## Post Walrasian Macroeconomics

Macroeconomics is evolving in an almost dialectic fashion. The latest evolution is the development of a new synthesis that combines insights of new classical, new Keynesian and real business cycle traditions into a dynamic, stochastic general equilibrium (DSGE) model that serves as a foundation for thinking about macropolicy. That new synthesis has opened up the door to a new antithesis, which is being driven by advances in computing power and analytic techniques. This new synthesis is coalescing around developments in complexity theory, automated general to specific econometric modeling, agent-based models, and nonlinear and statistical dynamical models. This book thus provides the reader with an introduction to what might be called a Post Walrasian research program that is developing as the antithesis of the Walrasian DSGE synthesis. While both the Walrasian and Post Walrasian approaches assume rational agents, they differ in the environment in which they model the interaction of those agents. To make their models tractable the DSGE approach, which is the culmination of the Walrasian modeling tradition, assumes either that agents operate in an information-rich environment, or that there is an outside controller who processes all information. The Post Walrasian model, which this collection explores, assumes that agents operate in information-poor environments, without any outside controller.

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## *Beyond the Dynamic Stochastic General Equilibrium Model*

**Edited by**

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# Foreword

In the past those who had been brought up in the Walrasian General Equilibrium tradition considered the field of Macroeconomics as essentially corresponding to the problem of aggregation. What meaningful relationships, they asked, among aggregate variables could be established starting from a set of independent utility maximizing individuals. This has not always been the case. Many earlier authors were content to specify the relations among aggregate variables and to test them without having recourse to models of individual behavior. It was nevertheless common practice to invoke individual decisions as a way of justifying the assumptions about, for example, the signs of the derivatives of the functions involved. This explains the famous remark that "70% of Keynes' *General Theory* is microeconomics." What is referred to as Walrasian macroeconomics (whether this is appropriate or not as an appellation can be judged by looking at Donald Walker's (2005) "Walrasian Economics") may be thought of as taking individual utility or profit maximizing behavior and translating it to the aggregate level. Generally, to avoid the aggregation problem, the aggregate data is treated as if it were the result of one individual's decisions. This, as is well known, is not legitimate from a theoretical point of view. Indeed, in the DSGE (Dynamic Stochastic General Equilibrium) synthesis the problem is not solved, just treated as if it were solved.

We continue to treat economic aggregates as though they correspond to economic individuals. It is this simple observation that makes the structure of the sophisticated models that economists build, unacceptable. All of the authors of the papers in this book agree with that observation, and in their papers they attempt to put their fingers on various weaknesses of standard macroeconomic models, to explain how these weaknesses arose, and to offer ways around them.

The attempt is heroic, and is only in the beginning stages. So a key question posed throughout the book is: What are the basic ingredients that we require from an alternative view? Given that this question is central, in this foreword I will suggest those themes that I believe should be included. I would include four main themes. First, we would like to model the economy as a system in which there is a *direct interaction* among individuals. We would like to specify agents who, in a sense, have local as opposed to global knowledge. It may well be the case that they have a limited, even wrong, view of the world. Second, we should require that agents behave in a "reasonable" but not "optimal" way; for example they may use simple rules and they should not act against their own interests. Moreover, these reasonable agents should evolve in the sense that they learn from previous experience. Third, the system should function over time but without necessarily converging to any particular state. It would be good to have a different notion of equilibrium from the standard one, a notion that corresponds to an economy that is in continual movement. Finally, whatever model we develop should have some testable conclusions; we should be able to imagine some empirical evidence that would lead us to refute our model.

Reading through the various contributions to this volume suggests that we have made progress in advancing towards an economic theory that incorporates the considerations I have just outlined. While we are far from general agreement on a particular paradigm, there are many positive indicators as to general progress.

## THE ROLE OF INFORMATION

Throughout this book we find references to the importance of information: who has it, and how it is processed by individuals and the system. In his introduction David Colander argues that this is key in understanding where Post Walrasian economics differs from its Walrasian counterpart. While I agree that information is central, I do not see the issue in quite the same way that he does. He characterizes Walrasian individuals, as is frequently done in the literature, as agents who possess a great deal of information, in effect all the information that there is in the economy, and who also have remarkable capacities to process it. Given that characterization he contrasts these Walrasian individuals with Post Walrasian individuals. In his Post Walrasian economics, these Walrasian omniscient agents are replaced by Post Walrasian agents who have more limited calculating power and more limited and local information.

The problem with this view, as I see it, is that in the formal Walrasian General Equilibrium, setting the amount of information that individuals have to treat is negligible. All that they need to know is the current vector of prices and they have to announce their excess demand vector which is then processed centrally. It is the extraordinary informational parsimony of the Walrasian system, as shown by the results of Jim Jordan (1982), that is so striking. From the Jordan perspective, a key to the internal breakdown of the Arrow-Debreu theory in the face of the Sonnenschein Mantel Debreu theorems is the information problem, but it is a different informational problem than Colander poses.

Suppose that we take the pure Debreu-like position and say that all that we seek is a set of prices that will clear the markets. The individuals have to know nothing about how these prices were generated or what mechanism is behind this. Despite their lack of information we can say that, given the assumptions, "if these prices were announced then the economy would be in equilibrium." We can say the same thing about the model extended to one with uncertainty. If all the agents had the same and appropriate view of the future distribution of prices, then this would coincide with the actual distribution of prices and we would be in a "rational expectations" equilibrium. Thus we need to attribute no calculating power to our agents and we can simply argue that should the economy, by some chance, wind up in this situation it would be in equilibrium. We do not explain why agents should have these beliefs nor do we say anything about their understanding of the economy. Of course, that assumes that a mechanism exists to generate those prices – a mechanism that Leijonhufvud named the Walrasian auctioneer. Assuming the Walrasian auctioneer, little information is needed by individual agents; the information has all been processed for them.

There seems to be a contradiction here but I believe that it has a rather simple explanation that can be explained by different views of what the Walrasian system is. Colander's characterization of Walrasian economics sees individuals interacting in an uncontrolled system – they must arrive at equilibrium through bargaining with others on their own. This is the sort of view that was expressed by Friedman when he defined the natural rate of unemployment as "the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility and so on." (Friedman 1968, p. 8)

Jordan's view of the Walrasian system is more abstract and precise. It assumes a central processor of information, which does the calculations, leaving the agents simply to react to the prices they face. For Colander the Walrasian agents incorporate all the processing capabilities required of the system — each is a central processor in their own right. From the Jordan perspective, there is a central processor who does all the work for them.

The problem with the informal Walrasian tradition is that it skips over the discussion of how, precisely, prices are arrived at, or simply assumes "price taking" behavior without answering the question of what "price taking" can mean if all the agents are doing the information processing themselves.

The formal Walrasian model, as captured by Arrow-Debreu does not have the problem. It is an equilibrium model, and does not pretend to be otherwise. That is, there is a price vector which all the agents face at any one time. One could think of some sort of computer that takes in the bids and offers for goods and does the calculations necessary to find an equilibrium price vector. This is what happens at the opening of the Paris Bourse today. The informal view of the Walrasian market, which Colander is referring to, involves agents interacting freely with each other and finding prices through bargaining. While this is surely what the early followers of Walras and Walras himself would have liked, my impression is that almost all of the formal Walrasian literature certainly, since Arrow-Debreu, works within the Jordan framework. The central goal of work within this formal Walrasian framework is to find a set of prices for which aggregate excess demand is zero for all goods. Yet, demand is not even defined unless prices are given. Thus within the strict Arrow-Debreu framework we have to assume that someone other than the agent is setting the prices. This is neither realistic nor philosophically satisfactory but is, I believe, why the Walrasian literature has retained what we can call the Jordan perspective.[1]

Since the Jordan perspective accepts the idea of some sort of central price setting mechanism all we look for in the models is what the system needs, in terms of information, to function at equilibrium. The Jordan results I have just mentioned provide an answer: if you want to have the economy functioning in a Pareto efficient state, then you cannot do better than the Walrasian system. Unfortunately applying the result to the real world

[1] There have, of course been sporadic attempts by distinguished general equilibrium theorists to incorporate price setting into the Walrasian model, see e.g. Negishi (1961, 1962), Novshek and Sonnenschein (1978), Mas-Colell (1982) and Dierker and Grodal (1986). However this has remained marginal.

situations doesn't get us very far. To see this, suppose that you ask the question: how much information would this system require to move from out of equilibrium to equilibrium, or to move from an inefficient state to an efficient state? To find an adjustment system that would do this for the Walrasian system would, as Saari and Simon (1978) showed, take an infinite amount of information. This is terribly destructive to any argument for a Walrasian system; it says that I cannot guarantee the convergence of a price adjustment mechanism given that my agents have the same knowledge that they have in the Arrow-Debreu world, even if I maintain the fiction of a centralized market-clearing system. We do not even have to worry about the introduction of more complicated informational systems to get into trouble. This is the mirror image of the information rich versus information poor trade-off. The formal Walrasian world is information poor — much too poor to function away from equilibrium.

So, despite their seeming differences, both perspectives lead to the same place in terms of the need for change, and in the direction of future research. They both direct researchers toward constructing a more realistic model of how information is processed by individuals and how they manage to coordinate their different wants.

## MODEL UNCERTAINTY

A crucial problem, when we move to a world where the individuals have limited knowledge and calculating capacities, concerns what information these agents do have. Brock and Durlauf's contribution points out that significant difficulties may arise if agents do not have the correct model of their environment. This may lead agents to behave "incorrectly." However, as Brock and Durlauf indicate, behaving incorrectly may actually be advantageous in certain circumstances. If their forecasting rules are not those that are optimal for the true model it may be the case that their behavior will be stabilizing. And, if they use the appropriate rule, their resultant behavior may tend to destabilize the economy. This insight is related to earlier work by Brock and Hommes (1997) where agents use good forecasting rules, but, as the economy settles to a steady state, less-good but less-costly rules do just as well; however, when the agents learn to adopt these rules, the economy becomes less stable and the better rule comes back on its own. This switching among rules leads to complicated dynamics. The important ideas that their work captures are that the learning may have a strong impact on the dynamics of the economy, and that macromodels must incorporate that learning.

There is however, another aspect of this problem. Specifically, agents may believe in the "wrong model" but, by behaving accordingly, what they observe may confirm their beliefs. This was the message of the "sunspots" literature (Cass and Shell [1983]). Woodford (1990) compounded this problem by showing that agents might rationally learn their way to these wrong, but self fulfilling, beliefs. (In Kirman [1983a], I analyzed a very simple duopoly model where the two agents believed that they were monopolists and I showed the same sort of result. A reasonable learning process would lead them to a view of the world that was wrong, but which was perfectly consistent with what they observed.) The basic message of the work is that if we have agents who are doing their best to learn about what is going on, but who have a view of the world that is incorrect, we have no guarantee that they will converge to the "truth."

Such processes might well correspond to what is going on in many economic situations. Agents have a view of the world and they are doing the best that they can given that view. It is only if something exogenous disturbs this comfortable situation that they will reflect on the situation. This is simply because the space over which they are learning is not big enough to contain alternative models. This recalls work by Kalai and Lerner (1993) who showed that, if people are to converge, through learning, on an equilibrium, their initial views of the world have to have something in common. (The condition they use is technical, and essentially means that players cannot assign zero probabilities to any of the outcomes of the game which are actually possible.) This brings up a crucial problem when dealing with heterogeneous agents who have, in particular, differing beliefs about the world in which they function. If agents have a totally false idea of reality there is little hope for convergence to an equilibrium of the "true" model.

In the context of this book, the above propositions suggest that people living in a high dimensional world, but who only have a low dimensional view of it, may never learn about the other dimensions. (This is not exactly what has been argued by Brock and Durlauf but is closely related to the questions that they raise.) Indeed, in this I am reiterating many of the points made by Branch (Chapter 7 in this volume). As he shows, heterogeneity of expectations can arise in a misspecified equilibrium situation. Such results are reassuring for those who have been puzzled by the persistent empirical evidence for such heterogeneity of expectations. Perhaps the most important idea here is that we should not regard learning as a way of justifying the static or steady state equilibrium that we are interested in, but we should accept that the learning process itself may

lead the economy to have interesting dynamics which do not converge to an equilibrium in the standard sense.[2]

## SOCIAL AND ECONOMIC INTERACTION AND NOTIONS OF EQUILIBRIUM

It has been observed by many people that direct interaction among economic agents can modify aggregate behavior. This is something that is largely absent from Walrasian models, and Brock and Durlauf's other contribution to this book gives a nice account of such issues. A long time ago Koopmans said that it would not matter if people's preferences and choices changed at random so long as there were many of them and the individual changes were sufficiently independent. Föllmer (1974) was the first to provide a formal analysis of this insight. What he showed was that equilibrium prices would not be modified even if individuals' preferences were affected by their neighbors' *provided that the influence was not too strong*. The policy problem is to determine what is "too strong" and when we are likely to be in such situations. Finding answers to these questions is important because once local interaction has a significant influence on the behavior of economic agents, all sorts of aggregate effects can appear.

The insight about aggregate effects of interactive agent behavior was the basis of Schelling's famous segregation model. LeBaron's contribution to this volume captures some of the insights of models of financial markets in which individuals change their forecasts as a result of the opinions of their neighbors or, as a result of their own experience. (See e.g. Kirman [1991], Lux and Marchesi [1999], and Föllmer, Horst, and Kirman [2005].) These models demonstrate that the population of traders will likely switch from forecasting in one way to another and that these switches will be reinforced by the feedback into prices. As a result, as the population of traders changes from being dominated by one type of forecast, based on fundamentals for example, to another type, based perhaps on extrapolation, bubbles and crashes will occur.

Since there is no equilibrium in the standard sense, the question then is: can we find some sort of equilibrium notion, or do we have to content ourselves with saying that "anything can happen." In Föllmer, Horst, and Kirman (2005) we suggest such an alternative notion. Although prices are

[2] My impression is that misspecified equilibria lie behind much of the fascinating work of Evans and Honkopohja (2001) and all the authors that they refer to.

constantly changing and never settle to any steady state, we can show that the time averages of prices will converge, that the process is ergodic, and that a unique limit price distribution will exist. Thus, despite complicated dynamics, there is some structure in the evolution of prices such that, though they never settle down, it is an appropriate concept of equilibrium. Why is this interesting? Because I think this gives us an idea of equilibrium which is not Walrasian in the usual sense, but which is specifiable, and which is consistent with the empirical evidence because it also allows us to explain a number of the stylized facts in financial time series such as "fat tails" and "long memory."

## CONCLUSION

The work in this volume is on the right path, and should give young researchers many indicators as to where they should go. How could one not be persuaded by Leigh Tesfatsion, Rob Axtell, and Blake LeBaron's arguments for more agent-based modeling; such work is likely to become more and more important over time. In terms of empirical work, Søren Johansen and Katarina Juselius show that we can do much better than we currently are doing in extracting information from data, and that some of the tests of DSGE models are more problematic than is generally believed. They show us how we can put ourselves in a position to reject certain hypotheses or conclusions from the theory, a result that, as I said at the outset, is of fundamental importance.

The book also has insights in terms of policy. Peter Howitt joins me in comparing human economic agents to ants. This analogy does not go down well in all circles but, as he says, we can learn a lot from the metaphor. Dynamics are important, and assuming away the possibilities of internally generated bubbles in one's models, as is done by most DSGE models, will give us little insight into how to deal with such bubbles should they actually occur.

This book helps open the door to the macroeconomics of the future, even though it would be too optimistic to say that we are right on the threshold of a new and complete macroeconomic paradigm. It sketches out the outline of a paradigm that is beginning to take form, showing that many of the elements are there. The work in this volume puts the emphasis on the right questions. But there are so many possible paths that we find ourselves in the position that a well-known professor of medicine explained in his first lecture which my father attended as a medical student, "Ladies and Gentlemen," said the professor. "In twenty years time you will come to

realise that half of what I will teach you will turn out to be wrong! Unfortunately I cannot tell you now which half it will be."

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