your session begins with your presentation on a USB drive.
- Introduce yourself to your session chair so they are aware of who you are. Then upload your presentation.
- Invited and contributed talks have been allocated a maximum of - **20 minutes** - including question/discussion time. Chairs have been instructed to be strict on time so parallel sessions are in sync. You will be given a 5-minute and a 1-minute warning and the chair will stop your presentation at the end of the allotted time, regardless of whether or not you are finished.
- Please stay for the entire session, for the courtesy and benefit of your audience.
- Speak clearly and loud enough to be heard at the back of the room. Be aware of the fact that the ISF is a truly international conference; often more than half of the audience has a first language other than English. If you belong to this group yourself, try to speak slowly and as clearly as possible.

Guidelines for Chairs

Before the session begins

- Be in the room at least 5 minutes before your session begins.
- Make sure that all presentations are uploaded and ready to go.
- Remind each presenter of their allocated time of **20 minutes** and the procedure you will use 5- and 1-minute warnings using flashcards (see below).
- Remind each presenter that if they want questions or discussion they need to finish before the 20 minutes.
- Insist that all speakers use the microphone if one is provided.
- Check speakers' names (pronunciation), titles, and affiliations.

During the session

- Start on time.
- Use flash cards for 5 minutes and 1 minute to remind speakers about their remaining time. Hold each speaker to his or her allotted time printed in the program. Timing and floor discussion are your responsibilities.
- Do not allow even one extra minute, because then you will deprive the next speakers of time that was promised to them and for which they have prepared their talks.
- If a presenter ends early or does not attend, use that extra time for questions and comments from the audience, the panel, or yourself. **DO NOT START** the next paper early because someone from another session may have planned to listen to selected talks in your session.
- Make sure the presenters do not block the screen.

International Institute of Forecasters

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:

- Develop and unify forecasting as a **multidisciplinary field of research** drawing on management, behavioral sciences, social sciences, engineering, and other fields.
- 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.
- Bring together decision makers, forecasters, and researchers from **all nations** to improve the quality and usefulness of forecasting.

Annual Conference

As the premier, international forecasting conference, the ISF provides the opportunity to interact with the world's leading forecasting researchers and practitioners. The ISF offers a variety of networking opportunities, through keynote speaker presentations, academic sessions, workshops, meals, and social programs.

IIF Membership Benefits

Annual membership to the International Institute of Forecasters offers the following benefits:

- ***International Journal of Forecasting (IJF)***
- **FORESIGHT*: The International Journal of Applied Forecasting***
- **International Symposium on Forecasting – discounted registration**
- ***The Oracle*, the IIF's quarterly online newsletter**
- **Listing as a consultant, job postings**
- **Access to on-going research**

The annual membership rates to the IIF are US$145 (one year) and US$265 (two years) for regular members and US$55 for students. If you would like to receive only one of our publications—The International Journal of Forecasting OR Foresight: The International Journal of Applied Forecasting—your annual membership rate will be US$125 and US$40, respectively.

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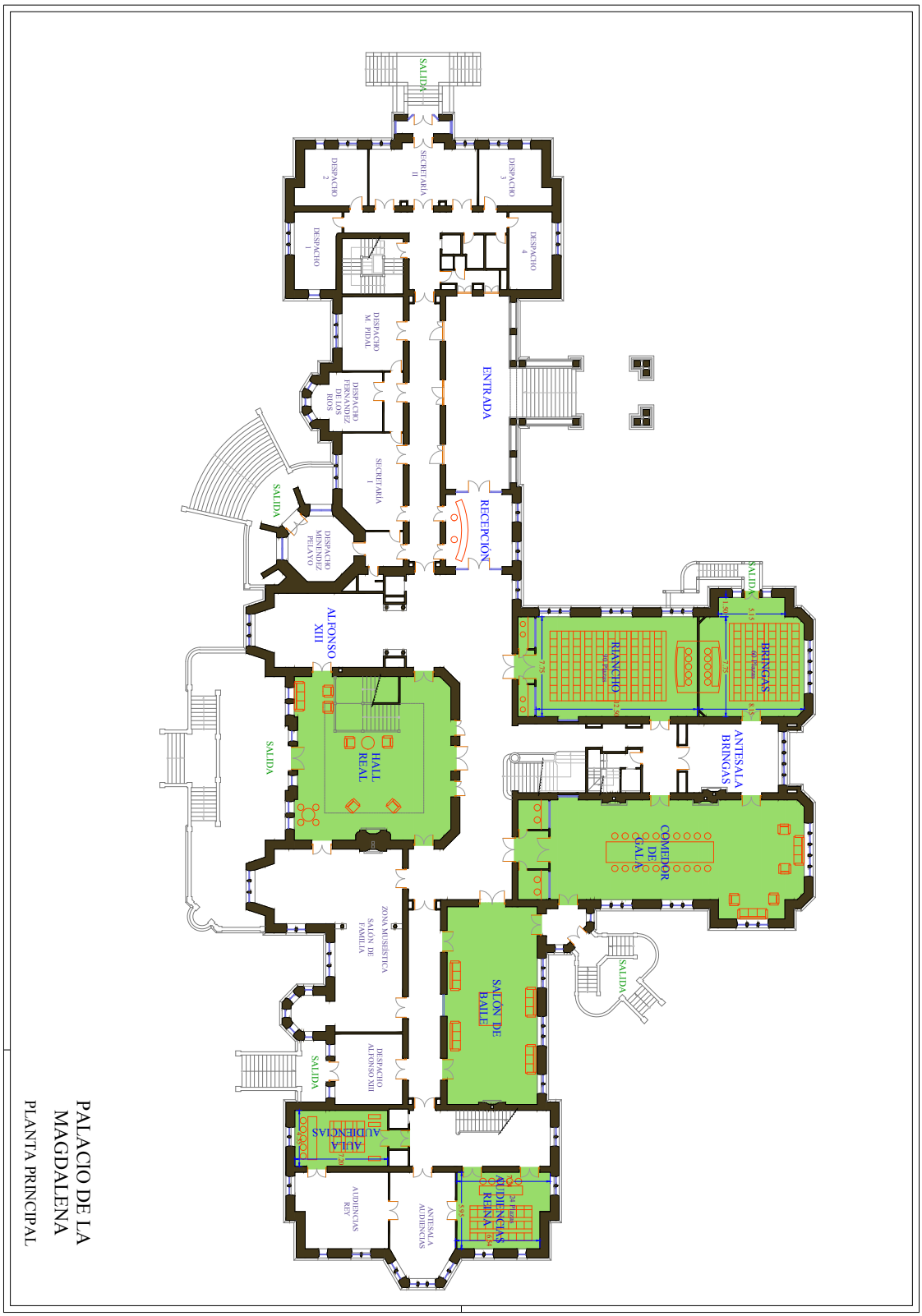

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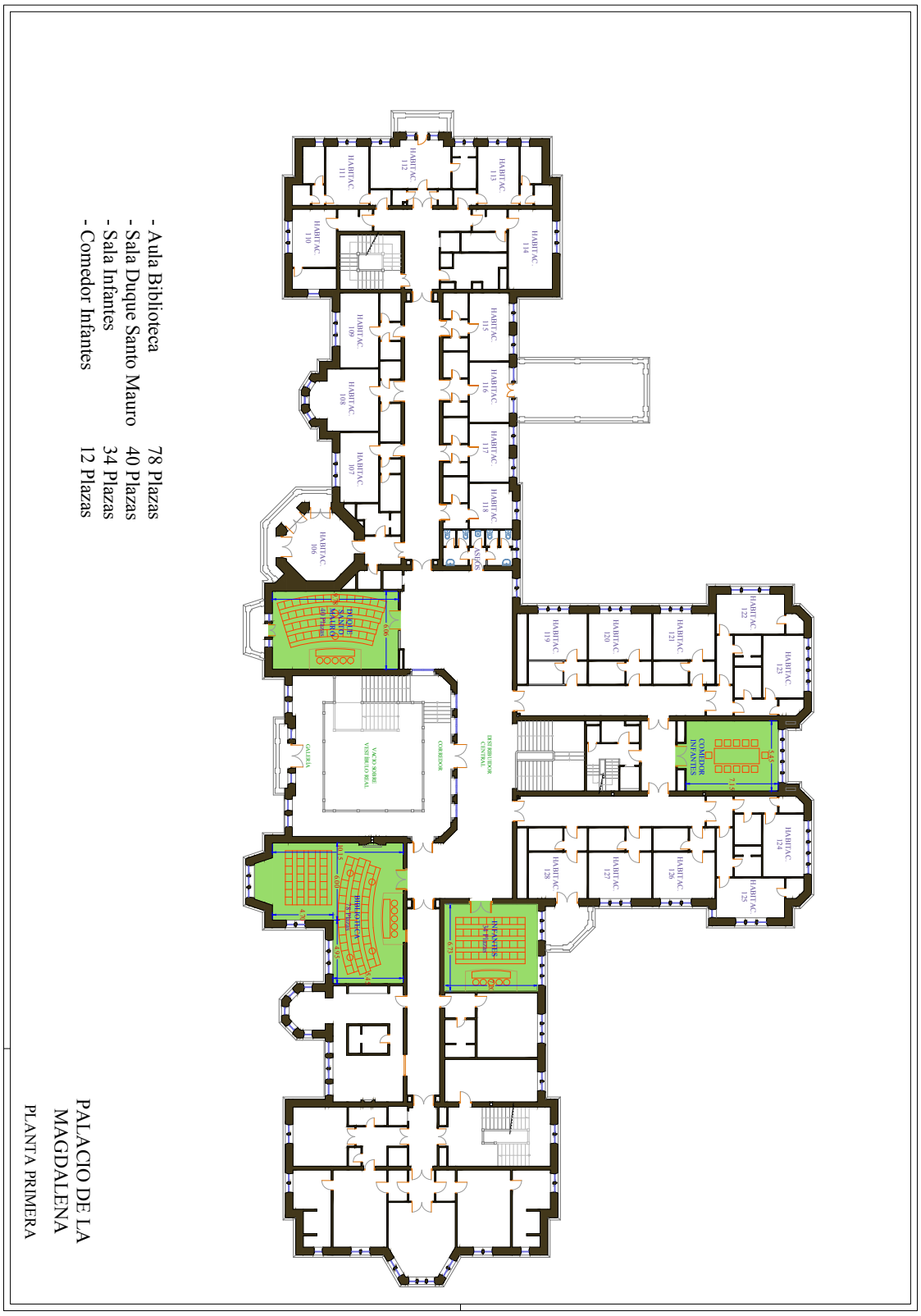

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