Learning and Expectations Formation.

Training School, EABCN

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Overview

This course reviews the implications of relaxing the rational expectations assumption in dynamic models. We focus on applications to macroeconomics and asset pricing. We study the implications of replacing the rational expectations hypothesis by the view that agents are learning and constantly trying to improve their forecasts. The course reviews the basic theoretical results of the learning literature, applications of learning models to explain empirical phenomena and to inform the design of fiscal and monetary policy.

Learning is a new way of thinking about macroeconomic dynamics. It was used initially to assess the plausibility of rational expectations equilibria (REE) and to select among equilibria when there are multiple REE. Lately more work focuses on empirical performance and policy implications. The modern approach to *adaptive learning* differs from the *adaptive expectations* approach of the 1950's by using rational expectations equilibria as a reference point and by emphasizing the implications of *small* deviations from full forecast rationality. The macroeconomic predictions induced by adaptive learning dynamics recently allowed to interpret and replicate a variety of empirical phenomena that would otherwise appear puzzeling from the viewpoint of RE models.

Practice Sessions

There will be four hours of practice sessions in total, given by Sofía Bauducco (Banco de Chile). Sofía will discuss how to write programs to simulate and estimate the models discussed in the theory sessions, and she will show outputs of such programs. Matlab code to perform the simulations will be distributed. There is no PC-lab in the facilities where the course takes place. Whenever possible, course participants should bring their own laptop computer with Matlab so they can run the programs on their own computer.

Schedule:

Teacher's initials indicate who gives each session.
The content of each Part is shown in the program below

Monday Oct. 19:
-9:00-11:00: Part I (AM)
-2:00-4:00: Part I (AM)
-4:30-5:30: Practice session (SB)

Tuesday Oct. 20:
-9:00-11:00: Part I (AM)
-2:00-4:00: Part II (KA)
-4:30-5:30: Part II (KA)

Wednesday Oct. 21:
-9:00-11:00: Part III (KA)
-2:00-4:00: Part III (KA)
-4:30-5:30: Practice session (SB)

Thursday Oct. 22:
-9:00-11:00: Part IV (AM)
-2:00-4:00: Part IV and V (AM)
-4:30-5:30: Practice session (SB)

Friday Oct. 22:
-9:00-11:00: Part V (KA)
-1:45-2:45: Part V (KA)
-2:45-3:45: Practice session (SB)

PROGRAM

* indicates recommended readings for the course.

General background:

* Sargent, T.J. (2008), 'Evolution and Intelligent Design', AEA Presidential Address, American Economic Review, Vol 98(1), pp. 5-37

Books and survey papers on learning:

Sargent, T.J. (1993), 'Bounded Rationality in Macroeconomics', Oxford: Clarendon Press.

Marimon, R. (1997), 'Learning from Learning in Economics', in Kreps, D.W. and K. Wallis (eds.), *Advances in Economic Theory and Econometrics, Volume 1*, Cambridge: CUP.

Sargent, T.J. (1999), 'The Conquest of American Inflation', Princeton Univ. Press.

Evans, G.W. and S. Honkapohja (1999), "Learning Dynamics", in Taylor, J.B. and M. Woodford, eds., (1999), *Handbook of Macroeconomics, Volume I A*, Elsevier: Amsterdam, 449-542.

Evans, G.W. and S. Honkapohja (2001), 'Learning and Expectations in Macroeconomics', Princeton University Press.

PART I: Introduction, Fundamental Tools & Convergence to Rational Expectations

I.a Why models of learning and which ones?

- Rational Expectations Equilibria (REE): structure, information assumptions, multiplicities.

- Learning in equilibrium (Bayesian REE) versus learning of an equilibrium (adaptive learning).

- Today's adaptive learning approach versus 1950's adaptive expectations.

- Critical views: free parameters and other problems.

- A basic laboratory: the monetary seignorage model.

* Chapter 1 in Evans, G. and S. Honkapohja (2001), 'Learning and Expectations in Macroeconomics', Princeton University Press.

Sargent, T.J. and N. Wallace (1987), 'Inflation and the Government Budget Constraint' in Economic Policy in Theory and Practice, ed. by Assaf Razin and Efraim Sadka. New York: Macmillan.

I.b The mathematical toolkit

(Day I, afternoon)

- least squares and other learning mechanisms

- Stochastic approximation

- o.d.e. approach

Main references in the economics literature:

* Chapters 2 and 3 in Evans, G. and S. Honkapohja (2001), 'Learning and Expectations in Macroeconomics', Princeton University Press.

Marcet, A. and T. Sargent (1989), 'Convergence of Least Squares Mechanisms in Self-Referential Linear Stochastic Models', Journal of Economic Theory 48, 337 - 368.

Marcet, A. and T. Sargent (1989), "Convergence of Least Squares Learning in Environments with Hidden State Variables and Private Information", Journal of Political Economy 97(6),1306-1322 .

Evans, G.W. and S. Honkapohja (1998), 'Economic Dynamics with Learning: New Stability Results', Review of Economic Studies, 65, 23-44.

I.c Convergence to RE

- E-stability principle of RE equilibria

- Examples: a model of money demand, a model of seignorage, asset pricing, heterogeneous agents.

- Least squares and related learning schemes in multivariate linear economies

PART II: Learning and Monetary Policy Design

II.a Price level determination in Basic Sticky Price Models under Rational Expectations

- Introduction to the New Keynesian model and its linearized form

- Equilibrium determinacy and Taylor principle

* Chapter 2 in Galí, Jordi (2008), 'Monetary Policy, Inflation and the Business Cycle', Princeton University Press.

II.b Designing monetary policy rules when agents are learning

- insuring expectational stability (E-Stability) of the targeted policy outcomes

- insuring fast convergence to the targeted policy outcome following expectational deviations

- potential pitfalls of policy designs that wrongly assume rational private sector expectations

Bullard, Jim and Kaushik Mitra (2002), 'Learning about monetary policy rules', Journal of Monetary Economics, 49(6), 1105-1129.

* Evans, George and Seppo Honkapohja (2003), 'Expectations and the Stability Problem for Optimal Monetary Policy',Review of Economic Studies, 70, 807-824,

* Orphanides, Athanasios and John C. Williams (2005), 'Inflation Scares And Forecast-Based Monetary Policy', Review of Economic Dynamics, 8(2), 498-527.

* Ferrero, Giuseppe (2007), Monetary policy, learning and the speed of convergence, Journal of Economic Dynamics and Control, 31, 3006-3041.

Marcet, A., Sargent, T.J., (1995), Speed of convergence of recursive least squares: learning with autoregressive moving-average perceptions. In: Kirman, A., Salmon, M. (Eds.), Learning and Rationality in Economics. Basil Blackwell, Oxford, pp. 179–215.

Part III: Models of Learning and the Cyclical Response to Shocks

III.a Learning and the propagation of nominal shocks in basic sticky price models

* Adam, Klaus (2005), 'Learning to Forecast and Cyclical Behavior of Output and Inflation', Macroeconomic Dynamics, 9(1), 1-27.

* Adam, Klaus (2007), 'Experimental Evidence on the Persistence of Output and Inflation', Economic Journal, 117, 603-635

Santoro, Sergio (2008), 'Adaptive Learning and Inflation Dynamics in a Flexible Price Model', mimeo

III.b Learning in more elaborate dynamic general equilbrium (DGE) models

* Milani,Fabio (2007), 'Expectations Learning and Macroeconomic Persistence', Journal of Monetary Economics, 54(7), 2065-2082.

Wouters, Raf and Sergey Slogodyan (2007), 'Learning in an Estimated Medium Scale DSGE Model', mimeo

Part IV:Observed Monetary Policy and learning

IV Explaining postwar US monetary policy and hyperinflationary experiences with models of learning

Sargent, T.J. (1999), 'The Conquest of American Inflation', Princeton Univ. Press.

Marcet, Albert and Juan P. Nicolini (2003), 'Recurrent Hyperinflations and Learning', American Economic Review, 93, 1476-1498.

Part V: Models of Learning to Understand Asset Prices.

V.a Models of learning to understand asset price behavior

* Adam, Klaus, Albert Marcet and Juan Pablo Nicolini (2008), 'Stock Market Volatility and Learning', mimeo.

Timmermann, Alan (1996), 'Excess volatiliy and predictability of stock market prices in autoregressive dividend models with learning', Review of Economic Studies, 63, 523-557.

V.b Decision theoretic foundations of learning models and fragility of present value formulations

*Adam, Klaus, Albert Marcet, and Juan Pablo Nicolini (2008), ´Internal Rationality and Asset Prices', mimeo