

Heterogeneous-Agent Macro Workshop

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June 6–8, NBER, Cambridge, MA

Workshop objective: This workshop covers recent developments in the literature on heterogeneous-agent macroeconomics. The objective is twofold: 1) give you a solid understanding of the current state of literature on monetary and fiscal policy with heterogeneous agents (the so-called “HANK” literature), in both open and closed economies, and, through this application, 2) introduce you to state-of-the-art solution methods for general equilibrium heterogeneous-agent models. The hope is to equip you with the necessary knowledge and tools to conduct your own research in the area.

On the methods side, we will cover the “sequence-space” approach to solving general equilibrium models with heterogeneous agents. We will go through the details of solving for steady states and impulse responses, as well as estimation methods for standard models. We will also cover models with discrete choices and/or fixed costs.

Even though HANK is our main application, we emphasize that these methods are applicable to many other areas within heterogeneous-agent macroeconomics. As an illustration, we will cover models of price setting with menu costs.

We also emphasize practicality. The material comes with Python notebooks that contain the source code for all models and results that we cover in class. Over the course of five computer tutorials, we will go through these notebooks, as well as simple problem-set type questions. There, we will share practical tips on how to set up models, solve them, and write code that is fast and efficient.

Our goal is to get you to the point where you can solve complex models in a limited amount of time. Because of this, all of our tutorials will use the [sequence-space-jacobian](#) (SSJ) toolbox. This will jump-start us by avoiding rewriting everything from scratch. Our objective, however, is not just to teach you how to use SSJ, but also to give you a deep understanding of what is going on in its background, so that you can use it or modify it for your own advanced application.

Prerequisites. A solid grasp of macroeconomics at the level of a first-year PhD course (in particular dynamic programming and the standard 3-equation New Keynesian model) is essential. In addition, basic familiarity with Python is required (useful Python resources are provided below.) All the students attending the workshop have finished the 2nd year of their PhD or equivalent.

Location. All events take place at the Royal Sonesta Hotel. Lectures are in Longfellow BC room (West Tower). Lunches will be in Longfellow A. Dinners will be in Parkview (East Tower).

Funding. Meals, flights and accommodation are covered by the NBER under the generous support of the National Science Foundation.

Workshop material. Lecture notes will be posted as we go along on the NBER workshop webpage:

<https://www.nber.org/conferences/heterogeneous-agent-macro-workshop-spring-2022>.

Accompanying code will be posted as we go along on the class GitHub repo at:

<https://github.com/shade-econ/nber-workshop-2022>.

Python preparation. If you are relatively new to Python, we recommend having the **Anaconda distribution of Python** installed to make sure you have all necessary libraries. There are many outstanding resources you can find online, but two good introductory resources are the **introductory lecture series at QuantEcon** and the **Python data science handbook** (ignoring the machine learning content in the latter).

If you are accustomed to Matlab or Julia, QuantEcon's **Matlab-Python-Julia cheatsheet** can be useful, as can **NumPy for Matlab users** (ignoring now-obsolete "matrix" class at the end).

Overall, a good goal prior to the workshop is to make sure that you can run and mostly follow the **"Standard Incomplete Markets Steady State" notebook** posted in the course GitHub repo, which covers the initial material of the class and does not require our SSJ toolkit.

For the in-class tutorials, you will need **SSJ** installed on your laptop. We are aware of issues with some users and are planning an update before the workshop starts which should fix most of these, so don't panic if this doesn't work for you right away.

Other preparation. Before each day, you are encouraged to read ahead the class lecture notes. The references provided in the syllabus may also be useful.

Laptops. Please come with your laptop fully charged as well as a charger so that you can follow the tutorials. There will be power outlets in the classroom.

Covid policy. To minimize Covid risks, we ask that everyone wears a mask during classes, except for the presenter.

Class plan. The plan for each class is outlined below.

Time	Topic	Instructor
<i>Monday</i> <i>Fiscal policy with heterogeneous agents</i>		
8:30am	The standard incomplete markets model: steady state	Matt
10am	The standard incomplete markets model: transitional dynamics	Matt
11:30am	The canonical HANK model	Ludwig
2:00pm	Fiscal policy in the canonical HANK model	Ludwig
3:30pm	Tutorial 1: using SSJ for fiscal policy analysis	Michael + L
<i>Tuesday</i> <i>Monetary policy with heterogeneous agents</i>		
8:30am	Monetary policy in the canonical HANK model	Adrien
10am	Monetary policy topics in closed economies	Adrien
11:30am	Tutorial 2 : using SSJ for closed-economy monetary policy analysis	Michael + A
2:00pm	Monetary policy in the open economy	Ludwig
3:30pm	Tutorial 3 : using SSJ for open-economy monetary policy analysis	Michael + L
<i>Wednesday</i> <i>Advanced topics in heterogeneous-agent macro</i>		
8:30am	Estimating HANK	Adrien + M
10:00am	Discrete choice with extreme-value taste shocks	Bence
11:30am	Tutorial 4: using SSJ for EV discrete-choice models	Bence
2:00pm	Price-setting with menu costs	Matt

Background reading

Useful literature overviews

Heathcote, J., Storesletten, K. and Violante, G.L. (2009). **Quantitative Macroeconomics with Heterogeneous Households**. *Annual Review of Economics* 1(1):319–354

Krueger, D., Mitman, K. and Perri, F. (2016). **Chapter 11 - Macroeconomics and Household Heterogeneity**. In: J.B. Taylor and H. Uhlig (eds.) *Handbook of Macroeconomics*, vol. 2, pp. 843–921. Elsevier

Kaplan, G. and Violante, G.L. (2018). **Microeconomic Heterogeneity and Macroeconomic Shocks**. *Journal of Economic Perspectives* 32(3):167–194

Galí, J. (2018). **The State of New Keynesian Economics: A Partial Assessment**. *Journal of Economic Perspectives* 32(3):87–112

Methods

*Auclert, A., Bardóczy, B., Rognlie, M. and Straub, L. (2021b). **Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models**. *Econometrica* 89(5):2375–2408

Ahn, S., Kaplan, G., Moll, B., Winberry, T. and Wolf, C. (2018). **When Inequality Matters for Macro and Macro Matters for Inequality**. *NBER Macroeconomics Annual* 32(1):1–75

Reiter, M. (2009). **Solving Heterogeneous-Agent Models by Projection and Perturbation**. *Journal of Economic Dynamics and Control* 33(3):649–665

Day 1: Fiscal policy

1. The standard incomplete markets model

*Lecture slides 1

Deaton, A. (1992). *Understanding Consumption*. Oxford University Press, USA

Carroll, C.D. (1997). *Buffer-Stock Saving and the Life Cycle/Permanent Income Hypothesis*. *Quarterly Journal of Economics* 112(1):1–55

Aiyagari, S.R. (1994). *Uninsured Idiosyncratic Risk and Aggregate Saving*. *Quarterly Journal of Economics* 109(3):659–684

Kaplan, G. and Violante, G.L. (2022). *The Marginal Propensity to Consume in Heterogeneous Agent Models*. Working Paper 30013, National Bureau of Economic Research

2. The canonical HANK model

*Lecture slides 2

*Auclert, A., Rognlie, M. and Straub, L. (2018). *The Intertemporal Keynesian Cross*. Working Paper 25020, National Bureau of Economic Research,

Werning, I. (2015). *Incomplete Markets and Aggregate Demand*. Working Paper 21448, National Bureau of Economic Research,

Auclert, A., Bardóczy, B. and Rognlie, M. (2021a). *MPCs, MPEs and Multipliers: A Trilemma for New Keynesian Models*. *Review of Economics and Statistics* Forthcoming

Broer, T., Hansen, N.J.H., Krusell, P. and Öberg, E. (2020). *The New Keynesian Transmission Mechanism: A Heterogeneous-Agent Perspective*. *Review of Economic Studies* 87(1):77–101

3. Fiscal policy in the canonical HANK model

*Lecture slides 3

*Auclert, A., Rognlie, M. and Straub, L. (2018). *The Intertemporal Keynesian Cross*. Working Paper 25020, National Bureau of Economic Research,

Woodford, M. (2011). *Simple Analytics of the Government Expenditure Multiplier*. *American Economic Journal: Macroeconomics* 3(1):1–35

McKay, A. and Reis, R. (2016). *The Role of Automatic Stabilizers in the U.S. Business Cycle*. *Econometrica* 84(1):141–194

Hagedorn, M., Manovskii, I. and Mitman, K. (2019). *The Fiscal Multiplier*. Working Paper 25571, National Bureau of Economic Research,

Day 2: Monetary policy

4. Monetary policy in the canonical HANK model

*Lecture slides 4

Auclert, A. (2019). *Monetary Policy and the Redistribution Channel*. *American Economic Review* 109(6):2333–2367

Kaplan, G., Moll, B. and Violante, G.L. (2018). *Monetary Policy According to HANK*. *American Economic Review* 108(3):697–743

McKay, A., Nakamura, E. and Steinsson, J. (2016). *The Power of Forward Guidance Revisited*. *American Economic Review* 106(10):3133–3158

Werning, I. (2015). *Incomplete Markets and Aggregate Demand*. Working Paper 21448, National Bureau of Economic Research,

Auclert, A., Rognlie, M. and Straub, L. (2020). *Micro Jumps, Macro Humps: Monetary Policy and Business Cycles in an Estimated HANK Model*. Working Paper 26647, National Bureau of Economic Research,

5. Monetary policy in the open economy

*Lecture slides 5

*Auclert, A., Rognlie, M., Souchier, M. and Straub, L. (2021c). *Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel*. Working Paper 28872, National Bureau of Economic Research,

Galí, J. and Monacelli, T. (2005). *Monetary Policy and Exchange Rate Volatility in a Small Open Economy*. *Review of Economic Studies* 72(3):707–734

Guo, X., Ottonello, P. and Perez, D. (2021). *Monetary Policy and Redistribution in Open Economies*. Working Paper 28213, National Bureau of Economic Research,

Aggarwal, R., Auclert, A., Rognlie, M. and Straub, L. (2022). *Excess Savings and Twin Deficits: The Transmission of Fiscal Stimulus in Open Economies*. *NBER Macroeconomics Annual 2022*

Day 3: Advanced topics

6. Estimating HANK

*Lecture slides 6

Auclert, A., Bardóczy, B., Rognlie, M. and Straub, L. (2021b). **Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models.** *Econometrica* 89(5):2375–2408

Herbst, E.P. and Schorfheide, F. (2015). *Bayesian Estimation of DSGE Models.* Princeton University Press

Fernández-Villaverde, J., Rubio-Ramírez, J. and Schorfheide, F. (2016). **Chapter 9 - Solution and Estimation Methods for DSGE Models.** In: J.B. Taylor and H. Uhlig (eds.) *Handbook of Macroeconomics*, vol. 2, pp. 527–724. Elsevier

7. Discrete choice with extreme-value taste shocks

*Lecture slides 7

Iskhakov, F., Jørgensen, T.H., Rust, J. and Schjerning, B. (2017). **The Endogenous Grid Method for Discrete-Continuous Dynamic Choice Models with (or Without) Taste Shocks.** *Quantitative Economics* 8(2):317–365

Druedahl, J. (2021). **A Guide on Solving Non-convex Consumption-Saving Models.** *Computational Economics* 58(3):747–775

Bardóczy, B. (2022). **Spousal Insurance and the Amplification of Business Cycles.** *Manuscript*

8. Price-setting with menu costs

*Lecture slides 8

*Auclert, A., Rigato, R., Rognlie, M. and Straub, L. (2022). **New Pricing Models, Same Old Phillips Curves?** *Working Paper*

Golosov, M. and Lucas, R.E. (2007). **Menu Costs and Phillips Curves.** *Journal of Political Economy* 115(2):171–199

Alvarez, F., Le Bihan, H. and Lippi, F. (2016). **The Real Effects of Monetary Shocks in Sticky Price Models: A Sufficient Statistic Approach.** *American Economic Review* 106(10):2817–2851

Alvarez, F. and Lippi, F. (2022). **The Analytic Theory of a Monetary Shock.** *Econometrica* forthcoming