An Introduction to the Heterogeneous Agents Resources and toolKit

Chris Carroll, Matt White

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Agenda: A Flavor of HARK

1. "Microeconomic" models in HARK: the `AgentType` class
2. Example HARK model
   - Consumption with permanent and transitory shocks to income
3. 30,000 foot view: What else is in HARK?

Microeconomic Models in HARK

- Concern decision-making of one agent
- Discrete time
- Sequence of choices
  - Household: Consumption, labor supply, portfolio choice, etc
  - Firm: Investment, Employment, R&D, ...
- Agents treat inputs to problem as *exogenous*

Key restriction: Essentially, Bellman equation

Model solution can be constructed as iteration on sequence of "one period problems," conditional on solution to subsequent period.

Two kinds of heterogeneity

- *Ex post* heterogeneity: Agents differ because a different sequence of events or shocks has happened to them
  - Luck of the draw
- *Ex ante* heterogeneity: Agents differ in objectives, preferences, expectations, etc before anything "happens" to them
  - Some people are more risk averse than others, e.g.

HARK's "Master Class": `AgentType`

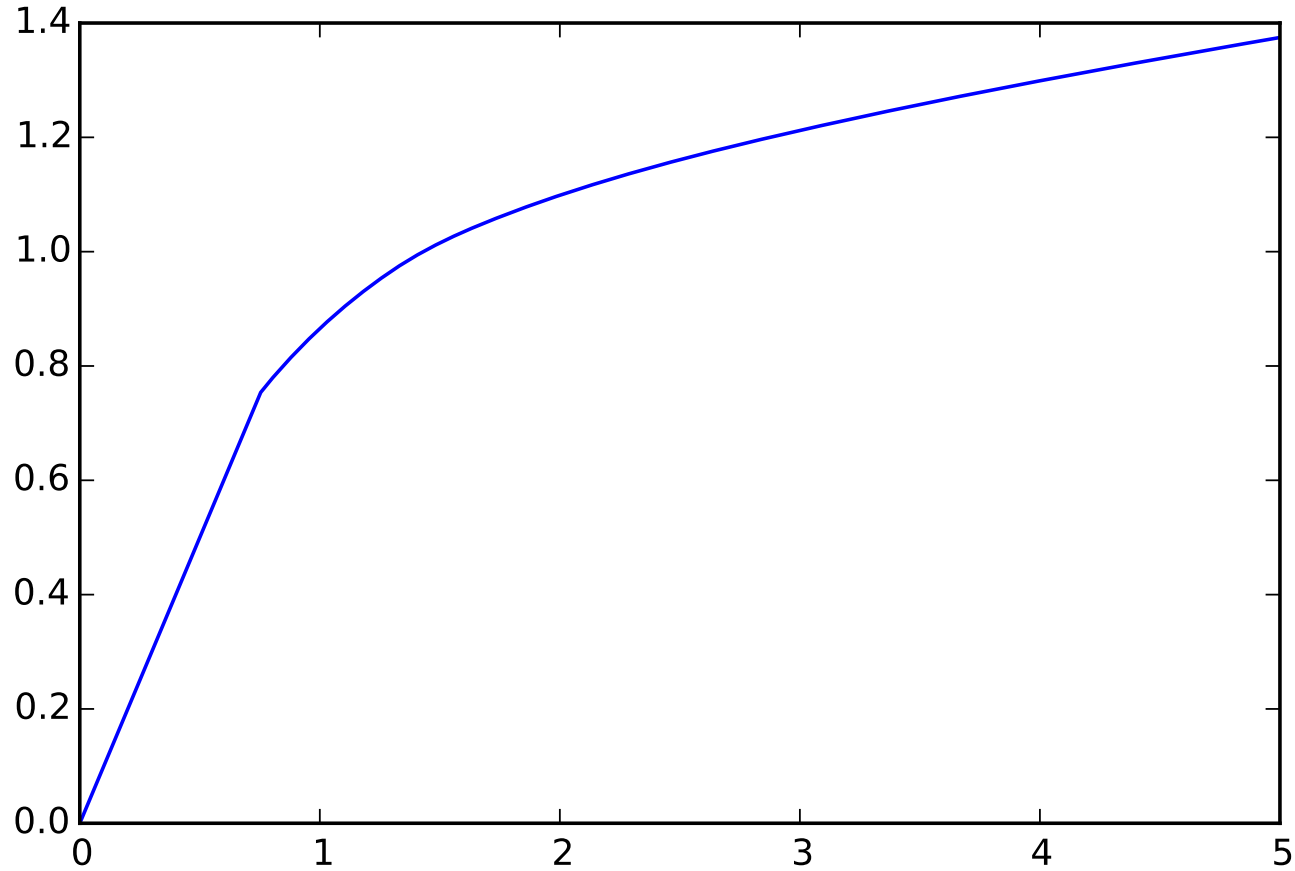
- General purpose class for representing economic agents
- Each model creates a subclass of `AgentType`
  - e.g. `PerfForesightConsumerType` is an `AgentType` subclass
  - Includes attributes, functions, and methods...
    - All `AgentType` subclasses have a `solve()` method
  - Common structure $\Rightarrow$ different models "play nicely" together
  - Even though guts of `solve()` method differ for each subclass
  - Much easier to compare and exchange models
- Complex models extend basic ones through "class inheritance"

Workhorse: Buffer Stock Consumption Model

Class `IndShockConsumerType`

- Inherits attributes of `PerfForesightConsumerType`
  - Geometric discounting β per period
  - One choice: How much to consume vs save
  - CRRA utility from consumption
  - Exogenous interest factor for asset returns
- Adds assumptions about income uncertainy and constraints
  - Mathematical Details: Formal model

Buffer Stock Model Consumption Function



Horizontal Axis: "Money"; Vertical Axis: "Spending"

What Else Is In HARK or the Econ-ARK?

- General purpose tools for generating and representing distributions, interpolated functions, etc
- Tools for estimation / optimization (fairly sparse)
- Framework for "macroeconomic" models: `Market` class
- Several extensions of basic consumption-saving model
- Some small demonstration exercises
- All results from several papers:
  - "The Distribution of Wealth and the Marginal Propensity to Consume" by Carroll, Slacalek, Tokuoka, and White (2017)
  - "Sticky Expectations and Consumption Dynamics" by Carroll, Crawley, Slacalek, Tokuoka, and White (2018)
  - Several others are close
- Much room for improvement: endogenous labor supply (e.g.)

References I

Carroll, Christopher D., Edmund Crawley, Jiri Slacalek, Kiichi Tokuoka, and Matthew N. White (2018): "Sticky Expectations and Consumption Dynamics," *Manuscript, Johns Hopkins University*.

Carroll, Christopher D., Jiri Slacalek, Kiichi Tokuoka, and Matthew N. White (2017): "The Distribution of Wealth and the Marginal Propensity to Consume," *Quantitative Economics*, 8, 977–1020, At `http://econ.jhu.edu/people/ccarroll/papers/cstwMPC`.

Fagereng, Andreas, Martin B. Holm, and Gisle J. Natvik (2017): "MPC Heterogeneity and Household Balance Sheets," discussion paper, Statistics Norway.