Topics in Empirical Macroeconomics

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COURSE DESCRIPTION

Structural vector autoregressions are the workhorse models in empirical macroeconomics. The Bayesian approach to estimation and inference of (S)VAR models has gained popularity as models have become more complex. The goal of this course is to equip participants with the tools they need for state-of-the-art empirical research in macroeconomics and to develop practical skills to apply Bayesian methods to policy-relevant research questions. The first part of the course covers the basics of Bayesian econometrics including standard choices of prior distributions and numerical simulation methods. The second part of the course challenges the current practice of identification of VAR models by introducing a more general Bayesian framework that encompasses standard identification approaches as special cases. Drawing structural inference from VAR models requires making use of prior information. This course provides formal tools of Bayesian analysis that allow to incorporate prior beliefs about both the structural coefficients and the impacts of shocks in a flexible way and to characterize the contribution of prior information. The third part of the course extends the standard VAR model to allow macroeconomic dynamics to evolve over time and to incorporate a large cross section of variables. The course introduces state-space modeling as the common framework for both extensions. The methods introduced in the lectures will be illustrated with applications to the labor market, monetary policy, and oil price shocks in Matlab.

COURSE OBJECTIVES

The course is designed to:

- develop an understanding of estimation techniques and their implementation;
- enhance your knowledge of the relevant concepts and techniques necessary to understand empirical macroeconomics published in leading journals and to improve your ability to read and critically evaluate current empirical research in macroeconomics;
- apply different estimation and identification methods to interesting economic problems and prepare you to conduct independent empirical research.

This will be a hands-on course where the methods introduced in the lectures will be illustrated with applications in Matlab. Thus, the general emphasis is less on theory and derivations, and more on methods and practical issues that can be helpful in future dissertation work.

GRADING

The final grade for the course is based on a take-home exam with programming exercises in Matlab. In addition, PhD students are required to give a 20-minute presentation of a research idea.

<u>Main textbook</u>:
Hamilton, J.D., *Vector Autoregressions*, Cambridge University Press, in progress.

<u>Other reference textbooks and useful resources</u>:
Greenberg, E., *Introduction to Bayesian Econometrics*, Cambridge University Press, second edition, 2012.
Hamilton, J.D., *Times Series Analysis*, Princeton University Press, 1994.
Kim, C.J., and C.R. Nelson, State-Space Models with Regime Switching, MIT Press, 1999.
Koop, G., *Bayesian Econometrics*, John Wiley & Sons Ltd., 2003.
Lancaster, T., *Introduction to Modern Bayesian Econometrics*, John Wiley & Sons Ltd., 2004.

<u>Reading list</u>: Starred items (*) are the most important.

COURSE OUTLINE

I. Introduction to Vector Autoregressions

1. <u>VARs and Economic Forecasts</u>
- Hamilton, Chapter 1. (*)

2. <u>Tracing out Dynamic Effects: VARs vs Local Projections</u>
- Hamilton, Chapter 2. (*)
- Jordà, Ò. (2005), "Estimation and Inference of Impulse Responses by Local Projections," *American Economic Review*, 95(1), 161-182. (*)
- Plagborg-Møller, M., and C.K. Wolf (2021), "Local Projections and VARs Estimate the Same Impulse Responses," *Econometrica*, 89(2), 955-980. (*)

II. The Basics of Bayesian Econometrics

1. <u>Bayesian Inference in the Linear Regression Model</u>
- Kim and Nelson, Chapter 7.
- Koop, Chapter 2.

2. <u>Bayesian Estimation of Vector Autoregressions</u>
- Casella, G., and E.I. George (1992), "Explaining the Gibbs Sampler," *American Statistician*, 26, 167-174. (*)

- Doan, T., R. Litterman, and C. Sims (1984), "Forecasting and Conditional Projection Using Realistic Prior Distributions," *Econometric Reviews*, 3(1), 1-100.
- Hamilton, Chapter 3. (*)
- Kadiyala, K.R., and S. Karlsson (1997), "Numerical Methods for Estimation and Inference in Bayesian VAR-models," *Journal of Applied Econometrics*, 12, 99-132.
- Todd, R.M. (1984), "Improving Economic Forecasting With Bayesian Vector Autoregressions," *Federal Reserve Bank of Minneapolis Quarterly Review*, Fall, 18-30. (*)

III. Structural VAR Models

Identification Issues

Nakamura, E., and J. Steinsson (2018), "Identification in Macroeconomics," *Journal of Economic Perspectives*, 32(3), 59-86.

Ramey, V. (2016), "Macroeconomic Shocks and Their Propagation," *Handbook of Macroeconomics*, edited by J.B. Taylor and H. Uhlig, vol. 2, 71-162. (*)

Sims, C.A. (1980), "Macroeconomics and Reality," *Econometrica*, 48, 1-48.

1. Bayesian Analysis of Structural VARs
- Sims, C.A., and T. Zha (1998), "Bayesian Methods for Dynamic Multivariate Models," *International Economic Review*, 39(4), 949-968.
- Waggoner, D.F., and T. Zha (2003), "A Gibbs Sampler for Structural Vector Autoregressions," *Journal of Economic Dynamics and Control*, 28(2), 349-366.
- Chib, S., and E. Greenberg (1995), "Understanding the Metropolis-Hastings Algorithm," American Statistician, 49(4), 327-335. (*)

2. A Bayesian Interpretation of Traditional Identification Assumptions

Baumeister, C., and J.D. Hamilton (2022), "Structural Vector Autoregressions with Imperfect Identifying Information," *AEA Papers and Proceedings*, 112, 466-470. (*)

Baumeister, C., and J.D. Hamilton (2024), "Advances in Using Vector Autoregressions to Estimate Structural Magnitudes," *Econometric Theory*, 40(3), 472-510.

   a. Short-Run Restrictions
- Blanchard, O.J., and R. Perotti (2002), "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output," *Quarterly Journal of Economics*, 117(4), 1329-1368.
- Christiano, L.J., M. Eichenbaum, and C.L. Evans (1999), "Monetary Policy Shocks: What Have We Learned and to What End?" *Handbook of Macroeconomics*, edited by J. B. Taylor, and M. Woodford, 65-148. (*)

- Kilian, L. (2009), "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market," *American Economic Review*, 99(3), 1053-1069. (*)

b. Long-Run Restrictions

- Blanchard, O.J., and D. Quah (1989), "The Dynamic Effects of Aggregate Demand and Supply Disturbances," *American Economic Review*, 79(4), 655-673. (*)
- Gali, J. (1999), "Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?" *American Economic Review*, 89(1), 249-271.

c. Sign Restrictions

- Arias, J.E., J.F. Rubio-Ramirez, and D.F. Waggoner (2018), "Inference Based on SVARs Identified with Sign and Zero Restrictions: Theory and Applications," *Econometrica*, 86(2), 685-720.
- Baumeister, C., and J.D. Hamilton (2015), "Sign Restrictions, Structural Vector Autoregressions, and Useful Prior Information," *Econometrica*, 83(5), 1963-1999. (*)
- Baumeister, C., and J.D. Hamilton (2020), "Drawing Conclusions from Structural Vector Autoregressions Identified on the Basis of Sign Restrictions," *Journal of International Money and Finance*, 109, 1-8. (*)
- Fry, R., and A. Pagan (2011), "Sign Restrictions in Structural Vector Autoregressions: A Critical Review," *Journal of Economic Literature*, 49(4), 938-960.
- Rubio-Ramirez, J.F., D.F. Waggoner, and T. Zha (2010), "Structural Vector Autoregressions: Theory of Identification and Algorithms for Inference," *Review of Economic Studies*, 77(2), 665-696. (*)
- Uhlig, H. (2005), "What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure," *Journal of Monetary Economics*, 52, 381-419. (*)
- Watson, M.W. (2019), "Comment on 'On the Empirical (Ir)Relevance of the Zero Lower Bound' by Debortoli, Gali, and Gambetti," *NBER Macroeconomics Annual*. (*)

3. Inference When Identifying Assumptions are Doubted

- Baumeister, C., and J.D. Hamilton (2019), "Structural Interpretation of Vector Autoregressions with Incomplete Identification: Revisiting the Role of Oil Supply and Demand Shocks," *American Economic Review*, 109(5), 1873-1910. (*)
- Baumeister, C., and J.D. Hamilton (2018), "Inference in Structural Vector Autoregressions When the Identifying Assumptions are Not Fully Believed: Re-evaluating the Role of Monetary Policy in Economic Fluctuations," *Journal of Monetary Economics*, 100, 48-65. (*)
- Belongia, M.T., and P.N. Ireland (2021), "A Classical View of the Business Cycle," *Journal of Money, Credit, and Banking*, 53(2-3), 333-366.
- Brinca, P., J.B. Duarte, and M. Faria-e-Castro (2021), "Measuring Labor Supply and Demand Shocks during COVID-19," *European Economic Review*, 139, article 103901.

4. <u>External Instruments/Proxy SVARs</u> (time permitting)
- Caldara, D., and E. Herbst (2019), "Monetary Policy, Real Activity, and Credit Spreads: Evidence from Bayesian Proxy SVARs," *American Economic Journal: Macroeconomics*, 11(1), 157-192.
- Gertler, M., and P. Karadi (2015), "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, 7(1), 44-76. (*)
- Känzig, D. (2021), "The Macroeconomic Effects of Oil Supply News: Evidence from OPEC Announcements," *American Economic Review*, 111(4), 1092-1125. (*)
- Känzig, D. (2023), "The Unequal Economic Consequences of Carbon Pricing," mimeo, Northwestern University.
- Mertens, K., and M. Ravn (2013), "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States," *American Economic Review*, 103(4), 1212-1247. (*)
- Paul, P. (2020), "The Time-Varying Effect of Monetary Policy on Asset Prices," *Review of Economics and Statistics*, 102(4), 1-15.
- Stock, J.H., and M.W. Watson (2012), "Disentangling the Channels of the 2007-09 Recession," *Brookings Papers on Economic Activity*, Spring, 81–156.
- Stock, J.H., and M.W. Watson (2018), "Identification and Estimation of Dynamic Causal Effects in Macroeconomics," *Economic Journal*, 28, 917-948. (*)

IV. State-Space Models

Hamilton, Chapter 4. (*)
Carter, C.K., and R. Kohn (1994), "On Gibbs Sampling for State Space Models," *Biometrika*, 81, 541-553.
Hamilton, J.D. (1994), "State-Space Models," in: *Handbook of Econometrics*, 4, eds. R.F. Engle and D. McFadden, 3039-3080, Elsevier.

1. <u>Time-Varying Parameter Models and the Kalman Filter</u>
- Baumeister, C., and G. Peersman (2013), "The Role of Time-Varying Price Elasticities in Accounting for Volatility Changes in the Crude Oil Market," *Journal of Applied Econometrics*, 28(7), 1087-1109. (*)
- Cogley, T., Morozov, S. and T.J. Sargent (2005), "Bayesian Fan Charts for U.K. Inflation: Forecasting and Sources of Uncertainty in an Evolving Monetary System," *Journal of Economic Dynamics and Control*, 29(11), 1893–1925. (*)
- Cogley, T., and T.J. Sargent (2005), "Drift and Volatilities: Monetary Policies and Outcomes in the Post WWII U.S.," *Review of Economic Dynamics*, 8, 262-302.
- Del Negro, M. and G.E. Primiceri (2015) "Time-Varying Structural Vector Autoregressions and Monetary Policy: A Corrigendum," *Review of Economic Studies*, 82(4), 1342-1345. (*)

- Primiceri, G.E. (2005), "Time-Varying Structural Vector Autoregressions and Monetary Policy," *Review of Economic Studies*, 72(3), 821-852. (*)
- Leiva-Leon, D., and L. Uzeda (2023), "Endogenous Time Variation in Vector Autoregressions," *Review of Economics and Statistics*, 105(1), 125–142.

2. <u>Stochastic Volatility Models and the Independence Metropolis-Hastings Algorithm</u>

- Jacquier, E., N.G. Polson, and P. Rossi (1994), "Bayesian Analysis of Stochastic Volatility Models," *Journal of Business and Economic Statistics*, 12, 371-418. (*)
- Kim, S., N. Shephard, and S. Chib (1998), "Stochastic Volatility: Likelihood Inference and Comparison with ARCH Models," *Review of Economic Studies*, 65(3), 361-393.
- Jo, S., and R. Sekkel (2017), "Macroeconomic Uncertainty through the Lens of Professional Forecasters," *Journal of Business and Economic Statistics*, 37(3), 436-446.

3. <u>Structural Breaks: How to Deal with the COVID-19 period</u>

- Carriero, A., T.E. Clark, M. Marcellino, and E. Mertens (2022), "Addressing COVID-19 Outliers in BVARs with Stochastic Volatility," *Review of Economics and Statistics*, forthcoming.
- Hamilton, Chapter 6. (*)
- Lenza, M., and G.E. Primiceri (2022), "How to Estimate a Vector Autoregression after March 2020," *Journal of Applied Econometrics*, 37(4), 688-699. (*)
- Ng, S. (2021), "Modeling Macroeconomic Variations after Covid-19," NBER Working Paper 29060.

4. <u>Large Datasets: Dynamic Factor Models and Factor-Augmented VAR Models</u>

- Stock, J.H., and M.W. Watson (2016), "Factor Models and Structural Vector Autoregressions in Macroeconomics," *Handbook of Macroeconomics*, edited by J.B. Taylor and H. Uhlig, vol. 2, 415-525.
- Baumeister, C., P. Liu, and H. Mumtaz (2013), "Changes in the Effects of Monetary Policy on Disaggregate Price Dynamics," *Journal of Economic Dynamics and Control*, 37(3), 543-560.
- Bernanke, B., J. Boivin, and P. Eliasz (2005), "Measuring Monetary Policy: A Factor-Augmented Autoregressive (FAVAR) Approach," *Quarterly Journal of Economics*, 120, 387-422. (*)
- Buch, C.M., S. Eickmeier, and E. Prieto (2014), "Macroeconomic Factors and Microlevel Bank Behavior," *Journal of Money, Credit, and Banking*, 46(4), 715-751.
- Hamilton, Chapter 7. (*)
- Kose, M.A., C. Otrok, and C.H. Whiteman (2003), "International Business Cycles: World, Region, and Country-Specific Factors," *American Economic Review*, 93(4), 1216-1239.