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 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 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 accomodation 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:


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


**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.

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

**Useful literature overviews**


**Methods**


Day 1: Fiscal policy

1. The standard incomplete markets model

*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

4. Monetary policy in the canonical HANK model

*Lecture slides 4


5. Monetary policy in the open economy

*Lecture slides 5


Day 3: Advanced topics

6. Estimating HANK

*Lecture slides 6


7. Discrete choice with extreme-value taste shocks

*Lecture slides 7


8. Price-setting with menu costs

*Lecture slides 8


