The DSGE Model and the Post Walrasian Alternative in Historical Perspective

The new DSGE synthesis in macroeconomics is nicely captured in Michael Woodford's *Interest and Prices* (2003), which pulls together many strands from an immense literature that has grown up over the last two decades. Woodford's book can be seen as the culmination of attempts to establish a new "neoclassical synthesis" that combines the best of the New Classical and Real Business Cycle literature that rose to prominence in the decade of the 1980s, with the best of the New Keynesian literature that rose up in reaction during the decade of the 1990s. Woodford is quite explicit about this. The Real Business Cycle model is, for him, the benchmark. It shows us how it is possible to understand output fluctuation as an equilibrium response to taste and technology shocks. But it can't explain everything we see, in particular VAR evidence that monetary impulses (both anticipated and unanticipated) have real effects (pp. 174-5). This evidence provides room for a New Keynesian elaboration of the RBC model to include sticky nominal prices and wages. The end result is a model that, because it is built from optimizing microfoundations, is immune to the Lucas (1976) critique of old-style Keynesian econometric models, but is nonetheless also able actually to fit (not just to calibrate) the data.

The point of reviving the neoclassical synthesis is not however primarily to influence academic economics. Rather, the central ambition of the book is to influence policy by providing a framework for policy analysis and discussion by practical central bankers. The subtitle makes this ambition explicit: "Foundations of a Theory of Monetary Policy." The whole point of reviving the neoclassical synthesis is to revive the role that economics once played as a policy science during the heyday of the original neoclassical synthesis. Now, instead of the Solow growth model as the benchmark we have the Real Business Cycle Model, and instead of the optimal response to an output gap at a moment in time we have optimal policy rules that take into account the effect of forward looking expectations. (Also, instead of fiscal policy, we have monetary policy, but that's another story.) It's all a lot more sophisticated than what used to be, but the family resemblance is impossible to miss for anyone who knew the parents.[1]

Since this synthesis is just being digested by the profession, the question that any proposed Post Walrasian alternative must answer is: Where does the Post Walrasian approach fit within that synthesis? In this paper, I explore that question by distinguishing three views of the way time is treated in economic models: the classical, the Walrasian DSGE, and the Post Walrasian. While this is a slightly different take on the separation of Walrasian and Post Walrasian than Colander makes with his emphasis on information processing capabilities and available information sets, it is related. I emphasize that processing capability and information availability always fall short, not because of any human deficiency but rather because of the open-ended nature of the problem that real world agents face.

[1] I have developed these ideas in more detail in Mehrling (2006) from which the last two paragraphs come.

As Alan Greenspan has recently said, speaking about the problem of monetary management by the central bank, "despite extensive effort to capture and quantify what we perceive as the key macroeconomic relationships, our knowledge about many of the important linkages is far from complete and, in all likelihood, will always remain so." Our problem, he says, is not just probabilistic risk but also, more seriously, "Knightian uncertainty" in which the probabilities themselves are unknown. In the face of an unknown and unknowable future, Greenspan advocates what he calls a "risk-management approach to policy," an approach that explicitly recognizes the limits of our knowledge (Greenspan 2004). What Post Walrasian economics does is to extend that same recognition to every other agent in the economy. We all face the problem of choosing appropriate behavior in the face of the unknown, and the aggregation of all our behaviors is the macroeconomics that we observe.

Classical Economics and Time

The classical economists who laid the foundations of our subject had a characteristic strategy for handling the uncertain future. They built their science by treating the present as determined by the past. The important thing about the past is that it has already happened. The past is a fact and nothing we do today can change it. It is also a knowable fact, at least in principle, so we can hope in our economic theories to draw a deterministic link between known causes and observable effects. In pursuit of this hope, the classical economists sought to discover the laws of motion of the economic system.

Such laws, supposing they can be found, will generally leave some residual uncertainty about the motion of the system simply because of outside factors. But these factors are also presumably susceptible to explanation by deterministic laws which are not yet included in the analysis. Uncertainty about the future is, in this way of thinking, no different in principle from uncertainty about the present. It is just a matter of insufficiently detailed knowledge of the past and of the laws of motion linking that past to the future.

The one free variable in the classical system is human action, including collective human action. In Adam Smith's view, much of individual behavior is driven by innate human propensities, but reason offers each individual the opportunity to direct those propensities, and so to live a better life. The same reason also offers societies the opportunity to make their own history, not perhaps just as they might please, but also not as completely determined by the dead hand of the past. Economic theory, as a product of reason, has its purpose to provide direction for the application of reason, both individual and collective.

Because we don't know all the facts and laws of motion, we cannot know the precise effects of specific interventions, but that shouldn't stop us. We can, the classicals were confident, identify the most salient facts and laws and in doing so employ our reason to improve on the results of simple animal instinct. We can each do this individually in our own lives, and the miraculous results of the market system are the consequence. And we can also do it collectively, by consciously removing any and all

remaining obstacles to the full play of human reason. Reason says that we can do it, and so reason also says that we should do it.

This classical view of how to handle the problem of time persisted from Adam Smith throughout the 19th century, including the classic works of both Alfred Marshall (1890) and Leon Walras (1874). Marshall's famous epigram "natura non facit saltum," nature does not make jumps, connects him firmly with the classical tradition in this regard. The continuity of the present with the past (and hence also the future with the present) was what made a scientific understanding of the present possible, and so provided traction for the reasoning powers of rational economic man.

The 20th Century

But the times they were achanging. What is rational to do today depends in part on what we expect to happen tomorrow, but attempts to expand the scope of economic reason to incorporate the future ran head on into what John Maynard Keynes famously called the "dark forces of time and ignorance which envelop our future" (Keynes 1936, 155). In the 20th century view, uncertainty about the future was no longer something that science could hope eventually to penetrate. The salient fact about the world was no longer the continuity of the past and future, but rather the radical disjuncture between the two on account of the speed of change, not least the speed of technological change. The one thing the rational mind could know about the future is that it would in important ways be different from anything now imaginable, perhaps better but also perhaps worse.

Inevitably, the analytical problems posed by this new view of time emerged first in the world of finance, where the valuation of capital assets involves both assessment of future income flows and also appropriate discount factors for those flows. Keynes himself, having looked deeply into the matter of risk and uncertainty in his 1921 Treatise on Probability, emphasized the inherent limits of individual rationality in this regard, and placed his faith instead in the collective rationality embodied in various "semi-autonomous bodies within the State" (Keynes 1926). Keynes' answer to radical uncertainty was mechanisms of social control that he hoped could pick a path through the uncertain future, preserving the upside of expanded individual freedom while protecting against the downside of economic and social barbarism.

The post World War II development of the theory of monetary and fiscal policy can be viewed as the elaboration of two specific mechanisms of social control for this purpose. The famous Keynesian cross, that explained how the flow of current demand determines the flow of current output, set the pattern for how to do science in the face of an unknowable future. It was a theory that avoided the unknowable future by treating the present as determined by the present. "Animal spirits" that affect current expenditure are the free variables that, for individual agents, take the place of impossible rational analysis of the future. And fiscal and monetary policy are the free variables that, for the collectivity, select one future path among the many that are possible.[2]

[2] See Mehrling (1997) for the story of Alvin Hansen and the rise of American Keynesianism.

The Keynesian "present-determines-present" solution was however only temporary. Even if one agreed with Keynes that full extension of rational analysis to the future was impossible, surely one could ask for a better theory than animal spirits! The Keynesian project of rational policy choice also seemed to require some specification of what is expected to happen in the future, if only because policy actions today actually have their impact in the future, notwithstanding the stylization of the Keynesian cross. For both projects, the work of the American Irving Fisher showed the way forward.

Here is Fisher's account of the "dark forces of time and ignorance" problem: "To attempt to formulate mathematically in any useful, complete manner the laws determining the rate of interest under the sway of chance would be like attempting to express completely the laws which determine the path of a projectile when affected by random gusts of wind. Such formulas would need to be either too general or too empirical to be of much value" (Fisher 1930, 316). Thinking about the problem in this way, Fisher decided that he could make the most progress toward a rational analysis of the future simply by assuming, as a first approximation, that the future is in fact completely known. Fisher's bold abstraction from the problem of uncertainty gave us what is arguably the first fully specified model of intertemporal general equilibrium, a model that is recognizably the direct ancestor of the DSGE models of today which extend Fisher's model of certainty to incorporate probabilistic risk.

Fisher summarized his worldview using the following diagram:[3]

	Present Capital		**Future Income**
Quantities	Capital-wealth	→	Income-services
			↓
Values	Capital-value	←	Income-value

The arrow in the first row captures the classical view of time, in which the accumulation of capital-wealth from the past determines the flow of future income-services that people can enjoy. The arrow in the second row captures the 20th century view of time, in which future income flows determine current capital valuations. The diagram captures perfectly the worldview of a man caught with one foot in the 19th century and the second in the 20th. The past determines present physical quantities, but the future determines present capital values.

[3] Fisher (1907, 14). A similar diagram is presented in Fisher (1930, 15) using the terms "capital goods" and "flow of services" instead of capital-wealth and income-services. For a fuller treatment of the economics that Fisher developed to flesh out his world view, see Mehrling (2001).

The third arrow, pointing down from the first row to the second, shows that Fisher kept most of his weight on the first foot. The simplifying assumption that the future is known pegs Fisher as ultimately a man of the 19th century. By abstracting from uncertainty he makes rational analysis of the future possible, but only by stripping that future of what the 20th century would view as its most salient feature. As a consequence it was Keynes, not Fisher, who initially caught the spirit of the age. But, as I have suggested, it was Fisher, not Keynes, who served as the ancestor of the DSGE model that currently dominates macroeconomics. How did that happen?

What made possible the extension of Fisher's intertemporal general equilibrium to a world of uncertainty was the development within the subfield of finance of a theory of asset pricing in a world of risk. The key breakthrough was the Capital Asset Pricing Model.[4] In this model, the quintessential form of capital is the equity share, which represents ownership of a risky future cash flow. Present value calculations have a long history in economics, but the advance of CAPM was to show how to price risk. The importance of CAPM came from the fact that, once you know how to price risk, you have a strategy for handling the "dark forces of time and ignorance" without policy intervention by the state, simply by economizing on the willingness of people to bear risk. The theory says that first you want to eliminate as much of the unpriced risk as you can (by means of diversification), and then you want to shift the priced risk to those members of society who are best equipped or most willing to bear it.

Finance was first to crystallize a general equilibrium model of the 20th century view that the future determines the present, but the wider significance of the new view was only felt as it found its way into economics. In macroeconomics, the most important consequences were the Rational Expectations revolution and then Real Business Cycles.[5] Just so, in modern DSGE models, present conditions are largely understood as the effect of an anticipated future. The physical capital stock of course is inherited from the past but the economic importance of that stock, as measured by its current valuation, all comes from the future.

The DSGE models thus offer a solution to the problem that both Keynes and Fisher thought was impossible; they offer a story about how rational analysis can be extended to the unknown future. The consequence of that extension, we can now see clearly, is nothing less than an inversion of the classical strategy for handling the problem of time. One hundred years after Irving Fisher, we are now prepared fully to embrace the radical idea that the future, or rather our ideas about the future, determine the present. Like Irving Fisher, we have one foot in the past and one in the future, but unlike him most of our weight is on the future, not the past. In the modern view, it is expectations about future income that determine current capital value, and it is current capital value that determines the investments that get made and survive as current capital-wealth.

[4] For a fuller story of the rise of modern finance see Bernstein (1992) or Mehrling (2005).
[5] See Mehrling (2005, Ch. 8).

	Present Capital		**Future Income**
Quantities	Capital-wealth	→	Income-services
	↑		
Values	Capital-value	←	Income-value

Inevitably, the extension of rational analysis to incorporate the future has had the effect of reducing the apparent scope for social control of the kind that Keynes (and Fisher too) thought would be necessary. Because markets provide sufficient scope for individual rationality to solve the problem of uncertainty, there is no problem for the collectivity to solve. This is the fundamental source of all of the New Classical policy-invariance results that have challenged the Keynesian world view. Just so, DSGE models with flexible prices have little room for macroeconomic policy intervention (Woodford 2003, Chapter 2).

Of course, sticky price versions of the DSGE model provide more scope. In Woodford's treatment the emphasis is on the freedom of the central bank to set the nominal rate of interest which also, given price stickiness, sets the real rate of interest. Note well, however, that it is not the current rate of interest but rather the full policy rule, which rational agents project into the future, that produces the current effect. Even in a sticky price world, policy works mainly by affecting expectations about the future.

The Post Walrasian View

Post Walrasians take a different tack, emphasizing that the future is not a knowable fact, not even in principle, and not even in probabilistic terms. Theories of asset pricing that posit known probabilities abstract from this feature of the world, and so do the various versions of the DSGE model of the macroeconomy. As such, they offer nothing more than one possible story about one possible future. The important thing is that, to the extent that people believe this story, or any other story, they adjust their current behavior accordingly. In this sense, one of the most important lessons of the DSGE model is that economic theories themselves are the significant knowable facts in the modern world. Post Walrasians ask what happens in a world where a large number of people interact, each one behaving according to their own theory about the future.

The DSGE model that dominates standard macroeconomic discourse is of course one possible candidate for a story about a possible future, but it is clearly a very special case. Not only does it assume that everyone somehow converges on the same theory of the world, but the theory on which they are supposed to converge treats all uncertainty as merely exogenous risk with known probabilities. It is a theory that succeeds in taming

the uncertain future merely by assuming that uncertainty is already tame. That's fine, of course, as an abstraction and a first step. The justification, fair enough, is that we must walk before we can run. But one major drawback, as we have seen, is the lack of room for a theory of economic policy, since in this special case individual rationality is enough to achieve social rationality and there is nothing much left for collective intervention to add.

Post Walrasian work represents an attempt to broaden out from the DSGE model in order to deal with the deeper uncertainty that the DSGE approach assumes away. In such a world rational choice no longer provides much analytical traction, so Post Walrasian work treats agents as dealing with information poor environments, and having limited information processing capabilities. Nevertheless the general idea that behavior should be model-consistent remains attractive. Model consistency replaces rational expectations as the closure of Post Walrasian models.

The important thing is that Post Walrasian work seeks to model the process by which one among many possible futures is selected, rather than imposing constraints on the model that ensure only a single equilibrium outcome. In this regard Post Walrasian work builds on the classical Marshallian concept of adaptive dynamics, but freed of the mathematical assumptions necessary to guarantee stability and convergence to a single equilibrium. The Swedish contemporaries of Keynes arguably had something like the Post Walrasian program in mind in their various attempts to model economic process, but the analytical difficulty of the problem defeated them.[6] As a consequence, what we got instead was Keynes, and then Fisher (as I have recounted above). Post Walrasian work has, in this sense, been waiting in the wings for a century until the present moment when analytical technology has caught up to our analytical needs.

The payoff to be anticipated from such work is not only a richer picture of macroeconomic phenomena, but also a richer sense of the potential role for policy intervention to improve that performance. Agents operating on their own, developing their own theories of the future to guide their present behaviors and interacting with one another through markets, will produce some macroeconomic outcome. But other macroeconomic outcomes will also be possible. Here there is a possible role for Keynes' "semi-autonomous bodies within the State," but also for economic institutions more generally, private as well as public. In the DSGE framework, a role for policy depends on some market imperfection, like sticky prices. In the broader Post Walrasian framework, a role for policy emerges naturally as a way of delimiting the range of possible futures.

The attraction of agent-based modeling is that it offers a way to do economic theory that takes uncertainty seriously while still retaining the analytical discipline of model-consistent behavior. Indeed model-consistent behavior is built in from the beginning in a model like LeBaron's (this volume, Chapter XX) since agents adapt their behavior in light of their experience. To date, the agent-based literature has focused on

[6] Laidler (1999, 57-59). The American institutionalists of the interwar period were similarly interested in modeling process, but also similarly unsuccessful (Mehrling 1997).

rather simple behavioral rules, like LeBaron's functions of past aggregate data. But there seems to be no reason in principle why higher order behavioral rules cannot also be investigated.

Agents could, for example, be endowed with some knowledge about the structure of the world in which they are living, and permitted to condition their behavior on certain deeper structural variables. The modeling of higher-order behavioral rules would, in effect, have the agents inside the model each formulating their own "model of the model," models that are subsequently adapted in the light of experience.[7] Behavior will always be model consistent even though agents never learn the "true" structure of their world.

The agent-based literature is full of examples that demonstrate how the aggregate behavior of the system changes when we add a new kind of agent. Here we can see a clear opening for development of a theory of economic policy. For example, the central bank could be considered as a new kind of agent, operating perhaps with the very same information set as the most sophisticated agents in the model, but with different instruments and a different objective function. It seems unlikely that a world that includes such an agent will exhibit the same aggregate behavior as a world without such an agent. In other words, policy invariance is unlikely to be a robust feature of agent-based models, even when individual behaviors are all constrained to be model-consistent.

Conclusion

The Post Walrasian view builds on the tradition of Fisher and Keynes, both of whom recognized the problem of time as the significant challenge for further development of economics. By contrast to their classical forebears, Fisher and Keynes both recognized the degree of freedom offered by the open-ended future; when behavior depends on expectations about the future, volatility is the consequence. But both also held out hope that human reason, and the institutions that human reason would invent, could find ways to manage that volatility.

Following in the footsteps of Fisher and Keynes, modern economics has developed both modern finance and the DSGE model that now lies at the core of modern macroeconomics. These developments have gone a long distance toward grappling with the problem of time, but more work remains to be done. The Post Walrasian view envisions a world of even greater uncertainty than that embraced by modern finance and the DSGE model, and a world that is for that very reason amenable to a wider range of refinements and improvements than have yet to be considered. The volatility of capital values and incomes is just a fact, an inevitable consequence of shifting ideas about the future in a period of rapid technological change. The policy challenge remains to shift that volatility onto the shoulders of those most able and willing to bear it.

[7] The phrase "model of the model" comes from Hyman Minsky, whose heterodox views on macroeconomics can in retrospect be seen as anticipating key features of the Post Walrasian program. See Mehrling (1999) for a fuller treatment.

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