the prewar wage/output system is individually significant at the .05 level) must be hiding some "true" stickiness from the observer. It would certainly be surprising if any of the moving average terms from that system were significantly different from zero.

Another obstacle to interpreting the moving average coefficients is Taylor's decision to ignore the contemporaneous correlation of the innovations to the two equations, which in the systems he estimates are always significantly different from zero (and positive). Although there are, as he says, an infinite number of possible decompositions of this correlation, his model specifically implies one. Since prices are modeled as being unresponsive to contemporaneous demand shocks, it seems natural to allow price shocks (assuming they represent something more than pure measurement error) to enter the output gap equation contemporaneously. This might upset the interpretation of the output equation as a policy reaction function. In fact, it would lead to a model with three equations—one for price adjustment, one for real GNP, and a monetary policy rule. In any event, given the size of the contemporaneous correlations involved, such an orthogonalization may well make quite a difference to the results.

In conclusion, John Taylor's paper has made a very useful and provocative contribution to the analysis of price/wage interaction in two disparate periods of United States history. If there are still questions to be answered about the roles of wages and prices in the behavior of the economy between the two periods, then this simply underscores Taylor's concluding statement in the paper: that the policy implications of understanding why the Phillips curve has become flatter with the passage of time are sufficient motivation for further study of the issues.

Comment J. Bradford DeLong and Lawrence H. Summers

In his contributions to this volume John Taylor reaches exactly the opposite conclusion from that in our paper (chap. 12); he finds that improved macroeconomic performance has taken place in spite of rather than because of the increased rigidity of wages and prices in the postwar period. Our explanation has the virtue of parsimony. We attribute the major change in economic performance to the major change in economic structure rather than telling a complex story involving offsetting effects. Moreover, Taylor provides no explanation of the forces that have accounted for the huge decline in the variance of aggregate demand shocks he claims took place. As we shall argue below, Taylor's

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theory that monetary policy has become less accommodative over time also seems implausible. He rests his conclusions on bivariate time series analysis of prices and output. We begin by showing that his conclusions can be reproduced in a model where increased price flexibility increases macroeconomic instability and then turn to other aspects of his argument.

Begin with an aggregate demand curve similar to that in section 12.3 of our paper:

$$q_{t+1} = \beta_1(m_t - p_t) + \beta_2(E_t p_{t+1} - p_t) + \epsilon_t \tag{1}$$

and assume perfect foresight for investors:

$$E_t p_{t+1} = p_{t+1}. \tag{2}$$

Equation (1) contains q_{t+1} in order to make the timing come out right: think of firms placing orders for investment goods this period, orders that do not show up in output until next period.

For simplicity, specify a simpler aggregate supply equation than in section 12.2;

$$p_{t+1} - p_t = p_t - p_{t-1} + \alpha q_{t+1}. \tag{3}$$

The inflation rate accelerates or decelerates depending on the output gap. This aggregate supply equation is the simplest that both is "superneutral" and exhibits "persistence."

To close the model, a money supply rule is needed. The simple assumption of section 12.2, the assumption of no movement at all in the money stock will not be a satisfactory underpinning for empirical analysis. We assume:

$$m_t = (1 - \lambda)p_t + \lambda p_{t-1}. \tag{4}$$

The money stock accommodates to the price level partially within the period and fully after two periods. A value of one for λ would imply no accommodation within the period; a value of zero would imply complete accommodation within the period.

Denoting $p_t - p_{t-1}$ by $\dot{p}_t$, solving the model, produces:

$$\dot{p}_t = \frac{1 - \lambda\beta_1}{1 - \alpha\beta_2}\dot{p}_{t-1} + \frac{\alpha}{1 - \alpha\beta_2}\epsilon_t \tag{5}$$

$$q_t = \frac{\beta_2 - \lambda\beta_1}{1 - \alpha\beta_2}\dot{p}_{t-1} + \frac{1}{1 - \alpha\beta_2}\epsilon_{t-1}. \tag{6}$$

Stability requires that:

$$\lambda > \beta_2/\beta_1 \tag{7}$$

$$\alpha < \frac{2}{\beta_2 + \lambda\beta_1}. \tag{8}$$

If ϵ_t follows a white-noise process with unit variance, then solving for the inverse of the variance of output leads to the equation:

$$\frac{1}{\sigma_q^2} = 1 - \left(\frac{3}{2}\beta_2 + \frac{1}{2}\beta_1\lambda\right)\alpha + \left(\frac{\beta_2^2}{2} + \frac{\beta_1\beta_2\lambda}{2}\right)\alpha^2. \tag{9}$$

Therefore further increases in the price flexibility parameter α are destabilizing and *increase* the variance of output, so long as

$$\alpha < \frac{1}{2\beta_2} + \frac{1}{\beta_2 + \beta_1\lambda}. \tag{10}$$

But (7) and (8) imply that α must satisfy (10). In this model, the variance of output is least when α equals zero, when there is no flexibility at all in the aggregate price level.

And yet empirical analysis of a system generated by (1) through (4) would produce results that might mimic quite closely those Taylor obtained for the postwar period. An economist who knew the timing of the aggregate supply equation might be able to recover it exactly:

$$\dot{p}_t = \dot{p}_{t-1} + \alpha q_t. \tag{11}$$

And an attempt to estimate a combined aggregate demand/monetary reaction function equation would yield:

$$\begin{aligned} q_t - q_{t-1} = &\left(-\frac{\lambda\beta_1 - \beta_2}{1 - \alpha\beta_2} - \frac{1}{\alpha}\right)\dot{p}_{t-1} \\ &+ \left(\frac{\lambda\beta_1 - \beta_2}{1 - \alpha\beta_2} + \frac{1 - \alpha\lambda\beta_1}{\alpha(1 - \alpha\beta_2)}\right)\dot{p}_{t-2}, \end{aligned} \tag{12}$$

where $\lambda\beta_1 - \beta_2$, $1 - \alpha\beta_2$, and $1 - \alpha\lambda\beta_1$, are all positive.

These coefficients are too large to be taken seriously. However, their size (but not their sign) is clearly an artifact of the model. The coefficients on $\dot{p}_{t-1}$ and $\dot{p}_{t-2}$ are highly correlated, and the introduction of a supply shock or of serial correlation in the demand shock would quickly bring them down to more reasonable values—their large size in (12) is due to the fact that the difference between $\dot{p}_{t-1}$ and $\dot{p}_{t-2}$ carries lots of information about ϵ_{t-1}. It is interesting that (11) and (12) might be rewritten as:

$$\dot{p}_t = \dot{p}_{t-1} + \alpha q_t \tag{13}$$

$$q_t = q_{t-1} = -\pi_1\dot{p}_{t-1} + \pi_2\dot{p}_{t-2} + u_t, \tag{14}$$

which bear a close resemblance to Taylor's (5) and (7):

$$\dot{p}_t = .88\dot{p}_{t-1} + .25q_t \tag{15}$$

$$q_t - q_{t-1} = -1.03\dot{p}_{t-1} + .73\dot{p}_{t-2}. \tag{16}$$

Therefore we conclude that Taylor's empirical findings are neither evidence for nor evidence against the hypothesis that an increase in persistence has led to an increase in stability. By assuming that the size of the shocks is independent of the structure of the model, he can reach one conclusion. By specifying a different underlying model—one that stresses the role of variations in the real interest rate in producing variations in output—the opposite conclusions emerge.[1]

It is a striking feature of Taylor's structural analysis that in explaining the changes in cyclical patterns between the pre–World War I period and the present one, he finds that all the structural parameters in his model change. Particularly surprising are his conclusions about monetary policy. He finds that it has become less accommodative under the current fiat money regime than it was under the earlier gold standard. He attributes the looseness of short-run monetary policy under the gold standard to the effects of foreign price shocks, which should have led to specie inflows. There are at least two important flaws in this argument. First, it is implausible that, at a time when imports represented only about 6% of GNP, foreign price shocks were the principal source of inflation shocks, especially using the GNP deflator to measure prices. Second, analyses of the gold standard surveyed in Bordo and Schwartz (1984) have made it clear that short-run specie flows in response to price shocks were negligible during the gold standard period. There thus seems to be little evidence for the monetary policy assumptions necessary to drive Taylor's conclusions.

Reply John B. Taylor

In their comments on my paper DeLong and Summers introduce a simple three-equation macromodel to argue their main point. Using this model, they show that a *decrease* in price flexibility—that is, a reduction of the coefficient of demand in the price adjustment equation—leads to a *decrease* in the variance of real output. They assert that this model is roughly consistent with the empirical findings in my paper. Therefore, they argue, my empirical findings support the view that a decrease in price flexibility unambiguously decreases output variance, contrary to my own stated views.

1. Taylor's finding that output is a decreasing function of past inflation is not evidence that the positive effect—through the real interest rate—of inflation on output is small. Taylor's negative coefficient is for an equation that is itself not structural, that is a combination of the aggregate demand equation and the monetary policy reaction function.