Testing the NAIRU Model for the United States

Ray C. Fair[*]

March 1997

Abstract

The results in this paper reject, using U.S. data, the dynamics implied by the standard (NAIRU) view of the long-run relationship between unemployment and inflation. An alternative way of thinking about this relationship is suggested.

1 The NAIRU Model

The concept of the natural rate of unemployment plays an important role in guiding policy actions and in framing how most macroeconomists think about the relationship between unemployment and inflation. The standard model of inflation, the NAIRU model, is very clearly articulated in Mankiw's (1994) intermediate text. Begin with the supply equation:

$$Y_t = Y_t^* + \alpha(P_t - P_t^e), \quad \alpha > 0 \tag{1}$$

where Y is output, Y^* is the natural rate of output, P is the price level, and P^e is the expected price level. All variables are in logs. Rewrite this equation with P_t on the left-hand side and subtract P_{t-1} from both sides:

$$P_t - P_{t-1} = P_t^e - P_{t-1} + \frac{1}{\alpha}(Y_t - Y_t^*) \tag{2}$$

---

[*] Cowles Foundation, Yale University, New Haven, CT 06520-8281. Voice: 203-432-3715; Fax: 203-432-6167; e-mail: fair@econ.yale.edu; website: http://fairmodel.econ.yale.edu. All the data used in this paper can be downloaded from the website.

or

$$\pi_t = \pi_t + \frac{1}{\alpha}({}_t - {}^*_t) \tag{3}$$

where π is the actual rate of inflation and π is the expected rate. Replace $\frac{1}{\alpha}({}_t - {}^*_t)$ with $-\beta({}_t - {}^*_t)$, $\beta > 0$, where is the actual unemployment rate and * is the natural rate, under the assumption that ${}_t - {}^*_t$ is highly negatively correlated with ${}_t - {}^*_t$. Finally, add supply shocks, ${}_t$, to arrive at the standard equation:

$$\pi_t = \pi_t - \beta({}_t - {}^*_t) + {}_t \tag{4}$$

Equation (4) by itself does not guarantee the absence of a long-run trade-off between unemployment and inflation. If, for example, π_t were 3 percent for all t, lowering ${}_t$ below the natural rate for all t would result in a long-run finite increase in the rate of inflation. Similarly, if $\pi_t = \delta\pi_{t-1}$, $\delta < 1$, lowering ${}_t$ below the natural rate for all t would result in a long-run finite increase in the rate of inflation. If, on the other hand, $\pi_t = \pi_{t-1}$, lowering ${}_t$ below the natural rate for all t would result in an ever increasing inflation rate. The same is true if $\pi_t = \sum_{=1} \delta \pi_{t-}$, where $\sum_{=1} \delta = 1$ and is some integer greater than one.

Most views of inflationary expectations formation probably have coefficients like the δ 's summing to one, which combined with (4) imply that there is no long-run trade-off between unemployment and inflation. The following equation will thus be used to represent the standard view:

$$\pi_t = \sum_{=1} \delta \pi_{t-} - \beta({}_t - {}^*_t) + {}_t, \quad \sum_{=1} \delta = 1 \tag{5}$$

In this context ${}^*_t$ is the "nonaccelerating inflation rate of unemployment" (NAIRU).[1]

---

[1] Many years ago Sargent (1971) pointed out that estimating an equation like (5) cannot distin-

Support for the argument that equations like (5) represent the standard view can be found in many places. The following are three examples. First, a statement in a policy-oriented book on European unemployment: "We would not want to dissent from the view that there is no long-run trade-off between activity and inflation, so that macroeconomic policies by themselves can do little to secure a lasting reduction in unemployment."[2] Second, Tobin (1980, p. 39) pointed out a number of years ago that "Most Keynesian economists accepted the thrust of the Phelps-Friedman analysis [of no long-run trade-off between unemployment and inflation]."[3] Third, Krugman (1996, p. 37) in a recent article in the *New York Times Magazine* writes "The theory of the Nairu has been highly successful in tracking inflation over the last 20 years. Alan Blinder, the departing vice chairman of the Fed, has described this as the 'clean little secret of macroeconomics.'"

The results in this paper, on the other hand, suggest that equations like (5) are *not* good approximations. The main aim of this paper is to present and discuss these results.

To look ahead, if equations like (5) are not good approximations, then the standard long-run unemployment-inflation story must be changed. The new story, however,

---

guish between the case where the coefficient of $_t^e$ in (4) is one and the $_i$'s in (5) sum to less than one and the case where the coefficient of $_t^e$ is less than one and the $_i$'s sum to one. This paper is not concerned with discriminating between these two cases. The tests here are simply to examine whether the specification in (5) is a good approximation of the data. They are not tests of particular expectations hypotheses.

[2] Alogoskoufis et al. (1995), p. 124.

[3] Tobin (1972), however, presents a model in which there is a long-run trade-off at low inflation rates if nominal wage changes cannot be negative. Akerlof, Dickens, and Perry (1996) have recently expanded on this idea. They add a variable to an equation like (5) that is zero in periods of high inflation, but positive in periods of low inflation. In their model there is an absence of a long-run trade-off only at high inflation rates. The results in this paper call into question the Akerlof,

to lie on a second degree polynomial with an end point constraint of zero. Two unconstrained coefficients are thus estimated for the sixth test.

The seventh test is a stability test due to Andrews and Ploberger (1994) and discussed in Fair (1994, Chapter 4). This test does not require that a break point be chosen *a priori*, just a range in which the structural break occurred if there was one. The overall estimation period is 1954:1–1996:4, and the possible break period was taken to be 1970:1–1979:4.

Estimation and Tests of the Wage Equation

The coefficient restriction in (11) was imposed in the estimation of the wage equation, equation (9), where the values for β_1 and β_2 were taken to be the estimated values from the price equation. Given values for β_1 and β_2, the restriction in (11) is simply a linear restriction on the γ coefficients.

Four χ^2 tests were performed on the wage equation. The first is the test of the coefficient restriction in (11).

The second test adds the lagged values $_{t-2} - \lambda_{t-2} - {}_{t-2}$, $_{t-3} - \lambda_{t-3} - {}_{t-3}$, $_{t-4} - \lambda_{t-4} - {}_{t-4}$, and $_{t-5} - \lambda_{t-5} - {}_{t-5}$. Again, this is a fairly general test of the dynamic specification. Adding the lagged values in this form preserves the real wage restriction discussed above.

The third test is to estimate the equation under the assumption of a fourth order autoregressive process of the error term and see if the autoregressive coefficients are jointly significant. The same procedure was followed here as was followed for the price equation.

The fourth test is the Andrews-Ploberger stability test. Again, the same procedure was followed here as was followed for the price equation.

The Data and Estimation Technique

The data are described in Fair (1994), and this description will not be repeated here. The price variable is a private nonfarm price index. It is a price index of the output of the U.S. nonfarm, nonfinancial corporate business sector. It is exclusive of indirect business taxes. The wage variable is designed to match as closely as possible the average wage rate pertaining to the nonfarm, nonfinancial corporate business sector. It is a total compensation wage rate (exclusive of employer social security taxes), and it is adjusted for overtime hours.[8]

The estimation technique is 2SLS, with the variables $_t$, $_t$, $_t$, and D_t treated as endogenous. This means that the price and wage equations are assumed to be imbedded in a larger model, where $_t$ and D_t are endogenous. The variables used for the first stage regressors are the main predetermined variables in the US model in Fair (1994). The list of these variables and a complete description of all the data are available from the website mentioned in the introductory footnote.

The value computed for each χ^2 test is $({}^{**} - {}^{*})/\sigma^2$, where ** is the value of the 2SLS minimand before the addition, * is the value of the minimand after the addition, and σ^2 is the estimated variance of the error term after the addition. Under fairly general conditions, as discussed in Andrews and Fair (1988), this value is distributed as χ^2 with degrees of freedom, where is the number of variables added.

---

[8] In terms of the notation in Fair (1994), is log [illegible]F, is log F, τ is $\log(1 + D5G)$, λ is $\log LAM$, is log [illegible]M − log [illegible]F_{-1}, the unemployment rate is , and output is . $D5G$ is the employer social security tax rate, and [illegible]M is the import price index.

Table 1
Estimates and Tests of the Price Equation (8)

$${}_t = \beta_0 + \beta_1 {}_{t-1} + \beta_2({}_t + \tau_t - \lambda_t) + \beta_3 {}_t + \beta_4 D_t + \beta_5 t + \epsilon_t$$

	Estimate	t-statistic
β_0	.0036	0.24
β_1	.885	48.61
β_2	.100	4.70
β_3	.042	18.24
β_4	.00050	7.23
β_5	.00021	5.38
SE	.00357	
DW	1.77	

Tests:	χ^2	df	p-val
1. Variables lagged once added	0.97	4	.914
2. Variables lagged once and twice added	2.97	8	.936
3. Fourth order autoregressive error	2.21	4	.698
4. Wage led once added	0.05	1	.822
5. Wage led one through four added	5.51	4	.239
6. Wage led one through eight added	1.65	2	.439

AP Stability Test: AP=7.57 (one percent critical value = 8.70)

Estimation period: 1954:1–1996:4

The Results

The results for the price equation are presented in Table 1. The demand pressure variable that had the largest t-statistic was the current value of the unemployment rate with $\alpha = .02$: $D_t = 1/({}'_t + .02)$. This is the variable used for the results in Table 1. It is the case, however, that other functional forms gave similar results. For example, simply using ${}_t$ for the demand pressure variable resulted in a t-statistic (in absolute value) of 6.73 and a standard error of .00363, which compare to 7.23 and .00357 in Table 1. The data do not discriminate well among alternative functional forms, probably because there are so few observations of very low unemployment rates.

Table 2
Estimates and Tests of the Wage Equation (9)

$$_t - \lambda_t = \gamma_0 + \gamma_1(\ _{t-1} - \lambda_{t-1}) + \gamma_2\ _t + \gamma_3\ _{t-1} + \gamma_4 t + \mu_t$$

	Estimate	t-statistic
γ_0	-.0419	-3.76
γ_1	.918	32.60
γ_2	.639	7.65
γ_3	-.563	
γ_4	.000009	0.27
SE	.00689	
DW	1.65	

Tests:	χ^2	df	p-val
1. Coefficient restriction	5.30	1	.021
2. Four lags added	4.96	4	.292
3. Fourth order autoregressive error	14.72	4	.005

AP Stability Test: AP=13.22 (one percent critical value = 6.96)

Coefficient constrained.
Estimation period: 1954:1–1996:4

The coefficient estimates in Table 1 are highly significant except for the estimate of the constant term. All the tests are passed: none of the additions results in a significant χ^2 value, and the stability test is passed. This is strong evidence in support of the equation. For example, if the dynamics were misspecified, one would expect the lagged values that were added for the first and second tests to be significant, which is not the case.

The results for the wage equation are presented in Table 2. The estimates of β_1 and β_2 in Table 1 were used for the coefficient restriction (11), and the wage equation was estimated under this restriction. The coefficient estimates are significant except for the estimate of coefficient of the time trend. The test results are not as strong for the wage equation as they are for the price equation. The restriction and lags tests are passed at the one percent level, but the autoregressive error test is not, with a p-value of .005. Also, the stability test is not passed. Somewhat less confidence should thus be placed on the wage equation than on the price equation. Regarding the demand pressure variables, all 34 versions were tried, one by one, in the wage equation, and none was significant.

3 Tests of the NAIRU Specification

The Tests

The final form of the price equation in the previous section can be derived by lagging equation (8) one period, multiplying through by $_1$, subtracting this expression from equation (8), and then using equation (9) to substitute out the wage rate. The final form of the price equation is[9]:

$$
\begin{aligned}
p_t\ D\ \frac{1}{1\quad {}_2\ {}_2}[.\ {}_0 C\ \ {}_2\ {}_0\quad {}_0\ {}_1 C\ \ {}_5\ {}_1/\ C\ .\ \ {}_1 C\ \ {}_2\ {}_3 C\ \ {}_1/p_t\ \ {}_1 \\
C\ \ {}_2\ t\quad {}_2\ {}_1\ t\ \ {}_1 C\ \ {}_3 s_t\quad {}_3\ {}_1 s_t\ \ {}_1 C\ \ {}_4 D_t\quad {}_4\ {}_1 D_t\ \ {}_1 \\
C.\ \ {}_5\quad {}_5
\end{aligned}
$$

the coefficients sum to .58 for equal to 8 and 12 and to .45 for equal to 24. It is interesting that the summation restriction is not rejected at the one percent level even though the unrestricted coefficients sum to much less than one.

The rest of the results in Table 3 show that the four variables are significant at the one percent level for each value of both with and without the restriction imposed. The variables add more explanatory power (i.e., the χ^2 values are larger) when the restriction is not imposed than when it is.

Overall, the results in Table 3 provide a strong rejection of equation (13). The evidence in favor of the summation restriction is weak at best, and the four variables that equation (12) says should be added are highly significant.

Table 4 presents more details for the $= 12$ case (the results for the other two values of are similar). Three estimates of equation (13) are presented, one with the summation restriction imposed, one without the restriction imposed, and one with the four variables added without the restriction imposed. When the four variables are added (the third set of estimates in Table 4), the two with the largest t-statistics in absolute value are $_{t-1}$ and $_{t-1}$. The key variable of these two is $_{t-1}$. Adding this variable breaks the first derivative restriction mentioned above, and the restriction is clearly rejected by the data. Although not shown in the table, when only $_{t-1}$ of the four is added, its coefficient estimate is -.030, with a t-statistic of -7.07.

Note that the signs of the coefficient estimates of $_{t-1}$ and D_{t-1} in Table 4 are as expected from equation (12), namely opposite from the signs of the coefficient estimates of $_t$ and D_t. The coefficient estimates of τ_t and τ_{t-1} are of the same sign but are highly insignificant, and τ is clearly not an important variable.

Table 4
Estimates of Equation (13) for $= 12$

	$\sum$ restriction		no $\sum$ restriction		no $\sum$ restriction	
Variable	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
cnst	-.0085	-2.60	-.0082	-2.59	-.0460	-4.72
t	-.00002	-0.85	-.00039	-1.45	.00027	3.74
D_t	.00029	3.36	.00035	4.19	.00050	2.09
$_t$	.0039	1.15	.0161	3.50	.0718	4.93
τ_t	.101	0.87	.156	1.39	-.023	-0.11
$_{t-1}$					-.023	-4.36
D_{t-1}					-.00020	-0.77
$_{t-1}$					-.0369	-2.16
τ_{t-1}					-.049	-0.23
π_{t-1}	.374	4.77	.288	3.66	.139	1.86
π_{t-2}	.138	1.67	.074	0.91	-.006	-0.08
π_{t-3}	.194	2.34	.152	1.90	.093	1.26
π_{t-4}	.087	1.04	.066	0.82	.062	0.85
π_{t-5}	-.134	-1.60	-.147	-1.83	-.134	-1.91
π_{t-6}	.063	0.77	.034	0.42	.018	0.27
π_{t-7}	.024	0.30	.006	0.08	-.011	-0.17
π_{t-8}	.105	1.29	.087	1.12	.074	1.10
π_{t-9}	.044	0.55	.038	0.49	.012	0.17
π_{t-10}	-.090	-1.17	-.109	-1.47	-.110	-1.71
π_{t-11}	.150	2.16	.100	1.47	.101	1.71
π_{t-12}	.045		-.005	-0.07	.028	0.49
SE	.00427		.00410		.00354	
DW	1.95		1.91		2.04	

Coefficient constrained
Estimation period: 1955:3–1996:4

Other Tests

If $^*_t$ in equation (5) does not have a trend, then the time trend does not belong in equation (13). The time trend is in fact not significant in Table 4 for the estimation of (13) both with and without the summation restriction imposed. If the time trend is excluded from equation (13) and the summation restriction is tested, the same conclusion is reached as was reached in Table 3, namely that the restriction is rejected at the five percent level but not at the one percent level.

The results in Table 3 are not sensitive to the use of the the unemployment rate in place of D_t, which is a nonlinear function of the unemployment rate.

The results for $= 24$ are also not sensitive to constraining the 24 coefficients as in Gordon (1997), namely taking the first four to be equal, the next four to be equal, and so on, making a total of 6 unrestricted coefficients to estimate.

Regarding tests with and without the time trend, note that equation (12) implies that the time trend belongs in the final form price equation. If the time trend is not included in equation (13), then the time trend needs to be added along with the other four variables for the test of (13) versus (12). Note from Table 4 that the coefficient estimate of the time trend goes from negative to positive and from insignificant to significant when the four variables are added. This is to be expected, since in the level form of the price equation, which equation (12) is, the time trend is picking up unaccounted for trend effects on the price level. When equation (13) is estimated without the time trend and then the five variables are added, the five variables are highly jointly significant, just as are the four in Table 3.

Many tests of equations like (13) use the GDP deflator as the measure of prices. Other popular measures are the CPI and the personal consumption deflator (PCD). Gordon (1997), for example, uses all three. None of these measures seems as good as the price index used in this paper if the aim is to measure prices set by U.S. firms. The GDP deflator includes prices of government output and indirect business taxes, for example, which are clearly not decision variables of firms. The CPI and PCD are

Table 5
Tests of Equation (13) Using the GDP Deflator

	“χ^2”	Critical 5% Value	Critical 1% Value	Sum of δ ’s
Test of Summation Restriction				
8	8.96	10.61	16.10	.80
12	4.68	9.18	13.40	.83
24	1.88	7.04	11.12	.82
The four variables added (summation restriction)				
8	14.17	15.13	21.48	
12	15.69	16.79	22.99	
24	19.07	14.13	19.10	
The four variables added (no summation restriction)				
8	25.23	13.33	18.80	
12	28.35	13.24	19.34	
24	24.70	13.10	18.56	

Estimation periods: 1954:3–1996:4 for $= 8$, 1955:3–1996:4 for $= 12$, 1958:3–1996:4 for $= 24$.

The computation of the critical values is discussed in the appendix.

to some extent even worse, since they include import prices in addition to indirect business taxes.

For what they are worth, results using the GDP deflator are presented in Table 5. The tests in Table 5 are the same as those in Table 3. The summation restriction is not rejected at even the five percent level in Table 5, and, unrestricted, the coefficients sum to more than they do in Table 3, namely .80, .83, and .82 versus .58, .58, and .45. The four variables are jointly significant at the one percent level when they are added to the equation without the summation restriction imposed, but except for $= 24$ they are not significant at even the five percent level when they are added with the restriction imposed. The results against equation (13) are thus weaker when the GDP deflator is used, although it is still the case that relaxing the summation restriction and adding the four variables results in a significant increase in fit. At any rate, it is not clear how much weight should be placed on these results given the problems associated with the GDP deflator alluded to above, but they do show that the results are somewhat sensitive to the use of alternative measures of prices.

4 Policy Implications

If equations (8) and (9) are correctly specified but for policy analysis one used equation (13) instead, how much difference would this make? Results that pertain to this question are presented in Table 6. The following experiment was performed, first using equations (8) and (9) and then using equation (13). The unemployment rate was decreased by one percentage point from its base path beginning in 1997:1, and the effects of this change on the predicted values of the price level were examined. For all the predictions the actual values for 1996:4 back were used as initial conditions, and and τ were taken to remain unchanged from 1996:4 on. The base prediction path for each experiment took the unemployment rate to be equal to its 1996:4 value for all future periods, and the new prediction path took the unemployment rate to be one percentage point lower than this value for all future periods.

The first two columns in Table 6 present the results using equations (8) and (9). The coefficient estimates used for these equations are those presented in Tables 1 and 2, and the equations were solved by the Gauss-Seidel iterative technique. After 12 quarters the predicted price level is 2.97 percent higher in the new case than in the base case. Inflation in the first year is about 1.1 percentage points higher (at an annual rate). It is about .95 percentage points higher in the second year and .85

As noted in Section 1, if the NAIRU specification is rejected, it changes the way one thinks about the trade-off between inflation and unemployment, but it does not have to imply that unemployment can be driven to very low levels with only a modest effect on the price level. There may be a strongly nonlinear relationship between the price level and unemployment at low levels of unemployment. Unfortunately, it is hard to estimate the level of the unemployment rate at which further decreases would lead to large increases in the price level because there are so few observations of very low unemployment rates. The searching over functional forms in this paper led to the use of $1/({}_t - \quad + .02)$, where ${}_t$ is the unemployment rate in period t and is the minimum value of the unemployment rate in the sample period. Other functional forms, however, including the linear form, led to similar results. It would not be trustworthy to use equations (8) and (9) in this paper to predict what the price level would be with demand pressure much tighter than existed historically.

Given the difficulty of estimating where the severe nonlinear zone begins, policy makers are faced with a hard problem. There are too few high-activity observations for any confidence to be placed on the point at which output should not be pushed further without severe price-level consequences. The results in this paper are of little help regarding this question. The main point of this paper for policy makers is that they should not think there is some unemployment rate below which inflation forever accelerates and above which it forever decelerates. They should think instead that the price level is a negative function of the unemployment rate, where at some point the function begins to become severely nonlinear. How bold a policy maker is in pushing the unemployment rate into uncharted waters will depend on how fast he or she thinks the nonlinearity becomes severe.

Appendix

An important question in a time-series study like the present one is whether the asymptotic distributions that are used for inferences are good approximations of the exact distributions. In some cases they are not. Fortunately, this question can be examined using stochastic simulation. Exact distributions can be computed and then compared to the asymptotic distributions.

Consider first the test that the δ 's sum to one in equation (13). The stochastic simulation procedure in this case is a follows. First, estimate equation (13) under the restriction that the δ 's sum to one. Record the coefficient estimates and the estimated variance of the error term. Call this the "base" equation. Second, assume that the error term is normally distributed with mean zero and variance equal to the estimated variance. The rest of the procedure is then as follows:

1. Using the normality assumption and the estimated variance, draw a value of the error term for each quarter in the estimation period. Add these error terms to the base equation and solve it dynamically to get new data for [illegible]. Given the new data for [illegible] and the other necessary data (which have not changed), test the hypothesis that the δ 's sum to one. This is done by estimating the equation (by OLS) with and without the constraint and computing the χ^2 value. Record this value.

2. Do step 1 J times, which give J χ^2 values. Call the distribution of these values the "exact" distribution.

3. Sort the χ^2 values by size, choose the value above which [illegible] percent of the values lie, and compare this value to the critical [illegible] percent value of the actual

χ^2 distribution.

These calculations were done for $J = 1000$ for each of the three values of . The computed five and one percent critical values are presented in Table 3 of the paper. These values are noticeably larger than the critical values from the actual χ^2 distribution, which are 3.841 and 6.635. The exact distribution appears to have a much fatter tail than does the actual distribution.

Consider next the addition of the four variables to equation (13). In this case equation (13) is first estimated without the four variables added to get the base equation. The rest of the procedure is the same as above, where in step 1 the test is adding the four variables to the equation. These calculations were also done for $J = 1000$ for each of the three values of   and both with and without the summation restriction imposed. The computed five and one percent critical values are also presented in Table 3. Again, these values are larger than the critical values from the actual χ^2 distribution, which are 9.488 and 13.277, although when the summation restriction is not imposed, the computed values are not too much larger than the critical values from the actual distribution.

As noted in the paper, all the hypothesis testing concerning Table 3 was done using the computed critical values. The same calculations and procedures were followed for the results using the GDP deflator in Table 5.

Finally, the above procedure was used to obtain exact distributions for the tests for equations (8) and (9), and in this case the exact distributions were close to the actual distributions. No adjustments were thus made for these tests.

References

[1] Akerlof, George, A., William T. Dickens, and George L. Perry, 1996, "The Macroeconomics of Low Inflation," prepared for the Brookings Panel on Economic Activity, March 28-29.

[2] Alogoskoufis, George, Charles Bean, Giuseppe Bertola, Daniel Cohen, Juan Dolado, and Gilles Saint-Paul, 1995, *Unemployment: Choices for Europe*, London: Centre for Economic Policy Research.

[3] Andrews, Donald W. K., and Ray C. Fair, 1988, "Inference in Nonlinear Econometric Models with Structural Change," *Review of Economic Studies*, 55, 615-640.

[4] Andrews, Donald W. K., and Werner Ploberger, 1994, "Optimal Tests When a Nuisance Parameter is Present Only Under the Alternative," *Econometrica*, 62, 1383-1414.

[5] Eisner, Robert, 1996, "A New View of the NAIRU," manuscript, Northwestern University, June 1996; in Davidson, P., and J. Kregel, eds., *Improving the Global Economy: Keynesianism and the Growth in Output and Employment*, Cheltinham, U.K., and Brookfield: Edward Algar, forthcoming, October 1997.

[6] Fair, Ray C., 1974, *A Model of Macroeconomic Activity. Volume I: The Theoretical Model*, Ballinger Publishing Co.

[7] ________, 1984, *Specification, Estimation, and Analysis of Macroeconometric Models*, Cambridge, MA: Harvard University Press.

[8] ________, 1994, *Testing Macroeconometric Models*, Cambridge, MA: Harvard University Press.

[9] Gordon, Robert J., 1980, "Comments on George L. Perry, 'Inflation in Theory and Practice,"' *Brookings Papers on Economic Activity*, 1, 249-257.

[10] ________, 1997, "The Time-Varying NAIRU and its Implications for Economic Policy," *Journal of Economic Perspectives*, 11, 11-32.

[11] ________, and Stephen R. King, 1982, "The Output Cost of Disinflation in Traditional and Vector Autoregressive Models," *Brookings Papers on Economic Activity*, 1, 205-242.

[12] Hansen, Lars Peter, 1982, “Large Sample Properties of Generalized Method of Moments Estimators,” *Econometrica*, 50, 1029-1054.

[13] Hendry, David F., Adrian R. Pagan, and J. Denis Sargan, 1984, “Dynamic Specifications,” in Z. Griliches and M. D. Intriligator, eds., *Handbook of Econometrics*, Amsterdam: North-Holland, 1023-1100.

[14] Krugman, Paul. R., 1996, “Stay on Their Backs,” *The New York Times Magazine*, February 4, 36-37.

[15] Mankiw, N. Gregory, *Macroeconomics*, 1994, New York: Worth Publishers, second edition.

[16] Staiger, Douglas, James Stock, and Mark Watson, 1996, “How Precise are Estimates of the Natural Rate of Unemployment,” NBER Working Paper No. 5477, March.

[17] Tirole, Jean, 1988, *The Theory of Industrial Organization*, Cambridge, MA: M.I.T. Press.

[18] Tobin, James, 1972, “Inflation and Unemployment,” *American Economic Review*, 1-18.

[19] ________, 1980, *Asset Accumulation and Economic Activity*, Chicago: The University of Chicago Press.