

International Economics

Academic year 2024-2025

Demystifying DSGE Models

EI074 - Autumn - 6 ECTS

Tuesday 12h15 - 14h00

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

Ka Lok Wong

[Office hours](#)

IMPORTANT

Regular attendance is compulsory, and any absence must be promptly communicated to the teacher. In the event of missing more than two sessions, students are expected to provide well-documented justifications for unforeseeable circumstances (e.g. illness, accident, death of a relative), directly to the Direction of Studies. Failure to justify absences beyond two sessions will result in the assignment of code N.

Students are also reminded of the following legal rules:

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Recording (as video or audio) a course without the consent of the teacher and other participants is strictly forbidden.

Syllabus

Course Content

This 7-week 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. This is followed by a case study of the canonical Smets-Wouters model, which is the "workhorse" of today's macroeconomists. The course then goes on to the (more difficult) terrain of the estimation of the DSGE parameters, via Bayesian techniques. It subsequently considers extensions to the Smets-Wouters model, including banking, housing, environment and unemployment, and concludes with consideration of Open Economy DSGE models.

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, due before class each subsequent week. There will also be a final examination. The problem sets will count for 80% of the course mark, the final examination for 20%. Collaboration with colleagues on the problem sets is permitted, 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; the remainder are optional and in some cases are listed only to provide the original work behind subsequent developments used in the course (denoted "*background*"). There is no textbook for the course, although you will find the book by Costa to be very helpful if you are entirely new to DSGE modelling. If you wish to go more deeply into DSGE modelling, you may find it useful to look at Galindo, H., Montecinos, A. and M. Ortiz (2024), *Dynamic Stochastic General Equilibrium Models*, Springer.

Week 1: Under the Hood – Nuts and Bolts of the RBC Model

* Costa, C. J. (2016), *Understanding DSGE Models*. Vernon Press, Malaga

[This short book guides you through the development of the RBC and the NK DSGE in great detail; this and the next section of the course are based on it]

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]

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 - *background*]

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 - *background*]

Week 2: Adding Bells and Whistles – The NK DSGE in All its Glory

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 - *background*]

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 - *background*]

* 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]

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 - *background*]

Week 3: Case Study – The Canonical Smets-Wouters DSGE

Christiano, L., Eichenbaum, M. and C. 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 - *background*]

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 - *background*]

King, R., Plosser, C. 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 - *background*]

* 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 practical use of NK DSGE models in macroeconomics]

* 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 and estimate in the next section]

Week 4: Bringing DSGE Models to the Data – Beyond Calibration and Simulation

An, S., and F. Schorfheide (2007), “Bayesian Analysis of DSGE Models,” *Econometric Reviews*, 26(2-4), 113–172

[The primary source for Bayesian estimation - *background*]

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 - *background*]

* Cho, S. and A. Moreno (2006), “A Small-Sample Study of the New-Keynesian Macro Model”, *Journal of Money, Credit and Banking*, 38(6), 1461-1481

[This canonical three-equation NK model is used in this section of the course]

Clarida, R., Galí, J. 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 - *background*]

Fernández-Villaverde, J., Rubio-Ramírez, J. 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]

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 - *background*]

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 - *background*]

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]

Week 5: Extensions to the NK DSGE: the Financial and Housing Sectors

* Bask, M. and J. Madeira (2021), “Extrapolative expectations and macroeconomic dynamics: Evidence from an estimated DSGE model”, *International Journal of Finance & Economics*, 26, 1101-1111

[Adds the BGG framework to the Smets-Wouters model; used in this section of the course]

* Bernanke, B., Gertler, M. and S. Gilchrist (1999), “The financial accelerator in a quantitative business cycle framework”, *Handbook of Macroeconomics*, 1(C), 1341-1393

[The canonical framework for financial frictions in DSGE models; studied in this section of the course]

DelNegro, M., Giannoni, M. and F. Schorfheide (2015), “Macro Inflation in the Great Recession and New Keynesian Models”, *American Economic Journal*, 7(1), 168-196

[One of the first – and best – to introduce financial frictions to the canonical Smets-Wouters model]

Gertler, M. and P. Karadi (2011), “A model of unconventional monetary policy”, *Journal of Monetary Economics*, 58, 17-34

[The canonical framework for introducing credit market frictions to DSGE models; used in many papers - *background*]

Gertler, M. and N. Kiyotaki (2010), “Financial Intermediation and Credit Policy in Business Cycle Analysis”, ch. 11 of *Handbook of Monetary Economics*, 3, 547-599

[Another framework for introducing credit market frictions to DSGE models; also used in many papers - *background*]

* Gertler, M., Kiyotaki, N. and A. Prestipino (2020), “A Macroeconomic Model with Financial Panics”, *Review of Economic Studies*, 87, 240-288

[Illuminating and insightful analysis of the dynamics of a financial crisis of the kind recently experienced; studied in this section of the course]

Gortz, C. and J. Tsoukalas (2017), "News and Financial Intermediation in Aggregate and Sectoral Fluctuations", *Review of Economics and Statistics*, 99(3), 514-530

[Introduces the Gertler-Karadi financial framework to a medium-scale DSGE]

* Guerrieri, L. and M. Iacoviello (2017), "Collateral constraints and macroeconomic asymmetries", *Journal of Monetary Economics*, 90, 28-49

[Estimates a *nonlinear* DSGE where *occasionally binding* collateral constraints on housing wealth drive an asymmetry in the link between housing prices and economic activity; we study this version of the canonical Iacoviello model in this section of the course]

Iacoviello, M. (2005), "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle", *American Economic Review*, 95(3), 739-764

[The canonical framework for introducing the housing market to DSGE models; used in many papers - *background*]

Kannan, P., Rabanal, P. and A. Scott (2012), "Monetary and Macroprudential Policy Rules in a Model with House Price Booms", *The B.E. Journal of Macroeconomics*, 12(1), 1-42

[Adds the Iacoviello framework for housing to a DSGE model incorporating also the Gertler-Karadi financial structure]

Menna, L. and P. Tirelli (2021), "Risk Premiums Nominal Rigidities and Limited Asset Market Participation", *Journal of Money, Credit and Banking*, 53(7), 1899-1921

[Introduces LAMP into a DSGE model akin to Smets-Wouters, leading to income redistribution and an empirically plausible risk premium]

* Villa, S. (2016), "Financial Frictions in the Euro Area and the United States: A Bayesian Assessment", *Macroeconomic Dynamics*, 20, 1313-1340

[Adds the Gertler-Kiyotaki-Prestipino framework to the Smets-Wouters model; used in this section of the course]

Week 6: Smörgåsbord – Environment and Unemployment

Airaud, F., Pappa, E. and H. Seoane (2023), "The green metamorphosis of a small open economy", *Centre for Economic Policy Research Working Paper* 17863

[An open economy EDSGE where production is characterized by low substitutability between resource and traditional inputs that firms can alter through directed input-saving technical change]

* Annicchiarico, B. and F. Di Dio (2015), "Environmental policy and macroeconomic dynamics in a new Keynesian model", *Journal of Environmental Economics and Management*, 69, 1-21

[The canonical *nonlinear* "EDGSE" – environmental DSGE – incorporating pollutant emissions which are a byproduct of output and examining different environmental policy regimes; we study this paper in this section of the course]

Annicchiarico, B. and F. Diluiso (2019), "International transmission of the business cycle and environmental policies", *Resource and Energy Economics*, 58, 1-29

[Adds environmental policy to a two-country open-economy DSGE model with intra-industry trade]

Carattini, S., Heutel, G. and Givi Melkadze (2023), "Climate Policy, Financial Frictions, and Transition Risk", *Review of Economic Dynamics* (forthcoming)

[An EDSGE model featuring "brown" and "green" sectors and including both pollution market and financial sector failures, remediated using macroprudential policies and carbon taxes]

* Casares, M., Moreno, A. and J. Vasquez (2014), "An estimated New-Keynesian model with unemployment as excess supply of labour", *Journal of Macroeconomics*, 40, 338-359
[Adds employment determination to the Smets-Wouters model; we study this version in the section on unemployment]

Galí, J., Smets, F., and Wouters, R. (2012), "Unemployment in an Estimated New Keynesian Model," NBER Macroeconomics Annual 26, 329-360
[Incorporates Galí's model of labour market frictions and unemployment model into the Smets-Wouters model]

Gallic, E. and Vermandel, G. (2020), "Weather Shocks", *European Economic Review*, 124, 1–26
[Incorporates a weather-dependent agricultural sector into the canonical NK-DSGE]

Mihailov, A, Razzu, G. and Z. Wang (2019), "Heterogeneous effects of single monetary policy on unemployment rates in the largest EMU economies", University of Reading DP 2019-07
[Estimates and simulates a version of the Galí-Smets-Wouters model on the four major EMU Economies]

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- *background*]

Week 7: Internationality – The Small Open Economy and Other Delights

de Walque, G., Lejeune, T., Rannenberg, A., and R. Wouters (2023), "BEMGIE: Belgian Economy in a Macro General and International Equilibrium model", *National Bank of Belgium*, WP435, March 2023
[The latest open-economy DSGE model – estimates an OE version of the SW model for both the EA and US, with Belgium as the SOE]

Frache, S., and H. Rodriguez (2021), "A DSGE model for Uruguay with commodity production", *Central Bank of Uruguay*, WP 2021-06 [*in Spanish*]
[A tractable SOE model based on that of GSW2012]

* Galí, 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, the basis for many subsequent papers - *background*]

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]

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 Galí-Monacelli model to central bank exchange rate policy in Australia, Canada, New Zealand and the UK - *background*]

* 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]