Commentary

Julio J. Rotemberg

The King and Lin (2005) paper analyzes the desirability of various interest rate rules in a standard model of sticky prices. A simplified version of this standard model consists of (PS), a price-setting rule, and (IS), an investment-equals-savings curve. These can be written as

$$\text{(PS)} \qquad \pi_t = \kappa\left(y_y - y_t^e\right) + \beta E_t \pi_{t+1} + \omega_t$$

$$\text{(IS)} \quad y_y - y_t^e = E_t\left(y_{t+1} - y_{t+1}^e\right) - \sigma\left(i_t - E_t \pi_{t+1} - v_t\right),$$

where π_t, i_t, y_t represent the observable inflation rate, nominal interest rate, and log of output at t, respectively; y_t^e represents the efficient level of output; and ω_t and v_t represent stochastic disturbances.

The paper considers a monetary authority that sets interest rates as a function of the economy's history and evaluates how these rules perform when the economy is subject to two types of shocks. The first of these shocks is a technology shock. This shock affects a_t in the production function

$$\text{(1)} \qquad y_t = \log\left(a_t f\left(k_t, n_t\right)\right),$$

where n_t and k_t represent the labor input and capital, respectively. Such a shock obviously affects the efficient level of output, y_t^e. In general, it would also affect v_t—that is, the real interest rate that is consistent with ensuring that the efficient level of output, y_t^e, is demanded at t, given that the efficient level of output will be demanded in the future.

The second shock considered by King and Lin is a shock to government purchases, and this shock too affects y_t^e and v_t. Because neither of these shocks affects ω_t in the (PS) equation, it is apparent from the inspection of (PS) and (IS) that these shocks are consistent with keeping inflation constant and output, y_t, equal to the efficient level, y_t^e. What is needed for such a policy is simply that the nominal rate of interest be set equal to a constant inflation rate, $\bar{\pi}$, plus v_t. Such a policy, particularly when coupled with a low value for $\bar{\pi}$, appears desirable from several different points of view (not the least that it avoids many of the distortions introduced by price rigidity). I thus agree with King and Lin that it provides a natural benchmark against which other interest rate rules can be judged.

While it is a good benchmark, it seems difficult to implement such a rule in practice because the Wicksellian natural rate of interest, v_t, is generally not observable right away. This difficulty provides a rationale for rules where the interest rate responds to the economy's history. Two of the rules considered in this paper are based on the equation

$$\text{(2)} \qquad i_t = \bar{i}, + \tau_1 \frac{1}{4} \sum_{j=1}^{4} \pi_{t-j} + \tau_2\left(y_{t-1} - y_t^*\right),$$

where y_{t^*} is a measure of trend output. With τ_1 = 1.5 and τ_2 = 0.5, this is the rule that Taylor (1993) shows to be similar to actual U.S. policy. King and Lin also consider a variant where τ_1 remains equal to 1.5 and τ_2 is set to zero. Because the central bank responds only to inflation and not to out-

Julio J. Rotemberg is a professor at the Harvard Business School.

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put in this latter rule, King and Lin call it an "inflation only" rule.

The paper spends some time discussing monetarist concerns. Monetarists criticized policies that kept interest rates stable on the ground that they would lead government purchase shocks (or, rather, IS shocks in general) to have too large an effect on output. Policies that stabilized money growth, they argued, would lead interest rates to increase in response to such shocks and thereby stabilize output.

Inspired by these concerns, King and Lin ask themselves whether the interest rate rules that they consider lead to excessive output stability or not. It is important to stress, though, that the monetarists critique was applied to attempts by the monetary authority to stabilize interest rates, whereas interest rates vary over time in the rules studied by King and Lin. An even more important difference between the framework underlying the monetarist analysis and that of King and Lin is that the former saw the stability of output as desirable, whereas the latter focus on a model where even changes in government purchases ought to lead to changes in output.

These differences are sufficiently large that the issue of whether a particular interest rate rule "destabilizes output" relative to the benchmark turns out to be quite different from the issue of whether this particular interest rate rule is desirable in terms of leading to an outcome that is close to the benchmark. The inflation-only rule, in particular, "destabilizes output" in the sense that the failure of interest rates to rise immediately when there is a positive shock to government purchases leads output to rise by more than it would under the benchmark rule. By contrast, the Taylor (1993) rule "stabilizes output" in the sense that its tendency to let interest rates rise when output is above its trend leads output to respond less to both government purchases and to technology shocks than it does in the benchmark for both.

At the same time, the inflation-only rule leads to paths of output that are quite close to those of the benchmark, particularly in response to technology shocks. Thus, this rule appears more desirable than rules that let interest rates respond to output as well, even though there is a sense in which the inflation-only rule "destabilizes" output. This is not altogether surprising. King and Lin focus on a setup where output ought to vary (with y_t^e), while inflation ought to be stable, and it thus makes sense that a rule that focuses only on inflation stabilization is superior to one that tries to stabilize output as well.

The question this raises, however, is whether the output fluctuations one would actually observe in the economy if inflation were stabilized would correspond to fluctuations in the efficient level of output, y_t^e. The combination of equations (PS) and (IS) is silent on this issue because of the existence of ω_t. Fluctuations in ω_t lead to fluctuations in inflation even in the case where output is equal to y_t^e so that, naturally, they would imply undesirable output fluctuations if monetary policy were able to stabilize inflation. Thus, as emphasized by Giannoni and Woodford (2003), fluctuations in ω_t justify efforts by the central bank to stabilize output.

This renders it important to ascertain the extent to which the economy is subject to the shocks to technology and government purchases studied by King and Lin and the extent to which the economy is subject instead to shocks to ω_t. Equations (IS) and (PS) cannot, by themselves, be used to make this judgment because they do not separately identify the roles of v_t, y_t^e, and ω_t. However, it would seem possible to use information on actual government purchases to identify fiscal shocks and information from an aggregate production function, such as (1), to identify technology shocks.

There is indeed an extensive literature seeking to measure the effect of fiscal shocks on aggregate activity (see Blanchard and Perotti, 2002, for a relatively recent example). One issue in this literature is that some components of government spending, and particularly those related to the welfare state, respond to fluctuations in gross domestic product (GDP) that are due to other causes. However, changes in military purchases in the United States after World War II are plausibly free from this problem, and Rotemberg and Woodford (1992) use these changes to construct a measure of government purchase shocks. They show, moreover, that the changes in GDP that follow these shocks are broadly consistent with those of a competitive model where markups are constant. On the other hand, they also show that real wages increase after an increase in military purchases, and this suggests that increases in military purchases lower markups.

By contrast, King and Lin's simulations show that when the monetary authority uses a Taylor rule, markups strongly rise. The reason is not hard to understand. In the standard neoclassical model as well as the King and Lin model, the principal reason output rises in response to an increase in government purchases is that this increase makes people feel poorer and increases their labor supply (reduces their consumption of leisure). There is thus downward pressure on real wages and on prices. The downward pressure on prices tends to translate into increased markups when prices are sticky, particularly if the monetary authority raises interest rates in response to increases in output.

One reason to be skeptical of this mechanism is that it requires that workers/consumers respond to shocks to their future wealth, and there is considerable evidence that people often do not adjust their consumption until their flow of income changes. Insofar as shocks that increase government purchases do not lead to immediate increases in taxes, the reduction in the flow of income is deferred and this might well also defer the increase in labor supply.

This argument as well as the evidence of Rotemberg and Woodford (1992) concerning the response of real wages both suggest that the increase in output that follows government purchase shocks may well be due to reductions in desired markups. This would mean that such shocks affect ω and might thus justify a monetary policy that is geared toward output stabilization.

The identification of technology shocks presents substantial difficulties. An approach that is known to be problematic is to equate technological change with computed Solow residuals. The problem is that short-term changes in the Solow residuals and movements in output induced by nontechnological factors can be connected through several mechanisms, including variations in labor effort and the existence of increasing returns to scale. A potentially more-promising method for detecting changes in the technology factor, a_t, is to use information about changes in the long-run level of output or labor productivity. Galí (1999) and Galí and Rabanal (2005), in particular, use a bivariate vector autoregression (VAR) that includes changes in hours and labor productivity and identifies technology shocks as those shocks that are orthogonal to the shocks that have no long-run effect on the level of productivity. Given the specification, these shocks clearly *do* affect productivity in the long run. The technology shocks identified by this method are initially followed by declines in hours. Because hours and output move together over the business cycle, it appears that this method does not give an important role for technology shocks in business fluctuations.

A source of concern with this method of identifying technology shocks is that a bivariate VAR in hours and productivity growth has difficulty explaining long-term changes in productivity growth. In the U.S. nonfarm business sector, the compound annual growth rate of productivity was 2.75 percent from 1947:Q1 to 1973:Q4, whereas it was 1.66 percent from 1974:Q1 to 1992:Q4. To see whether Galí and Rabanal's (2005) statistical model is consistent with this, I first estimated a VAR explaining changes in nonfarm hours and nonfarm productivity from 1949:Q2 to 2002:Q4 using four lags of the two variables. Using these estimated parameters, I generated 10,000 histories of the two endogenous variables by randomly generating residuals that had the same variance covariance matrix as those of the estimated VAR. For each history, I computed the compound rate of growth of labor productivity from observation 1 to observation 107 as well as the compound rate of growth from observation 108 to observation 183. The maximum difference between these two compound rates of growth across these 10,000 histories was 0.4 percent, which is considerably below the 1.1 percent difference in compound growth rates observed in the data between the first and second periods described here previously.

This difficulty with a bivariate VAR in first differences echoes some of the well-known difficulties posed by the post-1973 productivity slowdown. One way of capturing this slowdown is to suppose that there was a break in the economy's mean growth rate at some point in the early 1970s. This would imply that the population of the United States suffered a huge wealth loss at that time. Given the lack of a precipitous reduction in asset prices at the time, the idea that the economy's underlying rate of growth fell suddenly is not wholly convincing. An alternative view is to suppose that technological progress is much smoother.

This is the approach taken in Rotemberg (1999, 2003), where I fit a smooth trend, d_t, to output by minimizing

$$\text{(3)} \qquad \sum_{t=2}^{T-1}\left[d_t - 2d_{t-1} + d_{t-2}\right]^2 + (1/\lambda)\sum_{t=1+k}^{T}\left(y_t - d_t\right)\left(y_{t-k} - d_{t-k}\right),$$

where the parameter y_t is the output level at t and λ is set at the lowest possible value that ensures that

$$\text{(4)} \qquad \sum_{t=k+v}^{T-k-v}\left(y_t - d_t\right)\left[d_{t+v} - 2d_t + d_{t-v}\right] = 0.$$

The resulting trend is quite smooth and has two additional properties. The first is that the covariance of the cycle (the difference between y_t and d_t) at t and $t-k$ is small. For $k = 16$, this ensures that cycles are essentially over after four years. The second property is that the cycle at t is orthogonal to the deviation of the trend at t from the average of its values at $t+v$ and $t-v$. This ensures that the trend does not behave in a way that is similar to that of the cycle itself.

Rotemberg (2003) shows that a process for technical progress that is consistent with microeconomic evidence on diffusion lags generates movements in GDP that are quite similar to those of the trend that is constructed by this method. This means that, if technical progress does indeed take this form, stabilizing output relative to trend becomes a valid goal for monetary policy once again. On the other hand, the computation of trend output, y_{t^*}, may well be complicated in this case. In particular, Orphanides and van Norden (2002) argue that $y_t - y_{t^*}$ is particularly difficult to compute in real time when y_{t^*} is smooth and yet different from a linear trend.[1]

This raises the question whether, in practice, the Federal Reserve has had difficulty dealing with recent episodes of changes in technical progress. While a thorough answer to this question is well beyond the scope of this comment, it is worth studying briefly the increase in productivity that took place in the United States in the 1990s. The idea is to see whether allegiance to a monetary rule of the type used by Taylor (1993) to describe actual Federal Reserve practice caused difficulties when technical progress accelerated in the 1990s. To see that it could, note that (2) leads to a systematic relation between inflation, the real rate of interest, and the departure of output from y^*. In particular, treating inflation in adjacent periods as being essentially equal to π_t, it yields

$$\text{(5)} \qquad \pi_t = 2\left(i_t - \pi_t - i^*\right) - \left(y_t - y_t^*\right).$$

Over long periods of time, one would not expect the central bank to have much influence on the real interest rate, which appears on the right-hand side of this equation. Moreover, in line with the King and Lin model, one would expect a rise in productivity growth induced by technical progress to raise this real rate. In practice, it seems that trend real rates fell over the 1990s, however. If one applies the detrending method of Rotemberg (1999) to the real interest rate based on Treasury bill rates and the consumer price index (CPI) from 1981:Q1 to 2003:Q4, one finds that the trend real rate fell from 2.52 percent per annum in 1991:Q1 to 1.35 percent per annum in 1999:Q2. To compute the change in $y_t - y_{t^*}$, I use Taylor's (1993) method for obtaining y_{t^*}. This involves the fitting of a linear trend for the logarithm of real GDP from 1984:Q1 to 1993:Q2. The result is that $y_t - y_{t^*}$ went from being –1.8 percent in 1991:Q1 to 3.9 percent in 1999:Q2. Using (5), this increase in "cyclical" output over nine years, together with the corresponding reduction in the trend real rate of interest, ought to have lowered the inflation rate by about 8 percent per year. In practice, the 12-month CPI inflation rate was essentially the same in 1991:Q1 as it was in 1999:Q2.

[1] For a proposal for dealing with this problem, see Orphanides and Williams (2002).

The precise numbers that belong in the above calculation are obviously subject to a great deal of uncertainty. It remains the case, however, that the "natural real rate of interest," v_t, appears to have declined in the 1990s, whereas "cyclical output" would have increased a great deal if a naive linear trend had been used to compute the "natural" level of output. The use of a mechanical rule setting interest rates as a function of inflation and a naive measure of cyclical output would thus have tended to reduce inflation considerably. That inflation remained stable suggests that the Federal Reserve was able to deal effectively with these underlying changes in the economy. One reason for this may have been that, in spite of the difficulties noted by Orphanides and van Norden (2002) for the computation of trend output in real time, the Federal Reserve was able to obtain an accurate reading of this particular trend change. Insofar as the central bank can be counted on to track changes in trend output accurately, and insofar as technical progress affects only such trends, efforts at stabilizing cyclical output are more likely to be beneficial.

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