

Summary of Research

My work can be put into three broad categories: policy analysis, international business cycles, and transition.

I. Policy Analysis

For over ten years I have investigated different dimensions of how government policy impacts on economies. Much of this work has been aimed at fundamental theoretical issues about how policies should be set.

My first venture into this area began in my thesis in which I studied several open issues about policy coordination across countries. At the time I started working in this area, the conventional wisdom in the literature (and policy-circles) maintained that several results were true. First, if governments jointly cooperate in setting their policies, then their citizens will be better off. Second, policy coordination can only make a difference if governments are large enough to affect world prices. The standard intuition for the first result is that by choosing to cooperate, governments can only expand their set of choices. This intuition is correct in a static economy. I showed (in 21 and 32) that in the more realistic situation of an economy in which decisions are taken over time, so that it is not possible for governments to commit once and for all to a set of policies, the conventional wisdom was wrong. In such a dynamic economy without commitment, competition among governments is a good thing and can lead to better outcomes for all agents.

The work on policy coordination made me keenly aware that analysis of policy in economies in which governments can commit once and for all is very different from policy analysis in economies in which governments make their decisions over time. The existing work in the area by Kydland and Prescott and others focussed on showing when the optimal policy under commitment would not be carried out in an environment without commitment. (In the stan-

ard parlance, they showed that the Ramsey plan was typically time inconsistent.) What they didn't do was to formulate what should happen in an economy without commitment. In a series of papers (12, 14 and 18), Chari and I developed a simple but general formulation of the problem, which we called sustainable plans, and completely characterized the solution. The key was to interweave elements of competitive equilibrium with elements of dynamic game theory in a way that respected the competitive nature of private agents and the strategic logic used by the government. After a fair amount of debate we convinced Prescott to see the light and we co-authored a paper with him (33) in which he endorsed the new formulation. Our formulation is now the standard one (and is used, for example, in recent work of Nancy Stokey and Tom Sargent).

After setting out a general theory, Chari and I became interested in applying it empirically to the major policy issues in macroeconomics. In (10 and 17) Chari, Christiano and I studied the quantitative implications of optimal monetary and fiscal policy in business cycles models. Before we started, the standard work in the area was by Robert Barro. In some simple reduced form work he argued that it was optimal for the government to finance unexpected increases in government spending, say due to wars, running large budget deficits currently and slowly paying off the accumulated debt by raising taxes on labor income by a constant amount from then on. We showed that if one worked it out carefully, this was not even remotely close to the optimal policy. Actually, what the government should do is to raise taxes on bond and capital during the war rather abruptly and sell little debt. After the war it should lower these taxes and pay off the debt. At no time should it raise the taxes on labor income. Currently this work is controversial, although hopefully within a few years it will become the new standard.

In terms of optimal monetary policy we did a similar exercise. The standard intuition by Ed Phelps and others was that inflation is like any other tax and thus in any optimal tax package

it should always be used. In (7), Chari, Christiano and I showed that in standard money models this is not true. Inflation just adds extra distortions to the economy and the optimal policy is to follow Milton Friedman's controversial advice from thirty years ago, namely never to use inflation to raise revenues. Our work has been used by applied policy makers to help justify their anti-inflationary stances.

In (23), we summarized the state of the art of knowledge of optimal monetary and fiscal policy.

Recently, I have been interested in issues of transparency of monetary policy. A classic question in international economics is whether it is better to set monetary policy using money growth as an instrument or using exchange rates as the instrument. A common argument is that the exchange rates have a natural advantage over money growth rates as instruments since exchange rates provides signals that are both clearer and easier to monitor than those provided by money growth rates. In (38), Atkeson and I formalize this argument in a simple model. In it the exchange-rate regime is more transparent than the money regime in that it is easier to monitor policymakers actions in a regime that uses exchange rate targets than it is to monitor them in a system that uses money growth targets. We find that the greater transparency of the exchange rate regime makes it easier to provide the central bank with incentives to pursue good policies in this regime and hence gives it an advantage over the money-based regime.

In (37), Athey, Atkeson, and I analyze the optimal design of monetary rules. We suppose there is an agreed upon social welfare function that depends on the randomly fluctuating state of the economy and that the monetary authority has private information about that state. We suppose the government can constrain the policies of the monetary authority by legislating a rule. In general, well-designed rules trade off the need to constrain policymakers from the standard time consistency problem arising from the temptation for unexpected inflation with the desire to give

them flexibility to react to their private information. Surprisingly, we show that for a wide variety of circumstances the optimal rule gives the monetary authority no flexibility. This rule can be interpreted as a strict inflation targeting rule where the target is a prespecified function of publicly observed data. In this sense, optimal monetary policy is transparent.

A final policy issue I got interested in is the effect of NAFTA on trade. My brother, Timothy, and I gathered together a number of academics and policymakers for a conference on NAFTA at the Minneapolis Federal Reserve Bank. There were a number of policymakers including the then Minister of Trade from Mexico, Jaime Serra Puche. The results of the conference were presented by Timothy in an address to the Mexican Congress and were reported by Serra Puche to have been influential in helping to provide sound academic argument for integration. Timothy and I wrote several of the papers which were published in a book (26).

II. International Business Cycles

Another major area of interest to me has been various aspects of international business cycles. I have worked on several issues in this area.

A major area of interest in international macroeconomics is understanding movements in the trade balance over time. In the late 1980's when I started to work in this area with David Backus and Finn Kydland, the existing literature was split into two fairly distinct parts. In the theoretical part, economists like Helpman, Obstfeld, Svensson, and others were building theoretical models, which focused on consumption smoothing as the main force driving movements in the trade balance. Briefly, in their models when there is a recession, agents borrow from abroad by running a deficit and they pay it back when there is a boom in output. Separately, a group of empirical economists were running a number of reduced form regressions, only tangentially connected to any theory, with a hodgepodge of results. When Backus and I first started, we documented the patterns in the data in a systematic way for 11 countries over a 100 year period

in (15). The first feature that became apparent is that the trade balance is countercyclical. Thus, in the data, countries on net borrow during booms not recessions as the previous theory had predicted. As we saw it, the lack of connection between theory and data had led to theory which was not about the data, and empirical work with little hope of interpretation using theory. (Professing this view at various conferences attended by the theorists and empiricists who worked in this area did not make us tremendously popular.)

Backus, Kydland, and I set out to build a simple explanation of the countercyclicality of investment. Our story was that during a productivity driven boom, a country borrows to finance new productive investments; during a recession it lends because there are more productive opportunities elsewhere. Quantitatively, we showed that for plausible parameter values, this investment effect dominated the consumption smoothing effect and the resulting trade balance was procyclical. After several rounds of convincing skeptical referees, we published our work in the (13).

A second major area of interest is assessing the interaction of the terms of trade and the trade balance. Actually this connection has interested international economists since the work of Harberger and Laursen and Metzler in the 1950's. Backus, Kydland and I started off by showing that the existing theories of Helpman et al. predicted the opposite of what is in the data. In (11) and (31) we showed that an elaboration of our earlier model could generate dynamic patterns of trade balance and the terms of trade similar to those in the data. Now a chapter in the new Handbook of International Economics is devoted to it and related work by Baxter-Crucini and Stockman-Tesar. In related work (20), Backus and I investigated the financial side of international business cycles. We showed the standard portfolio balance model had a basic logical flaw in it. Moreover, we showed how regressions interpreted as supporting it bore no evidence on the theory.

The set of papers just discussed constitute the first generation of quantitative equilibrium models of international business cycles. They study models with complete markets and no frictions, besides transportation costs, and the shocks are from the real-side, technology shocks and government spending shocks. They document that, while successful on a number of dimensions, such models have a difficult time some features of the data: the models generate higher cross correlations of consumption than is in the data and too little volatility in the real exchange rate. For the last 7 years I have been working on adding various frictions and alternative shocks to these models to address specific issues.

In a number of papers I have investigated whether monetary shocks together with sticky prices can generate business cycles. Even though the sticky price story for the business cycles is the leading one for many economists there have been markedly few attempts to investigate whether a plausibly parameterized version of the model can generate the observed patterns in the data. In (4), Chari, McGrattan and I argue that the inability to produce persistent movements in output is the Achilles' heel of such models. We show that the standard sticky price model and a large number of variations of it cannot produce movements in output as persistent as in the data.

In (40), we investigate whether a two-country sticky price model can generate volatile and persistent movements in exchange rates. We are motivated by the early observations that nominal and real exchange rates are much more volatile than domestic price indices and by more recent work that documents large deviations from the law of one price for traded goods. We find that the model can generate volatile and persistent real exchange rates, as in the data. The main discrepancy between the model and the data, the *consumption-real exchange rate anomaly*, is that the model generates a high correlation between real exchange rates and relative consumptions while the data shows no clear pattern between these variables. We show that this anomaly will occur in any model with frictionless asset markets because in such a model the real ex-

change rate is tightly linked to the marginal utilities of consumption of domestic and foreign agents. We conclude that research in this area should focus on asset market frictions. We consider simple frictions, like incomplete markets, in this paper and in with other co-authors I consider more elaborate ones.

In (3), Alvarez, Atkeson, and I introduce a commonly discussed asset market friction, namely that agents must pay a Baumol-Tobin type fixed cost to access the asset market. In any period, some agents choose to pay the fixed cost and, at the margin, freely exchange bonds and money. Other agents choose not to pay the fixed cost and hence do not. In the model only the marginal utility of agents active in the asset markets matters for asset prices. We show that the model can generate liquidity effects, in that a money injection initially lowers interest rates, while the standard model without such a cost cannot.

In (42), we investigate an open economy version of the model. In it the consumption of active agents is highly volatile and persistent, hence so are the resulting real exchange rates. Moreover, the consumption of these agents is not highly correlated with aggregate consumption, and hence the model has a looser link between real exchange rates and aggregate consumption than the standard complete markets model. Preliminary results suggest that when asset markets are highly segmented this friction can go a long way in resolving the consumption-real exchange rate anomaly and at the same time generate other observed characteristics of the data.

In (2), Perri and I investigate the following idea. In complete market models, frictionless asset markets lead the marginal utilities of consumption to be equated across countries which, in turn, can lead to consumptions to be highly correlated across countries. We imagine that it is difficult to enforce contracts between sovereign nations which involve large transfers of resources at one date and state which are only backed by promises to pay at later dates and states. We model this view by assuming international loans are feasible only to the extent that they can be

enforced by the threat of exclusion from future borrowing. We show that, theoretically, this friction breaks the tight link between marginal utilities across countries present in frictionless models by introducing a stochastic wedge between them. We show that quantitatively this stochastic wedge leads to consumption to be much less correlated across countries than in the standard model. In (48), we have tentatively shown that with multiple traded goods such a friction can break the link between marginal utilities and real exchange rates and help account for the consumption-real exchange rate anomaly.

In some theoretical work with Harold Cole (6 and 9), I investigated why sovereign countries ever repay their debts. The standard answer had been that countries repaid their debts because defaulting on their debts would tarnish their reputations and make it harder for them to borrow in the future. Some interesting work by Bulow and Rogoff showed that this story did not work. Briefly, if a country could sagely save, then a country can smooth out fluctuations by building up a stock of savings and running it down when it needs funds. Thus the cost of not being able to borrow is minimal and the threat of losing this ability is not enough to deter default. Cole and I disagreed with Bulow and Rogoff. We showed that if reputation spilled over to other arenas of behavior, then reputation could indeed support debt. The idea was simply that if Mexico defaulted on its debt to the U.S. bankers, then this might cause other agents involved in trust relationships with Mexico, say other countries in strategic alliances U.S. or countries with various treaties, or even private citizens in its own country, to infer that the government of Mexico was not to be trusted. If these intertwined relationships were worth a great deal, then the desire to maintain a good reputation will be enough to give countries an incentive to repay their debts. In a sense our work resuscitated the literature on reputation and undercut the basis for the literature that sprang up from Bulow and Rogoff's work.

III. Transition

In addition to business cycles, I am interested in questions as to the medium and long term patterns of aggregates following major changes.

For example, during the Second Industrial Revolution, 1860–1900, many new technologies, including electricity, were invented. These inventions launched a transition to a new economy, a period of about 70 years of ongoing, rapid technical change. After this revolution began, however, several decades passed before measured productivity growth increased. This delay is paradoxical from the point of view of the standard growth model. Historians hypothesize that this delay was due to the slow diffusion of new technologies among manufacturing plants together with the ongoing learning in plants after the new technologies had been adopted. The slow diffusion is thought to be due to manufacturers' reluctance to abandon their accumulated expertise with old technologies, which were embodied in the design of existing plants. Motivated by these hypotheses, Atkeson and I in (39) build a quantitative model of technology diffusion which we use to study this transition to a new economy. We show that it implies both slow diffusion and a delay in growth similar to that in the data.

In some other work on transition (44), Chari and Ellen McGrattan and I documented patterns in the distribution of per capita income across countries. We argued that most of the new endogenous growth models are incapable of generating patterns even remotely similar to those in the data. We then developed a simple model with random distortions to the returns to capital and showed that quantitatively it was consistent with many of the patterns in the data. If we can convince people of our views then this paper will be a major one. It argues that most of the current theory and empirical work in growth theory is headed in the wrong direction. Moreover, simple modifications of theory that was around thirty years ago can account for the facts.

Atkeson and I also worked on a putty-clay model of energy in (5). Although it was originally motivated by transition, it turned into an energy paper. In the time series data, energy use responds very little in the short run to increases in the energy price. In cross section data, large differences in energy prices, due to tax rates, lead to large differences in energy use. Standard putty-putty models cannot mimic both the time series and the cross section data. These models need energy use to be very inelastic to fit the time series data, but elastic to fit the cross section in which the energy intensity of each type of capital is fixed. Intuitively, a putty clay model has a chance of fitting both sets of data. In contrast to a putty-putty model in which it is possible to smoothly conserve on the use of energy when the price of energy goes up, in the putty clay model the energy intensity of capital is fixed once and for all for the life of the capital good. For an example of a putty clay piece of capital, think of a car. For simplicity imagine that it can go at only one speed. If the price of gas goes up we still need to have the same amount of gas to travel the same distance. If the price of gas goes up a lot and stays up, we may well substitute out of gas-guzzling cars into more fuel efficient ones, that is from a piece of capital with a high energy intensity to a piece of capital with a low energy intensity, but it is difficult to make the gas-guzzler use less gas per mile. Thus, in the short run, if the price of gas goes up we simply pay more for it but use about the same amount of energy. In the longer run we all buy more fuel efficient cars. This basic idea had been around for about thirty years, but there were some thorny technical issues that prevented applied economists from using it. Atkeson and I solved these technical issues and showed that the putty-clay model can indeed mimic both the cross section and time series models. We think the basic structure has a wide variety of applications.

6 favorite articles

“International Business Cycles with Endogenously Incomplete Markets,” with Fabrizio Perri, forthcoming in *Econometrica*.

“Money, Interest Rates, and Exchange Rates With Endogenously Segmented Asset Markets,” with Fernando Alvarez and Andrew Atkeson, *Journal of Political Economy*, forthcoming.

“Sticky Price Models of the Business Cycle: Can the Contract Multiplier Solve the Persistence Problem?” with V. V. Chari and Ellen R. McGrattan, *Econometrica*, September 2000.

“Optimal Fiscal Policy in a Business Cycle Model,” with Lawrence J. Christiano and V. V. Chari, *Journal of Political Economy*, January 1994.

“Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?” with David K. Backus and Finn E. Kydland, *American Economic Review*, Spring 1994.

“Sustainable Plans,” with V. V. Chari, *Journal of Political Economy*, August 1990. (Reprinted in *Monetary and fiscal policy*, Persson, Torsten; Tabellini, Guido, eds. Cambridge and London: MIT Press, 1994.)

Journal Articles

1. "Measuring Organization Capital," with Andrew Atkeson, accepted subject to revision in *Journal of Monetary Economics*.
2. "International Business Cycles with Endogenously Incomplete Markets," with Fabrizio Perri, forthcoming in *Econometrica*.
3. "Money, Interest Rates, and Exchange Rates With Endogenously Segmented Asset Markets," with Fernando Alvarez and Andrew Atkeson, *Journal of Political Economy*, forthcoming.
4. "Sticky Price Models of the Business Cycle: Can the Contract Multiplier Solve the Persistence Problem?" with V. V. Chari and Ellen R. McGrattan, *Econometrica*, September 2000.
5. "Models of Energy Use: Putty-Putty vs. Putty-Clay," with Andrew Atkeson, forthcoming in *American Economic Review*, September 1999.
6. "A General Reputation Model of Sovereign Debt," with Harold Cole, *International Economic Review*, February 1998.
7. "The Optimality of the Friedman Rule in Economies With Distorting Taxes," with Lawrence J. Christiano and V. V. Chari, *Journal of Monetary Economics*, April 1996.
8. "Social Insurance and Transition," with Andrew Atkeson, *International Economic Review*, February 1996.
9. "The Role of Institutions in Reputation Models of Sovereign Debt," with Harold L. Cole, *Journal of Monetary Economics*, March 1995.
10. "Optimal Fiscal Policy in a Business Cycle Model," with Lawrence J. Christiano and V. V. Chari, *Journal of Political Economy*, January 1994.
11. "Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?" with David K. Backus and Finn E. Kydland, *American Economic Review*, Spring 1994.
12. "Sustainable Plans and Debt," with V. V. Chari, *Journal of Economic Theory*, January 1994.
13. "International Real Business Cycles," with David K. Backus and Finn E. Kydland, *Journal of Political Economy*, November 1992.
14. "Sustainable Plans and Mutual Default," with V. V. Chari, *Review of Economic Studies*, October 1992.
15. "International Evidence on the Historical Properties of Business Cycles," with David K. Backus, *American Economic Review*, September 1992.
16. "In Search of Scale Effects in Trade and Growth," with David K. Backus and Timothy J. Kehoe, *Journal of Economic Theory*, August 1992.
17. "Optimal Fiscal and Monetary Policy: Some Recent Results," with V. V. Chari and Lawrence J. Christiano, *Journal of Money, Credit, and Banking*, August 1991. (Reprinted in *Political economy, growth, and business cycles*, Alex Cukierman, Zvi Hercowitz, Leonardo Leiderman eds., Cambridge and London: MIT Press, 1992.)
18. "Sustainable Plans," with V. V. Chari, *Journal of Political Economy*, August 1990. (Reprinted in *Monetary and fiscal policy*, Persson, Torsten; Tabellini, Guido, eds. Cambridge and London: MIT Press, 1994.)

19. "International Coordination of Fiscal Policy in Limiting Economies," with V. V. Chari, *Journal of Political Economy*, June 1990. (Reprinted in *The Legacy of Robert Lucas, Jr.*, edited by Kevin D. Hoover, Elgar Reference Collection, Cheltenham, U.K.
20. "On the Denomination of Government Debt: A Critique of the Portfolio Balance Model," with David K. Backus, *Journal of Monetary Economics*, May 1989.
21. "Policy Cooperation Among Benevolent Governments May Be Undesirable," *Review of Economic Studies*, April 1989.
22. "Coordination of Fiscal Policies in a World Economy," *Journal of Monetary Economics*, May 1987.

Other Publications

23. "Optimal Fiscal and Monetary Policy," with V. V. Chari, *Handbook of Macroeconomics*, Vol. III, edited by John Taylor and Michael Woodford, Elsevier, 1999.
24. "Asking the Right Questions About the IMF," with V.V. Chari, Federal Reserve Bank of Minneapolis *Annual Report*, 1998.
25. "Reviving Reputation Models of International Debt," with Harold Cole, *Federal Reserve Bank of Minneapolis Quarterly Review*, Winter 1997.
26. *Modeling North American Economic Integration*. (Co-authored two chapters and edited with Timothy J. Kehoe.) Kluwer Academic Publishers, The Netherlands, 1996.
27. "Policy Analysis in Business Cycle Models," with V. V. Chari and L. J. Christiano, in T. Cooley, ed., *Frontiers of Business Cycle Research*, Prentice Hall, 1995.
28. "International Business Cycles: Theory vs. Evidence," *Federal Reserve Bank of Minneapolis Quarterly Review*, Fall 1993, and in Thomas F. Cooley, ed., *Frontiers of Business Cycle Research*, Princeton University Press, 1995.
29. "Capturing the NAFTA's Impact With Applied General Equilibrium Models," with Timothy J. Kehoe, *Federal Reserve Bank of Minneapolis Quarterly Review*, Spring 1994.
30. "A Primer on Static Applied General Equilibrium Models," with Timothy J. Kehoe, *Federal Reserve Bank of Minneapolis Quarterly Review*, Spring 1994.
31. "Relative Price Movements and International Business Cycles," with David K. Backus and Finn E. Kydland, in R. van der Ploeg, ed., *Handbook of International Macroeconomics*, Basil Blackwell, October 1993.
32. "Policy Cooperation Among Benevolent Governments May Be Undesirable: An Extension," in D. Lausell and M. Salmon, eds., *International Economic Policy Coordination*, Basil Blackwell, August 1991.
33. "Time Consistency and Policy," with V. V. Chari and E. C. Prescott, in Robert Barro, ed., *Handbook of Modern Business Cycle Theory*, Harvard University Press, May 1989.

Unpublished Research Papers

34. “Hot Money,” with V.V. Chari, submitted to *Journal of Political Economy*.
35. “Financial Crises as Herds,” with V.V. Chari, solicited by *Journal of Economic Theory*.
36. “Stationary Herds,” with V.V. Chari.
37. “On the optimality of transparent monetary policy,” with Susan Athey and Andrew Atkeson.
38. “Exchange-rate stabilization vs. money-stabilization: The advantage of transparency,” with Andrew Atkeson.
39. “The transition to a new economy following the Second Industrial Revolution,” with Andrew Atkeson, submitted to *Econometrica*.
40. “Can sticky price models generate volatile and persistent exchange rates?” with Ellen McGrattan and V.V. Chari, second revision at *Review of Economic Studies*.
41. “On the time consistency of the Friedman rule,” with Fernando Alvarez and Andy Neumeier, submitted to the *Journal of Political Economy*.
42. “A general equilibrium model of the forward premium anomaly,” with Fernando Alvarez and Andrew Atkeson, in progress.
43. “On the need for fiscal constraints in a monetary union,” with V.V. Chari, submitted to the *Journal of Monetary Economics*.
44. “The poverty of nations: a quantitative explanation,” with V.V. Chari and Ellen McGrattan, revising for resubmission to the *American Economic Review*.
45. “Decentralizing allocations in economies with enforcement constraints,” with Fabrizio Perri, solicited by *Journal of Economic Theory*.
46. “Paths of Development for Early and Late Bloomers,” with Andrew Atkeson, revise and re-submit at the *Quarterly Journal of Economics*.
47. “Sticky wages and the Great Depression,” with Ellen McGrattan, in progress.
48. “Real exchange rates with endogenous incomplete markets,” with Fabrizio Perri, in progress.