# 14.04 INTERMEDIATE MICROECONOMIC THEORY

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Grading TA: Matthew Ridley, mridley@mit.edu

Recitation TA: Michael B. Wong, mbwong@mit.edu

*Syllabus Version: September 3, 2019*

**Hours**

Lecture: Mondays and Wednesdays 2:30-4:00pm, E51-372
Recitation: Fridays 11am-12pm, E51-085
Professor Townsend office hours: Mondays after class, 4-5:00pm, E52-538
Matthew Ridley office hours: Thursdays, 4-5:00pm in E52-516
Michael Wong office hours: Wednesday after class 4-5:00pm, E52-416

**Overview**

This course provides an introduction to theory and data designed to meet the needs of students interested in economic science. It provides an introduction to consumer choice, the theory of the firm and general equilibrium models, with an overview of the main results and tools used in these subjects, both directly and indirectly as used in a variety of fields. This includes analysis of consumer and producer decisions, partial and general equilibrium analysis, insurance, the welfare theorems and failures of these theorems as with externalities but with resolutions, contract theory and mechanism design, policy analysis, the content of theory for data, and the design of media of exchange as with Bitcoin and markets made possible by distributed ledgers.

If you've had an economics class before, you're probably used to the following drill: learn some theory; if time permits, consider some stylized evidence that may or may not test the theory; repeat. That's not what we'll be doing in 14.04. The purpose of theory is to help us to think about how the world actually works. We're going to test them and learn from these tests, both when the data confirm the theory and when they reject it. John Maynard Keynes wrote, "Economics is a science of thinking in terms of models, joined to the art of choosing models which are relevant."

The Econometric Society and the Cowles Foundation framed economics as a science running in the laboratory of model economies. So, we are interested in inference, how do we measure, how do we estimate models, how to make welfare statements for actual policies as implemented and counter factual policies which might be undertaken.

In sum the class is organized around two intertwined themes:

1. Economic theory: what does it predict, and in what ways is it useful?
2. Empirical applications: Economic theory is a way of organizing facts and interpreting and patterns in the world. This class will use data to test theory and use theory to interpret data.

**Prerequisites**
This is an intermediate course in microeconomic theory and its application to real world phenomena and policy problems. The class assumes proficiency with economic theory at the 14.01 level as well as multivariate calculus. It is also quite helpful if you have taken some linear algebra, statistics or econometrics and are somewhat familiar with basic notions algorithms and computing, but for those who are not familiar with these additional tools, the TAs will provide a primer or fill in gaps for this material.

**Textbooks**
All class readings including relevant textbook chapters will be available on the class website. The four books listed at the top of the reading list will also be on reserve in the MIT library.

**Required readings**
Each lecture has an associated set of readings listed on the class schedule. These readings will be featured in lectures, exams and problem sets. If a reading is marked required, with *, you are responsible for it. For professional papers as opposed to textbook chapters, here are some guidelines:

a) What is the paper's research question?
b) What methodology is used to answer the question (e.g., an experiment, a quasi-experiment, a set of correlations, etc.)?
c) What are the key findings?
d) What is the economic interpretation of these findings?

**Recommended readings**
You will find a number of recommended readings on the syllabus for your education and entertainment. These papers should be useful—and in many cases fun—but you will not be tested on their content.

**Class attendance**
14.04 is not a by-the-book micro-theory class. A significant portion of the class will focus on applications from empirical and theoretical papers. It will be difficult to master this material unless you attend both the lectures and recitations. Thus you will have name cards and attendance will be part of your grade.

**Laptop/tablet/phone use during class**
I strongly discourage you against texting, tweeting, emailing, blogging, posting, browsing, Instagramming, Googling, shopping, etc., during class. It wastes your class-time—since you won't learn anything during lecture if you're distracted. And it's frequently distracting to your classmates. I'm sympathetic to your desire to use your laptop or tablet to view the online lecture notes and take notes of your own. I would encourage you instead to print out the online lecture notes the night before class, and to write your notes directly on the paper lecture notes. In my experience, it's still faster and more accurate to take notes in class using paper and pen than to mark up a PDF file on your device. Of course, you may be faster with a tablet than I am. When I walk around the class during lecture, I will see what's on your screen. If I notice that you are engaging in distracting technology use, I will ask you to close it down or take it elsewhere.

**Grading**
The class is not graded on a curve. It's possible for everyone to do well, and I'd be happy to have a reason to assign mostly A's. That said, if you make minimal effort, you will probably receive a C or worse. If I think you are headed for a D or F, I will try to warn you before the drop date.

Here are the grading mechanics:

- Best four  out of five  problem set grades: 30%
- Three exams: 60%
- Class attendance 5% and participation including pop questions: 5% = 10% total

*Problem sets (30%):*
I will assign five problem sets. Problem sets typically include a set of pure theory questions and a set of application questions, often based on readings. You must submit your problem sets in PDF form using Stellar. Late problem sets will not be accepted. No exceptions. In order to accommodate unanticipated events, illness, or conflicts in your schedule, I will automatically drop the problem set with the lowest score (for example, the one that you don't hand in).
You may collaborate with other students on problem sets, but you must write up all solutions independently and in your own words. If you submit a problem set that is a direct copy of another student's, this will be considered academic dishonesty and will be dealt with accordingly. If you are stuck on a question, feel free to come to either of the TA's office hours. We will do our best to point you in the right direction, but we will not fully answer the question for you. This is to ensure that you have adequate opportunity to master the material. After the problem set has been graded and handed back we are happy to go over solutions with you if they are still unclear.

*Three exams (20% each, 60% total)*
There will be two in-class, closed-book exams of 80 minutes in length. There will also be a closed book final exam during the finals period. You will have 120 minutes to complete the final. You should have extra time to help you to relax. It will count the same as each of the prior two exams. The date of the final exam is set by the MIT Registrar's office, which strategically withholds announcing the exam dates until late in the semester so that you cannot pick your classes based on final exam schedules. Each exam will tend to focus on the new material since the previous exam, although of course you will need to understand the older material to apply the new material. The final will be comprehensive, from the beginning of the class, as the material is cumulative.  The exams will be based on the lecture notes, problem sets, assigned readings, classroom discussion and TA sessions.

Performance on exams is highly correlated with performance on problem sets. If you miss an exam for an excused reason, I will offer a written makeup or an oral exam on the blackboard. Students typically find oral exams painful. But, I will not write a new exam for only one or two students—so, an oral exam is reasonably likely.

*Class participation (10%)*
If you participate regularly in class, I will learn your name and count your participation towards

your grade. I also cold call in class to help overcome your natural shyness and ward off your natural sleepiness. Though only 10%, from past experience this component has a lot of variation across students and matters significantly for final grades.

**Questions regarding grading**
Questions on grading should go first to the grading TA. Your grading TA must receive questions on exam or p-set grades no more than one week after the assignment/p-set has been handed back. To have the grading reconsidered, take the following steps:

1) Take the material to the grading TA along with a note describing specifically what you believe the problem to be. (Make a copy of your note and the problem set/exam for your own safekeeping.) Leave this along with your email address.
2) After the TA has contacted you by email, schedule a face-to-face meeting to discuss the question.

This procedure is designed to facilitate fair and consistent grading. Please note that regrade requests for problem sets and exams should be submitted only for obvious grading errors (e.g. adding up points incorrectly, failing to see a correctly answered question, etc.) We are very unlikely to honor requests of the form "I think I deserve more points on this question because..." Furthermore, note that if you do request a regrade, we reserve the right to regrade your entire problem set or exam. Therefore, your final grade may increase or decrease as a result of the regrade request.

**Getting help outside of class**
If you have questions on the class material or problem sets, there are four ways to get help:

1. Use the class web site. We'll have threaded discussions there (monitored by TAs and professor as needed) for all problem sets and class topics. You should get a pretty quick response—and a good answer.
2. Drop in during TA office hours.
3. Drop in during Prof. Townsend's office hours.
4. Ask question during recitation (and in class as appropriate).

Please do not send us your class-related questions by email (except for personal class-related matters). The Stellar wiki is a more efficient way for us to communicate with you, and it is also benefits your classmates. If you email class related questions to us, we may respond, but we will be irritated.

**Schedule**
Class topics and readings are subject to revision. It is possible that some topics and readings will be dropped if time runs short.

# 14.04 INTERMEDIATE MICROECONOMIC THEORY

## FALL 2019

## READING LIST AND LECTURE CONTENT

## A Brief Guide to this Reading List

Required readings are marked by an asterisk (*). Most readings can be found on the Stellar course website. We use the following acronyms and shorthand:

*Kreps:* Kreps, David M. 1990. *A Course in Microeconomic Theory.* Princeton: Princeton University Press

*Medville:* Townsend, Robert M. 1993. *The Medieval Village Economy: A Study of the Pareto Mapping in General Equilibrium Models*. Princeton: Princeton University Press.

*MWG:* Mas-Colell, A., Whinston, M. D., & Green, J. R. (1995). *Microeconomic theory.*

*NS:* Nicholson, W., and C.M. Snyder. 2016. *Microeconomic Theory: Basic Principles and Extensions.* Boston: Cengage Learning.

*Varian:* Varian, Hal. 1992. *Microeconomic Analysis.* Third Edition. New York: Norton.

*DLT*: Townsend, Robert. 2019. "Distributed Ledgers: Innovation and Regulation in Financial Infrastructure and Payment Systems" Working paper.

## Lectures 1-4, Introduction: Motivation for the Course, Basics for Studying Real Economies

Lecture 1: Economics Science – overall motivation and objectives of the course: Economics as Experiments, Models as Fully Articulated Systems or Labs, RCT's versus Natural Experiments, Prediction and Validation, Theory and Measurement Unified, Actual and Counterfactual Policy and Welfare, Big Data, Computation, Villages Economies Real and as Metaphors for Modern Systems, Bitcoin/Blockchain/Distributed Ledgers Review of the Syllabus

*Koopmans, T., 1947. "Measurement without theory." *The Review of Economics and Statistics*, 29(3): 161-172.

Varian, H., 2014. "Big data: new tricks for econometrics." *Journal of Economic Perspectives*, 28(2): 3-28.

Lucas Jr, R.E., 1980. "Methods and problems in business cycle theory." *Journal of Money, Credit, and Banking*, 12(4): 696-715.

Angrist, Joshua D., and Jörn-Steffen Pischke. 2010. "The Credibility Revolution in Empirical Economics: How Better Research Design Is Taking the Con out of Econometrics." *Journal of Economic Perspectives*, 24 (2): 3-30.

Matzkin, Rosa L., 2007. "Nonparametric identification,"Handbook of Econometrics,in: J.J. Heckman & E.E. Leamer (ed.), *Handbook of Econometrics*, edition 1, volume 6, chapter 73 Elsevier.

Ragnar Frisch (1926) "On a Problem in Pure Economics: Translated by JS Chipman." Preferences, Utility, and Demand: A Minnesota Symposium. 1926."

Townsend, R.M., 1988. "Models as economies." *The Economic Journal*, 98(390): 1-24.

Bank for International Settlements (BIS). 2017. "Distributed ledger technology in payment, clearing and settlement: An analytical framework." Committee on Payments and Market Infrastructures Papers No. 157 (February, 2017).

Iansiti, Marco and Karim R. Lakhani. 2017. "The Truth about Blockchain." *Harvard Business Review* 95 (1): 118-127.

Denison, Erin, Michael Lee, and Antoine Martin. 2016. "What do cryptocurrencies do?" Federal Reserve Bank of New York Conference Paper.

Lecture 2: General Equilibrium Economies: The Medieval Village Economy, Northern Thai Village Economies and Townsend Thai project, US States (trade and financial flows), NY Financial Markets. Economies in the Language of General Equilibrium: preference, endowments, technology (PET); Widely used constructs, Robinson Crusoe, Edgeworth Box, International Trade. Commodity Space for Dynamics, Geography, Uncertainty; Monetary Economics and Modern Financial Systems

*Medville, Chapter 1 "Introduction"

*Emerging Thailand: The Spirit of Small Enterprise
https://www.youtube.com/watch?v=b_rEmiu71Pk

Townsend R. 1995. "Financial Systems Northern Thai Villages." *Quarterly Journal of Economics*. Vol. 110, No. 4: 1011 -1046

Autor DH, Dorn D, Hanson GH. 2013. "The China Syndrome: Local Labor Market Effects of Import Competition in the United States." *Am. Econ. Rev.* 103(6):2121–68

Lecture 3: Consumer Choice: Consumption Set, Rational Preferences, Utility Functions, Some Properties of Preferences, Indifference Curves, Marginal Rates of Substitution, Example Indifference Curves and Functions; Application: Utility Maximization subject to Budget,

first order conditions, Major Method: General Constrained Optimization and Lagrangian Programs. Cobb-Douglas and expenditure shares

*Kreps Appendix A "Constrained Optimization"

*NS Chapter 3 "Preferences and Utility"

*NS Chapter 4 "Utility Maximization"

Lecture 4: Technology, Production Possibilities Sets and Properties, Returns to Scale, Aggregation over Production Sets; Major Application: Profit Maximization, Properties of Profit function, Hotelling Lemma, Isoquants, Cost Minimization and properties of cost curves; Method: Envelope Theorem. Illustrative example of basics onto modern systems: Input/Output and Google Search

*Kreps 7 "The Neoclassical Firm"

**Lectures 5-9, Pareto Optimality; Risk Sharing and Dynamics; Application to Village Economies; Social Networks and Supply Chains in Villages and in the US and Japan**

Lecture 5: Pareto Optimal Allocations and Model Prediction: Pareto Optimality, Pareto Dominance and Pareto Set, Utility Possibilities Frontier, Welfare function and a Programming Problem for determination of Optimal Allocations; Method: Separating Hyperplanes and theorems; Leading Example: Uncertainty and example in state space of the optimal allocation of risk with implications for data

*Kreps 5.1-4 (up to and including "the production and allocation of private goods")

Lecture 6: Risk sharing: Village India with ex post consumption and income data, ex ante Land Division in the Medieval Village Economy

*NS Chapter 8 "Expected Utility and Risk Aversion"

*Townsend, R.M. "Risk and insurance in village India." *Econometrica*, 62(3), 539-591

Medville, Chapter 2 "Uncertainty and Land-holding Patterns"

Lecture 7: Dynamic Optimization—Application: Storage, Seed and Starvation in Medieval Villages; Methods: Dynamic Programming, Value Functions

*Varian 19.1-3 "Time"

*Medville Chapter 3 “Storage as Risk Reduction”

Lecture 8: Risk Sharing Applications, continued: in Thai Villages, Risk and Return in Production Choice, using data on production and consumption, Idiosyncratic and aggregate risk; the Role of Gifts, Social Networks and the Transmission of Shocks in Villages: Informal Networks in US city neighborhoods, Fukushima Shock and Supply Chains in Japan

*Samphantharak, K., and Townsend, R.M. 2018, “Risk and return in village economies.” *American Economic Journal: Microeconomics* 10 (1): 1–40, 2018.

Kinnan, C., and Townsend, R.M., 2012. “Kinship and financial networks, formal financial access, and risk reduction.” *The American Economic Review*, 102(3): 289-293.

Kinnan, Cynthia, Krislert Samphantharak, Robert M. Townsend, and Diego Vera-Cossio. 2018.
“Networks and Risk Sharing in Village Economies.” Working paper, MIT.

Carvalho, Vasco M. and Nirei, Makoto and Saito, Yukiko and Tahbaz-Salehi, Alireza, Supply Chain Disruptions: Evidence from the Great East Japan Earthquake (December 11, 2016). Columbia Business School Research Paper No. 17-5.

Philip Bond and Robert M. Townsend. "Formal and Informal Financing in a Chicago Ethnic Neighborhood." Economic Perspectives, July/August 1996, Federal Reserve Bank of Chicago.

Lecture 9: Dynamic Programming with Additional Applications, Household Financial Accounts (income statement and balance sheet), household profiles with Life Cycle Maximization and a Wealth Planner for Thai Villages, bitcoin, statement of cash flow and distributed ledgers, cash management through the lens of dynamic models in Thailand, Sweden as a cashless economy and Kenya e-money, Trusted Third Party and the Decentralization issue of Ledgers

Samphantharak, K. and Townsend, R.M., 2009. *Households as corporate firms: an analysis of household finance using integrated household surveys and corporate financial accounting.* Econometric Society Monographs (Book 46). Cambridge University Press.

Samphantharak, Krislert, Scott Schuh, and Robert M. Townsend. 2018. “Integrated Household Surveys: An Assessment of U.S. Methods and an Innovation,” *Economic Inquiry* 56 (1): 50-80.

Townsend, R and Narapong Srivisal. “The extraordinary financial lives of Ordinary People: Huge Variation in Financial Situations.” Working paper.

*Alvarez, Fernando, Anan Pawasutipaisit and Robert M. Townsend. 2018. "Cash Management in Village Thailand: Positive and Normative Implications." Working Paper.

Jack, William, Tavneet Suri, and Robert Townsend. 2010. "Monetary Theory and Electronic Money: Reflections on the Kenyan Experience." *Economic Quarterly* 96 (1): 83–122

DLT: Section on "e-Payments and e-messages"

## Lectures 10-11, Private Information, Contracts, Mechanism Design

Lecture 10: Contracts and Mechanism Design, Concepts and Methods: Motivation from rents and spatially scattered Medieval estates; the Revelation Principle, Optimal Multi-period Contracts and Inter-temporal Tie-ins, Costly State Verification and Audits; the Space of Lotteries, Smart Contracts on Distributed Ledgers, Implementation of Mechanism Design

*Medville, Chapter 5 "Rentals with Unobserved Outputs"

DLT: Section on "Contract theory and smart contracts: Mechanism design"

Lecture 11: Contracts and Mechanism Design continued, Applications: occupation choice and business starts, distinguishing obstacles (limited commitment versus moral hazard) , rural versus urban Thailand and a battery of tests across information/financial regimes, linear programs to compute solutions to models and maximum likelihood for estimation in data

*Karaivanov Alex, Anna L. Pauson, and Robert M. Townsend. 2006 "Distinguishing Limited Liability from Moral Hazard in a Model of Entrepreneurship." *Journal of Political Economy* 114 (1): 100-144.

Karaivanov, Alexander. 2001. "Computing Moral Hazard Programs with Lotteries Using Matlab." Mimeo.

Karaivanov, Saurina, Townsend. "Family Firms, Bank Relationships and Financial Constraints: A Comprehensive Score Card", International Economic Review, Vol.-60, Issue-2, May 2019

## Lectures 12-13, Walrasian Equilibrium As Prediction; Application to International Trade, Tariffs, Real and Financial Liberalization

Lecture 12: Walrasian Equilibrium and Model Prediction: Application to International Trade, Commodity Price Differences across Countries, The Gains from Trade, Pricing Capital and Labor as Factors of Production, Who Wins and Who Losses from Tariffs, the Factor Price Equalization Theorem

*Kreps 6.1 "Pure Exchange and Price Equilibrium"

*MWG 15.D, "The 2 X 2 Production Model"

Lecture 13: Creating village, regional and national income and product accounts, GDP and NIPA; Flow of funds and balance of payments; Openness and prices in regional Thailand; Model of a small open economy with obstacles to trade, Calibration of the Model, Model-predicted and actual data compared at both village-level and individual-level; parallels for US economy: state-level trade and financial flows and impact of the China shock in the US

*Paweenawat, Archawa and Robert M. Townsend. 2019. "The Impact of Regional Isolationism: Disentangling Real and Financial Factors." Working paper.

Dawkins, C., T.N. Srinivasan and J Whalley, 2001. Chapter 58 - calibration. In Heckman, James J., and Edward E. Leamer (Eds) *Handbook of econometrics. Vol. 5.* Amsterdam: North Holland, pp. 3653-3703

Moll, B. R. M., Townsend and V. Zhorin. 2017. "Economic development, flow of funds, and the equilibrium interaction of financial frictions." *Proceedings of the National Academy of Sciences* 114(24): 6176-6184.

Batty, Michael, Jesse Bricker, Joseph Briggs, Elizabeth Holmquist, Susan McIntosh, Kevin Moore, Eric Nielsen, Sarah Reber, Molly Shatto, Kamila Sommer, Tom Sweeney, and Alice Henriques Volz (2019). "Introducing the Distributional Financial Accounts of the United States," *Finance and Economics Discussion Series* 2019-017. Washington: Board of Governors of the Federal Reserve System.

## Lectures 14-16, Prediction with Alternative Concepts, Core and Nash Bargaining; the Fundamental Welfare Theorems and Market Failures, and Contract Theory in Extended Commodity Spaces

Lecture 14: Model Prediction Continued: Core, Nash Bargaining; inter-relationships among Pareto Optima, Çore, Nash Bargaining and Walrasian Equilbrium, equivalence or lack thereof; N-replication economies, finite and continuum agent economies; Applications: the core in industrial organization and an example of non-existence, Nash bargaining in Thai villages

Hildenbrand, W. and A.P. Kirman, *Introduction to Equilibrium Analysis: Variations on themes by Edgeworth and Walras*. Oxford: North Holland, 1976. Ch. 1, pp. 1-33.\

Telser, Lester G. "The Usefulness of Core Theory in Economics" *Journal of Economic Perspectives*, Volume 8 (2) – May 1, 1994

Arun Chandrasekhar, Robert M. Townsend, and Juan Xandri. 2019. "Financial Centrality and The Value of Key Players."

Lecture 15: Fundamental Welfare Theorems: Competitive equilibria are Pareto optimal; any Pareto Optimum can be supported as equilibrium with Transfers; Sufficient Assumption and proofs, with first order conditions and with supporting hyperplanes; finite dimensional Euclidean Space and extension to Valuation Equilibria in more general spaces

*Kreps 6.3 "The Efficiency of a General Equilibrium"

Debreu, G., 1954. "Valuation equilibrium and Pareto optimum." *Proceedings of the National Academy of Sciences* 40 (7): 588-592.

Lecture 16: Welfare Theorems in Extended Commodity Space—Application to incentive constrained contracts; the space of lotteries; welfare theorems extensions and qualifications

*Prescott, E., and R.M. Townsend. 1984. "General competitive analysis in an economy with private information." *International Economic Review* 25 (1): 1-20

## Lectures 17-18, Existence of Equilibria: Walras, Nash and Applications

Lecture 17: Existence of Competitive Equilibria: Fixed Point Theorems, Negishi Algorithm Using second welfare theorem, Gross Substitutes, Recent Computer Science Contributions

*Kreps 6.4 "Existence and The Number of Equilibria"

Scarf, H.E., 1982. "The computation of equilibrium prices: an exposition." In Arrow, Kenneth J., and Michael D. Intriligator (Eds.) *Handbook of mathematical economics. Volume 2*. Amsterdam: North-Holland, pp. 1007-1061.

Negishi, T., 1960. "Welfare economics and existence of an equilibrium for a competitive economy." *Metroeconomica*, 12 (2-3): 92-97.

Echenique, F.; and Wierman, A. Finding a Walrasian Equilibrium is Easy for a Fixed Number of Agents. In Proceedings of the 13th ACM Conference on Electronic Commerce, of EC '12, pages 495-495, New York, NY, USA, 2012. ACM

Paes Leme and Chiu-wai Wong (2016) "Computing Walrasian Equilibria: Fast Algorithms and Structural Properties"

Lecture 18: Existence of Nash Equilibria: Nash equilibria in Mixed Strategies; Application to Financial Markets

Jehle, Geoffrey A. and Philip J. Reny. 2011. *Advanced Microeconomic Theory*. Third Edition. New York: Financial Times/Prentice Hall. Chs. 7.1-7.2.2 "Strategic Decision Making", "Dominant Strategies", "Nash Equilibrium"

Asu Ozdaglar's Lecture material from Course 6.254. "Existence of a Nash equilibrium"

Townsend, Robert. (1990) Financial Structure and Economics Organization: "Key Elements and Patterns in Theory and Early European History"

Dubey, Pradeep. (1982) "Price-quantity Strategic Market Games" EconometricaVol. 50, No. 1 (Jan., 1982), pp. 111-126

Fleming, Michael J. and Kenneth D. Garbade. "Explaining Settlement Fails" Federal Reserve Bank of New York: *Current Issues in Economics and Finance.* Volume 11, Number 9 September 2005

## Lectures 19-21, Microeconomics and Macro Aggregation, Theory and Data; Welfare Statements, Identification and Falsification

Lecture 19: Consumer Behavior, Demand Functions, Homogeneity, Income and Substitute Effects, Engle Curves and Giffin Goods, Compensated (Hicks) and Uncompensated (Marshall) Demands, a first look at the Slutsky Equation, indirect utility and the expenditure function, Duality of Utility Maximization and Expenditure Minimization, properties of the expenditure function and Hicksian demand

*NS Chapter 5 "Income and Substitution Effects"

MWG 3.D-F "The Utility Maximization Problem," "The Expenditure Minimization Problem," "Duality: A Mathematical Introduction"

Lecture 20: Gorman Aggregation, the positive and normative representative consumer for prediction and welfare respectively, indirect utility and properties, Roy's identity, Gorman Polar forms, Linear expansion paths and data, critical review of traditional and new founda-

tions of macroeconomics, Application: The Representative Consumer in Aggregated Models

*Daron Acemoglu. Introduction to Modern Economic Growth. Princeton: Princeton University Press. Chapter 5.2. "The Representative Household", 218-226

Lecture 21: Identification and Falsification with Data, as applied to Consumer Optimization and to General Equilibrium theory, A Unified Approach—Infinite Data and the Slutsky Matrix, Finite data and Reveled preference, Convexity not testable, computational considerations, Falsifiability, income data alone is not enough to test

*Varian 8.1-3 on Slutsky matrix

*Varian 8.5 "Integrability"

*Varian 8.7 "Revealed Preference"

## Lectures 22-23, Failures of the Welfare Theorems and Some Market Structure Remedies

Lecture 22: Failure of the Second Welfare Theorem – Nonconvexity; Failure of the First Welfare Theorem - Local Satiation, Pollution but Fixed with Markets in Rights, Externalities generally, rights for assignment to others, Infinite Horizon and Infinite wealth

*Arrow, K.J., 1969. "The organization of economic activity: Issues pertinent to the choice of market versus nonmarket allocation." In *The analysis and evaluation of public expenditure: the PPB-system*. Washington DC: Joint Economic Committee, 91st Cong., 1st sess 1, pp. 59-73.

Lecture 23: Economics of Platforms in a Walrasian Framework: Platform and Payment externalities, Internalizing Externalities with Market Design; Application: Competition in Cryptocurrencies

*Jain, Anil and Robert M. Townsend. 2019. "The economics of platforms in a Walrasian setting." Working paper.

## Lectures 24, Bitcoin, Blockchain, and Distributed Ledgers

Lecture 24: Bitcoin Values, Overlapping Generations and Bubbles, Lessons from Monetary Theory, Efficiency questions, is the bubble large enough in actual economies, the value of money as from cash-in-advance, removing indeterminacy in practice, a fin tech application in Southeast Asia, Commitment and a Digital Reserve Bank, activist monetary and token policy

DLT, Section on “Token Valuation”

*Townsend, Robert and Neil Wallace. 1987. “Circulating Private Debt: An Example with a Coordination Problem.” In *Contractual Arrangements for Intertemporal Trade*, edited by Edward C. Prescott and Neil Wallace. Minneapolis: University of Minnesota Press, pp 105-20.

*Townsend, Robert M. 1980. “Models of Money with Spatially Separated Agents.” In *Models of Monetary Economies*, edited by John Kareken and Neil Wallace. Minneapolis: Federal Reserve Bank of Minneapolis, pp. 265-303

Abel, Andrew B., N. Gregory Mankiw, Lawrence H. Summers, and Richard J. Zeckhauser. 1989. “Assessing Dynamic Efficiency: Theory and Evidence.” *Review of Economic Studies* 56 (1): 1-19

Tirole, Jean. 1985. “Asset Bubbles and Overlapping Generations.” *Econometrica* 53 (6): 1499-1528

Manuelli, Rodolfo, and Thomas J. Sargent. 2010. “Alternative Monetary Policies in a Turnpike Economy.” *Macroeconomic Dynamics* 14 (5): 727-762