# Hands-On Heterogeneous Agent Macroeconomics Using the Econ-ARK/HARK Toolkit

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Syllabus for a minicourse on Heterogeneous Agent Macroeconomics
Open Source Macro Bootcamp

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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.

The aim of this course is to 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 components: 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, students should 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.

Course handouts are available at:

`http://www.econ2.jhu.edu/people/ccarroll/courses/Choice/LectureNotes`

This syllabus contains readings and other assignments, indicated by a ⋆. Items indicated by a • should be skimmed .

# 1 Motivation and Preliminaries

## 1.1 Motivation

Day 1
Lecture 1
mins 60
CDC

The introduction and conclusion to last year's NBER Macro Annual paper by Ahn, Kaplan, Moll, Winberry, and Wolf (2017) provide a compact and well written discussion of the state and progress of HA macro.

Handout:

NBER-Macro-Annual-Heterogeneity-Discuss

Readings:

* Ahn, Kaplan, Moll, Winberry, and Wolf (2017), Introduction, Conclusion
* Carroll and Crawley (2017), Sections 1, 2, and 4

## 1.2 Consumption Theory in a Nutshell

Resource: Lecture Notes on Consumption

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

Handout:

- Consumption Under Perfect Foresight and CRRA Utility

### *1.2.2 Consumption with Labor Income Uncertainty*

Handout:

- A Tractable Model of Buffer Stock Saving

### *1.2.3 Habits*

Handout:

- Consumption Models with Habit Formation

# 2 Computational Tools

Day 1 Lect 2
mins 15
CDC

## 2.1 Vision for the Econ-ARK Project

- Intro-To-Econ-ARK

### 2.2 Intro to Heterogeneous Agents Resources and Toolkit (HARK)

- Intro-To-HARK

# 3 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.

### 3.1 Getting Started

Day 1
Lecture 2
mins 45
CDC

A Gentle Introduction

#### *3.1.1* ***Perfect Foresight*** *from A Gentle Introduction*

### 3.2 Adding 'Serious' Income Uncertainty

#### *3.2.1* ***Realistic Income Shocks*** *from A Gentle Introduction*

# 4 'Serious' HA Macro

Day 2, Lect 1
mins 60
CDC

### 4.1 Excercises in HARK

#### *4.1.1 Nondurables During the Great Recession*

Is it plausible to argue that the collapse in $C$ during the Great Recession was caused by an increase in uncertainty?

#### *4.1.2 Chinese Growth*

Could China's high saving rate reflect precautionary motives in a standard model?

### 4.2 Economics and computation of some papers written using HARK

#### *4.2.1 The Distribution of Wealth and the Marginal Propensity to Consume*

- `paper:` `http://econ.jhu.edu/people/ccarroll/papers/cstwMPC`
- `code:` `https://github.com/econ-ark/HARK/HARK/cstwMPC`

*4.2.2 Sticky Expectations and Consumption Dynamics*

- `paper:` http://econ.jhu.edu/people/ccarroll/papers/cAndCwithStickyE
- `code:` http://github.com/econ-ark/REMARK/Explorations/cAndCwithStickyE

# 5 The Future

Day 2, Lect 2
mins 60
CDC

The near-term and longer-term future of the Econ-ARK toolkit, and of macroeconomics.

## 5.1 Of Econ-ARK/HARK

- Tools Being Added Now

## 5.2 Of Macroeconomics

The term 'HA' is omitted because our view is that most future macroeconomics will be HA macroeconomics!

- Monetary and Fiscal Policy
  - Fiscal Policy
  - Monetary Policy
- Macroprudential Policy
  - Mortgages and Housing
    - How effective are Debt to Value or Debt Service to Income limits?
    - Model the dynamics of 'bubble' beliefs?
  - Financial markets:
    - How much fluctuation is due to households (vs finance industry itself)
- Growth and Inequality
  - Is Piketty Right? *What* is he right about?
  - Labor vs Capital Shares of GDP
- Macro-Labor
  - The Paradox of Toil
  - Unemployment Dynamics Over the Business Cycle

# 6 Live HARK Lab

Day 3, Lect 5
4ours
MNW

## 6.1 Exercises

# References


Ahn, SeHyoun, Greg Kaplan, Benjamin Moll, Thomas Winberry, and Christian Wolf (2017): "When Inequality Matters for Macro and Macro Matters for Inequality," in *NBER Macroeconomics Annual*, ed. by Jonathan Parker, and Organizers Martin S. Eichenbaum, vol. 32, Cambridge, MA. MIT Press, Available at http://www.princeton.edu/~moll/WIMM.pdf.

Blanchard, Olivier (2016): "Do DSGE Models Have a Future?," Discussion paper, Petersen Institute for International Economics, Available at https://piie.com/system/files/documents/pb16-11.pdf.

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