**International Economics
Development Economics**

Academic year 2020-2021

Demystifying DSGE Models

EI074 - Autumn - 6 ECTS

Wednesday 10h15 - 12h00

Course Description

This course deals with understanding, interpreting and building, DSGE models, including their estimation. Students will be introduced to the Dynare programming language in which DSGE models will be built and analysed. Participants should have solid quantitative skills. A basic knowledge of MATLAB would be helpful but is not necessary.

> **PROFESSOR**

John D.A. Cuddy

Office hours

> **ASSISTANT**

Théodore Renault

Office hours

Syllabus

Course Content
This 6-ECTS credit course is designed to help you to understand and use the New-Keynesian DSGE models which are the mainstay of modern macroeconomics. It first covers the development, calibration and simulation of the micro-founded Real Business Cycle (RBC) model and its elaboration via the inclusion of price and wage frictions and other features used in today's DSGE models. The course then goes on to the (much more difficult) terrain of the estimation of the DSGE parameters, via first Maximum Likelihood, then Bayesian, then DSGE-VAR techniques. It concludes with a case study of the canonical Smets-Wouters model, which is the "workhorse" of today's macroeconomists.

Evaluation
This is a "hands-on" course with a steep learning curve. The emphasis is on working through the details of actually building and estimating DSGE models. Therefore, the primary method of evaluation will be through the solutions provided to problem sets, of which there will be six, the first due before the third class of the course, the remainder before class each subsequent week. There will also be a final examination. The problem sets will count for 75% of the course mark, the final examination for 25%. You may collaborate with colleagues on the problem sets, but each participant must hand in his/her own completed problem set with some personal commentary/features to distinguish it from others.

Lab Sessions
The primary tool for the simulation and estimation of DSGE models will be the software Dynare, which runs under Matlab or Octave. Dynare and Octave are free; Matlab is not. In order to get you up to speed with Dynare, lab sessions will be organised on a schedule to be agreed These will provide you with the opportunity to improve your understanding of DSGE models, and to gain skill in using them. -

Reading List
Below you will find a reading list for each section of the course, together with a (very) short explanation of why the paper is on the list. The list is in alphabetical order, not order of priority; those with an asterisk (*) are essential reading. There is no textbook for the course, although you are likely to find the book by Costa to be very helpful if you are entirely new to DSGE modelling.

I. Under the Hood – Nuts and Bolts of the RBC Model

Gürkaynak, R. S. and Cédric Tille (eds.) (2017), *DSGE Models in the Conduct of Policy: Use as intended*. CEPR Press, London
[A warning guide to unthinking use of DSGE models]

King, R. G. and S. Rebelo (2000), "Resuscitating Real Business Cycles", in *Handbook of Macroeconomics*, ed. by J. B. Taylor, and M. Woodford, vol. 1b, chap. 14, pp. 927–1007. North Holland, Amsterdam
[A masterful exposition of everything you always wanted to know about RBCs]

* Kydland, F. E., and E. C. Prescott (1982), "Time to Build and Aggregate Fluctuations," *Econometrica*, 50(6), 1345–70
[The "original" RBC, which won them the Nobel Prize]

Lucas, Robert (1976), "Econometric Policy Evaluation: A Critique", in Brunner, K. and A. Meltzer, *The Phillips Curve and Labor Markets*, Carnegie-Rochester Conference Series on Public Policy, 19–46. American Elsevier, New York
[The reason we do all this]

Uhlig, H. (1999), "A Toolkit for Analysing Nonlinear Dynamic Stochastic Models Easily," in *Computational Methods for the Study of Dynamic Economies*, ed. by R. Marimon, and A. Scott, pp. 30–61. Oxford University Press, London
[The classic basis for log-linearizing DSGE models]

II. Adding Bells and Whistles – The NK DSGE in All its Glory

Alvarez, L. *et al* (2006), "Sticky Prices in the Euro Area - A summary of new micro-evidence", *Journal of the European Economic Association*, 4(2-3), 575-584
[This paper, by European central bankers, summarises the vast evidence on micro price-setting for euro area countries]

Bils, M. and P. Klenow (2004), "Some evidence on the importance of sticky prices", *Journal of Political Economy*, 112(5), 947-985
[The classic empirical paper documenting price "stickiness"]

Calvo, Guillermo A. (1983), "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics*, 12 (3), 383–398
[The paper which invented the "Calvo devil" and allowed price rigidity into the DSGE world]

Costa, C. J. (2016): *Understanding DSGE Models*. Vernon Press, Malaga
[A wonderful book which guides you through the development of the NK DSGE in great detail; this section of the course is based on it]

Dixit, Avinash K. and Joseph E. Stiglitz (1977), "Monopolistic competition and optimum product diversity". *American Economic Review*, 67 (3), 297–308
[The source of the aggregator used in most NK DSGE models]

* Erceg, C. J., Henderson, D. W. and A. T. Levin (2000), "Optimal monetary policy with staggered wage and price contracts", *Journal of Monetary Economics*, 46(2), 281-313
[The source model upon which a very large number of NK DSGEs are based]

Fernández-Villaverde, J., and J. F. Rubio-Ramírez (2006), "A Baseline DSGE Model", Manuscript, available at https://www.sas.upenn.edu/~jesusfv/benchmark_DSGE.pdf
[A masterful exposition of everything you always wanted to know about the basic DSGE]

Fuhrer, Jeffrey, C. (2000), "Habit Formation in Consumption and Its Implications for Monetary-Policy Models", *American Economic Review*, 90 (3), 367-390
[The original source for the introduction of habit formation into the NK DSGE model]

Galí, J. (2015), *Monetary Policy, Inflation, and the Business Cycle* (2nd ed.). Princeton University Press, Princeton
[An elegantly written introduction to the NK DSGE and its applications to monetary policy]

Rotemberg, Julio J. (1982), "Sticky prices in the United States", *Journal of Political Economy* 90(6), 1187–1211
[The "other" classic on price stickiness]

III. <u>Bringing DSGE Models to the Data – Beyond Calibration and Simulation</u>

An, S., and F. Schorfheide (2007), "Bayesian Analysis of DSGE Models," *Econometric Reviews*, 26(2-4), 113–172
[The primary source for Bayesian estimation]

Blanchard, O. J., and C. M. Kahn (1980), "The Solution of Linear Difference Models under Rational Expectations," *Econometrica*, 48(5), 1305–1312
[The origin of the (in)famous "Blanchard-Kahn" conditions]

* Cho, Seonghoon and Antonio Moreno (2006), "A Small-Sample Study of the New-Keynesian Macro Model", *Journal of Money, Credit and Banking*, 38(6), 1461-1481
[This is the model we use in this section of the course]

Clarida, R., J. Gali and M. Gertler (2000), "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory", *The Quarterly Journal of Economics*, 115(1), 147-180
[The source of the monetary policy rule used in many DSGE models]

Fernández-Villaverde, J., and J. F. Rubio-Ramírez (2007), "Estimating Macroeconomic Models: A Likelihood Approach," *Review of Economic Studies*, 74(4), 1059–1087
[The best exposition of Maximum Likelihood estimation methods for DSGE models]

Fernández-Villaverde, J., J. F. Rubio-Ramírez, and F. Schorfheide (2016), "Solution and estimation methods for DSGE models," *Handbook of Macroeconomics*, , ed. by J. B. Taylor, and H. Uhlig, vol 2a, 527–724. Elsevier, Amsterdam
[The definitive word on DSGE estimation]

Guerrón-Quintana, P. and J. Nason (2013), "Bayesian Estimation of DSGE Models" ch 21 in Hashimzade, N. and M. Thornton (eds.), Handbook of Research Methods and Applications in Empirical Macroeconomics. Edward Elgar, London
[An excellent survey]

Ireland, P. (2004), "A method for taking models to the data", *Journal of Economic Dynamics & Control* 28, 1205–1226
[The original paper on the subject; uses the measurement error approach]

* Ireland, P. (2004), "Technology Shocks In The New Keynesian Model", *The Review of Economics and Statistics*, November 2004, 86(4), 923–936
[The model which we use in this section of the course]

Klein, P. (2000), "Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Model," *Journal of Economic Dynamics and Control*, 24(10), 1405–1423
[This is the method used by Dynare to solve the models we feed it]

Rabanal, P. and J. F. Rubio-Ramírez (2005), "Comparing New Keynesian Models of the Business Cycle: A Bayesian Approach", *Journal of Monetary Economics* 52 (2005) 1151–1166
[The canonical application of the Bayesian estimation technology to a small NK DSGE; used in the section on DSGE-VAR modelling]

Rotemberg, J. J., and M. Woodford (1997), "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy," in *NBER Macroeconomics Annual 1997*, ed. by B. S. Bernanke, and J. J. Rotemberg. MIT Press, Cambridge
[A superbly well-written account of how to ensure that a DSGE model matches the data]

Ruge-Murcia, F. J. (2007), "Methods to estimate dynamic stochastic general equilibrium models," *Journal of Economic Dynamics and Control*, 31(8), 2599–2636
[An excellent overview of DSGE estimation methods]

IV. Smörgåsbord – URs, ZLBs and DSGE-VARs

Adolfson, M., S. Laséen, J. Lindé and M. Villani (2008), "Evaluating an Estimated New Keynesian Small Open Economy Model", *Journal of Economic Dynamics and Control*, 32(8), 2690-2721
[By economists at the Swedish central bank using DSGE-VAR for mis-specification analysis]

Binning, A. and J. Maih (2016), "Implementing the zero lower bound in an estimated regime-switching DSGE model", Norges Bank Research Paper 3/2016
[A rarity – one of the few attempts at estimating DSGE models over the ZLB period with binding ZLB constraints. By researchers at the Norwegian central bank]

Del Negro, M., and F. Schorfheide (2004), "Priors from General Equilibrium Models for VARs," *International Economic Review*, 45(2), 643 – 673
[The primary source for the DSGE-VAR methodology]

Filippeli, F., R. Harrison and K. Theodoridis (2018), "DSGE-based priors for BVARs and quasi-Bayesian DSGE estimation", Bank of England WP716
[Modifies the delN-Sch methodology by using more information from the DSGE model priors]

* Gali, J. (2011) "Monetary Policy and Unemployment", ch. 10 in *Handbook of Monetary Economics*, ed. by B. Friedman, vol 3a, 487-546. Elsevier, Amsterdam
[An elegant summary of modelling labour market frictions and unemployment in the NK DSGE; it is studied in this section of the course]

Hodge, A., T. Robinson and R. Stuart (2008), "A Small BVAR-DSGE Model for Forecasting the Australian Economy". Reserve Bank of Australia, RDP 2008-04
[An example of the use of a DSGE-VAR at a central bank]

Kulish, M., Morley, J. and T. Robinson (2017), "Estimating DSGE models with zero interest rate policy", *Journal of Monetary Economics*, 88, 35-49
[A superb applied paper on the ZLB]

Mortensen, D. and C. Pissarides (1994), "Job Creation and Job Destruction in the Theory of Unemployment", *Review of Economic Studies*, 61(3), 397-415
[The classic paper on unemployment via job search and match – the DMP model]

V. Internationality – The Small Open Economy and Other Delights

Adolfson, M., Laséen, S., Lindé, J. and M. Villani (2007), "Bayesian estimation of an open economy DSGE model with incomplete pass-through", *Journal of International Economics*, 72, 481-511
[One of the first to extend the serious closed economy DSGE model – eg, Smets-Wouters – to the open economy]

* Gali, J., and T. Monacelli (2005), "Monetary policy and exchange rate volatility in a small open economy", *Review of Economic Studies*, 72(3), 707–734
[The canonical small-scale SOE model upon which many others are based]

Justiniano, A., and B. Preston (2010), "Can structural small open-economy models account for the influence of foreign disturbances?", *Journal of International Economics*, 81(1), 61–74
[Another classic, studied in this section of the course]

Kamber, G., McDonald, C., Sander, S. and K. Theodoridis (2016), "Modelling the business cycle of a small open economy: The Reserve Bank of New Zealand's DSGE model", *Economic Modelling,* 59, 546–569
[The forecast and policy model used at the Reserve (i.e., central) Bank of New Zealand]

Kolasa, M. (2009), "Structural heterogeneity or asymmetric shocks? Poland and the euro area through the lens of a two-country DSGE model", *Economic Modelling,* 26, 1245–1269
[This was the first estimated SOE model to use a two-sector setup allowing for 'home bias' in preferences; it is included in this section of the course]

Kollmann, R., Pataracchia, B., Raciborski, R., Ratto, M., Roeger, W. and L. Vogel (2016), "The post-crisis slump in the Euro Area and the US: Evidence from an estimated three-region DSGE model", *European Economic Review*, 88, 21-41
[No small economies here – this estimates a three-large-region model (EA, US and Rest of World)]

Lubik, T. and F. Schorfheide (2007), "Do central banks respond to exchange rate movements? A structural investigation", *Journal of Monetary Economics*, 54, 1069–1087
[The classic application of the Gali-Monacelli model to central bank exchange rate policy in Australia, Canada, New Zealand and the UK]

* Rees, D., Smith, P. and J. Hall (2016), "A Multi-sector Model of the Australian Economy", *Economic Record*, 92(298), 374-408
[The DSGE model currently in use at the Reserve (i.e., central) Bank of Australia; it is studied in this section of the course]

VI. Case Study – The Canonical Smets-Wouters DSGE

Christiano, L. J., M. Eichenbaum, and C. L. Evans (2005), "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, 113(1), 1–45

[One of the classics, and used by Smets-Wouters in defining the investment part of their model]

Kimball, Miles S. (1995), "The Quantitative Analytics of the Basic Neomonetarist Model", *Journal of Money, Credit, and Banking* 27(4), 1241-1277
[The source of the Kimball aggregator used by Smets-Wouters]

King, R. G., C. I. Plosser, and S. Rebelo (1988), "Production, Growth, and Business Cycles: I The Basic Neoclassical Model," *Journal of Monetary Economics*, 21(2-3), 195 – 232
[The source of the K-P-R preference function used by Smets-Wouters]

* Smets, F., and R. Wouters (2003), "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area," *Journal of the European Economic Association*, 1(5), 1123–1175
[The original SW model which started the revolution in the use of NK DSGE models at central banks]

* Smets, F., and R. Wouters (2007), "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *American Economic Review*, 97, 586–608
[A revised version of SW2003, adjusted to fit better the US data; this is the one we study in this section of the course]