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What have central bankers learned from modern macroeconomic theory?

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ABSTRACT

In this essay I argue that modern macroeconomic theory has fallen behind the practice of central banking. After briefly summarizing the current state of macro theory, I focus on what strikes me as the two most important developments in monetary policy in the last two decades – inflation targeting and dealing with financial crises. My analysis rejects the claims made by several authors to the effect that the proliferation of inflation-targeting regimes around the globe represents an application of well-established principles of macroeconomic theory. As for how monetary policy can promote financial stability, a subject on which most economists agree modern theory has been of little help, I argue that macroeconomics has lost touch with the fundamental *raison d'être* of central banking. My diagnosis is that macroeconomic theory has become distracted by its preoccupation with states of equilibrium, a preoccupation that inhibits analysis of a market economy's coordination mechanisms. I conclude with a plea for a more diverse ecology of approaches to macroeconomic theory, one that finds room for agent-based computational economics as well as for more conventional equilibrium theories.

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1. Introduction

Technological innovation in today's world draw heavily on fundamental science. But the connection between science and technology was not always like this. Economic historians have long argued that the key technologies of the first Industrial Revolution owed nothing to scientific theory; that many of the inventions were made by “tinkerers” with no formal scientific education.¹ Indeed Rosenberg (1982) makes the case that, even well into the 20th Century, the causal link between science and technology was often the reverse of what we now take for granted; that scientific knowledge was the *result*, as much as or even more than it was the *cause*, of technological breakthroughs. For example, the science of aerodynamics was not sufficiently advanced to explain why birds can fly until the Wright brothers found out how to make humans fly; Vane discovered the principles underlying aspirin's anti-thrombotic effect only after practicing physicians had already discovered that the effect exists and had even begun prescribing aspirin for the prevention of heart attacks and strokes. Indeed, entire fields of scientific inquiry arose from discoveries made in the course of solving practical technological problems, such when Pasteur's attempts to deal with putrefaction in his family wine business opened up the field of microbiology, or when the knowledge generated by German dye-makers provided the clues that formed the basis of organic chemistry. In these and many more cases described by Rosenberg, practitioners had a lot more to teach theorists than the other way around; the practitioners discovered *what* works, and the theorists scrambled to keep up, looking for general covering laws that might explain *why* it works.

My purpose in this essay is to investigate the relationship between practitioners and theorists of monetary policy. Have central bankers, the practitioners, been applying developments of modern macroeconomic theory, as the developers of

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¹ For example Mantoux (1927). More recent authors, such as Jacob (1997) and Mokyr (2010), make a strong case that the prominence of science and the scientific method in British culture in the 18th and 19th Centuries helped create the human capital needed for the innovations that produced the Industrial Revolution. But this does not imply that any such innovation can be construed as an application of known scientific principles.

modern computer technology have been applying solid state physics and other branches of scientific theory, or has macroeconomic theory been lagging behind practice, as scientific theory did in the first Industrial Revolution? I will argue that, despite the impressive technical progress that macroeconomics has made, and despite the fact that the profession seems to have reached a consensus on methodology that allows it to move beyond the polemics that once characterized the subject, nevertheless macroeconomic theory has fallen behind the practice of central banking. After briefly summarizing the current state of macro theory, I will focus on what strike me as the two most important developments in monetary policy in the last two decades – inflation targeting and dealing with financial crises. My analysis rejects the claims made by several authors to the effect that the proliferation of inflation-targeting regimes around the globe represents an application of well-established principles of macroeconomic theory. As for how monetary policy can promote financial stability, a subject on which most economists agree modern theory has been of little help, I argue that macroeconomics has lost touch with the fundamental *raison d'être* of central banks. My diagnosis is that macroeconomic theory has become distracted by its preoccupation with states of equilibrium, a preoccupation that inhibits analysis of a market economy's coordination mechanisms. I conclude with a plea for a more diverse ecology of approaches to macroeconomic theory, one that finds room for agent-based computational economics as well as for more conventional equilibrium theories.

2. Modern macroeconomic theory

Many commentators² have remarked on the striking degree of fundamental agreement that has been forged in macroeconomics over the past four decades. Forty years ago the leading journals were filled with controversy over fundamental issues of theory, policy and methodology, to an extent that seems rather wild and unprofessional by 21st Century standards. Consider for example Friedman's (1968) AEA Presidential Address, in which he introduced the term "natural rate of unemployment." This article is now widely considered to be one of the landmark contributions to 20th Century macroeconomics, and its main message has been embraced by both fresh and salt water economists. But at the time when Friedman delivered the address it was seen as an aggressive attack on the foundations of mainstream Keynesian economics, and was vigorously rebutted by leading Keynesians such as Tobin (1972). The rational expectations revolution that began a few years after Friedman's address gave rise to further controversies over the right way to do macroeconomics, as did the real business cycle movement.

Today, in contrast, controversy over methodology has all but vanished from the literature. The articles on macroeconomics published in leading journals almost all use the same common methodology, that of dynamic stochastic general equilibrium (DSGE) theory, according to which the economy should be represented by a model with explicit micro foundations – endowments, technology (of production and of transaction), preferences and demography – as well as explicit stochastic processes governing shocks to these constituent components, and the economy should be assumed always to be in a state of rational-expectations equilibrium. Even modern Keynesians, the intellectual descendants of those who fought so hard to resist the rational expectations revolution, have adopted this common methodology, largely because the definition of DSGE is broad enough to include transaction technologies that give rise to the wage/price stickiness that has always been the hallmark of Keynesian economics.³ Although there are still notable economists who dissent from modern DSGE theory⁴ it is rare indeed to find their works published in the leading academic journals.

The consensus in the modern macro literature extends beyond methodology and into substantive issues. In particular, even real business cycle theorists, who initially resisted any nominal frictions, now commonly recognize the need for such frictions in any model that might be used to guide short-run monetary policy.

This "consensus view:" DSGE with nominal frictions, which has come to dominate the leading journals, is what I take as the definition of modern macroeconomic theory.⁵ While there are some important strands of the literature that are excluded by this definition because they depart from the DSGE methodology in one way or another, most notably the strand that specifies some form of adaptive learning instead of rational expectations, these other strands are still viewed with suspicion in many quarters, and in any event I do not believe that anyone would claim that the learning literature has exerted a major salutary influence on the conduct of monetary policy.⁶

By sticking to this narrow definition I am thus excluding from "modern macroeconomics" the IS–LM analysis that still constitutes the core of most undergraduate teaching of macroeconomics, at least up to the intermediate level, and which has long been recognized as being in need of a stronger micro foundation. I am also excluding the contributions of Milton Friedman and his immediate followers, who also were rarely explicit about micro foundations and did not typically invoke rational expectations. So my paper could well have been entitled "what have central bankers learned from mainstream macroeconomic theory since the rational expectations revolution."

² For example, Blanchard (2009), Chari and Kehoe (2006), Kocherlakota (2010) or Woodford (2009).

³ As opposed to what Leijonhufvud (1968) called the economics of Keynes.

⁴ For example, Leijonhufvud (1993), Borio and White (2003) and Laidler (2007).

⁵ Other writers have chosen to define modern macroeconomic theory or DSGE more broadly than I have, so as to include even models that depart from rational expectations equilibrium. See for example Kocherlakota (2010) or Chari (2010). The latter implicitly defines DSGE as including any logically coherent and completely specified model that explicitly represents behavior at the individual level.

⁶ One possible exception is the "Taylor Principle" to the effect that the central bank's policy interest rate must respond more than point for point to increases in inflation for the economy's rational expectations equilibrium to be expectationally stable. As I argued in Howitt (1992), however, the idea was already contained, at least implicitly, in Friedman's (1968) rendition of Wicksell's cumulative process.

3. The canonical new Keynesian model

From one point of view central bankers have learned a great deal from modern macro, in that almost all of them now use a New Keynesian DSGE model for projection and policy analysis, a model whose core is a variant of the canonical version presented masterfully by Woodford (2003), and whose log linear approximation can be reduced to three forward looking equations, namely the IS curve:

$$y_t = E_t y_{t+1} - (1/\sigma)(\dot{i}_t - E_t \pi_{t+1}) + \varepsilon_t^y$$

the Phillips curve:

$$\pi_t = \kappa y_t + \beta E_t \pi_{t+1} + \varepsilon_t^\pi$$

and the Taylor rule:

$$\dot{i}_t = \phi_y y_t + \phi_\pi \pi_t + \varepsilon_t^i$$

where the unknowns (y_t , π_t , \dot{i}_t) are the output gap, inflation and the nominal interest rate, the expectation operator E_t denotes the rational expectation conditional on time t information, the ε 's are random shocks, the coefficients (σ , κ , β , ϕ_y , ϕ_π) are all positive and $\beta < 1$.

It is one thing, however, to observe that all central bankers possess such models, but another to show that the models represent an improvement over the kind of models that were used in the 1970s, or that they are really useful for policy purposes. On this point the critics of DSGE such as Fair (forthcoming) are in agreement with supporters such as Chari et al. (2009) to the effect that the new models are no more useful than the old ones. Indeed Fair argues that the new models embody technological regress. What follows in this section is my own gloss on the arguments of these authors.

In the 1970s the models that were used by most central banks were built around the core of the familiar textbook IS–LM model, with some sort of Phillips curve added to account for inflation. So, in terms of these two core models, what central bankers have learned from modern macro theory can be summarized in terms of the difference between the canonical New Keynesian DSGE and the Old Keynesian IS–LM–PC framework, namely:

1. The new models have no need for the LM curve.
2. The new models have forward looking rational expectations where the old ones typically included lagged values of the same variables.
3. The parameters and shocks of the new model are claimed to be structural – invariant to policy interventions.

The first of these differences is of no great significance since it was already well understood before the onset of the rational expectations revolution⁷ that the LM curve was redundant when the central bank used the rate of interest as its policy instrument, at least within an analytical framework, like IS–LM, that assumed continual equality between the supply and demand for money.⁸ So the question now is whether the second and third of these differences have made a positive contribution to the implementation of monetary policy.

The second difference is actually less radical than might appear at first glance since, as several authors have noted, empirical implementations of the new models that are actually used in central banks have had to reinsert the lagged variables in order to fit the data. Of course we can now tell stories that would make the coefficients of the lagged variables structural, but that is the third difference. So in terms of the second difference the issue is not that anything has been replaced but that rational expectations have been added as additional variables. While the assumption of rational expectations by itself has the virtues of parsimony and elegance, the process of adding rational expectations to the list of variables that were already considered as proxying for expectations has neither of these virtues. Generally speaking, as Chari et al. (2009) have pointed out, the new Keynesian branch of DSGE theory that central bank models are based on has generated a proliferation of right-hand-side variables, which raises the question of whether they have been over fitted. In the end the only real test is whether the models can generate more reliable policy projections than could the older models without rational expectations. I am unaware of any demonstration that such is the case, but maybe I am missing something, and in any event the ability to project policy changes is critically dependent on whether or not the model's parameters really are structural – again it is the third difference that is really critical.

As for this third difference, the claim that DSGE models can be used for policy analysis because their coefficients and shocks are invariant to policy changes is not easy to verify objectively. In effect, the claim is that the models are free from a particular type of specification error, the type that is subject to the famous Lucas critique, when various coefficients represent the effects of the associated regressor working through expectational effects that will actually change when the policy regime is altered. But it is important to recognize that this is not the only type of specification error that can render coefficients non-structural, and that can therefore render a model unreliable for purposes of policy analysis. Generally speaking, a

⁷ See Poole (1970) for example.

⁸ Laidler (2007) reminds us that this was not an assumption that was shared by those working within the monetarist tradition, in which discrepancies between the supply and demand for money played an important causal role in generating real fluctuations in output and inflation, as well as in provoking financial crises.

model will be unreliable anytime that the model departs significantly from the actual processes that are driving the data. In such cases we can always find the coefficients that best fit the historical time series, but once the policy regime changes so will the best-fitting coefficients.

To judge how likely it is that New Keynesian DSGE models are free from specification error is of course a difficult task, and there is no definitive way of approaching the task. In the end it is impossible to avoid subjective judgments. A lot depends on how convincing one finds the stories we tell that underlie the mathematical model. The less confidence we have in those stories the less likely it will be that the related coefficients and shocks will be structural. By this subjective standard, I believe it is hard to make a good case for the claim of policy-invariance underlying the critical third difference mentioned above. In particular, I'm sure it would be hard to find many intelligent observers that were capable of understanding the models, without having been socialized by professional training, who would really be convinced by the stories told by the models' developers.

Consider for example the story underlying the IS curve, which is actually the intertemporal Euler condition of the representative household, with coefficient σ being that household's elasticity of marginal utility. The idea that the entire household sector of say the US economy is just a blown up version of a single person is on the face of it about as bold and unlikely a hypothesis as one could imagine. As Kirman (1992) has argued, if the hypothesis is invalid then the specification error made by ignoring heterogeneity is potentially much more serious than that made by treating expectations as structural. And the likelihood of the former type of specification error seems to me to be very high in light of the large literature showing that this aggregate Euler equation does a bad job, on multiple dimensions, of fitting the data.⁹

Consider also the Calvo pricing story underlying the Phillips curve, according to which firms stuck with prices that were set many months ago and that are way out of line with their competitors' prices and with their own marginal costs, are waiting desperately for a call from the Calvo fairy that would allow them to do something about the disastrous situation they find themselves in. Or consider the indexation story underlying the addition of lagged inflation to the Phillips curve, which, as Chari et al. (2009) have observed, does not correspond to any commonly observed practice among price setters and which in fact is contradicted by empirical microeconomic studies showing that most prices remain absolutely fixed for months at a time.

My conclusion from this cursory examination of new Keynesian DSGE models is that they offer no clear advantages over the old style of model that was in use well before the onset of the rational expectations revolution. Although every central bank seems to have one, this is not to say that the models are of great use to them. Certainly there is no central bank that would put monetary policy on autopilot using a DSGE model. Instead, I believe that in almost all central banks the DSGE model is just one of many inputs into a decision process that remains more art than science.¹⁰

4. Inflation targeting

Chari and Kehoe (2006) argue that, despite the empirical weaknesses of DSGE models, modern macroeconomic theory has exerted a major influence on central banking by establishing a compelling case for some important principles. They cite the now widespread practice of inflation targeting as a prime example of this influence, as do several other authors.¹¹ According to the consensus view put forth by these authors, inflation targets are best thought of as rules that constrain the actions of central banks, and these rules have been instituted because practitioners have learned two basic principles from modern macroeconomic theory: (1) that low and steady inflation should be the primary goal of monetary policy and (2) that policy goals should be pursued with commitment to rules that leaves no room for discretion, except for escape clauses that hardly ever need to be invoked. What I argue in this section is that, contrary to the consensus view, inflation targeting is actually an example of discretion rather than rules, that it was established almost entirely independently of modern macroeconomic theory, and that no compelling theoretical case for either of the above two principles has yet been established.

4.1. Inflation targeting as discretion

A rule in the Kydland and Prescott (1977) sense is a prescribed policy function that dictates the setting of a central bank's instruments in any given situation. This is not the way inflation targeting works. Instead of constraining the central banks' setting of instruments it constrains the setting of its goal, and leaves the bank free to use its discretion in deciding how precisely to achieve that goal. In the words of Bernanke and Mishkin (1997), inflation targeting is a case of "constrained discretion." Indeed, given the fact that inflation has such a lot of momentum, an inflation targeting central bank has enough discretion to engage in fine-tuning of the business cycle without jeopardizing its inflation target. This is especially true because of what Blanchard and Galí (2007) have called the "divine coincidence" between the policy actions that would control inflation and those that would control real output, at least under what many would regard as normal circumstances.

Even the term constrained discretion is somewhat misleading because it suggests that central banks are more bound by inflation targeting than they really are. Historically central bankers have typically been the sort of people who are averse to

⁹ As just one example, see Lettau and Ludvigsson (2009).

¹⁰ In this regard I agree with the analysis of Mankiw (2006).

¹¹ For example, Goodfriend (2007), Galí and Gertler (2007) and Woodford (2009).

inflation, given to following rules based on time-tested principles, cognizant of their responsibility for maintaining the value of the currency they control, and certainly not among the most likely to risk their reputation by pursuing inflationary policies in the hopes of some fleeting improvement in real output. Thus it takes no coercion to persuade the typical central banker to give top priority to fighting inflation.

The inflation bias that needs to be constrained by inflation targets comes instead from the central bankers' political masters, who are constantly putting short term pressure on them to finance popular expenditures and to keep economic conditions looking good just before election time. It is hardly an accident that in every country I am aware of that has instituted a policy of inflation targeting, the target has been agreed to not just by the central bank but also by the government of the day. By signing onto the target, the government is granting a large degree of *de facto* independence to its central bank. That is, by publicly agreeing that the central bank should pursue the low inflation goal that most central bankers would prefer in any event to follow, in an open and well defined manner, the government has put itself in a position where it will be difficult to pressure the bank into ignoring that goal when, in the future, higher inflation turns out to be politically expedient. Countries such as the United States and Germany where the central bank already enjoyed a great deal of *de jure* independence did not need this extra insulation from political pressure to bring down inflation, which I believe explains why inflation targeting was adopted by other countries such as New Zealand, Canada, the UK and Sweden whose central banks were generally regarded as being among the least independent.¹²

In sum, inflation targeting seems to me less like an example of policy makers learning from modern macroeconomic theory to prevent time inconsistent central banks from giving into the temptation to inflate in hopes of gaining some short-term increase in economic activity than it does an example of policy makers finally deciding that inflation was such a problem that it was worth giving central bankers more discretion to do what they have always wanted to do, by insulating them from political pressure to monetize government deficits. And of course the idea that central banks should have some independence from the political process in order to protect the integrity of the monetary order is an idea that has been around since long before the advent of modern macroeconomic theory, going back at least to Bagehot (1873).

4.2. The case for low inflation

Chari and Kehoe (2006) claim that one of the principles that modern macroeconomic theory has established conclusively is that low inflation is the most appropriate goal for monetary policy, a principle that has clearly been a major influence in the establishment of inflation targeting regimes.¹³ Again this strikes me as more a case of theory catching up to practice than the other way round. As I stated earlier low inflation has always been a high priority for central bankers. And the sad fact (for us theorists) is that modern macroeconomic theory has never managed to come up with a satisfactory account of why a high trend rate of inflation should entail a quantitatively significant cost to society.

The case for low inflation did not come from the original Kydland–Prescott analysis, which merely assumed that low inflation was one of the goals of monetary policy. Instead, the modern case comes from various DSGE studies that have confirmed the optimality of Friedman's rule, which is to reduce inflation to the point where the nominal rate of interest equals zero. That this is not what has motivated the institution of inflation targeting regimes can be seen in the fact that nowhere does a central bank target a rate that is anywhere near the negative 4% per annum that would be required by the Friedman rule in most calibrated models. In any event the saving that would arise in principle from going all the way to negative 4% consists of the elimination of a tax on non-interest-bearing money holdings, a saving that almost all published research estimates to be a trivial fraction of GDP because the base of this tax is just a tiny fraction of total wealth in any advanced economy.

New Keynesian DSGE models, in which money as a means of exchange and store of value plays no essential role¹⁴ offer another possible reason for targeting low inflation, namely the inefficiency that comes from having a wider dispersion of relative prices for no reason other than the fact that different sellers are at different stages of the price change cycle; those with more recent price changes will tend to have higher relative prices because they have made the most recent adjustment to inflation. In these models the optimal trend rate of inflation is clearly zero, except possibly for second-best public finance reasons (Phelps, 1972) or risk-sharing considerations (Levine, 1991) that might argue for a positive rate.

Howitt and Milionis (2007) show that in the deterministic new Keynesian DSGE of Yun (2005), the price dispersion cost can be substantial once inflation reaches even 6% or 7%, and that at 10% inflation the cost is enormous, being equivalent to 30% of aggregate consumption! But they also show that this argument is especially dependent on the Calvo pricing model that I have argued is particularly unconvincing. In particular, once the trend inflation rate reaches 10%, over 35% of aggregate output is produced by the 0.3% of firms that are selling at a price below marginal cost! These firms would certainly want to either raise their price or curtail production if it were not for the fact that they have not recently been visited by the Calvo fairy, but the model requires them anyway to produce however much is demanded at their obsolete prices. Replacing the

¹² See Howitt (2010). This argument must be qualified however by noting that the task of measuring central bank independence is not at all straightforward. As I pointed out in Howitt (1993), a case can be made the Bank of Canada has actually been quite independent from political pressure since the 1960s.

¹³ But certainly not the only influence, and in some cases not at all an influence. New Zealand's inflation targeting regime was put in place as part of a major overhaul of government administration, whose goal was to make regulators and policy makers more responsible for their actions. See Goodhart (2010). Canada's was put in place as a way to help avert a wage-price spiral following the introduction of a new nation-wide sales tax. See Crow (2002).

¹⁴ Indeed Woodford (2003) derives the canonical DSGE model in the context of a "cashless economy."

Calvo model by a Taylor model with as much as a seven quarter lag between price changes gets rid of this counterintuitive feature of the model and has no firms selling below marginal cost, but it also reduces the cost of a 10% inflation to about 1.5% of aggregate consumption.

Moreover, if one keeps the assumption of Calvo pricing but reinserts lagged inflation in the Phillips curve, as central bank DSGE models typically do, by invoking the usual indexation story – that price setters not visited by the Calvo fairy adjust their prices as a function of lagged inflation – then the cost of inflation in the DSGE model is almost entirely eliminated, because indexation greatly reduces the extent to which inflation raises price dispersion. For example, Billi (2011) presents a model that includes such indexation and is calibrated to US data, paying strict attention to the zero lower bound on nominal interest rates. He shows that while the optimal mean rate of inflation is less than 1% per annum under commitment it is almost 17% under discretion. Yet he also reports that the welfare cost of going from commitment to discretion is less than 0.5% of aggregate consumption!

I conclude that the primacy of inflation as a goal for monetary policy is not something that modern macroeconomic theory has been able to teach the practitioners of monetary policy. On the contrary, either the theory is right and the practitioners are being guided by superstition, or else once again we have an example of theory trying, in this case still unsuccessfully, to catch up with practice. Indeed it is clear from the timing of events that this must have been the case, since the first inflation targeting regimes went into place in the early 1900s, a time when the literature that culminated with Woodford's (2003) magnum opus was barely in its infancy.

4.3. The case for rules rather than discretion

The other basic principle that Chari and Kehoe argue central bankers have learned from modern macroeconomic theory is that policy should be governed by rules rather than discretion, although perhaps with escape clauses that rarely need to be invoked. That this principle follows from modern DSGE theory is clearly valid; a welfare maximizing central bank in a DSGE model could always do at least as well under commitment to a fixed rule as it could under discretion, because it would always have the option of choosing a rule that would commit itself to doing what it would have done under discretion, and would only choose to do something else if that would provide more social welfare. Of course the optimal rule might be hard to express, because it makes policy dependent on a variety of different contingencies, but in the typical DSGE model there is no cost of complexity. And in any event the list of contingencies could be kept short by bundling all the unlikely contingencies into the rarely-invoked escape clause.

This argument, standard though it has become, strikes me as suffering greatly from the fallacy of considering the economy as a closed system in which everyone understands how things work and all uncertainty arises simply from the stochastic nature of the shock process. That is indeed the nature of DSGE systems, in which the assumption of rational expectations requires that the nature of the economy¹⁵ be common knowledge. But such a system has no room for conjecture and refutation, no room for learning after a rule has been put in place that the theory underlying it is fatally flawed because of some unforeseen and unwanted empirical consequence.

Learning that a rule that once seemed optimal needs to be scrapped calls for something more than an escape clause. For this is not a situation in which some rare event has occurred – a war or a once-in-a-lifetime financial crisis – that calls for a temporary suspension. Instead, we are talking about a situation that calls for a permanent repeal, a complete backing down from what the central bank had been committed to. A central bank that finds itself in such a situation will find its credibility diminished by much more than if it had followed a judicious open-ended discretionary policy that left it free to learn from its mistakes without having to violate any prior commitment.

Lest one think that such a situation is unlikely to occur, consider the policy of “monetary gradualism” that the Bank of Canada followed from 1975 until about 1982. The policy was put in place in an attempt to deal with the double digit inflation which had been occurring in Canada for several years prior to 1975, as it had been in many OECD countries at the time. The Bank committed itself to a gradual reduction in the growth rate of the money supply, defined explicitly as M1, over the course of the next few years.

Monetary gradualism was precisely what state of the art monetary theory was calling for at the time. Indeed Friedman (1975) declared that the speech in which Bank Governor Gerald Bouey first announced the policy was “the best speech I have ever heard from a central banker.” And the Bank did indeed honor its commitment. The growth rate of M1 came down as scheduled. But by as early as 1977 it was clear that the policy was not having the intended effect of reducing inflation. As in almost every country that tried such a policy of targeted reductions in monetary growth (Goodhart, 1984), the demand function for the targeted definition of money started to shift negatively and unpredictably once the policy was put in place. By the time the policy had been in place for 6 years the shifts in demand for M1 had nullified almost all the anti-inflationary effect of the reduction in monetary growth, and the annual rate of CPI inflation in 1981 (12.5%) was even higher than it had been when the policy was initiated in 1975.

There is still some question as to the precise cause of these shifts in demand for M1, some saying that it was an example of the Lucas critique and others claiming that it was the coincidental effect of technological change in banking that was allowing deposit holders to economize increasingly on their holdings of non-interest-bearing deposits. But in either case the Bank

¹⁵ I borrow the phrase, and many of the ideas in this section, from Leijonhufvud (2010).

of Canada was put in a very difficult position by the fact that it had made a public commitment to the policy that was now clearly not working the way it should be. It was forced to choose between dropping the policy altogether, with the attendant loss of credibility that this would entail, and persisting with a policy that was doing nothing to deal with the inflation that many Canadians considered at the time to be the most pressing problem facing the nation. In fact, the Bank drifted into an unannounced policy of exchange rate targeting until the adoption in 1991 of the inflation targeting regime still in place today. Inflation did start to come down in 1982, when defending the exchange rate required the growth rate of the money supply to be reduced far below its previously announced targets and Canada experienced the worst recession of all OECD countries at the time. A case can be made that had the Bank of Canada not committed itself to a definite rule in 1975, but instead had followed a more discretionary policy that allowed itself room to learn from its mistakes, it could have brought inflation down sooner and at lower cost.¹⁶

4.4. Stabilization bias

In new Keynesian DSGE models the central bank needs to be committed to a rule not just to avoid the inflation bias that Kydland and Prescott argued would exist under discretion but also to avoid what Svensson and Woodford (2005) call the “stabilization bias” of discretion. That is, following a positive price shock that disturbed the Phillips curve, an optimal monetary policy under commitment would require the central bank to accommodate inflation somewhat during the period of the shock but then to bring inflation below its long-run target in future periods, even if the price shock were purely transitory. This future tightening of monetary policy would increase future expected losses, but the expectation now of lower inflation in the future would allow a more favorable inflation-unemployment tradeoff during the period of the shock, and the overall effect of that expected tightening would be to reduce the discounted sum of expected losses. The problem, however, is that if the central bank is not committed to this future tightening it will not undertake it, since the benefits in the form of improved inflation expectations will be bygone. More generally, Svensson and Woodford argue that the optimal inflation target should be history dependent in a way that would never be implemented by a central bank minimizing the “true” social loss function under discretion. Hence the central bank needs to be committed to a rule that implements the optimal inflation target.

I question whether this is something that central bankers have learned to do. Specifically, I do not believe they deliberately aim at tighter monetary policy long after a positive price shock has finished having a direct effect on the economy. Admittedly, inflation-targeting central banks aim to bring inflation back within the target bands within a certain period of time, after it has been shocked above the upper band. But I am not aware of any instance in which an inflation targeter has publicly announced that it is planning to compensate for a positive inflation error by deliberately going through a period of negative errors. And of course for them to demonstrate that they have learned the lesson they would have to not just plan such a period of negative errors but to commit themselves to such a period. That does not sound like any central bank with which I am familiar.

Now you might say that central bankers have at least learned from modern theory that they need to focus on managing expectations as much as they need to manage their policy rate. And clearly one of the salient characteristics of inflation targeting is the way in which the openness of the regime allows the central bank to influence interest rate and inflation expectations. But did they really need modern macroeconomic theory to understand the importance of their effects on expectations? Discussions of monetary policy going back at least through the early 20th Century are full of analysis of what was once called the “announcement effect” of policy,¹⁷ which was considered by many to be as important as the direct effect itself of policy, since it is only by affecting interest-rate expectations that monetary policy can successfully affect the long-term interest rates that matter for controlling aggregate demand. So although the management of expectations in the face of shocks is certainly an important part of monetary policy, this seems to me to be more likely a good reason for having expectations (rational or otherwise) play a prominent role in modern DSGE models, rather than being a result of the new theory.

5. Financial stability

Central banking has its origins in the need for financial stability. The Bank of England came to prominence during the series of panics in the late 18th and early 19th Centuries that required someone to act as lender of last resort in order to prevent self-fulfilling expectations of widespread illiquidity. The Federal Reserve System was created to provide an “elastic currency” that would alleviate the seasonal pressures that had drained the financial system in the fall of each year and had led to bank runs and waves of bank failures (see Johnson, 2010).

To preserve financial stability, a central bank needs to ensure that the supply of base money varies enough so as to avert panics and collapses when the demand for money is temporarily elevated. It also requires the central bank to stand ready on a regular basis to buy or sell short-term financial instruments at prices that do not fluctuate wildly from day to day. In effect, a central bank oversees a country’s money market in much the same way, and for much the same reason, that more conventional commercial enterprises manage the markets for the products they buy and sell. That is, in order to make the market

¹⁶ See Howitt (1993) for more details of this episode.

¹⁷ The term “announcement effect” in connection with economic policy seems to have been invented by Pigou (1928) but, as Hicks (1969) explained, Hawtrey (1919) contained extensive analysis of what amounts to the same thing a decade earlier under the heading of “psychological effects”. Smith’s (1958, p. 177) reference to announcement effects makes it clear that the concept was familiar to professional economists by the late 1950s.

function efficiently it must provide assurance to other transactors that they can trade when they want, on reasonably predictable terms.

The other main task of a central bank is to ensure the long-run value of the monetary unit. To use a well worn metaphor, a central bank is the only agent in an economy in a position to provide a “nominal anchor” for the unit in terms of which contracts are written, accounts are kept and prices are quoted. It does this by controlling the supply of base money.¹⁸ We have known since Edgeworth, Wicksell and Keynes that unless the supply of base money is controlled, the overall supply of money and credit cannot be controlled, and we have known for even longer that unless the supply of money is controlled the price level cannot be controlled.

Frequently these two central tasks of a central bank conflict with one other. To maintain financial stability the bank must often dampen interest-rate fluctuations by expanding or contracting the monetary base to meet the market’s day-to-day demands. But to avoid long-run inflation it must not supply whatever is demanded without limit. Thus there is a constant tension between the two tasks. The art of central banking consists largely in finding the right way to manage that tension.¹⁹

One of the shortcomings of modern macroeconomic theory as a guide for monetary policy is that it has lost sight of the origins of central banking and presents a distorted picture of what central banking has always been about. Instead of focusing on the basic conflict between financial stability and price stability it has, at least until the most recent financial crisis, been almost solely focused on the conflict between inflation and unemployment. The typical analysis of Federal Reserve Policy has focused on how it manages its so-called “dual mandate” which make no reference whatsoever to the Fed’s original mandate to provide an elastic currency. New Keynesian DSGE theory provides a logically coherent foundation for this dual mandate by showing that utilitarian social welfare can be approximated (inversely) by a loss function that depends upon inflation and the output gap.

Of course the tradeoff between inflation and unemployment is important, and no analysis of monetary policy would be complete without considering it. But the same can be said of the conflict between inflation and financial stability. Yet modern macroeconomic theory has largely ignored the latter conflict. Indeed the canonical new Keynesian DSGE model presented by Woodford (2003) has complete Arrow–Debreu contingency markets with costless enforcement of intertemporal budget constraints and hence no need to worry about bankruptcies and or strategic default risks. True, the financial accelerator of Williamson (1987), Bernanke and Gertler (1989), and Kiyotaki and Moore (1997) has been integrated into some DSGE models,²⁰ but mainly to indicate how various shocks can be amplified by financial considerations, not to indicate how the central bank might trade off the risks of inflation against the risks of financial instability.

Perhaps the closest the profession came to analyzing this tradeoff before the 2007–2008 crisis was during the late 1990s and on into the 2000s, when one of the hot topics of research was whether or not central banks should pay attention to asset prices, and if so in what way. But none of that analysis contemplated the bursting of a housing bubble that would bring down some of the largest financial institutions in the world, destroy credit markets and leave major economies with a huge overhang of household debt and negative housing equity, and none if it predicted that such events would generate the deep and prolonged downturn that followed.

Now that we have experienced the aforementioned events, macroeconomics is changing, and probably for the better. We now have DSGE models that incorporate the problems that can happen when the zero lower bound on nominal interest rates is hit, and derive the appropriate conduct of monetary policy in such situations, in terms not only of managing short term interest rates on government securities but also managing interventions in private credit markets. And the financial accelerator has been reintroduced into DSGE models (see Gertler and Kiyotaki (2010) for a survey) with amazing alacrity. However, as Mishkin (2011) argues, the models that were actually used by central bankers before the onset of the financial crisis placed little importance on financial frictions or financial stability, and offered no theoretical argument against the Greenspan doctrine of leaving financial markets alone and cleaning up afterwards if need be – a doctrine that has no defenders left now that we have seen the consequences.

5.1. The classical stability hypothesis

Why has modern macroeconomic theory lost sight of financial stability as a central goal of monetary policy? One possible answer is that the profession has not taken financial frictions seriously enough. This answer is implicit in the wave of research now being undertaken to imbed financial frictions more deeply into DSGE models of monetary policy, research that will undoubtedly result in an improved class of models. But in my view this answer does not go deep enough. The answer I would give instead is that by focusing exclusively on conditions of rational expectations equilibrium, modern macroeconomic theory has failed to develop any useful analysis of an economic system’s coordination mechanism.

¹⁸ This is not to say that the central bank must use the base as its instrument.

¹⁹ In the 19th Century the gold standard made the tension somewhat easier to manage by providing a nominal anchor. But the gold standard did not eliminate the tension, because its maintenance required the central bank to exert control over its liabilities, control that frequently jeopardized the goal of financial stability.

²⁰ There is also a large literature on “sudden stops,” starting with Calvo (1998) and most recently elaborated in terms of a real-business-cycle DSGE by Mendoza (2010), that examines financial crises in developing countries. A sudden stop is an event in which international lending comes to a halt, and typically a severe recession results. In equilibrium models of sudden stops, however, the economy reverts back to its usual dynamic behavior soon after the event, so in this sense the event does not threaten the ultimate stability of the economic system.

The most important task of monetary policy is surely to help avert the worst outcomes of macroeconomic instability – prolonged depression, financial panics and high inflations. And it is here that central banks are most in need of help from modern macroeconomic theory. Central bankers need to understand what are the limits to stability of a modern market economy, under what circumstances is the economy likely to spin out of control without active intervention on the part of the central bank, and what kinds of policies are most useful for restoring macroeconomic stability when financial markets are in disarray.

But it is also here that modern macroeconomic theory has the least to offer. To understand how and when a system might spin out of control we would need first to understand the mechanisms that normally keep it under control. Through what processes does a large complex market economy usually manage to coordinate the activities of millions of independent transactors, none of whom has more than a glimmering of how the overall system works, to such a degree that all but 5% or 6% of them find gainful unemployment, even though this typically requires that the services each transactor performs be compatible with the plans of thousands of others, and even though the system is constantly being disrupted by new technologies and new social arrangements? These are the sorts of questions that one needs to address to offer useful advice to policy makers dealing with systemic instability, because you cannot know what has gone wrong with a system if you do not know how it is supposed to work when things are going well.²¹

Modern macroeconomic theory has turned its back on these questions by embracing the hypothesis of rational expectations. It must be emphasized that rational expectations is not a property of individuals; it is a property of the system as a whole. A rational expectations equilibrium is a fixed point in which the outcomes that people are predicting coincide (in a distributional sense) with the outcomes that are being generated by the system when they are making these predictions. Even blind faith in individual rationality does not guarantee that the system as a whole will find this fixed point, and such faith certainly does not help us to understand what happens when the point is not found. We need to understand something about the systemic mechanisms that help to direct the economy towards a coordinated state and that under normal circumstances help to keep it in the neighborhood of such a state.

Of course the macroeconomic learning literature of Sargent (1999), Evans and Honkapohja (2001) and others goes a long way towards understanding disequilibrium dynamics. But understanding how the system works goes well beyond this. For in order to achieve the kind of coordinated state that general equilibrium analysis presumes, someone has to find the right prices for the myriad of goods and services in the economy, and somehow buyers and sellers have to be matched in all these markets. More generally someone has to create, maintain and operate markets, holding buffer stocks of goods and money to accommodate other transactors' wishes when supply and demand are not in balance, providing credit to deficit units with good investment prospects, especially those who are maintaining the markets that others depend on for their daily existence, and performing all the other tasks that are needed in order for the machinery of a modern economic system to function.

Needless to say, the functioning of markets is not the subject of modern macroeconomics, which instead focuses on the interaction between a small number of aggregate variables under the assumption that all markets clear somehow, that matching buyers and sellers is never a problem,²² that markets never disappear because of the failure of the firms that were maintaining them, and (until the recent reaction to the financial crisis) that intertemporal budget constraints are enforced costlessly. By focusing on equilibrium allocations, whether under rational or some other form of expectations, DSGE models ignore the possibility that the economy can somehow spin out of control. In particular, they ignore the unstable dynamics of leverage and deleverage that have devastated so many economies in recent years.

In short, as several commentators have recognized, modern macroeconomics involves a new “neoclassical synthesis,” based on what Clower and I (1998) once called the “classical stability hypothesis.” It is a faith-based system in which a mysterious unspecified and unquestioned mechanism guides the economy without fail to an equilibrium at all points in time no matter what happens. Is there any wonder that such a system is incapable of guiding policy when the actual mechanisms of the economy cease to function properly as credit markets did in 2007 and 2008?

None of the above should be taken as saying that economics was of no help to monetary policy. The lessons of Friedman and Schwartz (1963) concerning the financial collapse of the early 1930s, and of Bernanke's (1983) important improvement on their analysis, certainly allowed the Fed to avoid the mistakes of the earlier period. And the Fed was quick to recognize the centrality of various credit markets to the operation of the economy and quick to step in when those markets seized up. My point in this section is just that none of this policy response was guided by modern DSGE theory.

6. Agent-based computational economics

New Keynesian DSGE models do of course model one aspect of the coordination mechanism, which is the setting of wages and prices. This is the second part of the “DSGE with nominal frictions” consensus view. However, aside from the fact that the exigencies of tractability in a DSGE framework have forced modelers to assume contrived mechanisms for setting prices, like the Calvo fairy, and to modify those mechanisms with counterfactual indexation assumptions, there is much more to coordination than just the setting of prices and wages. And it is not even clear that stickiness in wages and prices, the defining element of modern Keynesian economics, plays much of a causal role in creating instability. Indeed, as many writers

²¹ On this point, see Laidler (2011).

²² Except in the literature that introduces search/matching frictions into DSGE models, a literature which has made enormous strides in the last few years.

starting with Keynes himself have pointed out, a greater degree of wage/price flexibility could easily make the economy less stable by inducing debt-deflation and adverse expectational effects.

Given the importance of the coordination mechanism in determining the stability properties of an economy, and given that the DSGE approach almost ignores the mechanism by assumption, the consensus that has settled on DSGE with nominal stickiness seems to me more an obstacle to progress than a sign of progress, especially since there are alternative approaches that can directly address the coordination problem. In particular, I am referring to the approach of agent-based computational economics (ACE), as laid out by the various contributors to [Tesfatsion and Judd \(2006\)](#).

The methodology of ACE is in some sense the polar opposite to that of DSGE. Instead of assuming that people have an incredibly sophisticated ability to solve a computationally challenging intertemporal planning problem in an incredibly simple environment (the simplicity being needed in order to make the equilibrium computable), the ACE approach is to assume that people have very simple rules of behavior for coping with an environment that is too complex for anyone fully to understand.²³ In short, it portrays an economic system as a human anthill, in which orderly social behavior can possibly emerge as a property of the interaction between diverse agents, none of whom has any understanding of how the overall system functions.

There are relatively few examples of ACE macro models in the literature to date.²⁴ My own investigations suggest however that ACE macro models can shed light on some of the issues that have so far eluded DSGE, light that might someday help central banks in steering away from potential instabilities. This work also suggests that the approach could be useful for understanding the fundamental rationale behind inflation targeting. To describe this work in detail would require a separate paper, so the following brief account will have to suffice for present purposes.

[Howitt and Clower \(2000\)](#) examined a primitive economy exchange populated by people with no understanding of their environment other than what has been learned from random meetings with other people, and with a desire to exchange their endowments for something they might want to consume. Starting in an autarkic situation, with no trade organization, it turns out that as long as people have a minimum of entrepreneurial spirit, a coherent network of trade facilities will emerge that allows almost all the potential gains from trade to be fully exploited; moreover a universal medium of exchange will also emerge as a byproduct of the evolution of market organization. Thus not only can the ACE approach account for the self-organizing and self-regulating properties of a market economy, it can also avoid one of the most serious problems of new Keynesian DSGE models, namely the difficulty of accounting for the existence of money without ad hoc assumptions like putting money in peoples' utility functions.

In [Howitt \(2006\)](#) I showed that this same economy exhibits a particular sort of multiplier process, in which the failure of one trading firm ("shop") increases the likelihood of other shop failures and can therefore result in a cascade that causes aggregate output in the economy to fall until a suitable set of replacement shops has emerged. There is nothing that price or wage flexibility can do to speed up the recovery process because what is needed is not different prices but new organizational structures. So although the approach can recognize nominal frictions, it does not lean on them exclusively to produce fluctuations in response to demand shifts.

[Ashraf and Howitt \(2008\)](#) showed that in an extended version of this model, calibrated to the US economy, the trend rate of inflation has a significantly positive effect on the equilibrium rate of unemployment, because inflation interferes with the workings of the market mechanism. Specifically, the higher is the rate of inflation the more difficult it is for the firms that operate markets to remain in business, because of the well-known tendency of inflation to induce noise into the price system. This is a result that falls naturally out of an ACE approach and which is hard to replicate in any DSGE model.

[Ashraf et al. \(2011\)](#) showed that banking problems can have a devastating effect on such an economy, causing it to spin out of control, because the credit that is provided by banks and other financial intermediaries is crucial to the functioning of markets. Such credit is particularly needed when one shop fails and the economy is threatened with a cascade of shop failures. In such circumstances, the easier it is for a potential entrant to find finance the more likely it is that the cascade will be counteracted or even averted by a replacement shop that allows other transactors to resume business as usual. But when banks and other financial intermediaries find their balance sheets in disarray they are less willing and able to provide this crucial finance.

The work that was briefly described the preceding paragraphs is still in preliminary stages. I have every expectation that it can be better done, and that many of the specific results we have found will be reversed by subsequent work. But the work shows at least that there is a way forward – a way to model the economy's coordination mechanisms that sheds light on the kinds of instabilities that central banks need to cope with and that can provide an intellectual foundation for understanding the costs and consequences of inflation.

7. Conclusion

This is not an argument for scrapping DSGE models altogether. On the contrary, when we understand as little as we do about macroeconomic systems, we need all the tools we can get. Moreover, even if modern new Keynesian DSGE theory does not represent a significant improvement over old Keynesian economics, it does embody much of the wisdom that has

²³ For a fuller description of ACE methodology see [Tesfatsion \(2006\)](#).

²⁴ See [Basu et al. \(1998\)](#), [Howitt and Clower \(2000\)](#), [Dosi et al. \(2006\)](#), [Howitt \(2006\)](#), [Deissenberg et al. \(2008\)](#), [Delli Gatti et al. \(2008\)](#), [Ashraf and Howitt \(2008\)](#), [Raberto et al. \(2010\)](#) and [Ashraf et al. \(2011\)](#).

accrued from the history of central banking. But it does not embody all of that wisdom. What central bankers and other policy makers need from macroeconomic theory at this point is a broader variety of approaches, so that they can see their problems from more than one angle, especially those problems that are hard to address using the currently popular mainstream approach. Fortunately I sense an increased willingness in the profession to satisfy that need for a diversity of approaches, now that the financial crisis and the great recession have shaken belief in the modern consensus. Whether this increased willingness will result eventually in a more useful array of theoretical frameworks is yet to be seen. Meanwhile, modern macroeconomic theory has more to learn from central bankers than it has to teach them.

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