Applied macroeconometrics.
CEMFI

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This course covers applied methods used in macroeconomics and finance to extract output gaps and to separate trend and cycles; to measure the effect of permanent and transitory shocks on domestic and international variables and to deal with large data (assets, consumers, firms, sectors, etc.). It also provides an introduction to the estimation of Dynamic Stochastic General Equilibrium (DGSE) models.

It is assumed participants are familiar with the following topics:

(a) Representative agent models used in dynamics macroeconomics.
(b) Basic statistics and theoretical econometric tools.
(c) Working knowledge of MATLAB/ Dynare programming language.

The lectures are largely based on:

- Methods for Applied Macroeconomic Research, Princeton University Press, 2007, by Fabio Canova
- Structural Macroeconometrics: Second Edition, Princeton University Press, 2011, DeJong and Dave
- Lecture notes of previous versions of the class were kindly made available by Fabio Canova and Jesús Fernández-Villaverde

Lecture notes will be posted together with homework and practice activities. Other useful books include:

- Time series analysis, Princeton University Press, 1994, J. Hamilton
- Structural Vector Autoregressive Analysis, Cambridge University Press, 2017, L. Kilian and H. Lutkepohl

Grading Policy

- Exam: 0.70.
- Homework: 0.15.
- Presentations: 0.15.

The exam will take the form of a term project which will include a replication of a paper and an original application.

Program

The material covered per week is indicative and can vary depending on the progress made. The reading list might be subject to changes.

Part I: Applied time series methods

Week 1

- Refresher of univariate time series models. Stationery and ergodicity. Autocovariances of AR and ARMA models.
- Covariance generating function.
- Invertibility.
- Introduction to Hitchhiker guide to empirical macroeconomics. Slides and video presentations can be found at: https://sites.google.com/view/fabio-canova-homepage/home/empirical-macro-toolbox

Week 2

- ML estimation of AR (1) (conditional and unconditional), AR(p) and ARMA(p,q). Properties of ML estimators and tests.

Week 3:

- Homework 1 due.
- Introduction to multivariate time series models.
- Wold theorem.
- Causality and exogeneity.
- Estimation and inference in classical VARs.

Week 4:

- Shock identification and estimation procedures.
- Bayesian methods for time series. Markov Chain Monte Carlo methods, Metropolis-Hastings and the Gibbs sampler
- Bayesian VARs.
- Priors for VARs and impulse responses.
- Forecasting and large VARs.
- Homework 2 due.

Reading list and potential papers for presentation:

- Giannone, D., Lenza, M. and Primiceri, G. (2019). Priors for the long run. Journal of the American Statistical Association, 114, 565-580.
- Chan, J (2022). Asymmetric conjugate priors for large Bayesian VARs, Quantitative Economics, 13, 1145-1169.
- Jarocinski, M. (2023). Estimating the Fed's unconventional monetary policy, ECB manuscript.
- Lenza and Primerci (2022). How to estimate a vector autoregression after March 2020. Journal of Applied Econometrics. Vol. 37, issue 4.
- Carriero, Clark, Marcellino, Mertens (2024). Addressing COVID-19 Outliers in BVARs with Stochastic Volatility. Review of Economics and Statistics, Vol. 106, Issue 5.
- Lutz K., Plante, M. and Richter, A. (2025). Macroeconomic responses to uncertainty shocks. The perils of recursive orderings, Journal of Applied Econometrics
- Altavilla, C., Brugnolini, L., Gurkaynak, R., Motto, R., and Ragusa, G. (2019). Measuring euro area monetary policy. Journal of Monetary Economics, 108: 162–179.
- Kaenzig (2021). The Macroeconomic Effects of Oil Supply News: Evidence from OPEC Announcements. American Economic Review. Vol. 111, No 5.
- Krishnamurthy, A., and Vissing-Jorgensen, A. (2011). The effects of quantitative easing on interest rates: Channels and implications for policy. Brookings Papers on Economic Activity, 215 265.

- Baumeister, C. and Hamilton, J. (2015). Sign Restrictions, Structural Vector Autoregressions, and Useful Prior Information. Econometrica 83(5): 1963—1999.
- Arias, J, Rubio, J. and Wagggoner, D. (2022) Uniform prior for Impulse responses, Emory University, manuscript.
- Inoue A. and Kilian, L. (2020) The Role of the Prior in Estimating VAR Models with Sign Restrictions, Dallas Fed, working paper 2030.
- Giannone, D., Lenza, M. and Primiceri, G. (2021). Economic Predictions With Big Data: The Illusion of Sparsity, Econometrica, 89(5), 2409-2437.
- C. K. Wolf (2022), What Can We Learn From Sign-Restricted VARs? AEA Papers and Proceedings, 112, pp. 471-475
- M. Bánbura, D. Giannone, M. Lenza (2015). Conditional forecasts and scenario analysis with vector autoregressions for large cross-sections. International Journal of Forecasting, Volume 31, Issue 3
- G. E. Primiceri (2005). Time Varying Structural Vector Autoregressions and Monetary Policy. ReStud, Volume 72, Issue 3
- Antolin Diaz, J. and J. Rubio Ramirez (2018). Narrative sign restrictions for VARs. American Economic Review, 108, 2802-2829.
- Van Ravenzwaaij, D., Cassey, P. , Brown , S. (2018) A simple introduction to Markov Chain Monte–Carlo sampling,https://link.springer.com/article/10.3758/s13423-016-1015-8 (not for presentation)

Week 5:

- Paper presentations on VARs
- Local projections and small sample issues.
- Asymmetric local projections.
- Cross sectional local projections.

Reading list and potential papers for presentation: (VARs and LPs):

- Miranda Agrippino, S. and Ricco, G. (2018) Bayesian Vector autoregression, hal-03458277.
- Cloyne, J., Ferreira, C., and Surico, P. (2020). Monetary policy when households have debt: New evidence on the transmission mechanism. Review of Economic Studies, 87(1): 102–129.
- Sílvia Gonçalves, Ana María Herrera, Lutz Kilian, Elena Pesavento (2024), State-dependent local projections, Journal of Econometrics, Volume 244, Issue 2
- Karadi, P. and M. Jarocinski (2020). Deconstructing Monetary Policy Surprises: The role of information shocks. American Economic Journal: Macroeconomics, 12(2), 1-43
- Canova, F. and F. Ferroni (2022) Mind the gap! Stylized Dynamic Facts and Structural Models, American Economic Journal, 14(4), 104-135.
- Keweloh, S. (2021). A Generalized Method of Moments Estimator for Structural Vector Autoregressions Based on Higher Moments. Journal of Business & Economic Statistics 39.3, 772 782.
- Lanne, M., Meitz, M., and Saikkonen, P. (2017). Identification and Estimation of Non-Gaussian Structural Vector Autoregressions, Journal of Econometrics, 196, pp. 288-304.
- Stock, J. and M. Watson (2018). Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments. Economic Journal, 128, 917-947.
- Cloyne, J., O. Jorda and A. Taylor (2023) State dependent local projections: understanding impulse response heterogeneity, CEPR working paper 17903.

- F. Canova (2022) Should we trust cross-sectional multiplier estimates?, forthcoming, Journal of Applied Econometrics,
- Bruns, M. and Lutkepohl, H. (2022) Comparison of local projection estimator for proxy vector autoregression, Journal of Economic Dynamics and Control, 134, 1-17.
- Plagborg-Moller, M. and C. Wolf (2020). Local projections and VARs estimate the same impulse responses. Econometrica, 89, 955-980.
- M. Plagborg-Moller, D. Li and C. K. Wolf (2024). Local Projections vs. VARs: Lessons From Thousands of DGPs. Journal of Econometrics, Vol. 244, Issue 2.
- M. Plagborg-Moller , J. L. Montiel Olea, E. Qian, and C. K. Wolf (2025). Local Projections or VARs? A Primer for Macroeconomists. Prepared for the NBER Macroeconomics Annual 2025
- A. MacKay and C. K. Wolf (2023). What Can Time Series Regressions Tell Us About Policy Counterfactuals? Econometrica, 91(5), pp. 1695–1725

Week 6:

- Paper presentations on LP + VARs
- Factor models.
- FAVARs. Some nonlinear models (TVAR, Markov switching, Threshold VARs).

Additional readings:

- Stock, J. and M. Watson (2016). Dynamic Factor Models, Factor-Augmented Vector Autoregressions, and Structural Vector Autoregressions in Macroeconomics. Handbook of Macroeconomics, volume 2, 415-525
- Hallin, M. and Liska, R. (2011). Dynamic factors in the presence of blocks. Journal of Econometrics ,163, 29-41.
- Chen, C. and Lee, J. (1995). Bayesian inference of threshold autoregressive models. Journal of Time Series Analysis, 16 (5), 483-492.

Week 7:

- Introduction to trend and cycle decompositions.
- Burns and Mitchell approach. Frequency domain decomposition methods.
- MA filters (the Hodrick and Prescott, band pass, wavelet).
- Hamilton filter, Unobservable component models.
- VAR methods. Collection of cyclical facts. Interpretation problems.
- Additional presentations of students could be scheduled here.
- Homework 3 due.

Additional readings:

- J. Hamilton (2018). Why you should never use the Hodrick and Prescott Filter, Review of Economics and Statistics, 100(5), 831-843..
- C. Chang, K. Chen, D. Waggoner and T. Zha (2015). Trend and cycles in China economy, NBER macroeconomic annual, 30(1),1-84.
- F. Canova (2022) FAQ: How to I estimate the output gap? https://sites.google.com/view/fabiocanova-homepage/home/current-research.

- M. Del Negro, D. Giannone, M. Giannoni and A. Tambalotti (2019) Global trends in interest rates, Journal of International Economics, 118, 248-262.

Part II: Structural estimation and inference in representative agents DSGE models.

Week 8:

- Perturbation methods for DSGE.
- Calibration of DSGE. Examples.

Papers for presentation:

- Bayer, Christian, Benjamin Born, and Ralph Luetticke. 2024. "Shocks, Frictions, and Inequality in US Business Cycles." American Economic Review 114 (5): 1211–47**.**
- Bianchi, Francesco, and Leonardo Melosi. 2017. "Escaping the Great Recession." American Economic Review 107 (4): 1030–58**.**
- Borağan Aruoba, Pablo Cuba-Borda, Frank Schorfheide, 2018, "Macroeconomic Dynamics Near the ZLB: A Tale of Two Countries," The Review of Economic Studies, Volume 85, Issue 1, Pages 87–118,
- Christiano, Lawrence J., Roberto Motto, and Massimo Rostagno. 2014. "Risk Shocks." American Economic Review 104 (1): 27–65**.**
- Fernández-Villaverde, Jesús, and Juan F. Rubio-Ramírez, "Estimating Macroeconomic Models: A Likelihood Approach, The Review of Economic Studies, Volume 74, Issue 4, October 2007, Pages 1059–1087.
- Ferrante, Francesco & Graves, Sebastian & Iacoviello, Matteo, 2023. "The inflationary effects of sectoral reallocation," Journal of Monetary Economics, Elsevier, vol. 140(S), pages 64-81.
- Justiniano, Alejandro, Giorgio E. Primiceri, and Andrea Tambalotti, 2011, "Investment shocks and the relative price of investment," Review of Economic Dynamics, 14 (1), 102–121.
- Nuño Galo, and Carlos Thomas. 2017. "Bank Leverage Cycles," American Economic Journal: Macroeconomics, vol. 9(2), pages 32-72.
- Smets, Frank, and Rafael Wouters. 2007. "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." American Economic Review 97 (3): 586–606**.**
- Winberry, Thomas. 2018. "A method for solving and estimating heterogeneous agent macro models," Quantitative Economics, 9 (3), 1123–1151.

Week 9:

- State space models, the Kalman filter
- ML estimation of DSGE. Examples
- Bayesian estimation of DSGE models (I)

Week 10:

- Bayesian estimation of DSGE models (II)
- Homework 4
- Paper presentations on DSGE estimation

Potential final reproduction projects (only suggestions, you can choose others, including the papers for presentation):

i) Ramey, V. A. and S. Zubairy (2018). Government spending multipliers in good times and in bad: evidence from us historical data. Journal of Political Economy 126(2), 850–901
ii) Alessandri, P. and H. Mumtaz (2019). Financial regimes and uncertainty shocks. Journal of monetary economics 101, 31–46.
iii) Debortoli, D., J. Galı, and L. Gambetti (2019). On the Empirical (Ir)Relevance of the Zero Lower Bound Constraint, NBER macro annual 2019, see also comment by M. Watson.
iv) Ascari, G., Friis, P., Florio, A. and Gobbi, A. (2023) Fiscal foresight and the effects of government spending: It's all in the monetary fiscal mix". In: Journal of Monetary Economics 134. 1–15.
v) Schuler, Y. S., Hiebert, P. P., and Peltonen, T. A. (2020). Financial Cycles: Characterisation and Real-Time Measurement. Journal of International Money and Finance, 100(1).
vi) Basu, S. and Bundick, B. (2017). Uncertainty shocks in a model of effective demand. Econometrica, 85(3):937–958.
vii) Jurado, K., Ludvigson, S. C., and Ng, S. (2015). Measuring uncertainty. American Economic Review, 105(3):1177–1216.
viii) Bachmann, R. and Bayer, C. (2013). 'wait-and-see'business cycles? Journal of Monetary Economics, 60(6):704–719.
ix) Angeletos, G.-M., F. Collard, and H. Dellas (2020). Business-cycle anatomy. American Economic Review 110 (10), 3030–70.
x) Barnichon, R. and C. Matthes (2018). Functional Approximation of Impulse Responses. Journal of Monetary Economics 99, 41–55.
xi) Jarocinski, M. and P. Karadi (2020). Deconstructing Monetary Policy Surprises—The Role of Information Shocks. American Economic Journal: Macroeconomics 12 (2), 1–43.
xii) Canova, F. (2007). G-7 inflation forecasts: Random walk, phillips curve or what else? Macroeconomic Dynamics, 11 (1), 1–30.
xiii) Tenreyro, S., and Thwaites, G. (2016). Pushing on a string: US monetary policy is less powerful in recessions. American Economic Journal: Macroeconomics, 8(4): 43–74.
xiv) Coibion, O., Y. Gorodnichenko, and M. Ulate (2018).The cyclical sensitivity in estimates of potential output. Brookings Papers on Economic Activity.
xv) Christiano, L. J., Eichenbaum, M., & Evans, C. L. (2005). Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. Journal of Political Economy, *113*(1), 1–45.
xvi) Gertler, M. and P. Karadi (2011). "A model of unconventional monetary policy," Journal of Monetary Economics, Elsevier, vol. 58(1), 17-34.
xvii) Bernanke, B. S., M. Gertler, and S. Gilchrist, (1999). "The financial accelerator in a quantitative business cycle framework," Handbook of Macroeconomics, in: J. B. Taylor & M. Woodford (ed.), Handbook of Macroeconomics, edition 1, volume 1, chapter 21, 1341-1393.
xviii) Nuño, G., C. Thomas, (2017). "Bank Leverage Cycles," American Economic Journal: Macroeconomics, vol. 9(2), 32-72.
xix) Smets, F., and R. Wouters, (2007). "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." American Economic Review 97 (3): 586–606**.**
xx) Comin, D., and M. Gertler (2006). "Medium-Term Business Cycles." American Economic Review 96 (3): 523–551.