

E. C. Prescott/K. Reffett  
Ecn 791: Dynamic General Equilibrium for Open and Closed Economies  
Reading List  
Spring 2012

### **Course Introduction**

The Arrow-Debreu-McKenzie approach to economic equilibrium is the language of modern macroeconomics since the work of Lucas, Kydland, Mehra, Prescott, among others, beginning in the 1970s. Beginning with the work of Lucas and Prescott (1971) and Prescott and Mehra (1980), the use of recursive methods to characterize the structure of dynamic general equilibrium in macroeconomics has become extensive. This has been true both from a theoretical perspective (i.e., characterizing the structural properties of recursive equilibrium, and relating recursive equilibrium in valuation/sequential equilibrium), as well as from a computational perspective (as recursive methods offer a powerful toolkit for developing efficient computational methods for solving dynamic general equilibrium models). The key transformation with the calibration approach introduced by Kydland and Prescott (1982). Since this paper, the "calibration" approach to characterizing the quantitative properties of dynamic general equilibrium models has been a dominant methodology. But as this much of the work since Kydland and Prescott takes place in non optimal economies (and, often, economies with limited commitment and/or heterogeneous agents), many interesting new questions arise. We will discuss some of these issues in this course.

This course takes place at two levels. First, we will introduce students to some of the relevant theory in dynamic general equilibrium theory (for both closed and open dynamic economies) with an eye for macroeconomic applications and recursive methods. This will include discussions, lectures, and presentations on recursive equilibrium theory, as well explorations of various computational methods that prove useful in constructing accuracy approximation methods for many common classes of dynamic macro models. We will also discuss many issues that complicate the study of recursive equilibrium, its computation, and include issues problems associated with time consistency and limited commitment, nonconvexities (w/ an emphasis on new trade theory), models of technological development and technological capital, Bewley models, and issues related to optimal taxation without commitment. In addition, some of the lectures will also focus discussing recent work proposing a continuous theory of recursive computation for dynamic equilibrium models, which can be presented using a unified order theoretic approach. Special cases of this computational theory will include (i) monotone methods in function spaces, (ii) correspondence-based/strategic dynamic programming methods in spaces of correspondences (e.g., Kydland-Prescott (1980) and versions of APS adapted to dynamic economies, and (iii) Interval iteration methods in function spaces. Time (and interest) permitting, we might also discuss recent work in recursive saddlepoint methods for dynamic economies with limited commitment. The

emphasis of these lectures on computation will be applied, and direct students toward a language for understanding iterative methods for computing dynamic equilibrium models.

Second, a key feature of the course is that we will directly discuss the current work of the Phd students taking the class. Our emphasis will be on developing and improving the theoretical and computational approaches that are being taken in this work. So a good deal of emphasis will be placed on improving student thesis writing (and potential job market papers). Logistically, we will expect students to prepare initial presentations of their research ideas, and then we will as a group sharpen how models are formulated, try to explore new results for the models, and also make certain that the computational approaches are rigorous. This actually is a very critical focus of the course, and will also influence some of the topics which will be the subject of our lectures. So this class (and its topics pursued) will be quite interactive.

### A Reference List for the Course

This is the *reading/reference* list on general equilibrium methods that form much of the background for the course. This is *not* a course outline. The material we will actually discuss in class will be a *strict* subset of this list. As our emphasis in class will be on recursive methods and recursive equilibrium, we have placed an (\*) next papers of particular interest. For additional references, see Stokey, Lucas, and Prescott (1989).

The key papers that outline the methodological approach to macroeconomics that are the foundation of this course are contained in following papers (all of very important, so look at them them):

Kydland, F. and E. Prescott. 1982. Time to Build and economic fluctuations. *Econometrica*.50, 1345-1371.

Prescott. E. 1986. Theory ahead of business cycle measurement. *Carnegie-Rochester Conference Series on Public Policy*. 25. 11-44 (also printed in *Quarterly Review, Minneapolis Fed*, Fall, 1986).

\_\_\_\_\_. 1988. Robert Solow's neoclassical growth model: an influential contribution. *Scandinavian J of Economics*. 90. 7-12

\_\_\_\_\_. 2006. Transformation of macroeconomic policy and research. *JPE*. 114. 203-235.

Lucas, R.E., Jr. 1980. Methods and problems in business cycles *Journal of Money, Credit, and Banking*. 12. 696-715.

Mehra, R. and E. Prescott. 1985. The equity premium: a puzzle. *Journal of Monetary Economics*. 15, 145-161.

The seminal reference on Markovian stochastic dynamics is the book of Meyn and Tweedie. An excellent introduction to the computational/theoretical issues related to stochastic dynamics that arise in economics is the book of John Stachurski's (see also his numerous papers).

Meyn, S. and R. Tweedie. 1993. *Markov Chains and Stochastic Stability*. Springer (reissued recently as a second edition).

Stachurski, J. 2009. *Economic Dynamics: Theory and Computation*. Princeton Press.

The lectures on computation will discuss fixed point theory in partially ordered spaces a great deal. There are numerous excellent books on partially ordered sets/lattices with chapters discussing applications of these concepts to parameterized fixed point theory. A few of classics in the field are books by Birkhoff, Davey/Priestley, and a book Gierz, et. al. The unpublished notes of Veinott on lattice programming and order theoretic fixed point theory are legendary, and a fantastic reference. The notes of Amann on topological and order theoretic fixed point theory are also excellent. Aliprantis and Border is a fantastic reference for mathematics in infinite dimensional space (w/ emphasis on economic applications).

Birkhoff, G. 1967. *Lattice Theory*. AMS Press.

Amann, H. 1977. *Order Structures and Fixed Points*. SAFA 2, ATTI del 2o Seminario di Analisi Funzionale e Applicazioni. MS.

----- . 1977. *Lectures on Some Fixed Point Theorems*.

Dugundji, J. and A. Granas. 1982. *Fixed Point Theory*.

Davey, and Priestley. 1990. *Introduction to Lattices and Order*. Cambridge Press.

Veinott, A. 1992. Lattice programming: qualitative optimization and equilibria. MS. Stanford.

Gierz, G., K.H. Hoffman, K. Keimel, J.D. Lawson, M.W. Mislove, and D.S. Scott. 2003. *Continuous Lattices and Domains*. Cambridge Press.

Aliprantis, C. and K. Border. 2006. *Infinite Dimensional Analysis: Hitchhikers Guide*. 3rd edition. Springer Press.

Finally, a few assorted papers that will be referred to in the lectures on computation.

Amann, H. 1976. Fixed equations and nonlinear eigenvalue problems in ordered Banach spaces. *SIAM Review*, 18(4), 620-709.

Guillerme, J. 1995. Intermediate value theorems and fixed point theorems for semi-continuous functions in product spaces. *Proceedings of the Mathematical Society*, 123(7), 2119-2122.

Markowsky, G. 1976. Chain-complete posets and directed sets with applications. *Algebra Univ*, 6, 53-68.

Nadler, S. 1968. Sequences of contractions and fixed points. *Pacific Journal of Mathematics*, 27(3), 579-585.

Tarski, A. 1955. A lattice-theoretical fixpoint theorem and its applications. *Pacific Journal of Mathematics*, 5, 285-309.

## 1. General equilibrium

Arrow, K. 1951. An extension of the basic theorems of classical welfare economics. in J. Neyman (ed), *Proceedings of the second Berkeley symposium on mathematical statistics and probability*, Berkeley. U. California Press.

\_\_\_\_\_. 1953. Le rôle des valeurs boursières pour la répartition la meilleure des risques" in *Econometrie*, Paris: Center National de la Recherche Scientifique, 41-48 (its also in RES, 1964 in English)

Debreu, G. 1954. Valuation equilibrium and Pareto optimum. in *Proceedings of the National Academy of Sciences*, 40, 588-592.

\* \_\_\_\_\_. 1959. *The Theory of Value*. Cowles Foundation.

\_\_\_\_\_. 1970. Economies with a finite number of equilibrium. *Econometrica*, 38, 387-392.

\*McKenzie, L. 1959. On the existence of equilibrium in a competitive market. *Econometrica*, 27, 54-71. (correction, 1961, *Econometrica*, 247-248.)

\*Negishi, T. 1960. Welfare economics and the existence of equilibrium in a competitive economy. *Metroeconomica*, 23, 92-97.

MasColell, A. 1986. The price equilibrium existence problem in topological vector lattices. *Econometrica*, 54, 1039-1053.

Aliprantis, C.D., D. Brown, and O. Burkinshaw. 1989. *Existence and Optimality of Competitive Equilibrium*. New York: Springer.

## 2. Some Papers on the Scope of General Equilibrium

MasColell, A. 1975. A model of equilibrium with differentiated commodities. *Journal of Mathematical Economics*. 2. 263-295.

Prescott E, and R. Townsend. 1984a. General competitive equilibrium in an economy with private information. *International Economic Review*. 25, 1-20.

\* \_\_\_\_\_. 1984b. Pareto optimum and competitive equilibria with adverse selection and moral hazard. *Econometrica*. 52., 21-45.

\*Jones, L. 1984. A competitive model of commodity differentiation. *Econometrica*, 52, 507-530.

Rogerson, R. 1988. Indivisible labor, lotteries, and equilibrium. *Journal of Monetary Economics*. 21. 3-16.

Hornstein, A. and E. Prescott. 1991. Insurance contracts as commodities: a note. *Review of Economic Studies*. 58. 917-928.

Cole, H. and E. Prescott. 1997. Valuation equilibrium with clubs. *Journal of Economic Theory*. 74. 19-39

Bison, A. and P. Gottardi. 1999. Competitive equilibrium with asymmetric information. *Journal of Economic Theory*. 87-1-48.

----- . 2006. Efficient competitive equilibrium with adverse selection. *JPE*. 114. 485-516

Prescott, E. C. R. Rogerson, and J. Wallenius, 2009. Lifetime Aggregate Labor Supply with Endogenous Workweek Length. *Review of Economic Dynamics*. 12. 23-36.

Citanna, A. and P. Siconolfi. 2010. Incentive efficient Walrasian price systems with adverse selection. MS.

### 3. Dynamic General Equilibrium

Bewley, T. 1969. A theorem on the existence of competitive equilibrium in a market with a finite number of agents and whose commodity space is  $L_\infty$ . CORE Discussion paper 6904. .

\*----- . 1972. Existence of equilibrium in economies with infinitely many commodities. *Journal of Economic Theory*, 4, 514-540.

----- . 1982. Integration of equilibrium theory and turnpike theory. *Journal of Mathematical Economics*, 28, 221-234.

\*Peleg, B. and M. Yaari. 1970. Markets with countably many commodities. *International Economic Review*, 11, 369-277.

\*Prescott, E., and R.E. Lucas, Jr. 1972. Price systems in infinite dimensional space. *International Economic Review*. 13, 416-422.

\*Brown, D. and L. Lewis. 1981. Myopic economic agents. *Econometrica*, 49, 359-368.

Magill, M. J.P. 1981. An equilibrium existence theorem. *Journal of Mathematical Analysis and Applications*. 84, 162-169.

Marimon, R. 1989. Stochastic turnpike property and stationary equilibrium. *Journal of Economic Theory*. 47. 282-306.

MasColell, A. and W. Zame. 1991. Equilibrium theory in infinite dimensional spaces. in W. Hildenbrand and H. Sonnenshein (eds). *Handbook of Mathematical Economics, vol 4*, Amsterdam: North Holland.

Dana, R. and C. LeVan. 1991. Optimal growth and Pareto optimality. *Journal of Mathematical Economics*, 20, 155-180.

Aliprantis, C.D., K.C. Border, and O. Burkinshaw, 1997. New proof of the existence of equilibrium in a simple one-sector growth model. *Macroeconomics Dynamics*, 1, 669-679.

Duran, J. and C. LeVan. 2003. Simple proof of existence of equilibrium in a one-sector growth model with bounded and unbounded returns from below. *Macroeconomic Dynamics*, 7, 317-332.

### 4. Recent work on Dynamic Programming

Rincon-Zapatero, J.P., and C. Rodriguez-Palmero. 2003. Existence and uniqueness of solutions to the Bellman equation in the unbounded case. *Econometrica*. 71. 1519-1555.

Laraki, R. and W. Sudderth. 2004. Preservation of continuity and Lipschitz continuity by optimal rewards operators. *Mathematics of Operations Research*. 29. 672-685.

LeVan, C., and Y. Vailakis. 2005. Recursive utility and optimal growth with bounded and unbounded returns. *Journal of Economic Theory*.

\*Hinderer, K. 2005. Lipschitz continuity of the value function in Markovian decision processes. *Mathematical Methods in Operations Research*. 62. 3-22.

Matkowski, J. and A. Nowak. On discounted dynamic programming with unbounded returns. *Economic Theory*.

\*Marinacci, M. and L. Montrucchio. 2010. Unique solutions for stochastic recursive utilities. *Journal of Economic Theory*. 145. 1776-1804.

\*Martins-da-Rocha, V. F., and Y. Vailakis. 2010. Existence and uniqueness of a fixed point for local contractions. *Econometrica*. 78. 1127-1141.

## 5. Recursive equilibrium (RE) Theory

\*Lucas, R.E., Jr. and E. Prescott. 1971. Investment under uncertainty. *Econometrica*, 39, 659-681.

\*Prescott, E. and R. Mehra. 1980. Recursive equilibrium: the case of homogeneous agents. *Econometrica*, 48, 1365-1379.

Mehra, R. 1984. Recursive equilibrium: a parametric example. *Economics Letters*, 16, 273-278.

Mehra, R. 1988. On the existence and representation of equilibrium in an economy with growth and nonstationary consumption.

\*Kehoe, T., D. Levine, and P. Romer. 1990. Determinacy of equilibria in dynamic models with finitely many consumers. *Journal of Economic Theory*, 50, 1-21.

Santos, M. 1992. Differentiability and comparative analysis in discrete-time infinite horizon optimization. *Journal of Economic Theory*. 57. 222-229.

## 6. Recursive Computation of RE under Full Commitment

### A. Monotone methods in Functions spaces

#### MONETARY ECONOMIES

\*Lucas, R. E., Jr. and N. Stokey. 1987. Money and interest rates in a cash-in-advance economy. 55, 491-513 (w/ correction in *Econometrica* in 1992).

Coleman, W. J., 1988. Money, interest rates, and capital in a cash-in-advance economy. MS.

#### ONE SECTOR MODELS, HOMOGENEOUS AGENT CASE

\*Coleman, W.J., II. 1991. Equilibrium in a production economy with an income tax. *Econometrica*, 59, 1091-1104.

----- . 1997. Equilibria in distorted infinite-horizon economies with capital and labor, *Journal of Economic Theory* **72** (1997) , 446-461.

----- . 2000. Uniqueness of an equilibrium in infinite-horizon economies subject to taxes and externalities , *Journal of Economic Theory* **95** (2000), 71-78.

Greenwood, J. and G. Huffman. 1995. On the existence of nonoptimal equilibria in dynamic stochastic economies, *Journal of Economic Theory*, **65**, 611-623

\*Datta, M., Mirman, L., and K. Reffett. 2002. Existence and uniqueness of equilibrium in distorted dynamic economies with capital and labor *Journal of Economic Theory*, **103**, 377-410

Datta, M., Mirman, L, Morand, O., and K. Reffett. 2002. Monotone methods for Markovian equilibrium in dynamic economies. *Annals of Operations Research*, **114**, 117-144.

Santos, M. 2002. On non existence of Markov equilibria in competitive-market economies.” *Journal of Economic Theory*, **105**, 73-98.

Morand, O. and K. Reffett. 2003. Existence and Uniqueness of Equilibrium in Nonoptimal Unbounded Infinite Horizon Economies. *Journal of Monetary Economics*. **50**, 1351-1373.

\*Mirman, L., O. Morand and K. Reffett. 2008. A qualitative approach to Markovian equilibrium in infinite horizon economies with capital. *Journal of Economic Theory*.

\*Datta, M., L. Mirman, O. Morand, and K. Reffett. 2010. Which recursive equilibria? MS. ASU.

ONE SECTOR STOCHASTIC MODELS W/ INCOMPLETE MARKETS (BEWLEY MODELS)

\*Huggett, M. 1993. The risk-free rate in heterogeneous-agent incomplete market economies. *Journal of Economic Dynamics and Control*. **17**. 953-969

Huggett, M. 1997. The one-sector growth model with idiosyncratic shocks. *Journal of Monetary Economics*,

\*Aiyagari, R. 1994. Uninsured idiosyncratic risk and aggregate saving. *Quarterly Journal of Economics*, **109**, 659-684.

Aiyagari, R. 1995. Optimal Capital Taxation with Incomplete Markets, Borrowing Constraints, and Constant Discounting. *Journal of Political Economy*. **103**. 1158-1175.

Becker R, and I. Zilcha. 1997. Stationary Ramsey equilibria under uncertainty. *Journal of Economic Theory*, **75**, 122-140.

Krusell, P. and T. Smith. 1998. Income and Wealth Heterogeneity in the Macroeconomy. *Journal of Political Economy*. **106**. 867-896.

\*Mirman, L. and K. Reffett. 2003. Multistep Recursive Methods. MS. Arizona State University.

Krebs, T. 2004. Non-Existence of Recursive Equilibria on Compact State Spaces When Markets Are Incomplete. *Journal of Economic Theory*.

Datta, M. Mirman, L. Morand, O. and K. Reffett. 2005. Markovian equilibrium in infinite horizon economies with incomplete markets and public policy. *Journal of Mathematical Economics*

Balbus, L, M. Datta, K. Reffett, L. Wozny. 2011. Recursive equilibrium via Monotone Decompositions. MS in progress. ASU.

#### *B. Correspondence-Based methods*

Duffie, D., Geanakoplos, J.D., Mas-Colell, A. McLennann, A. 1994. Stationary Markov equilibria, *Econometrica* 62, 745-782.

\*Kubler, F. and K. Schmedders. 2003. Stationary equilibria in asset-pricing models with incomplete markets and collateral. *Econometrica*, 71, 1767-1795

\*Miao, J. and M. Santos. 2005. Existence and computation of Markov equilibria for dynamic nonoptimal economies. MS. Boston University.

Krueger, D. and F. Kubler. 2007. Markovian equilibrium in macroeconomics. *New Palgrave Series*.

\*Feng, Z, J. Miao., A. Peralva-Alta, and M. Santos. 2009. Numerical simulation of nonoptimal economies. MS. Federal Reserve Bank of St. Louis

Peralva-Alva, A. and M. Santos. 2010. Problems with the numerical simulation of heterogeneous agent models and economic distortions. *Journal of the European Economic Association*.

\*Datta, M., L. Mirman, O. Morand, and K. Reffett. 2010. Computing (and not computing) recursive equilibrium in nonoptimal economies. MS. ASU.

#### *C. Topological Methods*

Kehoe, T. 1991. Computation and the multiplicity of equilibrium. in W. Hildenbrand and H. Sonnenshein (eds). *Handbook of Mathematical Economics, vol 4*, Amsterdam: North Holland.

Krebs, T. 2006. Recursive equilibrium in endogeneous growth models with incomplete markets. *Economic Theory*.

\*Miao, J. 2006. Competitive equilibria in economies with a continuum of consumer and aggregate shocks. forthcoming *Journal of Economic Theory*.

#### *D. Extensions: Stochastic OLG models*

Wang, Y. 1993. Stationary equilibria in an overlapping generations economy with stochastic production, *Journal of Economic Theory*, 61, 423-435.

Wang, Y. 1994. Stationary Markov equilibrium in an OLG model with correlated shocks, *International Economic Review*, 35(3), 731-744.



\*Morand, O. and K. Reffett. 2007. Stationary Markov equilibria in overlapping generations models with Stochastic Production. *Journal of Mathematical Economics*. 43 (3-4), 501-522.

Citanna, A. and P. Siconolfi, 2007. Short-memory equilibria in stochastic overlapping generations models. *Journal of Economic Theory*, 134, 448-469

Citanna, A. and P. Siconolfi, 2008. On the nonexistence of recursive equilibrium in stochastic OLG models. *Economic Theory*. 417-437.

\*Citanna, A., and P. Siconolfi. 2010. Recursive equilibrium in stochastic OLG economies. *Econometrica*. 78, 309-347.

McGovern, J. O. Morand, and K. Reffett. 2011. Partial ordering methods for recursive equilibrium in stochastic OLG models with production. MS. ASU.

## 7. Computation of RE for Economies without Commitment

### A. Kydland-Prescott Correspondence-Based Methods

\*Kydland, F. and E. Prescott. 1977. Rules rather than discretion: the inconsistency of optimal plans *Journal of Political Economy*, 85, 473-491

\*----- . 1980. Dynamic optimal taxation, rational expectations, and optimal policy. *Journal of Economic Dynamics and Control*. 2. 79-91.

### B. Strategic Dynamic Programming and APS methods

Abreu, D. 1988. On the theory of infinitely repeated games with discounting. *Econometrica*, 56, 383-396.

Abreu, D., D. Pearce, and E. Stacchetti. 1986. Optimal cartel equilibria with imperfect monitoring. *Journal of Economic Theory*, 39, 251-269.

----- . 1990. Toward a theory of repeated games with imperfect monitoring. *Econometrica*, 58, 1041-1053.

\*Atkeson, A. 1991. International lending with moral hazard and risk of repudiation. *Econometrica*, 59, 1069-1089.

Judd, K., S. Yeltekin, and J. Conklin. 2003. Computing supergame equilibria. *Econometrica*. 71. 1239-1354.

Phelan, C. and E. Stacchetti. 2001. Sequential equilibrium in a Ramsey tax model. *Econometrica*. 69. 1491-1518.

\*Sleet, C. and S. Yeltekin. 2003. On the computation of value correspondences. Mimeo. University of Iowa.

### C. Stochastic games, models with limited commitment, and APS in functions spaces

\*Curtat, L. 1996. Markov equilibrium in stochastic games with complementarities. *Games and Economic Behavior*. 17. 177-199.

- Amir, R. 1996. Strategic intergenerational bequest with stochastic convex production. *Economic Theory*. 8. 367-376.
- \_\_\_\_\_. 2002. Complimentarity and diagonal dominance in discounted stochastic games. *Annals of Operations Research*. 114. 39-56.
- \_\_\_\_\_. 2005. Discounted stochastic supermodular games. MS. U of Arizona.
- \*Balbus, L., and K. Reffett, L Woźny. 2010a. A constructive geometrical approach to uniqueness of Markov perfect equilibrium in stochastic games of intergenerational altruism. MS. ASU.
- \_\_\_\_\_.2010b. Stationary Markov equilibrium in altruistic stochastic OLG models without commitment. MS. ASU.
- \*\_\_\_\_\_.2010c. A constructive study of Markov equilibrium in stochastic games strategic complementarities. MS. ASU.
- \_\_\_\_\_.2011. Constructing Markov equilibrium for quasi-hyperbolic discounting consumers under uncertainty. MS. ASU.
- \*Doraszelskii, U. and J. Escobar. 2010. Restricted feedback in long-term relationships. MS. Harvard.

#### *D. Recursive Saddlepoint methods and other DP approaches*

- Dechert, W.D. 1982. Lagrangian multipliers in infinite horizon discrete time optimization models. *Journal of Mathematical Economics*. 9. 285-302.
- Marcet, A. and R. Marimon. 1998 (revised, 2009). Recursive contracts. Mimeo. European University Institute.
- \*Rustichini, A. 1998. Lagrange multipliers in incentive-constrained problems. *Journal of Mathematical Economics*, 29, 365-380.
- \_\_\_\_\_. 1998. Dynamic programming solution of incentive constrained problems. *Journal of Economic Theory*, 78, 329-354.
- LeVan, C. and H. Saglam. 2004. Optimal growth and the Lagrange multiplier. *Journal of Mathematical Economics*. 40, 393-410.
- Messner, M. and N. Pavoni. 2004. On the recursive saddlepoint method. MS. Bocconi.
- \*Sleet, C, and S. Yeltekin. 2010. Recursive Lagrangian methods: discrete time. MS. Carnegie.
- \*Cole, H. and. F. Kubler. 2010. Recursive contracts, lotteries, and weakly concave Pareto sets. MS. U Penn.
- Kovrijnykh, N. 2010. Debt contracts and partial commitment. MS. ASU.

## **8. Stochastic Dynamics**

- Mirman, L. 1971. Uncertainty and optimal consumption decisions. *Econometrica*.

\*Mirman, L. 1972. On the existence of steady measures for the one sector growth model with uncertain technology. *International Economic Review*.

\*Brock, W. and L. Mirman. 1972. Optimal economic growth and uncertainty: the discounted case. *Journal of Economic Theory*.

-----1973. Steady state behavior of a class of one-sector growth models with uncertain technology. *Journal of Economic Theory*.

Futia, 1982. 1982. Invariant distributions and the limiting behavior of Markovian economic models, *Econometrica* 50 (2), 377-408.

Bhattacharya, R. and Lee 1988. Asymptotics of a class of Markov processes that are not in general irreducible. *Annals of Prob*, 16., 1333-1347.

\*Hopenhayn and Prescott, 1987. Invariant distributions for monotone Markov processes. MS.

-----, 1992. Stochastic monotonicity and stationary distributions for dynamic economies. *Econometrica*. 60. 1397-406.

\*Torres, R. 1990. Stochastic dominance. MS.

\*Kamihigashi, T. and J. Stachurski. 2010a. Stochastic stability in monotone economies. MS.

-----2010b. A note on monotone Markov processes. MS.

## 9. Technological Capital Models

\*McGratten, E. and E. Prescott. 2009. Open, technology, capital, and development. *Journal of Economic Theory*. 144. 2454-2476.

\*-----2009. Unmeasured investment and the puzzling U.S. boom in the 1990s. Staff Report 369, Federal Reserve Bank of Minneapolis.

\*-----, 2010. Technology capital and the U.S. Account. *American Economic Review*. 100. 1493-1522.

Kapicka., M. How important is technological capital? Measurement and theory. MS. UC-Santa Barbara.

Hashmi, A. 2008. Intangible capital, barriers to technology adoption and cross-country income differences. MS.

## 10. New Trade Models

\*Melitz, M. 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, *Econometrica*, 71, 1695-1725

Ghironi, F. and M. Meltiz. 2005. International Trade and Macroeconomic Dynamics with Heterogeneous Firms. *Quarterly Journal of Economics*, 120, 865-915

-----2007. Trade Flow Dynamics with Heterogeneous Firms. *American Economic Review P&P*. 97.356-361.

Eaton, J. and S Kortum. 2002. Technology, Geography, and Trade. *Econometrica*. 70. 1741-1779.

\*Alvarez, F. and R.E. Lucas, Jr. 2007. General equilibrium analysis of the Eaton-Kortum model of International trade. *Journal of Monetary Economics*. 54. 1726-1768.

Lucas, R. E., JR. 2009. Trade and the Diffusion of the Industrial Revolution. *American Economic Journal: Macroeconomics*. 1. 1-25.

Rubini, L. 2010. Innovation and the Elasticity of Trade Volumes to Tariff Reductions. MS. ASU.

Arkolakis, C., A. Nostinot., and A. Rodriguez-Clare. 2010. New Trade Models, Same Old Gains? *American Economic Review*.

Ramondo, N. and A. Rodriguez-Clare. 2010. Trade, Multinational Production, and the Gains from Openness. MS.