

Income and Wealth Distribution in Macroeconomics

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Overview: This is a graduate course in the second year macroeconomics field. I will teach the first half until fall break and Chris Sims the second half (Chris will provide a separate reading list). My part of the course will partly focus on substance and partly on tools. In terms of substance, we will be concerned with the role of income and wealth distribution (or more generally heterogeneity) in the macroeconomy. We will first cover some theories aiming to explain why income and wealth are so unequally distributed and why inequality has increased over time in many developed countries, and then explore the implications of income and wealth heterogeneity for macroeconomic dynamics and macroeconomic policy. The models we cover have implications for both cross-sectional data and for time series behavior of an economy as a whole. At the beginning of the course we will cover a number of tools, namely continuous time methods that are useful for macroeconomics, particularly for analyzing models where the relevant state variable is a distribution. These include Hamiltonians, Stochastic Calculus, Hamilton-Jacobi-Bellman equations, and Kolmogorov Forward Equations. Rather than presenting an in-depth technical derivation of the methods from first principles, my aim is to provide you with a “cookbook” for you to use these methods in your own research and then to cover a few applications.

Organization: The class meets on Mondays and Wednesdays from 10:40am to 12:10pm. A preliminary syllabus is attached. I will add papers throughout the course. All lecture slides are available from my website <http://www.princeton.edu/~moll/notes.htm>.

Grading: Your course grade will be based on a few problem sets (20% of the grade) and either a take-home final or a term paper (80% of the grade). On a given problem set you can get one of the following grades: 0, 3, 4 and 5 (read: if you don't do the problem sets it will cost you 20% of the grade). You can choose between either writing a term paper or a take-home final.

- Term paper: final paper due on day before take-home final handed out (TBD). One-page proposal due on December 11. Your choice of paper should be consistent with your interests. The written project should be on an original research idea, necessarily related to the course's topics (including Chris' part). Descriptions or reviews of the literature are acceptable but not as ambitious. In any case, your idea should be expressed in the context of the relevant literature. Only one idea per project, please!
- Take-home final: at the end of January, at date set by registrar (TBD), covering both Chris' and my part of the course.

1. Deterministic Continuous Time Methods

1.A Methods:

Lecture Notes: Hamiltonians and Phase Diagrams

Acemoglu (2010), Chapter 7 “Review of the Theory of Optimal Control” in “Introduction to Modern Economic Growth”

1.B Applications:

Lecture Notes: Neoclassical Growth Model in Continuous Time

- http://www.princeton.edu/~moll/ECO503Web/Lecture3_ECO503.pdf
- http://www.princeton.edu/~moll/ECO503Web/Lecture4_ECO503.pdf

Acemoglu (2010), Chapter 8 “The Neoclassical Growth Model” in “Introduction to Modern Economic Growth”

Lecture Notes: “New Keynesian Model in Continuous Time” (useful for HANK papers in Section 3.D)

Additional readings

Werning (2012), “Managing a Liquidity Trap”, Working Paper

2. Stochastic Continuous Time Methods, Modeling Distributions

2.A Methods:

Lecture Notes: Stochastic Calculus, Hamilton-Jacobi-Bellman Equations, Kolmogorov Forward Equations, Finite Difference Methods

Codes for finite difference solution to HJB and KF equations:

<http://www.princeton.edu/~moll/HACTproject.htm>

Candler (1999), “Finite-Difference Methods for Dynamic Programming Problems.” In *Computational Methods for the Study of Dynamic Economies*, ed. Ramon Marimon and Andrew Scott. Cambridge, England: Cambridge University Press.

Kushner and Dupuis (1992), “Numerical Methods for Stochastic Control Problems in Continuous Time”, Springer New York

Sims (2001), “Solving Linear Rational Expectations Models”, *Computational Economics* (useful for Reiter method in Section 3.D)

- slightly simplified version: <http://elaine.ihs.ac.at/~mreiter/simplesims.pdf>
- good supplementary notes: “Solving Linear Rational Expectations Models” by Yossi Yakhin: http://www.robertopancrazi.com/LN3_solving_lrem.pdf

2.B Applications:

Gabaix (2009), “Power Laws in Economics and Finance”, *Annual Review of Economics*

Gabaix, Lasry, Lions and Moll (2016), “The Dynamics of Inequality,” *Econometrica* (forthcoming)

Merton (1975), “An Asymptotic Theory of Growth Under Uncertainty,” *Review of Economic Studies*

3. Income and Wealth Distribution in Macroeconomics

3.A Prerequisites (Not Taught)

Aiyagari (1994), “Uninsured Idiosyncratic Risk and Aggregate Saving” *The Quarterly Journal of Economics*

Krusell and Smith (1998). “Income and Wealth Heterogeneity in the Macroeconomy,” *Journal of Political Economy*

Den Haan (2010), “Assessing the Accuracy of the Aggregate Law of Motion in Models with Heterogeneous Agents”, *Journal of Economic Dynamics and Control*

Heathcote, Storesletten, and Violante (2008), “Quantitative Macroeconomics with Heterogeneous Households”, *Annual Review of Economics*

3.B Resources for numerical solution of discrete-time heterogeneous agent models (not taught)

Carroll et al, "ARK," <https://github.com/econ-ark>, particularly the heterogeneous agent part <https://github.com/econ-ark/HARK>

Stachurski and Sargent, "QuantEcon, <http://quant-econ.net/>, particularly codes for solving Aiyagari model: Python: <http://quant-econ.net/py/aiyagari.html>, Julia: <http://quant-econ.net/jl/aiyagari.html>

Gianluca Violante's lecture notes and codes:

Macroeconomic Theory I: <https://sites.google.com/a/nyu.edu/glviolante/teaching/macrotheory>

Quantitative Macroeconomics: <https://sites.google.com/a/nyu.edu/glviolante/teaching/quantmacro15>

3.B Empirical Evidence

Atkinson, Piketty, and Saez (2011), "Top Incomes in the Long Run of History," Journal of Economic Literature

Acemoglu (2002), "Technical Change, Inequality, and the Labor Market," Journal of Economic Literature

Kopczuk (2015), "What Do We Know About Evolution of Top Wealth Shares in the United States?," Journal of Economic Perspectives

Papers in RED special issue "Cross-Sectional Facts for Macroeconomists" (Krueger, Perri, Pistaferri and Violante, 2010): <https://www.economicdynamics.org/si-cross-facts/>

Kuhn and Rios-Rull (2016), "2013 Update on the U.S. Earnings, Income, and Wealth Distributional Facts: A View from Macroeconomics," Federal Reserve Bank of Minneapolis Quarterly Review

Thewissen, Nolan and Roser (2016), <https://ourworldindata.org/incomes-across-the-distribution/>

3.C Theories of Income and Wealth Inequality

Benhabib and Bisin (2016), "Skewed Wealth Distribution: Theory and Empirics", Annual Review of Economics

Cagetti and DeNardi (2006), "Entrepreneurship, Frictions, and Wealth," Journal of Political Economy

Fagereng, Guiso, Malacrino and Pistaferri (2016), "Heterogeneity and Persistence in Returns to Wealth"

Gabaix and Landier (2008), "Why Has CEO Pay Increased So Much?" Quarterly Journal of Economics

Sattinger (1979), "Differential Rents and the Distribution of Earnings," Oxford Economic Papers

Sattinger (1993), "Assignment Models of the Distribution of Earnings," Journal of Economic Literature

Jones and Kim (2016), "A Schumpeterian Model of Top Income Inequality"

Jones (2015), "Pareto and Piketty: The Macroeconomics of Top Income and Wealth Inequality", Journal of Economic Perspectives

3.D Macroeconomic Implications of Income and Wealth Heterogeneity

Krueger, Mitman and Perri (2016), "Macroeconomics and Household Heterogeneity," Handbook of Macroeconomics (forthcoming)

Achdou, Han, Lasry, Lions and Moll (2015), "Heterogeneous Agent Models in Continuous Time", Working Paper

Bayer and Waelde (2015), "The Dynamics of Distributions in Continuous-Time Stochastic Models"

Auclert (2016), "Monetary Policy and the Redistribution Channel", Working Paper

Kaplan, Moll and Violante (2016), "Monetary Policy According to HANK", Working Paper

Werning (2016), "Incomplete Markets and Aggregate Demand", Working Paper

McKay, Nakamura and Steinsson (2016), "The Power of Forward Guidance Revisited", American Economic Review

McKay and Reis (2016), "The Role of Automatic Stabilizers in the U.S. Business Cycle", Econometrica

Auclert and Rognlie (2016), "Inequality and Aggregate Demand", Working Paper

Ahn, Kaplan, Moll and Winberry (2016), "No More Excuses! A Toolbox for Solving Heterogeneous Agent Models with Aggregate Shocks", Work in Progress

Reiter (2009a), "Solving heterogeneous-agent models by projection and perturbation", Journal of Economic Dynamics and Control

Reiter (2009b), "Approximate and Almost-Exact Aggregation in Dynamic Stochastic Heterogeneous-Agent Models"

Parra-Alvarez, Posch and Wang (2015), "Identification and estimation of heterogeneous agent models: A likelihood approach" (preliminary and they say that new version is coming soon) <http://www.sv.uio.no/econ/english/research/news-and-events/events/others/dokumenter/parra-alvarez.pdf>

- useful background readings: Fernandez-Villaverde, Rubio-Ramirez and Schorfheide (2016) "Solution and Estimation Methods for DSGE Models", Handbook of Macroeconomics
- Hansen and Heckman (1996), "The Empirical Foundations of Calibration," Journal of Economic Perspectives
- Browning, Hansen and Heckman (1999), "Micro data and general equilibrium models," Handbook of Macroeconomics

Additional readings

Galor and Zeira (1993), "Income Distribution and Macroeconomics," Review of Economic Studies

Piketty, Thomas (1997) "The Dynamics of the Wealth Distribution and the Interest Rate with Credit Rationing," Review of Economic Studies

3.E Inequality and Growth

Benabou (2002), "Tax and Education Policy in a Heterogeneous Agent Economy: What Levels of Redistribution Maximize Growth and Efficiency?", Econometrica

Lucas and Moll (2014), "Knowledge Growth and the Allocation of Time", Journal of Political Economy

Staley (2011), "Growth and the diffusion of ideas", Journal of Mathematical Economics

Luttmer (2012), "Eventually, Noise and Imitation Implies Balanced Growth"

4. Firm Heterogeneity

4.A Methods: Stopping time problems

Stokey (2008), Chapter 6 “Exercising an Option” from “The Economics of Inaction: Stochastic Control Models with Fixed Costs”

Dixit (1993), “The Art of Smooth Pasting” *Fundamentals of Pure and Applied Economics* 55, The Routledge.

Dixit and Pindyck (1994), “Investment Under Uncertainty,” Princeton University Press.

4.B Theories of Firm Size Distribution

Luttmer (2007), “Selection, Growth, and the Size Distribution of Firms,” *Quarterly Journal of Economics*

Luttmer (2010), “Models of Growth and Firm Heterogeneity”, *Annual Review of Economics*

4.C Macroeconomic Implications of Firm Heterogeneity

Gabaix, Xavier (2011), "The Granular Origins of Aggregate Fluctuations." *Econometrica*

Carvalho and Gabaix (2012), “The Great Diversification and its Undoing”, *American Economic Review*

Additional readings on firm heterogeneity

Bertola and Caballero (1994), “Irreversibility and Aggregate Investment”

Caballero and Engel (1999), “Explaining Investment Dynamics in U.S. Manufacturing: A Generalized (S,s) Approach”, *Econometrica*

Khan and Thomas (2008), “Idiosyncratic shocks and the role of nonconvexities in plant and aggregate investment dynamics” *Econometrica*