

Why Heterogeneous Agents Models?

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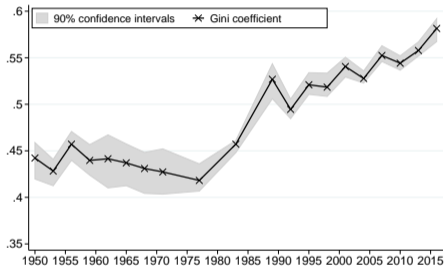
Models with heterogeneous agents

- Economic (individuals, firms, ...) agents are heterogeneous along important dimensions:
 1. Age.
 2. Locations (spatial or economical).
 3. Productivity.
 4. Wealth.
 5. Information.
 6. Beliefs and expectations.
 7.
- Even within narrowly defined subgroups, we observe large individual heterogeneity in behavior (unobserved heterogeneity emphasized by Heckman and Wolpin).

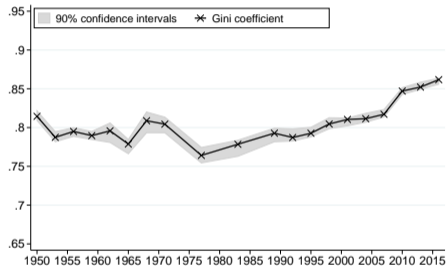
When is heterogeneity important? I

- Questions that are inherently about heterogeneity:
 1. What mechanisms accounts for changes in income and wealth inequality?
 2. What are the consequences of changes in tax progressivity?
 3. What are the consequences of changes in social security and welfare programs?
 4. What are the consequences of changes in educational policies?
 5. What are the consequences of bankruptcy regulations?
 6. What are the consequences of skill-biased technological change?
 7. What are the consequences of non-convex investment adjustment costs?
 8. What are the consequences of entry-exit in models of industry dynamics?
 9. Political-economy of all previous questions.

Income and Wealth Inequality from Kuhn et al. (2018)

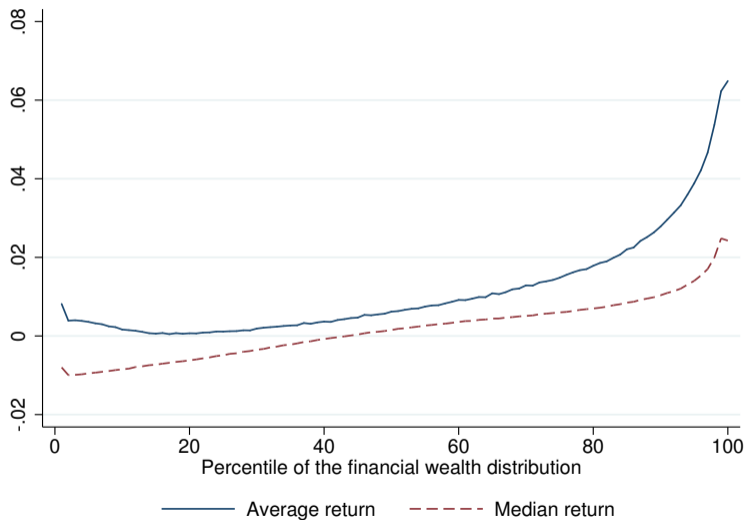


(a) Income

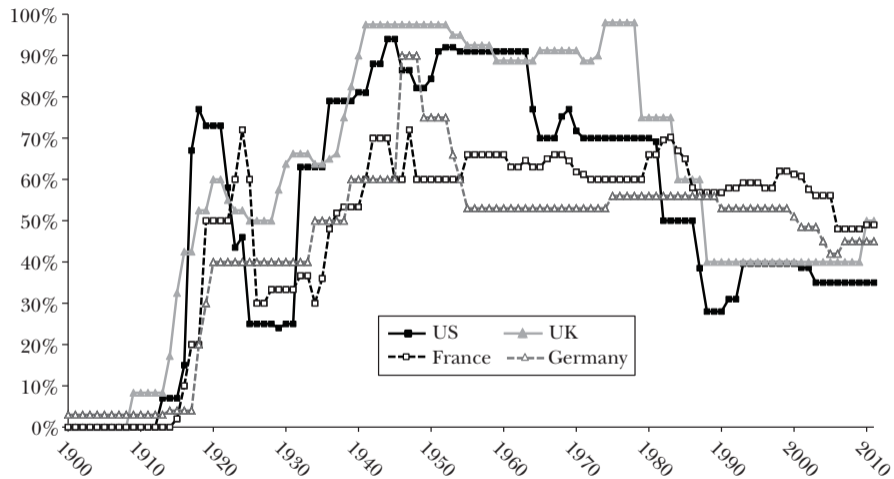


(b) Wealth

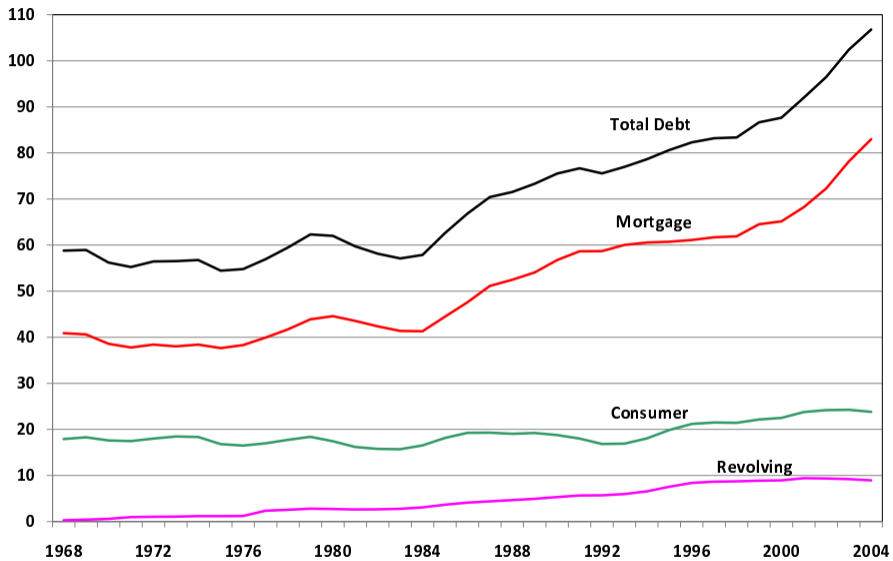
Figure 2. The correlation between financial wealth and its return

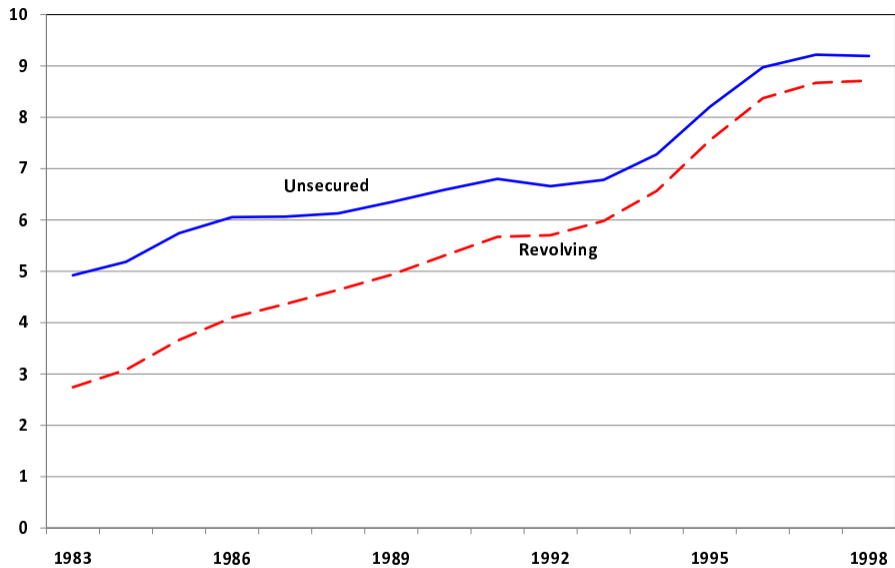


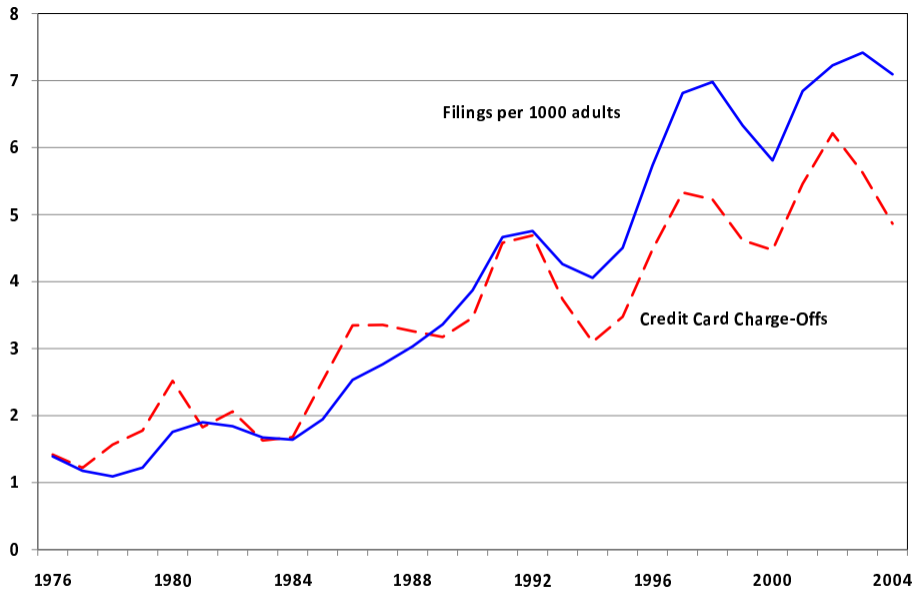
Top Marginal Income Tax Rates, 1900–2011



Source: Piketty and Saez (2013, figure 1).







When is heterogeneity important? II

- Questions about aggregation bias:
 1. Does heterogeneity matter for aggregate quantities and prices along the balanced growth path?
 2. Does heterogeneity matter for aggregate quantities and prices over the business cycles?
 3. And for the welfare cost of business cycles?
 4. What is the relation of heterogeneity and asset prices?
 5. What are the (aggregate and distributional) effects of temporary tax cuts?
 6. What are the (aggregate and distributional) effects of monetary policy?
 7. How does price stickiness matter for the business cycle?
 8. What is the relation of wealth inequality and financial frictions?
 9. Political-economy of all previous questions.

- Relation of this class of models with empirical micro, especially labor economics, industrial organization, and international trade.
- Thus, fruitful area for cross-fertilization.
- Plenty of work to be done:
 1. Substantive questions.
 2. Solution methods.
 3. Taking the models to the data.

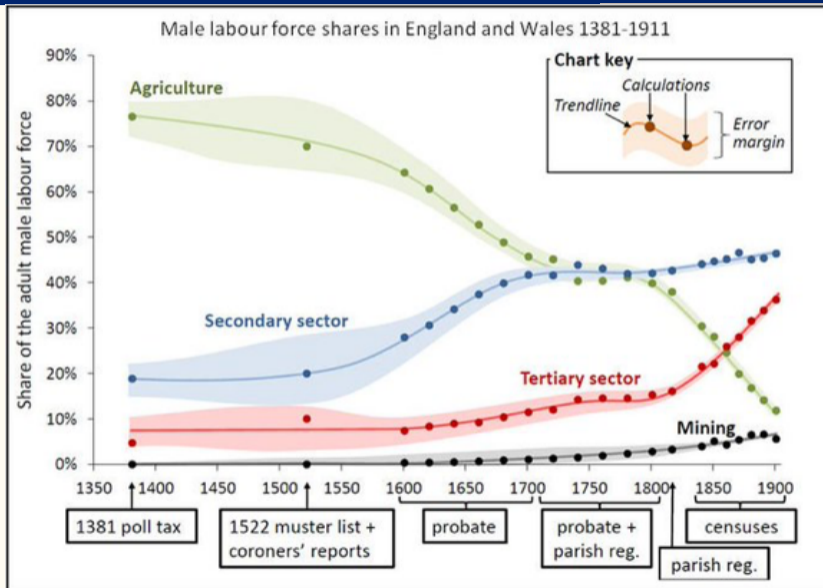
A warning

- But, before we continue, a word of caution: not every question requires a model with heterogeneous agents.
- And, even it does, we can have an exact aggregation result:
 1. Irrelevance result: [Caplin and Spulber \(1987\)](#).
 2. Exponential structure of distribution: Calvo pricing.
 3. Quasi-representative agent: [Angeletos \(2007\)](#).
 4. Block-recursivity: [Menzio and Shi \(2010\)](#).
- Subtle issue of how to compare a RA and a HA model.

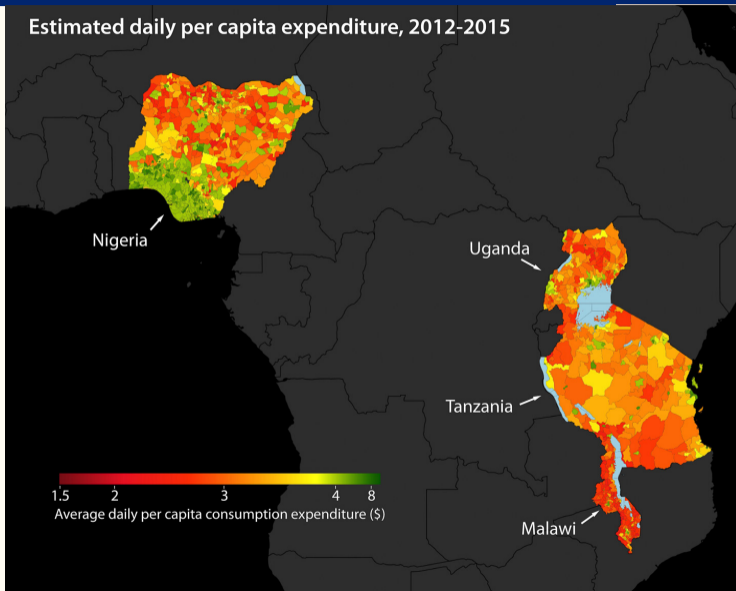
A short history

- Early start in the 1980s.
- Relation with micro data revolution.
- Certain disappointment in the early 2000s.
- Revival during the last decade.
- Why?
 1. New solution methods.
 2. Better computers and parallelization.
 3. “Everything is data”: (plain text, library records, parish and probate records, GIS data, electricity consumption, satellite imagery, web scraping, network structure, social media, ...).

Parish and probate data



Satellite imagery



Cell phone usage

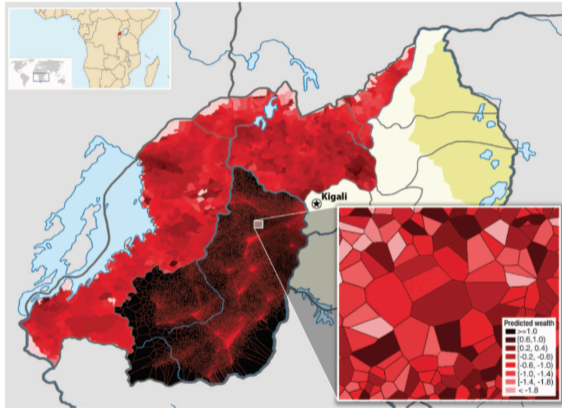


Fig. 2. Construction of high-resolution maps of poverty and wealth from call records. Information derived from the call records of 1.5 million subscribers is overlaid on a map of Rwanda. The northern and western provinces are divided into cells (the smallest administrative unit of the country), and the cell is shaded according to the average (predicted) wealth of all mobile subscribers in that cell. The southern province is overlaid with a Voronoi division that uses geographic identifiers in the call data to segment the region into several hundred thousand small partitions. (**Bottom right inset**) Enlargement of a 1-km² region near Kiyonza, with Voronoi cells shaded by the predicted wealth of small groups (5 to 15 subscribers) who live in each region.

Blumenstock et. al. (2015)

Type of models with heterogeneous agents, I

- Number of agents:
 1. Two (or a few agents): asset pricing, monetary economics.
 2. Several agents: OLG, networks, regions, industry dynamics, international trade.
 3. Continuum of agents: households, firms,
- We will focus on models with a continuum of agents. Why?
- I will make some references to models with several agents, as I believe there will be a fruitful area of research during the next decade.

Type of models with heterogeneous agents, II

- Equilibrium effects:
 1. Partial equilibrium.
 2. General equilibrium.
- Aggregate shocks:
 1. No aggregate uncertainty: Aiyagari (-Bewley-Huggett) models.
 2. Aggregate uncertainty: Krusell-Smith models.

Type of models with heterogeneous agents, III

- Convex vs. non-convex problems.
- Ex ante vs. ex post heterogeneity.
- Discrete vs. continuous time.
- HA models vs. ABE.

Computation of heterogeneous agent models

- The big bottleneck for the practical implementation of models with heterogeneous agents is computation.
- While usually we do not even have many theoretical results, lack of quantitative results make the model close to useless.
- There are many aspects of the computation of models with heterogeneous agents, but I will focus on the issues most specific to the field.
- I will explain why I find machine learning a promising approach to solve models with heterogeneous agents.

Taking heterogenous agent models to the data

- So far, most work has been done in terms of calibration.
- However, there are important reasons to implement fully-fledged estimation procedures.
- Building of moments and/or likelihood function is time-intensive.