School of Economics, University of Surrey

September 7th - September 12th, 2020

The Science and Art of DSGE Modelling

Two Parallel Dynare- and Matlab-Based Courses

Four One-Day Stand-Alone Options

The Courses will be followed by a

One-Day Conference

CRISTIANO CANTORE

BANK OF ENGLAND AND U. SURREY

c.cantore@surrey.ac.uk

SZABOLCS DEAK

UNIVERSITY OF EXETER

s.deak@exeter.ac.uk

VASCO GABRIEL

UNIVERSITY OF SURREY

v.gabriel@surrey.ac.uk

ESTEBAN JAIMOVICH

UNIVERSITY OF SURREY

e.jaimovich@surrey.ac.uk

HYUNGSEOK JOO

UNIVERSITY OF SURREY

h.joo@surrey.ac.uk

PAUL LEVINE

UNIVERSITY OF SURREY

p.levine@surrey.ac.uk

MARYAM MIRFATAH

UNIVERSITY OF SURREY

maryam.mirfatah@surrey.ac.uk

AFRASIAB MIRZA

UNIVERSITY OF BIRMINGHAM

a.mirza@bham.ac.uk

RICARDO NUNES

UNIVERSITY OF SURREY

ricardo.nunes@surrey.ac.uk

RIGAS OIKONOMOU

U. CATHOLIQUE LOUVAIN AND U. SURREY

rigas.oikonomou@gmail.com

MARIO PASCOA

UNIVERSITY OF SURREY

m.pascoa@surrey.ac.uk

LUCIANO RISPOLI

UNIVERSITY OF SURREY

l.rispoli@surrey.ac.uk

KIRILL SHAKHNOV

UNIVERSITY OF SURREY

k.shakhnov@surrey.ac.uk

Contents

1   Introduction

The Centre for International Macroeconomic Studies (CIMS) in the School of Economics, University of Surrey will a hold a 5-day summer course, September 7th - September 11th 2020 followed by a one-day Conference.

The first four days will consist of two parallel courses: one will be a *foundations course* aimed at early researchers with some knowledge of Real Business Cycle (RBC) or Dynamic Stochastic General Equilibrium (DSGE) macroeconomic models, but little or no experience of Dynare. This course assumes a basic knowledge of Matlab and will begin with the basics of Dynare and proceed to the construction, in stages, of a closed economy NK DSGE model. It will then progress to the estimation of the model by Bayesian methods and finish by showing how the model can be used to study optimal monetary policy.

The *advanced course* is aimed at researchers who are already fluent in Dynare and DSGE modelling or who wish to learn directly more advanced techniques. This course will be useful both for advanced PhD students, academic researchers, and central bank researchers engaged in macroeconomic modelling work. The advanced course covers models that are either computationally expensive to simulate, nonlinear, require additional recursive assumptions, or have infinite dimensional state-spaces thanks to heterogeneous agents. The basic and advanced courses will run in parallel for four days from September 7th - September 10th.

Then on day five, 11th September, all participants from both streams will be able to choose one from *four one-day advanced courses* covering credit market imperfections, DSGE-VAR models and forecasting, financial frictions, financial markets and the 2008 crisis, robust qualitative methods for macro, tractable heterogenous agents models (TANK and HANK). All these courses are of interest to macro-economists. These are all stand-alone courses and participants will be able to register only for this day. Details are provided below. Notes and model codes will be distributed to participants.

Finally on Saturday 12th September we will hold a *one-day Conference*. All participants on the Courses are invited to submit a paper on some aspect of Macroeconomics or DSGE modelling to be presented in either the Conference or Poster sessions.

Profiles for the instructors and details of the Courses are as follows.

2   Instructors

Cristiano Cantore is a Senior Research Economist at the Bank of England and a Reader in the School of Economics at the University of Surrey. He graduated from the Bocconi University (Milan, Italy) in 2004. He then completed his MSc degree in Economics at Pompeu Fabra University (Barcelona, Spain). In 2010 he completed the PhD in Economics at University of Kent. Cristiano has also worked at the OECD and at the ECB as a trainee, visited the Bank of Spain in 2012 as a research fellow and the University of California at San Diego as visiting professor in 2014. Cristiano's research interests include monetary and fiscal policies, with particular focus on macro labour issues. He has published in these areas in the Journal of European Economic Association, the Journal of Economic Dynamics and Control, The Scandinavian Journal of Economics, Macroeconomic Dynamics and Economics Letters For further details of publications see http://www.cristianocantore.com/

Szabolcs Deak is a Lecturer at the University of Exeter since 2019. He was previously a full-time Research Fellow in the School of Economics at the University of Surrey. He joined the School in September 2013 to support the research activities of the ESRC funded project "Agent-Based and DSGE Macroeconomic Models: A Comparative Study". He received his Masters degree in Economics from the University of Szeged (Hungary) in 1999 and worked there as a full-time Lecturer from 1999 to 2005. He went on to study Economics at post-graduate level from 2006 at Bocconi University (Milan, Italy), receiving his PhD in 2011. He previously worked at the Monetary Policy Research Division of the European Central Bank (Frankfurt am Main, Germany) and held a Jean Monnet Postgraduate Fellowship at the European University Institute (Florence, Italy). For further details of publications see IDEAS-RePEc.

Vasco Gabriel is Director of Learning and Teaching and a former Head of the School of Economics at the University of Surrey. He graduated in Economics from the Technical University of Lisbon in 1995, where he was awarded the ICEP prize. He received a masters degree in Econometrics in 1998 from the same institution. In 2002, he completed his PhD in Economics at Birkbeck College, University of London. He taught at the University of Minho, Portugal, before being appointed as a Lecturer at the University of Surrey in 2004 and Senior Lecturer in 2010. Vasco's main field of specialization is Macroeconometrics, focusing on the application of non-linear methods, as well as general

inference issues in macro models. He has published extensively in these areas including publications in Economic Letters, the Journal of Macroeconomics, the Journal of Money, Credit and Banking and the Oxford Handbook of the Indian Economy. For further details of publications see IDEAS-RePEc.

Esteban Jaimovich is a Reader in the School of Economics at the University of Surrey. He completed his PhD in Economics at University College London in 2007. He was previously Assistant Professor in Economics at the Collegio Carlo Alberto in Turin, during 2007-2012, and next joined the University of Surrey as Senior Lecturer in Economics in 2012. Esteban's research mainly focuses on poverty persistence, lack of sustained long-run growth and international trade. He has published various articles covering those topics in the Journal of the European Economic Association, the Journal of International Economics, the Journal of Development Economics, the European Economic Review, and other journals. For further details of publications see IDEAS-RePEc.

Hyungseok Joo is a Lecturer in the School of Economics at the University of Surrey. He graduated from the Yonsei University (Seoul, South Korea) in 2004. He then completed masters degree in Economics at University of Wisconsin in 2007, then he worked as a research analyst in tax and public finance area in a research institution in Korea. In 2015, he completed his PhD in Economics at Boston University, USA. He taught at the Wayne State University, USA, before being appointed as a Lecturer at the University of Surrey in 2019. His research fields are macroeconomics, international macro/finance, fiscal policy, and money and banking. For further details of publications see https://sites.google.com/site/hsjoo214

Paul Levine is a Professor in the School of Economics at the University of Surrey. He received a first-class BSc and a PhD, both in Mathematics, from the University of Manchester and an MSc in economics (distinction) at Queen Mary, London. In 1984 he became a senior research officer at the Centre for Economic Forecasting, London Business School and was appointed Professor of Economics at the University of Leicester in 1989. In 1994 he moved to the University of Surrey. He has acted as a consultant and/or visiting researcher at the IMF, the ECB, the central banks of Peru and Nigeria, and the World Bank. His main research is on the use of empirically-based DSGE models for the study of macroeconomic policy. He has published over 100 refereed articles or chapters and two

books. For further details of publications see IDEAS-RePEc.

Maryam Mirfatah is a Postdoctoral Research Fellow in Economics at the School of Economics, University of Surrey. She joined the Centre for International Macroeconomic Studies (CIMS) in 2018 on the project of "Macroeconomic Modelling and Policy Analysis for Emerging Economies". Currently, she is working on optimized simple monetary policy rules for open economies. Her research interests are in Macroeconomics, in particular the construction and estimation of DSGE models for the purpose of macroeconomic policy analysis. Maryam obtained her BSc in Statistics from Isfahan University of Technology, MSc in Economics from Azad University and a PhD in Economics (2019) from Yazd University, focusing on Money Growth Rules in Emerging Economies.

Afrasiab Mirza is a Lecturer in Banking and Finance at the Department of Economics at the University of Birmingham. He holds a BSc in Physics from the University of Toronto (Toronto, Canada) and a PhD in Economics from Queen's University (Kingston, Canada) obtained in 2014. Afrasiab's PhD focused on applying dynamic contract theory to financial regulation. His primary research fields are financial economics, contract theory, general equilibrium, and computational economics. He is currently working on how to design robust optimal monetary and financial policies across DSGE models based on their relative forecasting performance. For further details of publications see https://www.birmingham.ac.uk/schools/business/departments/economics/staff/

Ricardo Nunes is a Professor in the School of Economics at the University of Surrey. He graduated from Universitat Pompeu Fabra (Barcelona, Spain) obtaining a MSc in Economics in 2003 and a PhD in Economics in 2007. After graduating he spent 10 years in the Federal Reserve System under various roles. In 2007 he joined the Board of Governors of the Federal Reserve System, where he worked as an economist and senior economist. In 2014 he moved to the Federal Reserve Bank of Boston working as a senior economist and policy advisor. He was also a visiting researcher at the Bank of Portugal and the IMF and has given talks at various central banks. His main research is on monetary and fiscal policy. He has published extensively in these areas including the Quarterly Journal of Economics, Journal of Monetary Economics, Journal of Economic Theory, Journal of European Economic Association, among others. For further details of publications see https://sites.google.com/view/ricardonunes/home

Rigas Oikonomou is professor of economics at the University of Louvain and faculty member at the University of Surrey. He completed his PhD at the London School of Economics in 2010. Prior to joining Louvain and Surrey he worked at the London Business School, the HEC Montreal and the Universitat Autonoma Barcelona. Rigas works on various topics in theoretical and applied Macroeconomics. His research has been published in journals such as the Review of Economic Studies, the Economic Journal and the Journal of Economic Dynamics and Control. For further details see:

https://sites.google.com/site/rigasoikonomou/research

Mario Pascoa got his Ph.D. from UCLA in 1986, was assistant professor at the University of Pennsylvania from 1986 to 1992 and was at Universidade Nova de Lisboa prior to coming to Surrey in 2012. Having worked on monopolistic competition, large games and demand theory, his research over the last twenty five years has focused on collateral, repo markets and security pricing, both in finite horizon models and in economies with infinite lived agents. His published work includes contributions to Ponzi schemes and collateral (Econometrica 2002), lack of impatience and bubbles (JET 2011), re-hypothecation in repo (JET 2012), endogenous discounting and bubbles (JET 2019) and recourse loans (ET 2019). Has supervised ten doctoral students, placed in the U.S. (at Wisconsin-Madison), in Spain (at ESCP), in Brazil (at several business schools and economics departments) and in Portugal (at Nova).

Luciano Rispoli received his undergraduate degree in Economics in 2009 from Bocconi University. During his undergraduate degree he spent 6 months as an exchange student at the Australian National University. He then obtained a MSc in International Economics and Finance with distinction from the University of Sheffield in 2011. He then pursued his doctoral studies at Birkbeck College - University of London where he also worked as a Teaching Assistant and sessional Associate Lecturer. In 2016 he joined the University of Warwick as a Teaching Fellow where he taught Monetary Economics (MSc) and undergraduate micro and macroeconomics. In 2019 he joined the School of Economics at Surrey University where he currently teaches Quantitative methods (BSc), Corporate finance (BSc) and Financial Econometrics (MSc). His research fields are macro-econometrics and monetary policy.

Kirill Shakhnov is a Lecturer in the School of Economics at the University of Surrey.

In 2015, he completed his Ph.D. in Economics at European University Institute, Italy. He then held the Foscolo Europe Fellowship position at the Einaudi Institute for Economics and Finance and taught at LUISS University, before being appointed as a Lecturer at the University of Surrey in 2019. Kirill's primary research interests lie in the fields of international macroeconomics with a focus on sovereign bond markets and cryptocurrencies. The research is organized around three related topics: asset pricing of internationally traded assets, public finance, and the sources of macroeconomic fluctuations. For further details, please see https://sites.google.com/site/kshakhnov.

3   Time-Table For all Courses

Registration will take place on day 1 at 9.00-9.30pm. Then for each day (for both Courses and Options) the time-table is as follows:

09.30 am - 11.00 am: Session 1

11.00 am - 11.30 am: Coffee and Tea

11.30 am - 01.00 pm: Session 2

01.00 pm - 02.15 pm: Lunch

02.15 pm - 03.45 pm: Session 3

03.45 pm - 04.15 pm: Coffee and Tea

04.15 pm - 05.45pm : Session 4

4   Foundations DSGE Macro-Modelling Course

This Course is aimed at those with some knowledge of RBC and NK models but little or no experience of setting them up in Dynare. The contents of lectures given by Gabriel, Levine, Mirfatah, Nunes, Rispoli, and Shakhnov over the four days are as follows:

- **Day 1: Dynare Basics and the RBC Model**

    - Instructors: Levine, Shakhnov

    - Introduction to the 4-Day Course

    - Dynare Basics

- RBC Model

- Calibration and Use of an External Steady State

- Linearisation

- Exercises in Lab (all day)

- **Day 2: The New Keynesian Model, Stability and Global Sensitivity Analysis**

    - Instructors: Levine, Nunes

    - The New Keynesian (NK) Model

    - Stability-Indeterminacy

    - Introduction to the Global Sensitivity Analysis toolbox in Dynare

    - Exercises in Lab (all day)

- **Day 3: Bayesian Estimation of the NK Model**

    - Instructors: Rispoli, Mirfatah

    - Preparing the Data including use of various filters

    - An Introduction to Bayesian Methodology

    - Identification and Pre-estimation Checks

    - Direct Linear Estimation of the Non-Linear NK Model

    - Exercises in Lab (all day)

- **Day 4: More on Estimation and Optimal Monetary Policy**

    - Instructors: Gabriel, Levine

    - Model Comparisons by Likelihood Races

    - Comparison of Second Moments of Model with Data

    - Optimal Monetary Policy for Linear-Quadratic Problems

        * The Ramsey Problem

        * Optimal Time-Consistent Policy

        * Optimized Simple Rules

– Concluding Remarks

– Exercises in Lab (all day)

5   Advanced Macro-Modelling Course

The advanced course is aimed at people who are already fluent in Dynare and Matlab, but are finding that their ambition currently exceeds what they are able to do with these tools. We aim to distribute some of the numerical and computational tricks we have picked up over the course of our careers to enable people to tackle non-standard models. This course will be useful to anyone who is engaged in practical macroeconomic modelling work, especially if they are interested in working with models that are either computationally expensive to simulate, nonlinear, or infinite dimensional thanks to heterogeneous agents. Contents of the course to be given by Deak, Joo, Nunes, Oikonomou, and Shakhnov are as follows:

- **Day 1: Applied Dynamic Programming and Global Solution Algorithms**

  - Instructors: Joo, Nunes

  - The basic theory of dynamic programming

  - Numerical Integration

  - Function Approximation

  - Value Function Iteration

  - Policy Function Iteration

  - Projection Methods

  - Exercises in Lab (all day)

- **Day 2: Classical Heterogeneous Agents Models and Occasionally Binding Constraints**

  - Instructors: Deak, Shakhnov

  - Introduction to Models with Heterogeneous Agents

  - Solving Heterogenous-Agent Models without Aggregate Uncertainty: the Model of Aiyagari

– Solving Heterogenous-Agent Models with Aggregate Uncertainty: the Krussell-Smith Algorithm

– Alternative Algorithms

– Exercises in Lab (all day)

- **Day 3: Central Bank Communication, Imperfect Credibility, and Optimal Monetary Policy Applications**

  – Instructors: Nunes, Park

  – Policy communication and central bank design

  – Price level targeting and alternative objectives

  – Credibility and imperfect commitment

  – Time-Inconsistency and Recursive Contracts

  – Zero lower bound, exit strategies, and normalization policy

  – Applications to medium and large scale models

  – Exercises in Lab (all day)

- **Day 4: Modern Topics on Heterogeneous Agents and Wealth Accumulation.**

  – Instructor: Oikonomou

  – Fiscal Policy with heterogeneous agents:

    * Public debt, capital and labour taxes.

    * Life cycle models.

    * Numerical Solutions.

    * Constrained efficiency with incomplete markets

    * Portfolio choice with illiquid assets and the effects of fiscal policy.

  – Heterogeneous agents in continuous time.

    * Theory and numerical implementation.

    * Simple economies with idiosyncratic income risks.

    * Heterogeneous Agents New Keynesian models.

    – Concluding Remarks

    – Exercises in Lab (all day)

6   Day 5: Four Options

Participants can choose one from the following four full-day options. All options are *stand-alone* and can be chosen by all participants from both the foundations and advanced courses. The instructors of the options are Cantore, Gabriel, Jaimovich, Jensen, Levine, Mirza, and Pascoa.

6.1   Credit Market Imperfections and Poverty Traps

- Instructors: Jaimovich

- Technological Non-convexities and Poverty Traps

- Occupational Choice Models under Imperfect Credit Markets

- Misallocation of Talent and Market Failures

- Group Lending and Microcredit

- Risk and Insurance Motives in Economic Growth and the Village Economy Paradigm

6.2   DSGE-VAR Models and Forecasting

- Instructors: Gabriel

- Finite VAR approximation to solutions of DSGE models

- DSGE-VAR estimation

- DSGE forecasts in a Bayesian framework

- Estimation and out-of-Sample Forecasting

- Exercises in Lab (all day)

6.3   Financial Frictions in DSGE Models

- Instructors: Levine, Mirza

- Modeling Approaches to Financial Frictions in DSGE Models

- Bayesian Estimation and Comparison of Models

- Conventional and Unconventional Monetary Policy

- Implications of Financial Frictions for Optimal Policy

- Exercises in Lab (all day)

6.4   Tractable Heterogeneous Agents Models (TANK/HANK)

- Instructors: Cantore

  The course is aimed at those who are familiar with representative-agent DSGE models, but no prior knowledge of heterogeneous-agents models is required.

- Summary of the key insights from the TANK/HANK literature

- TANK and THANK models as in Bilbiie (2019)

  - Inverted Aggregate Demand Logic

  - Cyclical Inequality and iMPCs

  - Forward Guidance

- Zero-Liquidity HANK

  - Analytical Solution

  - Comparison with RANK

  - Taylor-principle

  - Forward Guidance

  - Endogenous uncertainty

  - Quantitative Easing

  - Distributional Consequence of Monetary Policy

  - Exercises in Lab (all day)