Introduction

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The field of macroeconomics can be divided loosely into two branches, a theoretical branch, which sets out the vision of how macroeconomic problems may come about and how they might best be dealt with, and an applied branch, which talks about actual policy – questions such as: Should one use monetary policy to stimulate output? Should one use fiscal policy to offset recessions? And: Should the interest rate or the money supply be used as a measure of monetary tightness? The two branches are of course related with theoretical work guiding policy, and experience in policy guiding theoretical work. But the relation is loose and indirect.

Over the last 30 years, the two branches of macro have become further and further divided as the theoretical macromodels have become more complicated and as our understanding of the statistical problems of fitting the models to the empirical evidence has improved. Today, almost all economists agree that the simple models of yesterday – both theoretical IS/LM type models and the structural macroeconometric models that accompanied them – were far from adequate as theoretical models or as a guide to policy. In response, modern macrotheory has become a highly technical theoretical and statistically sophisticated field of study in which microfoundations of macrotheory play a central role.[1]

Because of the technical difficulty of the tools needed to study macroeconomic theory grounded in microfoundations, the underlying vision of macrotheorists is often given short shrift in both the theoretical debates and in the training of students. Instead of talking about vision researchers focus on resolving technical issues, and teachers focus on

[1] Another branch of macroeconomics has moved away from these short-run issues and has concentrated on growth theory. This book does not deal with these broader growth theory issues. It concentrates on shorter run coordination issues that have traditionally been the focus of macrotheory since the 1930s.

providing students with the tools for resolving technical debates. The result is that, today, when graduate students study macroeconomics, they are given little sense of the history of macroeconomic debates, of how macropolicy works, or of the vision behind the model. They are left on their own to figure out such issues.[2]

ALTERNATIVE MACROECONOMIC RESEARCH PROGRAMS

Since the vision behind the research is central to an understanding of the nature of the macroeconomic debate of which this volume is part, it is probably best to begin with a short summary of what I see as the dominant macroresearch program, which I will call a Walrasian research program, and to contrast it with an alternative research program, which I will call a Post Walrasian research program.[3] Both these research programs have their foundations in a broad economic vision, a vision of the economy in which markets coordinate agent's actions through an invisible hand. Where they differ is, in their sense of what type of theoretical simplifications can shed light on macropolicy issues. Different simplifications lead to different research programs.

I find it helpful to begin distinguishing the two research programs by the assumptions they are willing to make about the information processing capabilities of agents and the information set available to those agents. Walrasians assume high-level information processing capabilities and a rich information set; Post Walrasians assume low-level information processing capabilities and a poor information set.[4]

[2] Just how much they are left on their own was made clear when I interviewed graduate students at top schools (Colander 2005). Consistently I was told by graduate students that at top universities monetary and fiscal policy were not discussed in their macro class, and that they had little idea of what the underlying vision was.

[3] I will discuss the choice of the Walrasian–Post Walrasian classification below.

[4] As Alan Kirman points out in his foreword, in formal general equilibrium theory, researchers assume the existence of a central information processor who has all the information he needs to achieve equilibrium. Macro thinking and theorizing has not closely followed formal general equilibrium theory; instead, it developed an informal Walrasian microfoundation that pictured individuals optimizing in an environment experiencing stochastic shocks of various types. That led to notions of search equilibria, "natural rates" of unemployment and "rational expectations equilibria" that did not fit in a formal general equilibrium where there was a central information processor with full information. It is these notions that I am terming as the Walrasian tradition in macro. It is this tradition that resolved the modeling problems presented by information processing by assuming a single representative agent, thereby avoiding all heterogeneous agent coordination issues that are a central concern to the contributors of this book.

Thus, Walrasians ask the question:

How does the market coordinate agents with high-level information processing capabilities operating in information-rich environments?

Post Walrasians ask the question:

How does the market coordinate agents with low-level information processing capabilities operating in information-poor environments?

The above distinctions are too stark. There is a continuum of processing capabilities and information sets that one can assume, and thus the Walrasian and Post Walrasian research programs blend together. All macroeconomists recognize that systems are complex and that ultimately agents have limited processing capabilities and operate in less-than-full information environments. But the aggregate analysis of such systems is far beyond our current technical analytic capabilities, and it is not clear that the partial analysis that we are currently able to do, which deals seriously with Post Walrasian concerns, yields relevant insights. So the choice is a Walrasian modeling approach that arrives at fairly clear conclusions for a system that is far from the system we want to describe, or a Post Walrasian modeling approach that arrives at ambiguous conclusions for a system that is closer to what we want to describe.

In the 1980s, most cutting-edge macrotheorists chose the Walrasian path, and economists who insisted on asking the Post Walrasian question were outside the mainstream. But, because of technological advances in analytic and computing technology, and the sense that, because of the recent research, we have a better grasp of the Walrasian question, more and more macroresearchers are turning to the Post Walrasian question. This volume is an introduction to that work.

When we think about the work presented in this volume, it should be clear that the Walrasian/Post Walrasian classification is not black and white, and that researchers can be working on both research programs simultaneously. For example, Michael Woodford, who has been instrumental in developing the Walrasian research program, did early work on the Post Walrasian research program (Woodford [1990], Woodford and Farmer [1997]). In fact, many of the Post Walrasian researchers are the students of key Walrasian researchers, and have been encouraged in their work by their Walrasian predecessors. Thus, the Walrasian/Post Walrasian distinction is a distinction about the nature of the research, not about researchers. With those qualifications, let me now discuss the research agendas of the two groups.

The Walrasian Question and the DSGE Synthesis

The dominant strand of research being done in macroeconomic theory today is designed to shed light on the Walrasian question. It is a question that a branch of applied mathematics, optimal control theory, is especially useful in answering, and researchers working in this tradition come into their work with a significant knowledge of dynamic stochastic optimal control theory. For that reason, work in this tradition has recently acquired the name the *dynamic stochastic general equilibrium (DSGE) synthesis.*

In the DSGE research program, general equilibrium theory is conceived of as solving a set of interdependent equations describing globally rational agent intertemporal optimization.[5] The general solution to this set of equations serves as a theoretical foundation for our understanding of macroeconomic coordination issues. I call it Walrasian because this research program is usually associated with Walras, who in *Elements of Pure Economics* attempted to provide a mathematical structure of how the aggregate economy would operate when conceived of as a set of interdependent equations capturing the actions of rational optimizing agents.[6]

The initial work on this Walrasian question began with a study of how globally rational agents with perfect information and foresight would operate because that was felt to be the easiest problem, and because it was felt that the solution to that problem would provide important insight into situations where there is less than perfect information. This meant that the Walrasian research agenda has been to study the coordination of an economy in which globally rational agents are optimizing in information-rich environments. Even when we limit the problem in this way, it is still necessary to make numerous simplifying assumptions to make the problem tractable. This includes eliminating all aspects of the problem that would lead to multiple solutions so that the model yields a unique, or at least a small number of, solutions.[7]

[5] Developing this vision proved very fruitful in finance, and in some ways the Walrasian research program in macro can be seen as an attempt to extend the work done in finance to macroeconomics.

[6] Whether this was Walras' vision is debatable. It follows from Jaffe's translation of Walras' 5th edition, but Walker (1983) argues that earlier editions provide a quite different vision, and that they are the better source of the Walrasian vision. He calls the work that has been done in this tradition neoWalrasian rather than Walrasian.

[7] Schumpeter stated that the existence of a unique solution was absolutely necessary for economics.

To achieve a unique solution, one must significantly limit the allowable interactions of heterogeneous agents in the model, which has generally been done by focusing on models that include a single representative agent. One must also restrict the analysis to models with linear dynamics, a restriction that assumes *away* a whole host of potential policy problems. Unfortunately, these assumptions are crucial to drawing policy implications from the Walrasian model, and are what allow Walrasian macroeconomists to make concepts such as the natural rate of unemployment and the natural rate of interest operational.

Since the assumptions are so important for drawing policy implications from the model, Walrasian researchers agree that there are substantial addenda that need to be made to the theoretical models before results can be drawn for policy. Thus, there is an active Walrasian research program focusing on modifying the assumptions that have been made to make the model tractable. However, until those expanded models come to fundamentally different conclusions from the standard model, most Walrasians believe, either explicitly or implicitly, that the perfect information model (with the necessary assumptions to make it tractable) serves as an intuitive guide for considering policy.

The dynamic stochastic general equilibrium (DSGE) synthesis is the newest, and in many ways the culmination of the developments in the Walrasian tradition. Essentially, it moves beyond perfect information by adding stochastic risk, describable by probability distributions, to the general equilibrium optimization problem over time. The DSGE synthesis sees the macroeconomic problem as a gigantic dynamic stochastic general equilibrium optimal control problem, and looks at the full optimization of individuals and firms, arriving at a solution by using rational expectations and model consistency assumptions. While the direct origins of the DSGE synthesis are in the real business cycle literature that evolved from the New Classical work, it is called a synthesis because much of the recent work within this New Classical tradition has included assumptions of nominal and institutional rigidities, work that has often been classified as New Keynesian. So the DSGE synthesis is the merging of the New Keynesian and New Classical traditions into a single approach. DSGE models consider agents who dynamically maximize their intertemporal objectives subject to budget and resource constraints within a variety of general equilibrium institutional settings that may include institutional and nominal rigidities. The most developed of this work can be seen in Woodford's recent book (2003), which spells

out a variety of models and teases out policy implications from those models.[8]

In terms of policy, the DSGE synthesis models suggest much more caution about the use of discretionary monetary or fiscal policy than did the neoclassical/NeoKeynesian synthesis models. The reason is that in an intertemporal equilibrium, the effects of most expected demand-based policy wash out as individuals adjust their actions to take expected policy into account. Walrasian agents are forward looking, and act on expectations of policy; they are not passive responders to policy action by government, as they were in IS–LM models. The most well-known DSGE policy prescription, which Woodford has strongly advocated, is the need for inflation targeting, in which the central bank announces an inflation target. This inflation targeting allows agents to base their dynamic optimization on a firmer foundation, which means that inflation targeting helps coordinate individual decisions. Work within the DSGE Walrasian approach is concentrating on checking robustness of the policy conclusions derived from the standard model when the models are expanded to include nominal and institutional rigidities.

With sufficient nominal price rigidities, some discretionary demand-based policy may be warranted, but that is only a slight adjustment to the general Walrasian policy view that aggregate demand-based policies will be ineffective in the long run. What this means is that much of the policy action is in expected policy, not in the actual policy; policy is considered in a broader context of policy regimes rather than in terms of specific policies to be followed in specific instances. Thus, modern DSGE macropolicy discussion focuses on credibility, credible rules, and optimal dynamic feedback rules.[9]

[8] Woodford's book is a tour de force that, according to one reviewer, is likely to become a "bible for central bank economists who regard themselves as having a public charge to design and implement stabilization policy as best they can." (Green, 2005, p. 121)

[9] Numerous other policy suggestions follow from the analysis but these have not been taken up generally. For example, in the *Handbook of Macroeconomics* (1999) edited by Taylor and Woodford, Chari and Kehoe suggest four substantive lessons for policymaking from the DSGE model without nominal rigidities: (1) Capital income taxes should be high initially and then roughly zero; (2) tax rates on labor and consumption should be roughly constant; (3) state-contingent taxes on assets should be used to provide insurance against adverse shocks; and (4) monetary policy should be conducted so as to keep nominal interest rates close to zero (Chari and Kehoe, 1999, p. 1673).

The type of policy discussion that is taking place can be seen in a recent paper by Schmitt-Grohé and Uribe (2005). In it they argue that the policy advice of "smooth distortionary income tax rates and highly volatile and unpredictable inflation rates" that follows from the model with no nominal rigidities is significantly modified if one has nominal rigidities.

Modern empirical work in the Walrasian macrotradition has given up trying to directly forecast with the theoretical models, and has concentrated more on showing general consistency of the model with filtered empirical evidence by calibrating the models with out-of-sample data. Success is interpreted to be when the data being generated by the model cannot be differentiated from real world data.

VAR analysis, not calibration, is generally used by Walrasians for forecasting and policy work. In terms of forecasting there has been no clear-cut empirical winner or loser in the formal empirical analysis, although restricted VAR forecasting comes out relatively well (Robertson and Tallman [1999]). The empirical forecasting debate is on the nature of restrictions one uses, and how those restrictions relate to theory. There is some work (Diebold [1998], Ingram and Whiteman [1994], Del Negro and Schorfheide, forthcoming) attempting to combine the DSGE insights with vector autoregression models, using the DSGE model as a Bayesian prior. In this work, the DSGE model is used to help guide the selection of variables within the VAR.

THE POST WALRASIAN QUESTION

From a Post Walrasian perspective, there is nothing wrong with the logic of the DSGE work, but there are serious questions about its relevance. At issue are the strong assumptions necessary to arrive at tractable models, assumptions that do not fit anyone's intuition about how the economy is likely to function. Thus while Post Walrasians see the development of the DSGE synthesis as an important stepping stone, they believe that it is, at best, a first step, and they have serious concerns about using that model to guide macropolicy considerations. Their work does not focus on looking at robustness relative to nominal and institutional rigidities, as the Walrasian work does, but instead considers the robustness relative to information processing capabilities of agents and the information set available to agents.

What motivates Post Walrasian work is a concern whether the policy results drawn from the DSGE synthesis will carry through once more realistic assumptions about these information-coordination issues are integrated into the model. The difference in views is captured by the well-known "economist searching for car keys under a streetlight" joke.[10]

The Post Walrasian/Walrasian debate is not limited to macroeconomics. The appropriate degree of rationality and information to assume available

[10] Of course, that joke also captures the difficulties with the Post Walrasian approach; Post Walrasians are searching for the keys in the dark.

to agents has long separated economists. Alfred Marshall, for example, shied away from general equilibrium analysis and concentrated on partial equilibrium analysis precisely because he felt that individuals did not have the capability of processing the large degree of information necessary to assume that the results of general equilibrium models were applicable. Modern behavioral economics is another manifestation of this issue: it suggests that the foundations of economic models must be empirically founded in individual's actions, not in an assumed global rational logic.[11]

While all economists accept that individuals are purposeful, and that markets coordinate aggregate activity, the debate is still open about how that takes place, and the Post Walrasian perspective sees the coordination problem as far more complicated than does the Walrasian perspective. From a Post Walrasian perspective, before one can draw policy implications from the model, those complications must be dealt with. The reason is that the interactions among agents in the macroeconomy are so complex, so intuitively likely to influence the aggregate results, that it seems beyond believability that the relevant aspects of such systems could be captured by a solvable system of simultaneous equations with a unique equilibrium that does not take those interactions into account.

The complexity that Post Walrasians see characterizing the macroeconomy presents a very serious problem for formal modeling because the lack of a unique equilibrium feeds back on the specification of the rationality of agents. With many potential equilibria, the specifications of agent rationality no longer can rely on agents fully understanding the underlying system unless they have a metamodel (models of models) to choose among equilibria. It is even unclear whether the underlying system can be fully specified. The best one can hope for is for agents to exhibit *metamodel consistent expectations*, and, even if one can specify precisely how selections can be made among alternative models, there is little presumption of expectational stability in metamodels since it is easy to conceive of metamodels that have sudden large shifts in expectations, as expectations shift from one model to another. This raises serious policy questions since such shifts can fundamentally alter policy prescriptions.[12]

[11] While agent actions may not be globally rational, they will likely be locally rational, if one can back out the actual decision process within the local environment. So the debate is not about rationality, but about the nature of rationality to use, and how to discover that rationality.

[12] At most, there are basins of attractions and any meaningful theory must deal with the questions: which basin of attraction will the economy gravitate toward, and how stable are the various basins?

In short, the Post Walrasian concern with the DSGE synthesis is that the complexity of interactions that characterizes complex systems is central to macropolicy problems, but is assumed away in DSGE models. It is for that reason that the Post Walrasian approach is associated with the complexity work that was done at Santa Fe and at various universities around the world. It may even be that the system of equations describing the agent interactions is currently unsolvable either because that system of equations with realistic interactions is analytically intractable or incomputable either because the dimensions of the interactions involve higher order interrelationships than we are capable of solving, or because of the sheer number of equations necessary to deal with the expectational heterogeneity.[13]

Taking complexity seriously presents a major challenge to any rational expectations of the macromodel. If we cannot assume that economists understand the economy, we cannot assume that the agents understand the economy. Thus, what we mean by agent rationality is called into question, and the foundations of agent behavior must be found in behavioral study, not in logic. This means that, from a Post Walrasian perspective, before we have an adequate model of the macroeconomy, we must deal specifically with model uncertainty by agents and by economists.

Notice that the difference between the Walrasian and Post Walrasian research programs concerns acceptable simplifications in modeling processes; the two approaches are not asking fundamentally different questions. A Post Walrasian would agree that simplifications must be made if the system is to be solvable. But they argue that the Walrasian simplifications violate Einstein's "more so" criterion because, by eliminating central elements of agent interactions, Walrasians make macrotheory more simple than it can be. Two standard Walrasian simplifications that Post Walrasians find objectionable are the representative agent assumption and agent rationality assumptions. The first is problematic because Post Walrasians see interactions of agents as significantly influencing the macroeconomy. The second is problematic because agent behavior in high-level uncertain systems is likely to be fundamentally different than in stochastically certain systems. For a Post Walrasian, information and institutions cannot be addenda because they are central to the core theory.

THE DIFFERENT QUESTIONS POSED

The different visions lead Walrasians and Post Walrasians to ask different questions about what is happening in the macroeconomy in their

[13] Alan Kirman has nicely captured these issues (Kirman, 1992).

research programs. Walrasians are searching for reasons for fluctuations; their underlying model is one of global equilibrium and stability in the absence of rigidities. Fluctuations come from exogenous supply shocks, which are not perfectly dampened because of nominal and institutional rigidities. That's why the research focuses on the implications of those rigidities. Thus the Walrasian question is: why are there fluctuations in the economy? Post Walrasians' underlying conception of the competitive macroeconomy is of a system with strong tendencies toward chaotic behavior, which is kept under control by institutions. For that reason the Post Walrasian question is the opposite of the Walrasian question. The Post Walrasian question is: why is there as much stability in the economy as there is? From a Post Walrasian perspective, what is unusual about the macroeconomy is not that it exhibits instability; it is that it is not in total chaos. Post Walrasians hypothesize that institutions place limits on chaos, which means that the modeling of microfoundations of the macroeconomy must take that institutional richness into account because those institutions impose stability on an otherwise chaotic system. Thus, whereas the Walrasian DSGE model sees institutional and nominal rigidities as slowing the movement to equilibrium, the Post Walrasian model sees institutions and nominal rigidities as central to how the macroeconomy maintains its stability.

THE DIFFERENT TOOLS AND MODELS USED

The different questions asked by the two research programs lead to differences in the tools. As I stated above, the DSGE model is structured around the stochastic dynamic optimal control theory generally assuming linear dynamics and unique equilibria. Post Walrasian analytic theory also uses stochastic dynamic control theory. However, because Post Walrasian researchers are attempting to deal with far more complicated systems (because they are not willing to make the Walrasian assumptions necessary to make the systems less complicated), their models tend to be much more complicated, and generally do not yield clear-cut analytic solutions. Post Walrasian models shed light on, but do not solve, the problem.[14]

Post Walrasians agree that a reasonable assumption of any model is *agent-modeler consistency*: the requirement that the agents in the model

[14] Thinking in reference to the streetlight joke mentioned above, the Post Walrasians' use of models is the equivalent of rubbing two sticks together in the hope that one can create a spark that might provide some guidance.