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) 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.

Even though HANK is our main application, we emphasize that these methods are applicable to many other areas within heterogeneous-agent macroeconomics. For instance, we will cover and show you how to solve consumption-savings model with fixed costs of working, and price-setting models 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. During our 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, some of our tutorials will using 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 the methods that it uses. For your own advanced application, you may want to either use SSJ, or write up your own sequence-space solution method. We’ll cover both approaches.

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. Breakfast, lunch, and all courses take place at the NBER main office at 1050 Mass. Ave. Dinners will be at local restaurants. Look out for announcements each day about dinner venues.
**Funding.** Meals, flights and accommodation are covered by the NBER under the generous support of the National Science Foundation and the Chae Initiative on Macroeconomic Policy at Harvard.

**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-2023. Accompanying code will be posted as we go along on the class GitHub repo at: https://github.com/shade-econ/nber-workshop-2023.

**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).

For the in-class tutorials, you will need SSJ installed on your laptop. For the discrete choice tutorial we will also use the Cubic-Spline package. You can install both via pip.

**First lecture online.** To save time on the first day, we have pre-recorded the first lecture. The link to the video recordings for the lecture is available in the GitHub repo. Please watch this lecture before class on Monday. You are encouraged to follow along and play around with the accompanying notebook yourself!

**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.

If you would like even more preparation, you can go over last year’s workshop material, as well the material in last year’s GitHub repo.

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

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>before Monday</td>
<td>Warm-up</td>
<td></td>
</tr>
<tr>
<td>online</td>
<td>The standard incomplete markets model and methods, part I</td>
<td>Matt</td>
</tr>
<tr>
<td>Monday</td>
<td>Methods and fiscal policy</td>
<td>Matt</td>
</tr>
<tr>
<td>8:30am</td>
<td>The standard incomplete markets model and methods, part II</td>
<td>Matt</td>
</tr>
<tr>
<td>10am</td>
<td>The standard incomplete markets model and methods, part III</td>
<td>Matt</td>
</tr>
<tr>
<td>11:30am</td>
<td>The canonical HANK model</td>
<td>Ludwig</td>
</tr>
<tr>
<td>2:15pm</td>
<td>Fiscal policy in the canonical HANK model</td>
<td>Ludwig</td>
</tr>
<tr>
<td>3:45pm</td>
<td>Tutorial: fiscal policy analysis</td>
<td>Ludwig</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Monetary policy and estimation</td>
<td></td>
</tr>
<tr>
<td>8:30am</td>
<td>Monetary policy in the canonical HANK model</td>
<td>Adrien</td>
</tr>
<tr>
<td>10am</td>
<td>Monetary policy topics</td>
<td>Adrien</td>
</tr>
<tr>
<td>11:30am</td>
<td>Tutorial: monetary policy analysis</td>
<td>Adrien</td>
</tr>
<tr>
<td>2:15pm</td>
<td>Tutorial: estimating the canonical HANK model</td>
<td>Adrien + Matt</td>
</tr>
<tr>
<td>3:30pm</td>
<td>Estimating HANK for central banks</td>
<td>Marco + Donggyu</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Advanced topics</td>
<td></td>
</tr>
<tr>
<td>8:30am</td>
<td>Discrete choice with extreme-value taste shocks</td>
<td>Bence</td>
</tr>
<tr>
<td>10:00am</td>
<td>Tutorial: discrete choice</td>
<td>Bence</td>
</tr>
<tr>
<td>11:30am</td>
<td>Non-rational expectations in the sequence space</td>
<td>Ludwig</td>
</tr>
<tr>
<td>2:00pm</td>
<td>Models of price setting and inflation</td>
<td>Matt</td>
</tr>
</tbody>
</table>
Background reading

Useful literature overviews


Methods


Day 1: Methods and fiscal policy

1. The standard incomplete markets model and methods

*Lecture slides 1


2. The canonical HANK model

*Lecture slides 2


3. Fiscal policy in the canonical HANK model

*Lecture slides 3


Day 2: Monetary policy and estimation

4. Monetary policy in the canonical HANK model

*Lecture slides 4


5. Advanced topics in monetary policy

*Lecture slides 5


6. Estimating the canonical HANK model

*Lecture slides 6


7. Estimating HANK for central banks

*Lecture slides 7


Day 3: Advanced topics

8. Discrete choice with extreme-value taste shocks

*Lecture slides 8

9. Non-rational expectations in the sequence space

*Lecture slides 9


10. Models of price setting and inflation

*Lecture slides 10


