

# Hands-On Heterogeneous Agent Macroeconomics

## Using the [Econ-ARK/HARK](#) Toolkit

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Syllabus for a short course on Heterogeneous Agent Macroeconomics  
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Because Representative Agent (‘RA’) models were not useful for understanding much of what happened in the Great Recession, policymakers including Larry Summers (2011), Fed Chair Janet Yellen (2016), former IMF Chief Economist Olivier Blanchard (2016), ECB Governing Board Member Benoit Coeure (2013), and Bank of England Chief Economist Andy Haldane (2016) have suggested that incorporation of heterogeneity (for example, across borrowers and lenders) must be an essential part of the agenda in developing new and better models. In confirmation of that intuition, a number of recent papers, most notably Kaplan, Moll, and Violante (2018) and Krueger, Mitman, and Perri (2016), have developed models that include a realistic description of microeconomic heterogeneity, and have shown that such models can generate more sensible macroeconomic implications than RA models for important questions like the operation of fiscal and monetary policy.

This course will provide a hands-on introduction to the construction of models with ‘serious’ heterogeneity (that is, heterogeneity that matches the microeconomic facts that theory suggests *should* matter for macroeconomic outcomes like consumption dynamics); why such heterogeneous agent (‘HA’) models have implications different from those of RA models; and how existing HA models can be adapted to new questions. (‘Hands-On’ means that students with their own laptops will run the and experiment with the code that solves these models in class.)

The course will have two main elements: Lectures explaining the conceptual foundations of the models work; and hands-on demonstrations of live working versions of such models using the open-source [Econ-ARK/HARK](#) toolkit.

Students should bring a laptop on which they have permissions to install and run new software. Prior to class, on that laptop, students should have installed the [anaconda3](#) stack, which is a distribution of python 3 that includes a robust set of extra tools that are useful for doing computational work. A good guide to installing anaconda is [here](#).

# 1 Preliminaries

I have hired a team of people from [Alphacruncher](#) to help with some of the technical and communications setup for the course, and a team member will be present at the beginning of the first day of classes, so we will begin the “hands-on” aspect of the course from the very beginning.

To minimize problems that can crop up with differences across computing platforms and security, we will be doing most of the work for the class “in the cloud” – using a virtual machine configuration set up by Alphacruncher.

But everything we do should be replicable by students on their own laptops if they install HARK and the free “Anaconda” python stack (set of computational tools).

1. Install [Anaconda](#): <https://docs.anaconda.com/anaconda/install>

2. Get Git

Get the command-line tool: <https://atlassian.com/git/tutorials/install-git>

Get a GitHub Account

Download the GitHub Desktop App

– And connect it to your online GitHub account

3. [Install HARK](#): Go to “Quick Start” in the README.md

- Follow the instructions for installing HARK for Anaconda

4. Clone the [DemARK](#) and [REMARK](#) repos

```
git clone https://github.com/econ-ark/DemARK
```

```
git clone https://github.com/econ-ark/REMARK
```

5. Using python from the command line:

```
pip install nose
```

```
python -c import HARK ; print(HARK.__file__)
```

```
cd [root directory for HARK]
```

```
python nose
```

## 2 Motivation

Models with serious microfoundations yield fundamentally different conclusions than RA models about core questions in macroeconomics.

1. How monetary policy works

- HA channels account for most of the mechanism of monetary transmission

2. Whether fiscal policy works

- ‘serious’ HA models are consistent with evidence of MPC’s of 0.5
3. What made the Great Recession Great
- RA models: Mostly a supply shock
  - HA models: Mostly a demand shock

Slides:

[Intro to Monetary Policy with Heterogeneity](#), Crawley (2019)

[Luetticke-RANK](#)

[Luetticke-HANK](#)

Readings:

- \* Ahn et al (2017), Introduction, Conclusion
  - Compact and well written discussion of the state and progress of HA macro.
- \* Carroll and Crawley (2017), [Sections 1, 2, and 4](#)
  - [This discussion](#) of that paper puts the relationship of HA to RA models in context.

## 3 Micro Models

### 3.1 Micro Consumption Theory Refresher

#### 3.1.1 *The Infinite Horizon Perfect Foresight Model*

Notes:

- [Consumption Under Perfect Foresight and CRRA Utility](#)
- [The Certainty Equivalent Consumption Function](#)

#### 3.1.2 *Consumption With Labor Income Uncertainty*

- Notes: [A Tractable Model of Buffer Stock Saving](#)
- Notebook: [Interactive Demo](#)

#### 3.1.3 *The Special Case of Rate-Of-Return Uncertainty*

Notes:

Origins: Merton (1969), Samuelson (1969)

### 3.1.4 Habits

Notes:

- [Consumption Models with Habit Formation](#)

## 4 Computational Tools

### 4.1 Vision for the Econ-ARK Project

- [Intro-To-Econ-ARK](#)

## 5 Hands-On Introduction

Here we will explain how to begin using the [Econ-ARK](#) toolkit for heterogeneous agent macro modeling, and will guide students through the use of the toolkit to solve increasingly sophisticated models, starting with partial equilibrium perfect foresight models and ending with some exercises using a full general equilibrium micro-macro model with idiosyncratic and aggregate risks.

### 5.1 A Gentle Introduction

This section builds our first simple models using the toolkit

We introduce, then build on, the ‘AgentType’ class

#### 5.1.1 Perfect Foresight

Notebook: [A Gentle Introduction to HARK - Perfect Foresight](#)

#### 5.1.2 Adding ‘Serious’ Income Uncertainty

Notebook: [A Gentle Introduction to Buffer Stock Saving](#)

## References

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