Monetary Policy and the Limitations of Economic Knowledge

by

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I have always found it useful to think of a modern free-enterprise economy as a human anthill. Like an anthill, it organizes individuals' activities into patterns more complex than the individuals can fully comprehend, it performs collective tasks that the individuals are hardly aware of, and it can adapt to shocks whose consequences none of the individuals can predict. Of course we humans have more cognitive ability than ants, but the U.S. economy is correspondingly more complex than an anthill. The unsettled state of macroeconomics is testimony to the fact that even those of us who should know best do not really understand much about how the economy works. And yet it does seem to work, at least most of the time and reasonably well.

This is not to say that macroeconomists know nothing, or that macroeconomic wisdom is unattainable. As I will argue below, I think there is much to be learned by viewing the economy as an anthill, and much we have already learned from an emergent Post Walrasian literature that has adopted this viewpoint. This literature has taught us about aspects of economic policy that are not even visible from the viewpoint of rational-expectations-equilibrium analysis, an analysis that evades the issue of limited economic knowledge by assuming that everyone operates with a consistent and correct (at some level) set of economic beliefs. My purpose here is to point out some of the insights that this Post Walrasian perspective yields concerning one component of economic policy, namely monetary policy.

Some background

The anthill metaphor raises two fundamental theoretical questions. The first concerns behavior in the face of radical uncertainty. How do people make choices in a

world where the consequences of those choices will depend on the behavior of a system they do not fully understand, and which they know they do not fully understand? The other question is how a system that none of its participants understands can somehow or other make collective sense; that is, how can an economy like that of the United States be in a fairly coordinated state of affairs most of the time, usually within five or ten percent of a full-employment growth path, without chronic shortages or surpluses, when people are constantly acting at cross-purposes because of the mistakes that are inevitable under radical uncertainty, under what circumstances can the economy's regulatory mechanisms work best to keep the system well coordinated despite this confusion, and what is it that goes wrong when the mechanisms appear to break down as during the Great Depression of the 1930s?

Corresponding to these two broad theoretical questions are two related policy questions. How should policy makers themselves act when faced with the same kind of radical uncertainty as faced by the private actors in the system, and what kind of government policies are needed to allow the economy's regulatory mechanisms to keep the economy close to a fully coordinated state instead of permitting cumulative departures?

Such questions occupied a prominent place in pre-rational-expectations macroeconomics. Although in many dimensions Keynes and Friedman had opposing visions of the economic system, both of them put decision-making under deep uncertainty about economic relationships at the forefront of their analysis. To Keynes what mattered was the uncertainty faced by private decision-makers, especially by entrepreneurs and investors, which made aggregate investment depend more on "animal

spirits" than on rational calculations. To Friedman what mattered was the uncertainty faced by policy makers, especially uncertainty concerning the long and variable lags in the effects of monetary policy, which he argued made discretionary policy likely to do more harm than good.

Moreover, both Keynes and Friedman argued that if the right kind of policies were not followed, the economic system's built-in stabilizing mechanisms would be unable to prevent departures from a coordinated full-employment state, although of course they differed in their definition of "the right kind of policies." For Keynes the right policies involved collective intervention to boost investment demand when animal spirits are low. He believed that if the economy were left to its own devices, the mechanisms which classical theory saw as stabilizing the system would actually destabilize it. In particular, wage- and price-flexibility might make departures from full employment cumulative, because of the dynamics of expectations, debt deflation and distributional effects. Although this instability argument was not picked up by mainstream Keynesianism, which for the most part focused on the more classical aspects of Keynes, specifically the stickiness of money wages, nevertheless it was prominent in the writings of influential interpreters of Keynes such as Tobin (1947, 1975), Patinkin (1948), Clower (1965) and Leijonhufvud (1968).

For Friedman the right policy was to keep the money supply growing at a constant rate. In his famous presidential address to the American Economic Association (1968) he argued that the attempt by a central bank to control something other than the money supply, or some other nominal variable that would be proportional to the money supply in a long-run equilibrium, would lead to a cumulative process of accelerating inflation or

deflation. Controlling the money supply, on the other hand, would provide the system with a nominal anchor and allow the system's built-in stabilizers to do their job.

But the idea of the economy as an anthill whose ability to organize activities into stable patterns depends on macroeconomic policy was cast aside by the rational-expectations revolution that started with Lucas's seminal (1972) article. The rational-expectations paradigm, which was quickly embraced by macroeconomists of all stripes, Keynesians as well as monetarists, assumes that the economy is never out of a state of perfect coordination, that it always organizes activities into stable patterns in such quick order that the details of the stabilizing mechanism, and the uncertainty associated with those details, can safely be ignored. That is, in a rational-expectations equilibrium everyone's expectations about what will happen are consistent with the macroeconomic forces actually at work, and also consistent with everyone else's expectations, no matter what kinds of policies are pursued.

In contrast, the newly emergent Post Walrasian literature on macro policy takes seriously the radical uncertainty implied by our limited understanding of the economy, and analyzes the effects of policy even when the economy is far from a rational-expectations equilibrium. Some of this literature is directly addressed at how policy makers should take uncertainty into account.[1] But here my focus is on another branch of the literature, one that originated after the onset of the rational-expectations revolution when people began to think critically about the revolutionary new paradigm.

In particular, Phelps and Frydman (1983) and Sargent (1993) made it clear that the assumption of rational expectations makes sense only if people are capable of learning macroeconomic relationships from the experience of living in the economy, and

[1] For example, Sims (2002), Hansen and Sargent (2003) and Brock, Durlauf and West (2003)

the classical consistency theorems of statistical theory do not imply that these relationships are in fact learnable, because of the self-referential nature of macroeconomic learning. That is, statistical theory guarantees that under quite general conditions people should be capable of consistently estimating relationships from observing a long-enough series of data generated by those relationships. But in macroeconomics the relationships that we are trying to learn about are affected by our very attempts to learn about them, as when we change our expectations of inflation as a result of recent experience and this affects the actual rate of inflation by shifting the Phillips curve. Whether or not the attempt to learn about a system whose properties are affected by our very attempt to learn them will ever converge to a rational-expectations equilibrium is the subject of a now burgeoning literature, which was recently summarized by Evans and Honkapohja (2001). Much of this literature focuses on the question of equilibrium selection. But from my point of view the literature is important primarily because it also sheds light on the bigger question raised by the anthill metaphor, which is whether or not the economy is capable of converging to any kind of coordinated equilibrium at all.

Thinking about the economy in these terms yields a number of insights about how macro policy works, and particularly about the role it plays in stabilizing or destabilizing the economy - making it closer to or further away from a full-employment rational-expectations equilibrium. I discuss below seven specific lessons that I think one can learn about monetary policy by taking this approach. I illustrate some of them in terms of very simple models, although I think they are all valid under much more general assumptions.

Lessons for monetary policy

1. Interest-rate rules

I begin with an argument that I presented about fifteen years ago (Howitt, 1992) concerning interest-rate rules. At the time, there was sizeable literature on the subject of interest-rate smoothing as a strategy for conducting monetary policy, and it seemed to me that this literature was ignoring one of the most important lessons of Friedman's presidential address. That lesson was his interpretation of Wicksell's cumulative process, according to which the attempt by a central bank to control interest rates too tightly would lead to accelerating inflation or deflation.

Friedman argued that at any given time there is a hypothetical ("natural") real rate of interest that would generate a full employment level of demand. If the central bank set nominal interest rates too low, given the expected rate of inflation, then the real interest rate would be below this hypothetical natural rate, and this would generate excess aggregate demand, which would cause inflation to rise faster than expected, because of an expectations-augmented Phillips curve. With inflation running faster than expected, people's expectations of inflation would at some point start to rise, and if the nominal rate of interest were kept fixed that would just fuel the fire even more by reducing the real rate of interest still further below its natural rate.

That idea made good sense to me but it seemed to have disappeared completely from the literature after the rational-expectations revolution.[2] I concluded that this was something that was invisible from the viewpoint of rational-expectations-equilibrium theory, that you cannot see the cumulative process if you assume the economy is always in a rational-expectations equilibrium, because the process involves the instability of the

[2] There was a literature about interest-rate rules and indeterminacy, but that was really a different issue.

economy's equilibrating mechanism, the very mechanism that rational-expectations theory assumes can safely be ignored and prohibits you from analyzing.

The instability problem can be illustrated with the following model:

(IS) $$y_t = -\sigma \cdot \left(i_t - \pi_t^e - r^* \right)$$

(PC) $$\pi_t = \pi_t^e + \phi \cdot y_t$$

where y_t is output, i_t is the nominal rate of interest, π_t and π_t^e are respectively the actual and expected rates of inflation, and r^* is the natural rate of interest. The first equation is the usual IS curve, in which the real rate of interest must equal the natural rate in order for output to equal its capacity (full-employment) value, here normalized to zero. The second equation is the expectations-augmented Phillips curve, expressed in terms of inflation and output rather than inflation and unemployment. (The coefficients σ and ϕ are both positive, as are all the coefficients in the equations below.)

Suppose that the central bank kept the nominal interest rate fixed, at some level *i*. Then the model would have a unique rational-expectations equilibrium in which the rate of inflation depends (positively) on the pegged rate of interest:

$$\pi_t = i - r^* = \pi^*$$

Thus according to rational-expectations theory there would be no problem of accelerating or decelerating inflation. But suppose the economy departed from its rational-expectations equilibrium because people did not have enough knowledge to form rational expectations. Then people would make forecast errors, and presumably they would try to learn from these errors. The problem is that under this particular policy regime the signals they would be receiving from their forecast errors would be misleading. Instead of

leading the economy closer to the equilibrium these signals would lead it ever further away.

More precisely, from (IS) and (PC) the forecast error at any date *t* is:

$$\pi_t - \pi_t^e = \phi \cdot \sigma \cdot \left(\pi_t^e - \pi^* \right).$$

So when people are expecting more than the rational expectation π^*, as they are when the central bank pegs the interest rate too low,[3] they will find that the actual rate of inflation is more than they had expected, and any sensible learning rule will lead them to raise their expectation, taking it even further away from its unique equilibrium value π^*.

At the time I was first writing this, the state of the art in macro theory was represented by Blanchard and Fisher's (1989) graduate textbook, where I finally found a contemporary reference (p. 577) to Wicksell's cumulative process. But that reference came with a warning that the idea was not to be taken seriously, because it was a relic of pre-rational expectations thinking, dependent on a mechanical adaptive-expectations rule. Surely if people's expectations do not converge under adaptive expectations they will keep trying different ways of forming expectations until they finally do converge. And once they do the economy will be in a rational-expectations equilibrium in which inflation is constant, equal to π^*, rather than accelerating.

That was the kind of thinking that even the best of us had been led into by the rational-expectations revolution. But it missed the essential point of Friedman's analysis. The problem is that when you are in the sort of world where every time you guess too high you get a signal that you are guessing too low, *any* rule that actually tries to learn

[3] That is, by the definition of π^*, the actual real interest rate $i - \pi_t^e$ is less than the natural rate r^* if and only if $\pi_t^e > \pi^*$.

from mistakes is bound to lead people astray, not just some fixed mechanical adaptive-expectations rule. The main purpose of my 1992 paper was to make just this point, only much more formally.

Moreover, as (PC) makes clear, when the economy generates higher and higher forecast errors it is also generating larger and larger departures of real output from its equilibrium value. In other words, the instability that is generated by a mistaken policy of trying to peg nominal interest rates is also preventing the economic system from converging to a full-employment equilibrium. This is the sort of problem that the anthill metaphor of Post Walrasian theory helps us to identify, and the sort of problem that rational-expectations theory assumes out of existence.

In that 1992 paper I also showed that the central bank can correct the Wicksellian instability problem by making the nominal rate of interest respond to the actual rate of inflation, provided that the response is greater than point-for-point. That provision has since come to be known as the "Taylor" principle. If followed it would at least make convergence to a rational-expectations equilibrium possible. Intuitively, following the "Taylor" principle would imply that once expectations caught up to the rise in actual inflation, the nominal rate of interest would rise by enough to ensure that the real rate of interest also rises. This would reduce the output gap, according to the (IS) relationship, and this in turn would make the actual inflation rate fall below the expected inflation rate, according to the expectations-augmented Phillips curve (PC).

In other words, if the "Taylor" principle is obeyed then when people forecast a rate of inflation that exceeds the unique rational-expectations value they will receive the correct signal that their forecast is indeed too high, because they will end up observing a

rate of inflation lower than expected. This will help them to correct their expectational error, rather than compounding it as would happen with a fixed nominal rate of interest.

Thus an adaptive point of view allows one to see how Wicksell's cumulative process makes sense, how it threatens the economy's capacity for self-regulation, and what kind of policy it takes to avoid the problem. Moreover, Woodford (2003) shows that the analysis is much more general that my original analysis indicated, by proving that the "Taylor" principle is necessary for expectational stability in a broad class of New Keynesian models.

2. The Harrod problem

Another problem for monetary policy arises when people's decisions are affected by their expectations of the growth rate of output, rather than or in addition to expectations of inflation. That complicates the problem of monetary policy and adds further requirements to the kind of interest-rate policy needed to stabilize the economy. I started thinking about this several years ago when I reread Harrod (1939) on the inherent instability of the warranted rate of growth.[4]

The issue Harrod raised lies at the heart of the coordination problem that Keynes was wrestling with. That is, when technological progress or capital accumulation creates a bigger capacity output, what guarantees that aggregate demand will rise by just the right amount to utilize the increased capacity? If demand does not rise by that much then the result will be excess capacity and unemployment. To avoid this, in the absence of an activist fiscal policy, it is necessary for investment demand to increase by just the right

[4] My understanding of Harrod was helped greatly by reading Sen (1960) and Fazzari (1985).

amount. But investment demand is driven by expectations of how fast the economy will be growing, and those expectations in turn depend on the economy's actual growth rate.

What Harrod argued, in the context of a simple multiplier/accelerator model, is that whenever investors' expected growth rate rises above the "warranted" growth rate — what we would now call simply the equilibrium growth rate — the familiar Keynesian multiplier raises the actual growth rate by more than the initial increase in the expected growth rate. So again we have the phenomenon of misleading signals; whenever investors are expecting more than the equilibrium rate, they will get a signal that they have forecast too little. In such a world the expectations needed for the economy to be in equilibrium are virtually unlearnable.

The multiplier-accelerator model that Harrod used is no longer on the frontier of macroeconomics. However, something very like his instability problem can be seen in a model that is on the frontier, one that also shows why Harrod's insight is important for monetary policy. Specifically, consider the following variant of the New Keynesian model analyzed by Woodford (2003, ch. 4). It has a new IS curve with expectations of output on the right hand side as well as the level, an interest-rate rule and an expectations-augmented Phillips curve:

(ISa) $$i_t = -\sigma \cdot \left(y_t - y^e_{t+1}\right) + \pi^e_{t+1} = \sigma \cdot g^e_{t+1} + \pi^e_{t+1}$$

(MP) $$i_t = \phi_\pi \pi_t + \phi_y g_t$$

(PCa) $$\pi_t = \pi^e_{t+1} + \phi \cdot \left(y_t - y^*_t\right)$$

In Woodford's analysis, the interest-rate rule (MP) reacts to the level of the output gap: $x_t = y_t - y^*_t$ instead of to the growth rate g_t of output, and the growth rate of capacity output is assumed to be a constant whose value is known by everyone. Under these

assumptions he shows that if people form their expectations of x_t and π_t by taking sample averages, or by using ordinary least squares each period to estimate the parameters of the model, then there is a unique rational-expectations equilibrium, which is stable under these learning schemes, if and only if the monetary policy rule obeys the above-mentioned "Taylor" principle of my 1992 paper; that is if and only if the interest rate reacts more than point for point to inflation ($\phi_\pi > 1$).[5]

However, things are different if the growth rate of capacity output is unknown and expectations are focused on the growth rate g_t rather than level x_t. For suppose that capacity output grows according to:

(G) $\qquad y_t^* = y_{t-1} + g_t^*, \quad g_t^* =$ a serially uncorrelated random variable

Equation (G) allows for "hysteresis"; that is, a shortfall of output below capacity in period *t-1* will lead to a reduction in capacity output in period *t*.[6] Then it can be shown, using the same methods as Woodford, that if people form their expectations of g_t and π_t by taking sample averages, or by using ordinary least squares each period to estimate the parameters of the model, then there is a unique rational-expectations equilibrium, which is stable under these learning schemes, if and only if the monetary policy rule obeys the two conditions:

$$\text{(a) } \phi_\pi > 1 \text{ and (b) } \sigma < \phi \cdot \phi_\pi + \phi_y .$$

Condition (a) is the "Taylor" principle, but it does not guarantee the additional condition (b). Under realistic values of the other parameters, (b) requires either a reaction

[5] In Woodford's analysis, the Phillips Curve (PCa) has a coefficient β slightly less than unity on expected inflation, which implies a slightly modified "Taylor" principle, but this small difference has no substantive implications for the issues at hand.

[6] Hysteresis could result from a number of different factors, including skill-loss by unemployed workers or reduced learning-by-doing.

coefficient to inflation that is much larger than unity or a significantly positive reaction coefficient to the growth rate.

Thus even this modern New Keynesian analysis implies that the Harrod problem is potentially important, that growth-rate expectations are a potentially destabilizing force in an economic system, and that a monetary policy that ignores them by focusing simply on de-trended output or output gaps will give a misleading impression of what a central bank must do to make the economy self-regulating. In particular, the Harrod problem implies that macroeconomic stability requires an even more vigorous and activist monetary policy when people are uncertain about the growth of capacity output than when this uncertainty is not present. The problem is obviously important for monetary policy in the 1990s and early 2000s, where debates continue about the long-term growth implications of the "new economy." This is yet another effect that is not visible from a rational-expectations-equilibrium point of view, and yet another policy lesson that we can learn from viewing the economy as an adaptive mechanism characterized by imperfect economic understanding.

3. Keynes-Cagan-Tobin instability

The difficulties raised in the two previous sections arise under a form of interest-rate targeting. But they do not imply that central banks should give up interest-rate targeting and go back to pure monetary targeting. For even if one could solve the velocity-instability problem that plagued attempts at monetary targeting in the 1970s and 1980s, there is no guarantee that a constant money-growth rule would allow the economy's automatic stabilizers to keep the system always near full employment as

Friedman believed. For the possibility that Keynes raised, namely that relying on wage- and price-adjustment without any activist macro policy might destabilize the economy rather than stabilize it, would not automatically be avoided by a Friedmanesque policy of a fixed rate of monetary expansion.

One of the destabilizing mechanisms that Keynes pointed out was that of inflation expectations. He argued that if the price level started falling in the face of excess capacity people might postpone purchases, waiting for prices to fall even further, thus exacerbating the problem of excess capacity rather than alleviating it. This is closely related to problem that Cagan (1956) showed might destabilize inflation under a constant monetary growth rate. Cagan's analysis starts by noting that any rise in the expected rate of inflation will raise the opportunity cost of holding money, which will reduce the amount of purchasing power that people want to hold in the form of money. If there is no compensating reduction in the nominal supply of money then people's attempts to spend their excess money holdings will create inflationary pressure. Cagan showed that depending on the size of the interest-elasticity of the demand for money and the speed with which expectations adapt to forecast errors, the result could be to make the actual rate of inflation rise by even more than the expected rate of inflation, thus generating a cumulative process of accelerating inflation much like the process that Friedman later pointed out would arise under a fixed nominal rate of interest.

Cagan's analysis was conducted under the assumption of continuous full employment. However, an analysis similar to Tobin's (1975) shows that Cagan's results also hold in a simple Keynesian IS-LM system, in which the same stability condition that Cagan found is now a condition for the stability of full employment. This analysis makes

it clear that inflation expectations can indeed impair an economy's capacity for self regulation under a non-interventionist monetary policy, as Keynes had argued in his *General Theory* (1936, ch.19).

The key to this analysis is to recognize that the demand for money, which underlies the LM curve, depends on the nominal rate of interest, whereas the demand for real goods and services, which underlies the IS curve, depends on the real rate of interest. Because of this, the reduced-form level of output that is determined by the IS-LM system will depend positively on the expected rate of inflation. That is, for any given expected rate of inflation we can express both curves, IS and LM, as functions of the nominal rate of interest. But if the expected rate of inflation were to increase then any given nominal rate of interest would correspond to a lower real rate of interest, boosting aggregate demand and thus shifting the IS curve to the right.

Consider the following model:

(IS-LM) $$y_t = a_m m_t + a_\pi \pi_t^e$$

(MPa) $$\Delta m_t = \mu - \pi_t$$

(PC) $$\pi_t = \pi_t^e + \phi \cdot y_t$$

(AE) $$\Delta \pi_t^e = \beta \cdot \left(\pi_t - \pi_t^e \right)$$

in which the reduced-form output from the IS and LM curves depends positively on the log m_t of the real money supply (which enters the LM curve) and also positively on the expected rate of inflation (which enters the IS curve as discussed above). Equation (MPa) states that the growth rate of the real money supply, which can be expressed as the change in m_t, is the difference between the constant growth rate μ of the nominal money stock and the rate of inflation. Equation (PC) is the familiar expectations-augmented

Phillips curve and (AE) is the adaptive-expectations equation, which in modern terms is sometime seen as a "constant-gain" learning algorithm[7] (Evans and Honkapohja, 2001, pp. 48 ff.).

It is straightforward to show that the conditions for stabilizing this model are identical to the Cagan stability conditions:

$$\beta \cdot a_\pi / a_m < 1$$

the left-hand side of which is precisely the speed of adaptation of expectations β times the semi-elasticity of demand for money with respect to the rate of interest.

Thus again Post Walrasian theory has resurrected what some had thought was a relic of pre-rational-expectations theory, namely the expectational instability problem that Keynes, Cagan and Tobin analyzed, and has provided a new viewpoint from which we can see that this relic actually makes sense and that it raises policy issues which, although old, remain unresolved.

4. Uncertainty-avoidance by the private sector

One of the ways in which people cope with radical uncertainty of macroeconomic forces is to avoid basing their decisions on expectations. Instead of attempting to anticipate the unforcastable they take a wait-and-see attitude, reacting only after the fact. Thus for example wage negotiations that do not respond to information that raises the likelihood of a future rise in inflation may cost workers something if that future inflation in fact materializes, but much of the cost can be recovered in the next round of negotiations by holding out for *ex post* increases to catch up with inflation. Indeed the

[7] A constant-gain algorithm makes sense in a world that exhibits structural shifts, because a decreasing-gain algorithm like least-squares learning with infinite memory would give almost no weight to recent observations and thus would fail to respond quickly to structural shifts.

work of Riddell and Smith (1982) provides strong evidence of such behavior in contractual wage data. Likewise firms may wait until costs have actually risen before marking up their prices rather than trying to anticipate unpredictable increases in their costs and in their rivals' prices.

This sort of behavior probably explains the evidence found by Fuhrer (1997) of backward-looking behavior in the Phillips curve. An extreme form of this backward-looking behavior would result in a Phillips curve like:

(PCb) $$\pi_{t+1} = \pi_t + \phi \cdot \left(y_t - y_t^* \right)$$

which differs from the more common expectations-augmented Phillips curves (PC) and (Pca) above in that the right hand side has the actual past rate of inflation instead of the expected future rate.

It turns out that this change has important implications for monetary policy. Indeed if the Phillips curve is given by the backward form (PCb) instead of the forward form (PC) then the full-employment equilibrium in the system of the previous section will *always* be unstable under a constant rate of monetary growth. In effect, the backward Phillips curve (PCb) together with (IS-LM) makes the second derivative of the price level (the change in the rate of inflation) depend negatively on the price-level itself. A linear model in which the second derivate of a variable depends negatively on its level would produce a pure sine wave, like a thermostat that raises the inflow of heat in proportion to the temperature. Such a system would lie exactly on the knife-edge between convergence and explosive divergence. In the economic system we are investigating, the destabilizing tendency imparted by having expected inflation in the IS curve is enough to tip this system into explosive divergence.

So once again we see a reason why a non-activist monetary policy might prevent an economy from being self-regulating, a reason that we have found by looking at the economy from an adaptive Post Walrasian perspective but which would be invisible from a rational-expectations viewpoint. In this case it would be invisible not because the system has a stable rational-expectations equilibrium. Indeed it can easily be shown that even if we replaced the adaptive equations assumption (AE) by perfect foresight ($\pi_t^e = \pi_{t+1}$) the system would still be unstable. Rather it would be invisible because the system just does not make sense under rational expectations; that is, the backward-looking Phillips curve (PCb) depends on behavior that explicitly avoids reliance on expectations, rational or otherwise.

This instability result is a sort of dual to the analysis of Sargent (1999), according to whom the U.S. inflation rate has been unstable because the Phillips curve is forward-looking, the Fed wrongly believes that it is backward-looking, and there is constant-gain learning by the Fed. In my model, inflation is unstable because the Phillips curve is backward-looking, the Fed acts as if it wrongly believes that it is forward-looking, and there is constant-gain learning by the public. Which model is closer to the truth is the subject much ongoing empirical research on the nature of the Phillips curve,[8] none of which would make much sense from a strict rational-expectations-equilibrium point of view.

[8] For example, Galí and Gertler (1999), Rudd and Whelan (2003) and Mavroeidis (2004).

5. Learning-induced volatility

Many of the fluctuations observed in the level of economic activity may be attributable not to fluctuations in fundamental driving variables, or even to fluctuations in extraneous sun-spot variables, but rather to fluctuations in expectations that take place as part of the learning process. In this respect, there is an interesting recent paper by Orphanides and Williams (2003). It takes a New Keynesian model with a hybrid forward/backward Phillips curve and supposes that people form expectations in accordance with a constant-gain learning algorithm. It compares the optimal policy for a policymaker trying to minimize a loss function involving inflation and output to what would be an optimal policy in a world where people had rational expectations and the central bank knew that they did.

What Orphanides and Williams argue is that monetary policy should be *less* activist in its response to fluctuations in output than in a rational-expectations world, and the reason again has to do with imperfect macroeconomic knowledge, specifically the difficulty of identifying shifts in the natural rate of unemployment. That is, when the central bank loosens its policy in response to a rise in the rate of unemployment, there is some chance that the rise in unemployment is actually a rise in the natural rate of unemployment, not a deviation above the natural rate. If so, then the policy reaction risks starting an inflationary process that will be hard to bring under control. With people following a constant-gain learning algorithm it takes some time before inflation starts to take off, but then it also takes some time before inflation will come back down again once the mistake is realized and policy is corrected. During the correction period the

economy will have to undergo a recession, unlike what would happen under rational expectations.

This result of Orphanides and Williams offers an interesting alternative to Sargent's (1999) explanation of the rise and fall of US inflation. Specifically, it suggests that policy mistakes were made in the 1970s and 1980s by a Fed that persistently underestimated the natural rate of unemployment, and that once these mistakes were realized, the sluggishness of macroeconomic learning on the part of private agents implied that only by inducing a recession could the Fed bring back inflation back down again.

An adaptive perspective makes that lesson quite clear, and suggests an extra degree of caution in the conduct of monetary policy over and above what would be implied by a rational-expectations perspective. Of course this lesson conflicts with those of the previous sections, which argued for a more interventionist policy, not less. But the lesson is worthwhile even if it is not right, because it shows us what to look for when carrying out the empirical analysis necessary to judge how interventionist policy should be. The role of theory is to point out possible effects and provide a framework in which to interpret empirical work aimed at quantifying the often conflicting effects suggested by theory. In this case only an adaptive theoretical framework is capable of performing those functions because the policy issues involved would simply not arise if the economy were always in a rational-expectations equilibrium.

6. Monetary theory and policy

Another benefit of viewing the economy as an anthill is that an adaptive approach makes it easier to understand the relationship between monetary theory and policy. We are part of the policy process, which is something that we do not always take into account. Indeed, monetary policy in industrialized countries has followed academic fashion pretty closely since World War II. In the 1950s and 60s, when most academic macroeconomists were Keynesians, and believed that the quantity of money was not worth paying much attention to, that instead central banks should be looking closely at interest rates and various non-monetary measures liquidity, that is what central banks were doing. When monetarism rose in the academic literature, central banks started to experiment with monetary targeting. Then, as the profession started to lose faith in monetarism, central banks moved to exchange-rate targeting, and then to inflation targeting.

In many of these developments it was clear that economic theory played a leading role. Monetary theory was certainly one of the factors accounting for the apparent herding behavior of central banks, who always seemed to be doing the same thing at the same time.[9] That is, central banks learn from each other and also from academic economists. This social learning takes place in conferences, summit meetings, policy debates, and many other channels through which ideas about monetary theory and policy are constantly being exchanged.

[9] Another factor is the strategic complementarities involved in the bureaucratic policy-formation. That is, it is easier for the officials of a central bank to defend its policies against criticism if they can show that the bank is just following state-of-the-art policy advice, like the other central banks around the world, than if the bank has set out on an independent course of its own.

Moreover, it is not just the policy makers that are learning from monetary theorists. Often the conduct of monetary policy is way ahead of the theory, and we academic economists often have more to learn from practitioners than they have from us. I came to realize this when I was a participant in monetary-policy debates in Canada in the early 1990s. The Bank of Canada was moving to inflation targeting at the same time as the country was phasing in a new goods and services tax. The new tax was clearly going to create a problem for the Bank by causing an upward blip in the price level. Even if the Bank could prevent this blip from turning into an inertial inflationary spiral, the immediate rise in inflation that would accompany the blip threatened to undermine the credibility of the new inflation-reduction policy.

The Bank dealt with this problem by estimating the first-round effect of the new tax on the price level, under the assumption that the path of wages would not be affected, and designing a policy to limit the price blip to that estimated amount. It announced that this was its intention, and that after the blip it would stabilize inflation and bring it down from about six percent to within a one to three percent band over the coming three years.

At the time I was very skeptical. Along with many other academic economists I thought it was foolish for the Bank to announce that it was going to control something like inflation, which it can only affect through a long and variable lag, with such a high degree of precision. To me the idea reeked of fine-tuning, and I thought the Bank was setting itself up for a fall. But I was wrong. In the end the Bank pulled it off just as planned. The price level rose by the amount predicted upon the introduction of the new

tax, and then inflation quickly came down to within the target range, where it has been almost continuously ever since.[10]

This is not the only recent example of a central bank succeeding in doing something that academic economists have declared to be foolish. Indeed it seems that the most successful central bankers in recent years have been those that have paid the least attention to academic economists. Alan Greenspan ignored mainstream academic advice when unemployment went below 4%. Economists kept telling him to watch out, that inflation was right around the corner if he continued to follow such an expansionary policy. He did it anyway, and we are still waiting for the predicted inflation almost a decade later.

The idea that theory might have more to learn from practice than vice versa would not surprise any student of Nathan Rosenberg, who has spent many years studying the relationship between science and technology. Rosenberg (1982) argued that since the Industrial Revolution science has probably learned more from technology than technology has learned from science. The whole field of microbiology, for example, grew out of applied research conducted in the wine industry. That is, Pasteur was trying to solve problems arising in his family's wine business. So it is no surprise that the relationship between theory and policy is a reciprocal one that involves feedback in both directions.

Rosenberg points out that because of this two-way feedback it is wrong think of technology as being "applied science." Technological knowledge is no more derivative from scientific knowledge than the other way round. Instead, technology and science produce different kinds of knowledge. Technological knowledge is the knowledge of

[10] For a detailed account of these events see Laidler and Robson (2004).

what works, while scientific knowledge is the knowledge of why certain things work. I think the same relationship holds between society's stock of knowledge concerning the conduct of monetary policy and its knowledge concerning monetary theory. Monetary policy is not just applied monetary theory. Monetary policy shows what works, whereas monetary theory tries to explain why.

In short, one of the useful lessons we can learn once we take into account our limited understanding of macroeconomic forces is that we should be hesitant to criticize monetary policies on the grounds that they have no theoretical foundation. When theory and practice are at odds it is often the theory that is most in need of modification. A more hopeful lesson is that we do in fact have something to offer policy makers. This is again something we could not see from a rational-expectations point of view, because if everyone (including policy makers) had rational expectations then there would be nothing we could tell central bankers about how the economy works that they did not already know.

7. Inflation targeting

Finally, one of the things that we can learn from an adaptive approach is why the policy of inflation targeting followed by various central banks since 1990 has been such an apparent success. Inflation has come down since the 1980s throughout the world, not just in the United States. In many countries with a low degree of central-bank independence, like New Zealand, Canada, the United Kingdom, Sweden and Australia, this reduction has been accomplished by an explicit inflation-targeting regime. Why is

this? There is a rational-expectations answer, but in my view there is an even better Post Walrasian answer that invokes limited economic knowledge.

The rational-expectations answer is based on the Kydland-Prescott (1977) theory of time-inconsistency. According to this argument, inflation targeting is a way to constrain well-meaning but easily-tempted central bankers. It prevents them from trying to exploit the short-run Phillips curve that would be in place once people lowered their expectations of inflation. As long as a central bank is free to do this, so the argument goes, no attempt to reduce inflation will be credible. But under inflation targeting the central bank is constrained to keep inflation within a specific target range.

The Kydland-Prescott theory has never struck me as being a very persuasive explanation of inflation targeting, partly because central bankers are not the type that are easily tempted by temporary short-term gains to generate a long-term inflation problem. On the contrary they are typically much more averse to inflation and far-sighted in their thinking than most people. The Kydland-Prescott argument requires a particular kind of preference; the utility function of the governor of the central bank has to depend negatively on just two arguments, unemployment and inflation. I doubt that this is an accurate description of what motivates any central banker of record. Instead, I think the evidence favors the account that has been given by observers from Thornton (1802) and Bagehot (1873) through Milton Friedman,[11] namely that people entrusted with as much responsibility as a central banker are typically motivated by the hope of being seen to have acquitted themselves admirably in fulfilling their duties, one of the most important of which is to preserve the value of the currency. This is not an objective that would be well served by engineering an inflation in exchange for some fleeting short-term benefit.

[11] Quoted by King (1997)

Moreover, even if Kydland and Prescott were right about the utility function of central bankers, still not many of them would be tempted to undertake inflationary policies for a short-term improvement in the economy if left to their own devices. In the Kydland-Prescott theory they are tempted because an expansionary monetary policy is assumed to produce mostly benefits (falling unemployment) in the short run, whereas most of the inflation cost comes later. But in fact most countries where sudden expansionary policies are carried out suffer immediately from capital flight and from credibility problems. It is only later that they may possibly get the benefits, because the effects of monetary policy on the business cycle take several months to materialize. Because of this, the temptation they face, if anything, imparts a deflationary bias to monetary policy rather than the inflationary bias of the Kydland-Prescott analysis.

The explanation I prefer for the success of inflation targets starts by recognizing that it is not central bankers but their political masters that are tempted to follow inflationary policies, and the temptation comes from the obvious political advantage of avoiding a recession before an election and from the desire to secure low-cost debt-financing. It is important to realize that where inflation targeting is practiced it is not just the central bank that signs on to the policy; it is also the government. By so doing the government is making it very difficult for itself to pressure the central bank into pursuing inflationary policies for political reasons, especially in the more open and transparent environment that has accompanied inflation targeting. Thus it is no wonder that the central banks who have undertaken inflation targeting tend to be those who previously had the least amount of independence from their political masters. The new policy has

provided them with a degree of *de facto* independence that allows them to pursue the long-run objective of low inflation free from short-term political pressure.

The second part of this explanation begins by noting that inflation is a target of monetary policy rather than an instrument. Because of this, inflation targeting has allowed central banks to maintain their credibility while experimenting and continuing to learn from experience. Recall what happened when the Bank of Canada attempted to follow a policy of targeting the growth rate of the money supply in the second half of the 1970s. After having committed itself to targeted reductions in M1 growth, the Bank soon learned that the demand for M1 was undergoing negative shocks which were nullifying the effects of these reductions on inflation. This put the Bank in the awkward situation of having to choose between allowing inflation to persist, thereby defeating the ultimate objective of the policy, or violating its commitment to the targets, thereby undermining its own credibility and reducing its ability to talk inflation down. Nor was the Bank of Canada the only central bank in the world that found itself in such a dilemma. As Goodhart (1984) pointed out, every country in the world that undertook a monetary targeting policy found that the demand for whatever M that they were targeting somehow suddenly started to decrease.

If these central banks had been committed to inflation targets rather than money-growth targets, the lessons that they learned in the 1970s when they tried reducing monetary growth could easily have been put to use without jeopardizing the long-run goal of inflation reduction. They could have started right away aiming for much lower monetary growth, or switched to controlling some other monetary aggregate, or they could even have abandoned the discredited policy in favor of some other approach to

inflation control that placed less reliance on monetary aggregates. In the end that's what many of them did, but only after a lengthy and costly delay caused by the understandable wish to maintain their reputation for constancy.

Moreover, under the open and transparent framework of inflation targeting, central banks have been able to explain more clearly than ever what is going on when they change tactics. They can explain openly that what they are doing is just a tactical policy that in no way involves a change in the publicly announced policy of inflation control. In other words, they are free to benefit from new information that teaches them something about how the economy works, rather than having to hope that no such lessons will be forthcoming. This new environment has not only allowed monetary policy to be conducted more effectively, it has also helped the private sector in forming their forecasts.

This is one more example of how the anthill metaphor of Post Walrasian analysis helps us to understand why monetary policy works the way it does. Policy makers are involved in the adaptation process just like everyone else, and a policy that gives them clear goals and instrument-independence allows that adaptation to result in better policies rather than undermining credibility. Some may regard it as ironic that credibility, which rational-expectations theory did so much to bring to the forefront of monetary theory, could best be maintained by a policy that makes sense only from a perspective that denies the very premises of rational-expectations theory. But to see this as ironic would be to forget that central bankers have been concerned with maintaining their credibility since long before the notion of rational expectations was conceived.

Conclusion

This essay has discussed seven of the lessons to be learned from taking an adaptive view of monetary policy, one that sees the economy as a system of which the individual participants have limited understanding and are aware of those limitations. The lessons can be summed up broadly by the statement that whether or not an economic system is self-regulating, able to closely track a coordinated state of full employment in the face of continual external disturbances, depends very much on the conduct of monetary policy. One of our primary goals as monetary theorists should be to find out just what kinds of monetary policies best promote that kind of systemic stability.

This is an important question no matter what one's attitude towards the efficacy of "the invisible hand." Believers in the free market often say that the best monetary policy is a non-activist one that leaves the market free to do its job. Others often say that activism is required because left to its own a free market system is inherently unstable. Neither of these ideological positions is helpful, for both beg the question of what kind of policy is "activist" or "non-activist". Friedman would argue that a non-activist policy is one that keeps the money supply growing at a predetermined constant rate. But central bankers in the 1950s thought that stabilizing nominal interest rates constituted a non-activist policy because it avoided wild fluctuations in the instruments directly under their control. Both positions cannot be right.

To determine what kind of policy provides the best background and/or supplement to an economy's built-in regulatory mechanisms, we must go beyond ideology and develop objective models that are capable of being confronted with real-world data, models that take into account the possibility that the economy can be away

from a fully coordinated state of full employment for more than an instant. The main virtue of the adaptive approach illustrated above is that it does take this possibility seriously. The approach has already begun to shed light on the human anthill, but the work is just beginning.

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