Economics 784, Advanced Macroeconomics
Empirical and Computational Methods

James M. Nason — Spring 2022
Department of Economics — NC State University

I. Administration

Instructor: James M. Nason — *Office*: Rm. 4116, Nelson Hall
email: jmnason@ncsu.edu — *tel*: (919) 513–2884
Meet: Monday & Wednesday — *Location*: TBA
Time: 1:30pm–2:45pm — *Office Hours*: By appointment

II. Objectives

Develop empirical methods and computational tools to evaluate macro theories and policy.

III. Materials

There is no assigned textbook. Three books are recommended, which are

Chan, J., G. Koop, D.J. Poirier, J.L. Tobias 2020, Bayesian Econometric Methods, second edition. Cambridge, UK: Cambridge University Press,

De Jong, J.N., C. Dave 2011, Structural Macroeconometrics, second edition, Princeton, NJ: Princeton University Press,

and

Geweke, J. 2010, Complete and Incomplete Econometric Models, Princeton, NJ: Princeton University Press.

The list aims to cover a range of interests including Bayesian econometrics, business cycle measurement, linear and nonlinear solution methods, and Bayesian calibration. We will also study published and working papers. Further, students are expected to work at the level of

Canova, F. 2007. Methods for Applied Macroeconomic Research. Princeton, NJ: Princeton University Press.

Durbin, J., S.J. Koopman 2012. Time Series Analysis by State Space Methods, Second Edition. Oxford, UK: Oxford University Press.

Geweke, J. 2005. Contemporary Bayesian Econometrics and Statistics. New York, NY: John Wiley & Sons, Inc.

Hamilton, J.D. 1994. Time Series Analysis. Princeton, NJ: Princeton University Press.

Harvey, A.C. 1991. Forecasting, Structural Time Series Models and the Kalman Filter. Cambridge, UK: Cambridge University Press.

Heer, B., A. Maußner 2009. Dynamic General Equilibrium Modeling, Second Edition. New York, NY: Springer-Verlag Science.

Herbst, E., F. Schorfheide 2015. Bayesian Estimation of DSGE Models Princeton, NJ: Princeton University Press.

Kim, C-J., C.R. Nelson 1999. State-Space Models with Regime Switching. Cambridge, MA: MIT Press.

Marimon, R., A. Scott 1999. COMPUTATIONAL METHODS FOR THE STUDY OF DYNAMIC ECONOMIES. Oxford, UK: Oxford University Press.

Rubin, A., J.B. Carlin, H.S. Stern, D.B. Dunson, A. Vehtari, D.B. Rubin 2013. BAYESIAN DATA ANALYSIS, THIRD EDITION. New York, NY: Chapman & Hall/CRC.

Sargent, T.J. 1987. MACROECONOMIC THEORY, SECOND EDITION. New York, NY: Academic Press.

Turkman, M.A.A., C.D. Paulino, P. Müller 2019, COMPUTATIONAL BAYESIAN STATISTICS: AN INTRODUCTION. Cambridge, UK: Cambridge University Press.

IV. Lecture Notes

Material for Economics 784 (*i.e.*, this course outline and lecture notes) are available online at `https://www.jamesmnason.net/teaching-lectures/`.

V. Requirements

(A) Final grades will be based on course performance during the Spring 2022 semester (January 10, 2022–April 25, 2022). During the Spring 2022 semester, there will be assignments, problem sets and a final project. More information will be provided on the assignments, problem sets, and a final paper. I encourage group study sessions when working on the problem sets.

(B) The goal of the course is to give students computational and empirical skills needed to conduct research on monetary economics (and more generally macro) questions using state of the art tools. Achieving these aims requires a platform on which to develop and practice these tools. You have your choice of computing and statistical for Economics 784.

Economists employ several different computing and statistical platforms. A widely used computing platform, especially by macroeconomists, is MatLab®. It is available on the computer systems of many universities and government agencies. There are also several open source statistical and computing platforms. Among these are GNU OCTAVE, GRETL, JULIA, PYTHON, R PROJECT FOR STATISTICAL COMPUTING, and SAGEMATH. GNU OCTAVE is similar to and compatible with MatLab®. GRETL is an econometric package that can be run from a *GUI* command window. PYTHON is a programming language that offers much more than the computational and statistical routines that economists need. Relevant computational and statistical routines are the PYTHON packages NUMPY and SCIPY. The latter contains commands for engaging linear algebra while the former is about numerical computing. An underused PYTHON package is STATSMODELS. STATSMODELS is a suite of estimation and non-parametric routines. Another useful PYTHON module is MATPLOTLIB, which as the name suggests is a collection of routines to plot data. SAGEMATH is a computational package that engages PYTHON, among other open source packages, but is intended to solve mathematical computing problems.

The instructor for Economics 784 relies on the JULIA computing language. JULIA is a high level dynamic computing language (*i.e.*, uses standard language to express programming concepts and commands unlike Fortran or C++). Econometricians and macroeconomists should find the transition to programming in JULIA easy because it is similar in appearance to packages widely used statistical and computational software programs. Along with numerical accuracy, a robust compiler, and good library math and statistical functions, JULIA has packages to access PYTHON and R commands. There are also commands built into JULIA can engage distributed parallel computing on the latest multi-core, multi-threaded processors. JULIA claims an efficiency (*i.e.*, speed) advantage compared with other computing platforms. Since Economics 784 seeks to teach students several Monte Carlo simulation algorithms, this could be a reason to learn and use JULIA. Its online Documentation has information about commands and programming structure along with suggestions to write efficient code.

A useful resource for JULIA and Python is QUANTECON, which is maintained by Tom Sargent, John Stachurski, and their colleagues, but not to be confused with the journal. They provide online QuantEcon Lectures to learn JULIA and PYTHON along with libraries of code and documentation in JULIA and PYTHON are aimed at problems of interest to economists.

Economics 784 hopes to give students experience in coding that will help them start their dissertation research.

VI. Some Important Dates for the Spring 2022 Semester

More information will be provided about problem sets and other assignments during the Spring 2022 semester. The course requires a final project that has to be handed in to the instructor no later than the next to last class, Wednesday April 20 2022. The final project will be discussed later in the semester.

VII. Operating Procedures

Late problem sets, late assignments, and a late final paper will not be accepted without prior arrangement. I make no exceptions.

EXCUSES: Your rule of thumb should be, "Would I try this on my boss (the person who writes my annual review and signs my pay check)?" If not, please do not try it on me.

VIII. Extraordinary Operating Procedures

Given the state of the world, the format of the class could be subject to temporary changes due to ongoing disruptions caused by COVID. If necessary, any changes will be communicated by email and students should frequently check for updates.

IX. Course Outline and Schedule of Topics

0. Introduction, Computing, and Other Matters: 01/10/2022. [`Assignment`]

1. Business Cycles and Aggregate Fluctuations: 01/12 and 01/19/2022.

Frisch (1933), Slutsky (1937), Koopman (1947), Beveridge and Nelson (1981), Watson (1986), Hansen and Sargent (1993), Harvey and Jaeger (1993), King and Rebelo (1993), Cogley and Nason (1995), Hodrick and Prescott (1997), Canova (1998a, 1998b), Burnside (1998), Baxter and King (1999), Gómez (1999, 2001), Kozicki (1999), Harvey and Proietti (2000), Morley (2002), Harvey and Trimbur (2003), Murray (2003), Morley, Nelson, and Zivot (2003), Murray (2003), Schleicher (2003), Canova (2007, ch. 3), Harvey, Trimbur, and Van Dijk (2007), Hamilton (2018), and Schüler (2020, 2021). [`Problem Set 1`]

2. Calibrating and Solving Rational Expectations Macro Models

(*A*) Calibrating DSGE Models: 01/24/ and 01/26/2022.

Prescott (1986), Rogoff (1986), Gregory and Smith (1990, 1991, 1996), Watson (1993), Canova (1994), Pagan (1994), Hansen and Heckman (1996), Kydland and Prescott (1996), Sims (1996), Kehoe (2007), Canova (2007, ch. 7), Geweke (2010), De Jong and Dave (2011, ch. 11), Del Negro and Schorfheide (2011), Guerrón-Quintana and Nason (2013), and Kano and Nason (2014).

(*B*) Solving Linear Rational Expectations Models: 01/31/2022.

Blanchard and Kahn (1980), Sargent (1987, chs. XI, XI, XII, and XIV), King and Watson (1998), Zadrozny (1998), Klein (2000), Sims (2001), De Jong and Dave (2011, ch. 4), and Lee and Park (2021).

3. Vector Autoregressions: Theory and Methods

(*A*) Introduction to VARs: 02/02 and 02/07/2022.

Sims (1980), Hamilton (1994, chs. 1, 2, 3, 4, 10, and 11), Sims, Stock, and Watson (1990), Mittnik and Zadrozny (1993), Canova (2007, ch. 4), Lütkepohl (2013), Olea and Plagborg-Møller (2018), Herbst and Johannsen (2021), Olea and Plagborg-Møller (2021), and Plagborg-Møller and Wolf (2021).

(*B*) Bayesian VARs: 02/07, 02/09, and 02/14/2022.

Canova (2007, ch. 9 and ch. 10.1–10.3), Koop and Korobilis (2010), Sims and Zha (1998, 1999), Robertson and Tallman (2001), Waggoner and Zha (2003a, 2003b), Karlsson (2013), Olea and Plagborg-Møller (2018), Plagborg-Møller (2019), Ferroni and Canova (2020), and Petrova (2022). [`Problem Set 2`]

(*C*) Identification: 02/14, 02/16, 02/21, and 02/23/2022.

<u>Short- and Long-Run Restrictions</u>: Shapiro and Watson (1998), Blanchard and Quah (1989), Vahid and Engle (1993), Cochrane (1994a, 1994b), Lippi and Reichlin (1994), Amisano and Giannini (1997), Faust and Leeper (1997), Pagan and Robertson (1998), Faust, Swanson, and Wright (2004), Taylor (2004), Canova (2006), Gospodinov (2010), Kilian (2013), Leeper, Walker, and Yang (2013), Canova and Sahneh (2018), Chahrour and Jurado (2018), Forni, Gambetti, and Sala (2020), Miranda-Agrippino and Rey (2020), Bauer and Swanson (2021), Brunnermeier, Palia, Sastry, and Sims (2021), Inoue and Rossi (2021), Lewis (2021), and Ludvigson, Ma, and Ng. (2021).

<u>Sign Restrictions</u>: Faust (1998), Faust and Rogers (2003), Uhlig (2005), Inoue and Kilian (2013), Baumeister and Hamilton (2015, 2021), Uhlig (2016), Arias, Caldera, and Rubio-Ramírez (2019), Baumeister and Hamilton (2020), Ahmadi and Drautzburg (2021), Arias, Rubio-Ramírez, and Waggoner (2018), Giacomini and Kitagawa (2021), and Giacomini, Kitagawa, and Read (2021a).

<u>Instrumental Variables</u>: Leeper (1997), Lunsford (2015), Ramey (2016), Antolín-Díaz and Rubio-Ramírez (2018), Stock and Watson (2018), Jentsch and Lunsford (2019), Arias, Rubio-Ramírez, and Waggoner (2021), Bruns (2021), Giacomini, Kitagawa, and Read (2021b), Miranda-Agrippino and Ricco (2021), and Olea, Stock, and Watson (2021). [`Problem Set 3`]

3. An Introduction to Bayesian Tools for Macroeconomists

(*A*) Estimating Linear Rational Expectations Models: 02/28, 03/02/, 0/07, and 03/09/2022.

Hamilton(1994, ch. 13), Stoffer and Wall (2007), Canova (2007, ch. 11.4), Geweke (2005), De Jong and Dave (2011, chs. 2 and 4), Del Negro and Schorfheide (2008, 2011), Komunjer and Ng (2011), Gelman et al (2013, ch. 7), Guerrón-Quintana and Nason (2013), Turkman, Paulino, and Müller (2019, chs 4.1, 4.2, 5, 6.1, 6.2, and 9.6.1), and Kocięcki and Kolasa (2018), Canova, Ferroni, and Matthes (2020), and Canova and Matthes (2021).

(*B*) Using VARs to Evaluate Monetary Policy: 03/21, 03/23, 03/28, 03/30, 04/04, and 04/06/2021.

Sims (1992), Gordon and Leeper (1994), Strongin (1995), Eichenbaum and Evans (1995), Leeper, Sims, and Zha (1996), Cushman and Zha (1997), Bernanke and Mihov (1998), Christiano, Eichenbaum, and Evans (1999), Leeper and Roush (2003), Leeper and Zha (2003), Lanne and Lütkepohl (2008), Fernández-Villáverde, Rubio-Ramírez, and Sargent (2005), and with Watson (2007), Rubio-Ramírez, Waggoner, and Zha (2010), Bouakez and Normandin (2010), Bekaert, Hoerova, and Duca (2013), Baumeister and Hamilton (2018), Caldara and Herbst (2019), Fabo, Jančoková, Kempf, and Pástor (2020), Jarociński and Karadi (2020), Wolf (2020), and Bacchiocchi and Kitagawa (2021). [`Problem Set 4`]

(*C*) Markov-Switching and Time-Varying Parameter Bayesian VARs: 04/11 and 04/13/2022.

Canova (2007, chs. 10.4 and 11.3), Cogley and Sargent (2005), Primiceri (2005), Sims and Zha (2006), Sims, Waggoner, and Zha (2008), Cogley, Primiceri, and Sargent (2010), Herwartz and Lütkepohl (2014), Nason and Tallman (2015), Makalic and Schmidt (2016), Warren (2017), Bitto and Früwirth-Schnatter (2019), Follett and Yu (2019), Cadonna, Früwirth-Schnatter, and Knaus (2020), Petrova (2019), Hauzenberg (2021), and Prüser (2021). [`Problem Set 5`]

(*D*) A TVP-Bayesian SVAR to Evaluate Monetary Policy: 04/18, 04/20, and 04/25/2022.

Canova and Pérez Forero (2015) and Del Negro and Primiceri (2015).

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