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The model of the U.S. economy developed by Arthur B. Laffer and R. David Ranson[1] of the Office of Management and Budget has received a great deal of attention from both economists and politicians. Inquiry has been devoted mainly to the effects of monetary and fiscal policy on nominal GNP. "The most unusual finding of the [Laffer-Ranson] model is that changes in the money stock work all of their effects on nominal GNP in the same quarter."[2] However, Laffer and Ranson also have a striking conclusion regarding the relation between inflation and unemployment. "The evidence displayed here does not support a significant partial relationship between the rate of change of the GNP price deflator and the rate of unemployment. The results do not confirm the existence of a 'Phillips Curve.' "[3]

The purpose of this note is to examine the relation between unemployment and inflation in the Laffer-Ranson (LR) model. We will see that while there is no explicit relationship between the rate of change of the GNP price deflator and the rate of unemployment in the model, there is an implicit one, with the rate of change of the money stock being the connecting link. The note begins with a description of the variables and equations in the LR model. The relation between unemployment and inflation is examined in both the short run and the long run. Then an alternative relation is obtained by reestimating the price equation of the model.

THE LAFFER-RANSON MODEL

In the LR model there are four endogenous variables and five exogenous variables. The endogenous variables are nominal GNP, ΔLY; the GNP price deflator, ΔLP; the unemployment rate, ΔLUR; and real GNP, ΔLy.

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1. Arthur B. Laffer and R. David Ranson, "A Formal Model of the Economy," *Journal of Business* 44 (July 1971): 247–70.

2. James L. Pierce, "Critique of 'A Formal Model of the Economy for the Office of Management and Budget' by Arthur B. Laffer and R. David Ranson" in U.S., Congress, Joint Economic Committee, *The 1971 Economic Report of the President*, Hearings, 92d Cong., 1st sess., 1971, p. 302.

3. Laffer and Ranson, p. 257.

The exogenous variables are the conventional money supply, $\Delta LM1$; federal government purchases of goods and services, ΔLG; a measure of the proportion of industrial man-hours lost due to strikes, ΔSH; Standard and Poor's Composite Index of Common Stock Prices, $\Delta LS\&P$; and the market yield on thirteen-week Treasury bills, i. All variables are expressed in terms of the quarterly change in their log with the exception of the interest rate, which is converted from an annual rate to a quarterly rate. In addition there are three seasonal dummy variables, D_1, D_2, and D_3, corresponding to the first, second, and third quarters of the year. Only the GNP price deflator is seasonally adjusted.[4]

Nominal GNP, the GNP price deflator, the unemployment rate, and real GNP are determined by three estimated relations and one definitional relation, respectively. The nominal-GNP relation estimated for 1948: I–1969: IV is

$$\begin{aligned}\Delta LY = {} & \underset{(5.5)^{**}}{1.10\Delta LM1} \\ & + \underset{(6.9)^{**}}{.136\Delta LG} - \underset{(-3.3)^{**}}{.068\Delta LG_{-1}} - \underset{(-1.9)}{.039\Delta LG_{-2}} - \underset{(-1.2)}{.024\Delta LG_{-3}} \\ & - \underset{(-3.7)^{**}}{.045\Delta SH} + \underset{(2.2)^{*}}{.068\Delta LS\&P_{-1}} \\ & + \underset{(4.9)^{**}}{.032} - \underset{(-12.1)^{**}}{.098D_1} + \underset{(2.6)^{*}}{.025D_2} - \underset{(-4.0)^{**}}{.029D_3}, \end{aligned} \tag{1}$$

$$\bar{R}^2 = .958, \qquad \text{S.E.} = .0131, \qquad \text{D-W} = 2.15;$$

the GNP-price-deflator relation estimated for 1952: I–1969: IV is

$$\begin{aligned}\Delta LP = {} & \underset{(1.7)}{.038\Delta LM1} + \underset{(2.7)^{**}}{.30\Delta LP_{-1}} + \underset{(2.0)^{*}}{.22\Delta \text{LP}_{-2}} \\ & + \underset{(2.7)^{**}}{.31i_{-1}} + \underset{(0.1)}{.000059}, \end{aligned} \tag{2}$$

$$\bar{R}^2 = .443, \qquad \text{S.E.} = .00272, \qquad \text{D-W} = 1.79;$$

the unemployment-rate relation estimated for 1948: II–1969: IV is

$$\begin{aligned}\Delta LUR = {} & \underset{(-6.5)^{**}}{-3.0\ Ly} - \underset{(-5.2)^{**}}{2.4\Delta Ly_{-1}} - \underset{(-1.3)}{.59\Delta Ly_{-2}} - \underset{(-3.7)^{**}}{1.8\Delta Ly_{-3}} \\ & + \underset{(1.1)}{.057} + \underset{(2.0)^{*}}{.18D_1} - \underset{(-2.9)^{*}}{.20D_2} + \underset{(1.0)}{.09D_3}, \end{aligned} \tag{3}$$

$$\bar{R}^2 = .799 \quad \text{S.E.} = .0790 \quad \text{D-W} = 1.74;$$

and the relation defining real GNP is

$$\Delta Ly = \Delta LY - \Delta LP, \tag{4}$$

4. Ibid., p. 252.

where the *t*-statistics are in parentheses; * and ** denote significance at the 5 percent and 1 percent levels, respectively; $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom; S.E. is the standard error of estimate; and D-W is the Durbin-Watson statistic.[5]

Since the total-spending equation, (1), has received a great deal of scrutiny, and the unemployment-rate equation, (3), is essentially a dynamic form of Okun's Law, I will comment only on the price equation, (2). Inflation is assumed to be a linear function of growth in the money stock and lagged rates of inflation and interest. The money supply variable, $\Delta LM1$, is included in (2) although it does not have a statistically significant effect on the price variable, ΔLP. However, if the equation is reestimated for the longer period 1947: IV–1969: IV, the change in the money supply does have a statistically significant effect.[6] The unemployment rate, which is a function of demand pressure, is excluded from the price equation because it does not have a significant effect.[7] Nevertheless, the change in demand pressure is represented in part by the growth in the stock of money, which influences the change in total spending in (1). Finally, the lagged price variables and the interest variable, i, are included to reflect anticipated price change but may reflect past demand pressure as well.

THE SHORT-RUN RELATION

Although there is no direct relation between the change in the GNP price deflator and the change in the unemployment rate in the *LR* model, there is an indirect one, since the change in the money supply influences both variables. Representing the change in demand pressure, $\Delta LM1$ affects ΔLP directly in (2) and ΔLUR indirectly through (1)–(4). In the short run, where the values of the lagged variables are given, a decrease in $\Delta LM1$ decreases ΔLP and increases ΔLUR by decreasing ΔLY more than ΔLP and, thus, decreasing ΔLy. Hence, there is a short-run trade-off between the inflation rate and the change in the unemployment rate associated with the use of monetary policy.

We can derive the short-run trade-off between ΔLP and ΔLUR by solving for $\Delta LM1$ in (2) and then substituting the expression along with (1) and (4) into (3) to obtain

$$\begin{aligned}\Delta LUR = &-83.8\Delta LP + 26.1\Delta LP_{-1} + 19.1\Delta LP_{-2} \\ &- 2.4\Delta Ly_{-1} - .59\Delta Ly_{-2} - 1.8\Delta Ly_{-3} \\ &+ 26.9i_{-1} + .135\Delta SH - .204\Delta LS\&P_{-1} \\ &- .408\Delta LG + .204\Delta LG_{-1} + .117LG_{-2} + .072\Delta LG_{-3} \\ &- .034 + .474D_1 - .275D_2 + .177D_3.\end{aligned} \tag{5}$$

5. Ibid., pp. 251–52.
6. Ibid.
7. Ibid., p. 255.

In the short run, for example, a 0.1-point decrease in the quarterly rate of price inflation, brought about by a 2.6-point decrease in the rate of change of the money stock, is associated with an 8.4 percent increase in the rate of change of the unemployment rate.

Although (5) is expressed in terms of the difference between current and lagged unemployment, it also describes a nonlinear Phillips relation between the current inflation rate and the current unemployment rate, since the lagged unemployment rate is given in the short run. For example, at a 5 percent rate of unemployment, a 0.1-point decrease in the inflation rate is associated with a 0.4-point increase in the unemployment rate. However, this is not the usual sort of Phillips relation,[8] which is associated with the use of both monetary and fiscal policy, since demand pressure generated by fiscal policy is not represented in the price equation.

THE LONG-RUN RELATION

According to monetarists,[9] there is a natural rate of unemployment so that in the long run it is possible to have price stability at this rate but impossible using aggregate demand policy to reduce the rate of unemployment below the natural rate without accepting an accelerating rate of inflation. Thus there is no long-run trade-off between the inflation rate and the unemployment rate, but there is one between the change in the inflation rate and the unemployment rate.

Although long-run total spending is determined almost completely by the money supply in the *LR* model, the long-run relation between inflation and unemployment implied by the model is not the one associated with the monetarist position. In the long run the total-spending equation is

$$\Delta LY = 1.10\Delta LM1 + .005\Delta LG - .045\Delta SH + .068\Delta LS\&P + .006, \quad (6)$$

the price equation is

$$\Delta LP = .079\Delta LM1 + .646i + .00012, \quad (7)$$

and the unemployment-rate equation is

$$\Delta LUR = -7.79\Delta Ly + .074, \quad (8)$$

where the lagged variables in (1)–(3) are equal to their current values, and the seasonal dummies in any equation are averaged in with the constant term. For given values of ΔLG, ΔSH, $\Delta LS\&P$, and i, there is no long-run trade-off between the inflation rate and the unemployment rate,

8. See Roger W. Spencer, "The Relation between Prices and Employment: Two Views," Federal Reserve Bank of St. Louis *Review* 51 (March 1969): 15–21.

9. See Milton Friedman, "The Role of Monetary Policy," *American Economic Review* 58 (March 1968): 1–17.

since $\Delta LM1$ represents only the change and not the level of demand pressure; but there is one between the inflation rate and the change in the unemployment rate.

Solving for $\Delta LM1$ in (7) and then substituting the resulting expression, (6), and (4) into (8) we obtain the implied trade-off between ΔLP and ΔLUR:

$$\Delta LUR = -100.5\Delta LP + 69.9i + .351\Delta SH - .530\Delta LS\&P - .039\Delta LG + .027. \quad (9)$$

In the long run a 0.1-point decrease in the quarterly rate of inflation, brought about by a 1.3-point decrease in the rate of change of the money stock, is now associated with a 10.1-percentage-point increase in the rate of change of the unemployment rate.

For given values of the exogenous variables, (9) implies that there is a "natural rate of inflation," so that in the long run it is possible to have full employment at this rate but impossible to reduce the rate of inflation below the natural rate without accepting an accelerating rate of unemployment. This natural rate is calculated by setting ΔLUR equal to zero and solving for ΔLP:

$$\Delta LP = .696i + .004\Delta SH - .005\Delta LS\&P - .0004\Delta LG + .0003. \quad (10)$$

The rate of change of the money supply which will yield this rate of inflation is then derived by equating (7) and (10) and solving for $\Delta LM1$. For example, in 1969: IV the implied natural rate of inflation was 5.4 percent per annum, and the associated rate of growth of the money stock was 6.1 percent. However, the natural rate of inflation is not immutable, since it is determined primarily by the interest rate, for which there is no equation in the model. Therefore, there may be a long-run trade-off between the inflation rate and the unemployment rate implicit in the *LR* model, with the interest rate reflecting the level of demand pressure.

AN ALTERNATIVE RELATION

The relation between unemployment and inflation in the LR model is not the conventional Phillips relation. However, the period of estimation for the price equation of the model, 1952: I–1969: IV, includes the abnormal Korean War years in which the rate of inflation was determined first by expectations based upon World War II experience and then by wage and price controls, rather than by demand pressure.

If the price equation including the unemployment rate in its lagged values is reestimated for the period 1955: I–1969: IV, the result is

$$\Delta LP = \underset{(1.014)}{0.034\Delta LM1}$$

$$+ \underset{(1.892)}{0.258}\Delta LP_{-1} + \underset{(1.124)}{0.152}\Delta LP_{-2}$$

$$- \underset{(0.604)}{0.062}i_{-1} \qquad (11)$$

$$- \underset{(-2.422)^{**}}{0.005}LUR_{-1} - \underset{(-0.598)}{0.001}LUR_{-2} - \underset{(-0.939)}{0.003}LUR_{-3} + \underset{(0.220)}{0.001}LUR_{-4}$$

$$+ \underset{(3.349)^{**}}{0.018}$$

$$\bar{R}^2 = .701, \qquad \text{S.E.} = .002, \qquad \text{D-W} = 2.031,$$

where *LUR* is the long of the unemployment rate.

Neither the money stock nor the interest rate is statistically significant in (11). Even the lagged inflation rates are not significant. Only the coefficient on the unemployment rate lagged one quarter is significantly different from zero. Thus (11) describes a static Phillips relation between price inflation and unemployment. However, this result is by no means definitive. It only demonstrates that there is a significant relationship between the rate of change of the GNP price deflator and the rate of unemployment using the variables and specification chosen by Laffer and Ranson.

CONCLUSIONS

There is an unusual relation between unemployment and inflation in the Laffer-Ranson model. The price equation of the model includes the change in the supply of money, which corresponds to the change in demand pressure, but excludes the unemployment rate, which is a proxy for the level of demand pressure. Hence there is a short-run trade-off between unemployment and inflation associated with monetary policy, but there is no long-run trade-off in the model. In the long run the LR model implies that there is a "natural rate of inflation," which is a function of the interest rate. Thus simply including a monetary variable in the price equation does not imply a monetarist view of inflation, which is that there is a natural rate of unemployment.

An alternative relation is obtained if the price equation is reestimated excluding the exceptional years of the Korean War period, which were included by Laffer and Ranson. The money supply does not have a significant effect on the inflation rate, but the unemployment rate does. The result is a simple Phillips relation, describing a trade-off between unemployment and inflation in both the short run and the long run.