The Science and Art of DSGE Modelling:
A Dynare-Based Course on Model Construction,
Calibration, Estimation and Policy Analysis

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1 Introduction

International Business School Suzhou (IBSS) at Xi’an Jiaotong-Liverpool University will hold a 4-day course, from 7-10 April, 2014 on the construction and estimation of Dynamic Stochastic General Equilibrium (DSGE) macroeconomic models, and their use for policy analysis. The material will cover the underlying theory of the New Keynesian (NK) workhorse model beginning with its flexible-price core, the Real Business Cycle (RBC) Model. It will also cover the theoretical basis for Bayesian Estimation. This is a hands-on course all based on available facilities in the software platform Dynare. Model software will be provided, consisting of models set-up in Dynare in a manner suitable for simulation, calibration, estimation and policy analysis.

Days 1 and 2 will concentrate on the theory, basic construction of DSGE models and the estimation of the linearized NK Model in a Dynare environment. It is designed for those without any experience of setting up DSGE models in Dynare. Days 3 and 4 will focus on intermediate and advanced topics including empirical implementations based on Bayesian methodology and optimal policy analysis. The fee for academics and PhD students is CNY6,000 for the four days. For participants from central banks, ministries or the private sector the fee is CNY12,000. Lunch, coffee, course notes and model software are included in this cost.

Taken over the four days the participants will be guided through a seamless methodology for the construction, estimation and policy analysis of micro-founded macroeconomic models proceeding from the RBC through to a NK model with financial frictions. The methodology can be summarized by the following steps:

1. The construction of a DSGE model describing the first-order conditions for economic agents in the form of a set of non-linear difference equations
2. The solution of the steady state to be used for both solution and calibration
3. Bayesian estimation methods
4. Model comparisons between different models or variants of same model
5. Model validation by comparison with second moments
6. Computational Methods: first order and second order solutions
7. Optimal policy analysis

We will show that the main features of NK-DSGE models consist of a ‘Real Business Cycle’ (RBC) core, with an outer shell that includes nominal rigidities and other frictions. We then discuss how to take these models to the data, focusing on empirical implementations based on Bayesian system estimation methods. Finally we demonstrate the latest facilities developed for optimal policy analysis. This is a hands-on course based for the most part on existing facilities in the software platform Dynare (see Adjemian et al. (2011) and other useful documentation available on their website www.dynare.org). The mornings will be devoted to lectures and in the afternoons students will attend a tutorial session in a computer laboratory.

2 Instructors

The instructors for the course are Professor Paul Levine, Professor Joseph Pearlman and Dr Bo Yang. All have considerable experience in both teaching and research in the area of DSGE modelling.

Professor Paul Levine 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. 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 where he now leads the Centre for International Macroeconomic Studies (CIMS) in the School of Economics. He has acted as a consultant and/or visiting researcher at the IMF, the ECB, the National Institute of Public Finance and Policy in New Delhi and the central banks of Nigeria and Pakistan. His main research activity is in constructing empirically-based DSGE models for the purpose of macroeconomic policy analysis. Other research interests are Growth Theory, Labour Migration, Defence Economics and Conflict, and the Economics of Regulation. He has published over 100 refereed articles or chapters and 2 books in these areas.

Professor Joseph Pearlman received his BA in Mathematics, from Cambridge University, and his PhD in Control Systems from Imperial College. He subsequently received his MSc in Economics from the LSE, and shortly after spent a year as a visiting research fellow at London Business School. In 1992 he became a Principal Lecturer in economics
London Guildhall University, and in 2002 was appointed Professor of economics. In 2011 he moved to Loughborough University to take up the post of Professor of Monetary Economics, where he is also Deputy Associate Dean of Research in the School of Business and Economics. He has also been a visiting researcher at the IMF and the ECB, and has presented revision classes in macroeconomics at the International College of Economics and Finance in Moscow. His main research activity is in policy analysis and estimation for empirically-based DSGE models. Other research interests are Growth Theory, Least Squares Learning and Macroprudential Regulation. Some of his most recent articles have been published in the Journal of Economic Theory, Journal of Monetary Economics, Economic Journal and European Economic Review.

Dr Bo Yang is a Lecturer at Xi'an Jiaotong-Liverpool University (XJTLU), Suzhou, China and a visiting lecturer in the School of Economics at the University of Surrey, UK. Before joining XJTLU in 2012 he was a Postdoctoral Research Fellow in the Department of Economics at London Metropolitan University and an Associate Lecturer at the University of Surrey. He graduated from the University of Hull in 2003 and completed his MSc degree in Financial Economics with a Distinction at Queen Mary, University of London. In 2005, he moved to the University of Surrey to undertake a PhD with a full research scholarship. His PhD was on the topic of dynamic stochastic general equilibrium (DSGE) modeling. Following the completion of his PhD degree in 2008, he was appointed as a research officer to support the research activities of the EU-funded project. His research fields mainly include macroeconometrics, monetary economics, Bayesian econometrics and computational economics, focusing on the applications and quantitative analysis of macroeconometric models. He has published in the Economic Journal, the Economics Letters, the Review of International Economics, the Oxford Handbook of the Indian Economy and Handbook of Research Methods and Application.

### 3 Course Outline

#### 3.1 Preliminary Reading and Basic Requirements

Preliminary material will be circulated to participants a few weeks before the Course. We expect students to read Gali (2008) chapters 1-3 before the course. As the course is
software based we expect students to be familiar with the basics of Matlab and Dynare. Documentation to familiarize with Matlab is available on the Mathworks website and summarized below. We do not expect students to be familiar with advanced programming techniques in Matlab but a basic knowledge of matrix and array operations, graphics and programming skills is required to understand the material of the course.

1. Getting Started with Matlab documentation.
   
   http://www.mathworks.co.uk/help/techdoc/learn_matlab/bqr_2pl.html

2. A short video presenting the basics of Matlab.
   
   http://www.mathworks.co.uk/videos/matlab/getting-started-with-matlab.html

3. A long presentation with more details about operations, presenting plots and programming. (Requires registration and login; It is not required go through everything that is presented here for the course).
   
   http://www.mathworks.co.uk/webex/recordings/NA_110719_introml/index.html


5. Dynare Quick Start.
   
   http://www.dynare.org/documentation-and-support/quick-start

6. Dynare Example codes.
   
   http://www.dynare.org/documentation-and-support/examples

### 3.2 Programme of Lectures and Lab Sessions

- **Day 1: Basics I**
  
  - Introduction
  - Dynare, Matlab Basics
  - RBC Model with Zero Growth Steady State
  - Dynare Set-up of RBC Model without Separate Steady State
  - Exercises in Lab.
• **Day 2: Basics II**

  – The New Keynesian (NK) Model
  – Linearization
  – Dynare Basics of Bayesian Estimation
    * Preparing the Data Including Use of Various Filters
    * An Introduction to Bayesian Methodology
    * Estimation of Linearized Models
  – Exercises in Lab.

• **Day 3: Intermediate Topics**

  – Model Comparisons: Likelihood Races, Comparison of Second Moments with Data
  – IRFs, Variance and Historical Decomposition
  – Calibration and Use of the External Steady State
  – Estimation of Non-linear NK Model
  – An NK Model with Financial Frictions
  – Exercises in Lab.

• **Day 4: Advanced Topics**

  – More on Bayesian Methodology
  – Computational Methods: First-order and Second-order Solutions
  – Stability-Indeterminacy
  – Optimal Monetary Policy
    * The Ramsey Problem
    * Optimal Time-Consistent Policy
    * Optimized Simple Rules
  – Exercises in Lab.
3.3 Reading

There are a number of excellent books on modern dynamic macroeconomics that provide background reading for the course. Dejong and Dave (2007) covers many of the empirical aspects of DSGE modelling. This should be supplemented with Del Negro et al. (2007) and Del Negro and Schorfheide (2004). To understand the models themselves a good recent text-book to start with is Wickens (2012). Then go on to Gali (2008).


At some stage researchers will need to dip into three seminal books: one on New Keynesian models, Woodford (2003) and the other two covering the empirical side, Geweke (2005) and Canova (2007); but they are all challenging reads!

3.4 General Software

The course is based on the following software:

1. Dynare and Matlab programs (to be handed out after the Course).
2. Matlab with the optimization toolbox
3. The latest Dynare (Currently 4.3.3)

Users would also find Winedt or Lyx useful as part of the output from Dynare is in the form of Latex files.

References


