14.121 Microeconomic Theory I

Staff:
Instructor: Prof. Robert Townsend, E52-538, rtownsen@mit.edu, Office hours: after class
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Logistics:
Two lectures per week: Mon, Wed 1-2:30, E51-057, 14 sessions total
Recitations: Fri 1-2:30, E51-057
Lectures begin 9/6 and end 10/25
Exam: Fri 10/27 1-3, 50-340

Description:

This course provides an introduction to theory and data designed to meet the needs of students in the economics PhD program. It provides an introduction to consumer choice and general equilibrium models, with an overview of the main results and tools used in these subjects and both directly and indirectly in a variety of other fields.

Enrollment in this course is limited and permission of the instructor is required. Permission can be obtained by attending the first class meeting and providing information about previous coursework in mathematics and economics. The course assumes that students have taken undergraduate intermediate microeconomics classes. It also assumes that students are comfortable with multivariable calculus and linear algebra and have had some exposure to real analysis. Historically, many students from outside the economics department have had difficulty with the course. The enrollment limit may result in well-qualied students being turned away.

Textbook:

- Mas-Collel, A., Whinston, M., and Green, J., 1995. Microeconomic theory. Oxford University Press. [MWG]

Some students have also found the following books helpful:

- Debreu, G., 1959. Theory of value: an axiomatic analysis of Economic Equilibrium. New York, NY: Wiley.
- Jehle, G., and Reny, P., 2000. Advanced microeconomic theory. 2nd ed. Reading, MA: Addison-Wesley.
- Koopmans, T.C., 1957. Three essays on the state of economic science. New York, NY: McGraw-Hill, 1957.
- Quirk, J., and Saposnik, R., 1968. Introduction to general equilibrium theory and welfare economics. New York, NY: McGraw-Hill.

Grading and Requirements:
The course will be graded on the basis of a series of problem sets and a final exam. Problem sets will be due in class on assigned lecture dates. They will be graded on a check-, check, check+ basis. The grades are intended primarily to give you an idea of how you are doing in the course. You may work in groups, but please do the write-ups individually. We do not expect to see identical answers from different students. Class participation is strongly encouraged. The final exam will be held during the final recitation on Friday October 27, 2017.

(Tentative) Course Outline and Reading List

- **Topic 1 (9/6): Economic Science**

  Experiments and Research Design – Cowles Foundation, Frisch. Measurement Without Theory – Koopman's Critique. Econometrics and Theory – Non-Parametric Estimation and Classification, Matzkin. Natural Experiments – Angrist. Big Data – Varian- patterns vs forecasting. Instruments, Policy/Treatment and Monotonicity – Angrist, Heckman, Townsend/Urzua. Good Models and the Real World – Lucas. Economic Theory and Computer Science – contemporary work.

  References:

  - Chipman, J.S., 1998. The contributions of Ragnar Frisch to economics and econometrics. *Econometric Society Monographs,* 31, pp. 58-110.
  - Gabaix, X., 2014. A sparsity-based model of bounded rationality. *Quarterly Journal of Economics,* 129(4), pp. 1661-1710.
  - Koopmans, T., 1947. Measurement without theory. *The Review of Economics and Statistics*, 29(3), pp. 161-172.
  - Mitchell, W.C., 1913. Business cycles. University of California Press.
  - Matzkin, R.L., 2007. Nonparametric identication. *Handbook of Econometrics*, 6, pp. 5307-5368.
  - Angrist, J.D. and Pischke, J., 2010. The credibility revolution in empirical economics: how better research design is taking the con out of econometrics. No. w15794. National Bureau of Economic Research.
  - Varian, H., 2014. Big data: new tricks for econometrics. *Journal of Economic Perspectives*, 28(2), pp. 3-28.
  - Angrist, J.D. and Krueger, A.B., 2001. Instrumental variables and the search for identification: from supply and demand to natural experiments." *Journal of Economic Perspectives,* 15(4), pp. 69-85.
  - Townsend, R.M. and Urzua, S., 2009. Measuring the impact of financial intermediation: linking contract theory to econometric policy evaluation." *Macroeconomic Dynamics*, 13(S2), pp. 268-316.
  - Lucas Jr, R.E., 1980. Methods and problems in business cycle theory. *Journal of Money, Credit, and Banking*, 12(4), pp. 696-715.
  - SITE Summer Workship, 2016, Stanford University, https://site.stanford.edu/2016/session-4
  - 18th ACM Conference on Economics and Computation, June 26-30 2017, Massachusetts Institute of Technology, https://site.stanford.edu/2016/session-4

- **Lecture 2 (9/11): Fundamental Ingredients of Economies: The Breadth and Applicability of General Equilibrium Theory**

  Consumption Sets and incentive compatibility, limited information. Preferences and externalities. Commodity Space and finite, infinite time. Commodity space and states of the world, uncertainty. The transportation problem, linear programs. Leontief: input output and networks. Discrete commodity space and mixtures/lotteries. Demography and overlapping generations. Separation in space, monetary economics and high velocity circulating private debt. Continuum of goods, time, and states. Continuum of agents, agent types. Example economies: from villages to regions and the world economy.

  References:

- General description of an economy: MWG 16.B
- Fisher, I., 1930. The theory of interest as determined by impatience to spend income and opportunity to invest it. New York, NY: Macmillan.
- Debreu, G., 1959. Theory of value: an axiomatic analysis of economic equilibrium. New York, NY: Wiley, Chapter 7.
- 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,* 1, pp. 59-73.
- Leontief, W.W., 1986. Input-output economics. Oxford University Press.
- Fajgelbaum, P.D. and Schaal, E., 2016. Optimal transport networks in spatial equilibrium. No. w23200. National Bureau of Economic Research.
- Taschereau-Dumouchel, M., 2017. Cascades and fluctuations in an economy with an endogenous production network. Working paper.
- Besley, T., Coate, S., and Loury, G., 1993. The economics of rotating savings and credit associations. *The American Economic Review*, 83(4), pp. 792-810.
- Samuelson, P.A., 1958. An exact consumption-loan model of interest with or without the social contrivance of money. *The Journal of Political Economy*, 66(6), pp. 467-482.
- Townsend, R.M., 1980. Models of money with spatially separated agents. In *Models of Monetary Economies*, eds. Kareken, J.H., and Wallace, N.. Federal Reserve Bank of Minneapolis, pp. 265-303.
- Townsend, R.M. and Wallace, N., 1987. Circulating private debt: an example with a coordination problem. In *Contractual Arrangements for Intertemporal Trade*, eds. Prescott, E.C., and Wallace, N.. University of Minnesota Press, 105-120.
- Manuelli, R., and Sargent, T.J., 2010. Alternative monetary policies in a turnpike economy. *Macroeconomic Dynamics*, 14(5), pp. 727-762.
- The continuum economy, http://www.hetwebsite.net/het/essays/edgew/continuum.htm
- Townsend, R.M., 1995. Financial systems in northern Thai villages. *The Quarterly Journal of Economics*, 11(4): 1011-1046.
- Sonnenchein-Mantel-Debreu Theorem: MWG 17.E
- Brown, D.J. and Matzkin, R.L., 1996. Testable restrictions on the equilibrium manifold. *Econometrica*, 64(6), pp. 1249-1262.
- Townsend, R.M., 1988. Models as economies. *The Economic Journal*, 98(390), pp. 1-24.
- Paweenawat, A., and Townsend, R.M., 2012. Village economic accounts: real and financial intertwined. *American Economic Review*, 102(3), pp. 441-446.
- Costinot, A., Donaldson, D.,. and Smith, C. Evolving comparative advantage and the impact of climate change in agricultural markets: evidence from 1.7 million fields around the world. *Journal of Political Economy*, 124(1), pp. 205-248.

- **Lecture 3 (9/13): Solution Concepts- Pareto Optimality, Walrasian Equilibrium, The Core, Nash Bargaining**

  Pareto Optimality. Walrasian Equilibrium. The Core. Nash Bargaining.

  References:

- Feasible allocations, Pareto optimal allocations, Walrasian equilibrium: MWG 16.B
- Utility possibility set, Pareto frontier, social welfare optimum: MWG 16.E
- Supporting Hyperplane Theorem: MWG M.G
- The core: MWG 18.B
- Aumann, R.J., 1964. Markets with a continuum of traders. *Econometrica,* 32(1-2), pp. 39-50.
- Aumann, R.J., 1987. Interview with Feiwel. In *Arrow and the ascent of modern economic theory*, eds. Feiwel, G.R.. New York University press.
- The continuum economy, http://www.hetwebsite.net/het/essays/edgew/continuum.htm
- Nash bargaining: MWG 22.E
- Bargaining problem, Wikipedia, https://en.wikipedia.org/wiki/Bargaining_problem
- Sertel, M.R., and Yildiz, M., 2002. Impossibility of a Walrasian bargaining solution. MIT mimeo.
- Telser, L.G., 1994. The usefulness of core theory in economics. *The Journal of Economic Perspectives*, 8(2), pp. 151-164.
- Sjostrom, W., 1989. Collusion in ocean shipping: a test of monopoly and empty core models. *Journal of Political Economy*, 97(5), pp. 1160-1179.
- Roth, A., 2012. Models of kidney exchange (a lightning overview). Presented at Market Design 285, Stanford University.

- **Lecture 4 (9/18): Risk Sharing in Village Economies, Pareto Optimal Allocation of Risk**

  The programming problems in state space. First order conditions and characterization of the optimal allocation of risk bearing. Risk and insurance in village India. Risk and return in village economies – Thai. Family, village networks, gifts.

  References:

  - General equilibrium under uncertainty: MWG 19.A-B
  - Townsend, R.M. "Risk and insurance in village India." *Econometrica*, 62(3), pp. 539-591
  - Samphantharak, K., and Townsend, R.M., Forthcoming. Risk and return in village economies. *American Economic Journal: Microeconomics*.
  - Kinnan, C., and Townsend, R.M., 2012. Kinship and financial networks, formal financial access, and risk reduction. *The American Economic Review*, 102(3), pp. 289-293.
  - Sripakdeevong, P., and Townsend, R.M., (2012). Informal networks and shadow banking. Unpublished project document, MIT.

- **Lecture 5 (9/20): The First Welfare Theorem and Some Failures with Fixes**

  Statement of the Theorem. Externalities and Limited Commodity Space. Potential Failure from Limited Liability. Failure with Infinite Agents. Money, Bubbles, and Liquidity.

  References:

  - Preference relations: MWG 1.B, 3.B-3.C
  - Production sets: MWG 5.B
  - First Welfare Theorem: MWG 15.C, MWG 16.A-C

- Goulder, 2013. Markets for pollution allowances: what are the new lessons? *Journal of Economic Perspectives*, 27(1), pp. 87-102.
- 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,* 1, pp. 59-73.
- Shleifer and Vishny, 2011. Fire sales in finance and macroeconomics. *Journal of Economic Perspectives*, 25(1), pp. 29-48.
- Kilenthong, W., and Townsend, R.M., 2016. A market based solution to fire sales and other pecuniary externalities. NBER Working Paper 22056.
- Arrow-Debreu equilibrium, sequential trade, asset markets, incomplete markets: MWG 19.C-G
- Radner, R., 1982. Equilibrium under uncertainty. *Handbook of Mathematical Economics*, 2, eds. Arrow, K.J., and Intrilligator, M.D.. North-Holland.
- Geanakoplos, J., and Polemarchakis, P.M., 1986. Existence, regularity, and constrained suboptimality of competitive allocations when the asset market is incomplete. In *Essays in Honour of K.J. Arrow*, 3, eds. Heller, W., Starret, D., and Starr, R.. Cambridge.
- Esteban, J., Mitra, T., and Ray, D., 1994. Efficiency monetary equilibrium: an overlapping generations model with nonstationary monetary policies. *Journal of Economic Theory*, 64, pp. 372-389.
- Acemoglu, D., 2010. Introduction to modern economic growth. Princeton University Press.
- Abel, A.B., Mankiw, N.G., Summers, L., Zeckhauser, R.J., 1989. Assessing dynamic efficiency: theory and evidence. *Review of Economic Studies*, 56(1), pp. 1-19.
- Geerolf, F., 2013. Reassessing dynamic efficiency. Working paper.
- Bewley, 1980. The optimum quantity of money. In *Models of Monetary Economies*, eds. Kareken, J.H., and Wallace, N.. Federal Reserve Bank of Minneapolis, pp. 169-210.
- Levine, 1989. Efficiency and the value of money. *Review of Economic Studies*, 56,pp. 77-88.

- **Lecture 6 (9/25): The Second Welfare Theorem and some Failures with Fixes**

  Khun Tucker and Envelope Theorems. Statement of the Theorem: Pareto Optimal Allocations can be attained as Walraisian Equilibria with Lump Sum Taxes and Transfers. The Programming Problem. Walrasian Equilibria. A Constructive Proof of Equivalence: Putting Those Pieces Together. Failures of the Second Welfare Theorem: Non Convexities in Production, Preferences. General Proof: Separating Hyperplanes. Debreu, Valuation Equilibria and Pareto Optima, for More General Commodity Spaces. Examples: Neoclassical Growth model, Heterogeneous Commodities. Non-Convexities with Continuum of Agents: Convex Hull and Mixtures.

  References:

  - Kuhn-Tucker: MWG M.K
  - Envelope Theorem: MWG M.L
  - Milgrom, P., and Segal, I., 2002. Envelope theorems for arbitrary choice sets. *Econometrica*, 70(2), pp. 583-601.
  - Second Welfare Theorem: MWG 16.D
  - Convex sets and separating hyperplanes: MWG M.G

- Debreu, G., 1954. Valuation equilibrium and pareto optimum. Proceedings of the National Academy of Sciences of the United States of America (PNAS), 40(7), pp. 588-592.
- Stokey, N., Lucas, R.E., with Prescott, E., 1989. Recursive methods in economic dynamics. Harvard University Press, pp. 445.
- Arrow, K.J., and Hahn, F.H., 1971. General competitive analysis. North Holland, pp. 169-182.
- Jones, L.E., 1983. Existence of equilibria with infinitely many consumers and infinitely many commodities: a theorem based on models of commodity differentiation. *Journal of Mathematical Economics*, 12(2), pp. 119-138.
- Mas-Colell, A., 1975. A model of equilibrium with differentiated commodities. *Journal of Mathematical Economics*, 2(2), pp. 263-295.

- **Lecture 7 (9/27): Applications to Labor, Contracts, IO**

  Gains from Extended Commodity Spaces. Indivisible Labor and the Business Cycle. General Competitive Analysis with Private Information: Contracts with Options and Preference Shocks. Firms as Clubs with Moral Hazard: Walrasian Equilibrin and Endogenous Industrial Organization.

  References:

  - Debreu, G., 1954. Valuation equilibrium and pareto optimum. Proceedings of the National Academy of Sciences of the United States of America (PNAS), 40(7), pp. 588-592.
  - Rogerson, R., 1988. Indivisible labor, lotteries, and equilibrium. *Journal of Monetary Economics*, 21(1), pp. 3-16.
  - Hansen, G.D., 1985. Indivisiable labor and the business cycle. *Journal of Monetary Economics*, 16, pp. 309-327.
  - Prescott, E., and Townsend, R.M., 1984. General competitive analysis in an economy with private information. *International Economic Review*, 25(1), pp. 1-20.
  - Prescott, E.S., and Townsend, R.M., 2006. Firms as clubs in Walrasian markets with private information. *Journal of Political Economy*, 114(4), pp. 644-671.
  - Mueller, R., and Townsend, R.M., 1998. Mechanism design and village economies: from credit, to tenancy, to cropping groups. *Review of Economic Dynamics*, 1(1), pp. 119-172.
  - Ashcraft, A.B., Gooriah, K., and Kermani, A., 2014. Does skin-in-the-game affect security performance? Working paper.

- **Lecture 8 (10/2): Introduction to Existence**

  Walrasian Demand Correspondence. Quasi Concavity and Upper Hemicontinuity. Properties of Individual Demand. Calculating Equilibrium Prices, an Example with Heterogeneous Preferences. Fixed Point Theorems: Brower, Kakutani. Properties of Aggregate Demand. Calculating Equilibrium Prices: Scarf's Algorithm. Calculating Equilibria: Negishi and the Second Welfare Theorem Again. Existence of Equilibria in Discontinuous Economies: Some Examples.

  References:

  - Correspondences: MWG M.H
  - Classical Demand Theory: MWG 3.D

- Scarf, H. and Hansen, T., 1973. The computation of economic equilibria. Cowles Foundation Monograph: Yale University, 22.
- Karlin, S., 1959. Positive operators. *Journal of Mathematics and Mechanics*, 8(6), pp. 907-937.
- Fixed Point Theorems: MWG M.I
- Existence and uniqueness of Walrasian equilibrium: MWG 17.A - 17.D
- Scarf, H.E., 1967. The approximation of fixed points of a continuous mapping. *SIAM Journal of Applied Mathematics*, 15(5), pp. 1328-1343.
- Scarf, H.E., 1982. The computation of equilibrium prices: an exposition. *Handbook of Mathematical Economics*, 2, pp. 1007-1061.
- Negishi, T., 1960. Welfare economics and existence of an equilibrium for a competitive economy. *Metroeconomica*, 12(2-3), pp. 92-97.
- Takayama, A., 1985. Mathematical economics. Cambridge University Press.
- Echenique, F., and Wierman, A., 2012. Finding a Walrasian equilibrium is easy for a fixed number of agents. Working paper.
- Leme, R. P., and Wong, C., 2016. Computing Walrasian equilibria: fast algorithms and structural properties. Working paper.
- Nash Equilibrium: MWG 8.D
- Dasgupta, P., and Maskin, E., 1986. The existence of equilibrium in discontinuous economic games, I: Theory. *The Review of Economic Studies*, 53(1), pp. 1-26.

- **Lecture 9 (10/4): Calibration in Micro and Macro**

  Introduction, Shoven and Whalley: Public Finance, Taxes in General Equilibrium. Calibration in Applied Micro: Computable General Equilibrium: An Example with Trade and Consumer Types/countries. Calibration in Dynamic Macro. Notes on GMM and Simulated Method of Moments.

  References:

  - Shoven, J.B, and Whalley, J., 1972. A general equilibrium calculation of the effects of differential taxation of income from capital in the U.S. *Journal of Public Economics*, 1(3-4), pp. 281-321.
  - Dawkins, C., Srinivasan, T.N., Whalley, J., 2001. Chapter 58 - calibration. *Handbook of Econometrics*, 5, pp. 3653-3703.
  - Harberger, A., 1962. The incidence of the corporation income tax. *Journal of Political Economy*, 70(3), pp. 215-240.
  - Stolper-Samuelson and Rybcszynski theorems: MWG 15.D
  - Gebreegziabher, Z., Stage, J., Mekonnen, A., Alemu, A., 2011. Climate change and the Ethiopian economy: a computable general equilibrium analysis. Environment for Development Discussion Paper Series.
  - Kehoe, T., 2003. An evaluation of the performance of applied general equilibrium models of the impact of NAFTA. Federal Reserve Bank of Minneapolis Research Department Staff Report 320.
  - Xu, Y., 2012 Carbon taxes or cap-and-trade: a computable general equilibrium analysis of Chinese economy. *EconModels*.

- Kydland, F., and Prescott, E., 1982. Time to build and aggregate fluctuations. *Econometrica*, 50(6), pp. 1345-1370.
- Lucas, R.E., 1987. Models of business cycles. Oxford: Basil Blackwell.
- Hansen, L.P., and Heckman, J.J., 1996. The empirical foundations of calibration. *The Journal of Economic Perspectives*, 10(1), pp. 87-104.
- Mikusheva, A., 2007. Lecture 19 notes: simulated MM and indirect inference. Course materials for 14.384 Time Series Analysis, MIT OpenCourseWare, Massachusetts Institute of Technology, http://ocw.mit.edu.
- McFadden, D., 1989. A method of simulated moments for estimation of discrete response models without numerical integration. *Econometrica*, 57(5), pp. 995-1026.

- **Lecture 10 (10/11): Aggregation – Positive and Normative Representative Consumers**

  Indirect Utility Function. Properties of the Value Function. Roy's Identity. Gorman Polar Forms. Linear Expansion Paths. Positive Representative Households and Gorman Aggregation. Normative Representative Households and Gorman Aggregation.

  References:

  - Indirect utility functions: MWG 3.D
  - Aggregate demand: MWG 4.B, 4.D
  - Deaton, A., and Muellbauer, J., 1980. An almost ideal demand system. *The American Economic Review*, 70(3), pp. 312-326.
  - Boyd, S., and Vandenberghe, L., 2004. Convex optimization. Cambridge University Press.
  - Chiappori, A., 2010. Testable implications of transferable utility. *Journal of Economic Theory*, 145(3), pp. 1302-1317.

- **Lecture 11 (10/16): Consumer Behavior and another Take on Welfare**

  Expenditure functions. Duality – utility maximization vs expenditure minimization. Hicksian Demand - compensated. Properties of the Expenditure Function and Hicksian Demand. Expenditures and a Welfare Measure. Compensating and Equivalent Variation.

  References:

  - Expenditure minimization and Hicksian demand: MWG 3.E
  - Duality: MWG 3.G
  - Welfare evaluation of economic changes: MWG 3.I
  - Blackorby, C., and Donaldson, D., 1990. The case against the use of the sum of compensating variations in cost-benefit analysis. *The Canadian Journal of Economics*, 23(3), pp. 471-494.

- **Lecture 12 (10/18): Measurement: Income and Interconnections**

  Some history of the national income accounts. Individual accounts and behavior: income, balance sheet, and cash flow; wealth dynamics – some case studies. Village economic accounts: from individual households to village output, savings investment accounts, village balance of payments, flow of funds. National level: consistency of US households surveys, an integrated statement of liquidity flows.

  References:

- History of national accounts, http://www.comptanat.fr/en/principe/histo.htm
- Kuznets, S., 1941. National income and its composition, 1919-1938. National Bureau of Economic Research.
- Wassily Leontief, Wikipedia, https://en.wikipedia.org/wiki/Wassily_Leontief
- Srivisal, N., Townsend, R.M., and Pawasutipaisit, A., 2017. Two exampled applications of Townsend Thai monthly micro dataset: when theories meet data. Presented at Chulalongkorn Business School, June.
- 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.
- Pawasutipaisit, A. and Townsend, R.M., 2011. Wealth accumulation and factors accounting for success. *Journal of Econometrics*, 161(1), pp. 56-81.
- Paweenawat, A., and Townsend, R.M., 2012. Village economic accounts: real and financial intertwined. *American Economic Review*, 102(3), pp. 441-446.
- Srivisal, N., 2012. Collaborative work with NESDB and UTCC. Presented at the Flow of Funds Accounts and Savings Workshop, April.
- Moll, B. and Townsend, R.M., and Zhorin, V., 2017. Economic development, flow of funds, and the equilibrium interaction of financial frictions. Proceedings of the National Academy of Sciences of the United States of America (PNAS), 114(24), pp. 6176–6184.

- **Lecture 13 (10/23): Identification and Falsifiability of Consumer Optimization Theory**

  Slutsky's Decomposition and Falsifiability. Integrability. Testing Individual Rationality with Finite Data: Weak Axiom of Revealed Preference, Afriat's Theorem: Testability of Consumer Rationality. Computational Considerations

  References:

  - Slutsky equation and Slutsky matrix: MWG 3.G
  - Integrability:
    * MWG 3.H
    * Jehle, G., and Reny, P., 2000. Advanced mcroeconomic theory. 2nd ed. Reading, MA: Addison-Wesley, pp. 80-86.
  - Weak axiom of revealed preference: MWG 2.F
  - Chambers, C.P., and Echenique, F., 2016. Revealed preference theory. Econometric Society Monographs (Book 56). Cambridge University Press.
  - Echenique, F., Golovin, D., and Wierman, A., 2011. A revealed preference approach to computational complexity in economics. Presented at EC'11, San Jose, California., June 5-9. ACM.

- **Lecture 14 (10/25): Testing General Equilibrium Theory**

  Testing General Equilibrium Theory with Infinite Data. Testing General Equilibrium Theory with Finite Data. "Anything Goes" Theorem. Falsifiability of General Models. Aggregate Income is not Enough - Chiappori

  References:.

- Sonnenschein-Mantel-Debreu: MWG 17.E
- Mas-Colell, A., 1977. Indivisible commodities and general equilibrium. *Journal of Economic Theory*, 16(2), pp. 443-456.
- Brown, D.J., and Matzkin, R.L., 1996. Testable restrictions on the equilibrium manifold. *Econometrica*, 64(6), pp. 1249-1262.
- Chiappori, A., Ekeland, I., Kubler, F., and Polemarchakis, P.M., 2004. Testable implications of general equilibrium theory: a differentiable approach. *Journal of Mathematical Economics*, 40, pp. 105-119.