

## Commentary

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*Robert J. Gordon*

The long-run **tradeoff** debate in perspective

During much of the past decade the Phillips curve was treated by many macroeconomists as an extinct prehistoric fossil, ridiculed as "fundamentally flawed" and part of the more general failure of Keynesian **macroeconometrics**.<sup>1</sup> But more recently a modest revival has begun for the beleaguered Phillips curve, a label that I mean to embrace any dynamic econometric specification in which the rate of change of wages or prices is **related** to the level of unemployment (or some similar utilization variable) and other **factors**.<sup>2</sup> This revival is one more example of the impact of economic events on ideas. The Phillips curve had earlier been discredited when its prediction of an inverse relationship between inflation and unemployment was contradicted in the 1970s by the emergence of a positive relationship. The revival can be attributed to the relative success of **pre-1981** Phillips curves in tracking the 1981-83 disinflation. Indeed, recent papers by Eckstein (1983), **Englander-Los** (1983), Perry (1983), Blanchard (1984), and myself (1984) find little evidence of instability in the Phillips curve, nor a failure to track the major portion of the recent disinflation.

Partly because Phillips-curve econometrics has been out of fashion, in recent years there have been relatively few conference sessions devoted to the numerous issues that arise in the specification of wage and price dynamics for the postwar **U.S. economy**.<sup>2</sup> Several weeks ago Ray Fair and I agreed that this session would provide a useful occasion to expose some of

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1. The quotes are from Lucas and Sargent, 1978, pp. 49, 56.

2. This neglect reflects in part the greater attention to long-period historical analyses, as in Schultze (1981, 1984), Taylor (1984), and the references cited therein. There has also been substantial attention to contrasts between the wage-price adjustment process in Europe and the U.S., as in Sachs (1983).

these issues to open discussion and scrutiny, and to facilitate this interchange he provided me with his **data**, so that we need not be concerned about data discrepancies as a source of **differing** conclusions in what follows.

Fair's paper raises two major issues that I'll discuss in **detail**: (1) his evidence 'against the Friedman-Phelps proposition of no long-run **tradeoff**,' and (2) the case he makes for a simple specification as contrasted with mine that he rightly characterizes as being more detailed in its implementation. His paper also develops a methodology for model comparison that is novel but complex. I view model comparison the same way he views model specification—simpler is better. I'll report comparisons of his and my approaches to specification using the old-fashioned garden-variety criteria of t-ratios and F tests on sets of omitted variables, and Chow tests and post-sample-period dynamic simulations to reveal structural shifts, and I won't try to duplicate or comment on his more involved procedure for model comparison.

Fair's models 1 and 2 incorporate a long-run **tradeoff** between inflation and unemployment because, **as** a mechanical matter, the sum of coefficients on lagged inflation in the wage equation is less than unity. His claim that such a wage equation provides evidence against the Friedman-Phelps natural-rate hypothesis (**NRH**) that no such long-run **tradeoff** exists immediately confronts the counterargument provided by Sargent (1971). The coefficient on lagged inflation in the wage equation represents a convolution of two separate sets of coefficients that cannot be separately identified: the coefficient on expected inflation, and the coefficient on lagged inflation in the formation of expected inflation. The finding that the product of the two coefficients is less than unity in one particular sample period does not provide any evidence that in another sample period, having a different monetary policy, the same rational agents might not apply a coefficient of unity to past inflation.

The logic of Sargent's argument is asymmetric. It demonstrates that those like Fair who estimate coefficients less than unity provide no evidence **against** the NRH, but it does not deny that those who estimate coefficients of unity provide evidence **consistent** with the NRH. Here again it is useful to recall the interaction of events and ideas. The **Friedman** and Phelps argument was brought to public attention in **1967** and 1968, just when the U.S. inflation rate was soaring upward beyond the predictions of the then-dominant econometric models. A last-ditch rear-guard action to defend the negative long-run **tradeoff** against the **NRH** was fought in **1969-71** by a number of economists, including myself in two early papers. However, there was no **Dunkirk**, and we did not escape from the invaders.

Instead, three factors came together to buy forever the opposition to the long-run version of the NRH. First was the failure of inflation to slow down in the recession of 1969-70, leading the Nixon administration in frustration to impose wage and price controls in August 1971. Second was the 1971 Sargent paper. Third was the growing econometric evidence, provided initially by Eckstein-Brinner (1972) and myself (1972), that, as additional data had accumulated, there was no longer evidence that the relevant sum of coefficients on past inflation was significantly less than unity. Thus the econometric argument that Sargent had invalidated could not even be sustained any longer on U.S. postwar data.

Over the past decade, whatever other changes have occurred in the way that Phillips curves are specified and estimated, one constant element has been that the data continue to be consistent with the NRH. Why, then, do the estimates of Fair's models 1 and 2 contain coefficients on past inflation low enough to yield a negatively sloped long-run tradeoff in his simulation exercises? The basic answer, as we shall see below, is an exclusion restriction imposed on his model—he allows only a short lag distribution on past prices, and dropping this restriction by introducing additional lags raises the sum of coefficients to unity.

### **Issues in the specification of reduced-form Phillips-curve equations**

This restriction is just one example of the many choices that must be made in the specification of Phillips curve equations, or, more generally, of any reduced-form characterization of the economy's dynamic aggregate supply schedule. Yet these choices must be made, for too many important issues in understanding macroeconomic behavior and the choices open to policymakers rest on estimates of such schedules. Is there a natural rate of unemployment? Has it changed? How rapidly will inflation accelerate or decelerate when the economy is away from the natural rate? What is the economy's sacrifice ratio: that is, the amount of output that must be sacrificed to achieve a permanent reduction of inflation by a given amount? Why were inflation and unemployment related negatively in the 1950s and 1960s but positively in the 1970s?

And there are smaller questions as well, each of which has already stimulated a substantial literature. Does a change in the relative price of oil influence the aggregate price level? Did the Nixon price controls work, temporarily or permanently? Did changes in payroll tax rates or the minimum wage rate aggravate inflation in the past, and would the manipulation of these rates give policymakers an additional instrument to influence the economy's sacrifice ratio? Do changes in the exchange rate and/or

import prices influence domestic inflation, again giving policymakers an influence of the sacrifice ratio through changes in the monetary-fiscal policy mix?

At least in principle, this set of questions can be addressed with a single reduced-form dynamic aggregate supply equation. It is easiest to think of such an equation as quantifying a "triangle" model of inflation. Just as we all know that relative prices depend on demand and supply, so inflation depends on demand and supply. The third side of the triangle, in addition to demand and supply, is inertia, the tendency of the inflation rate to mimic its own past behavior, due to some combination of contracts and costs of adjustment. The reduced form of a two-equation wage-price model like those in Fair's paper and in my early papers, or an explicit single-equation reduced form like those in my more recent papers, includes variables for demand, supply, and inertia. The influence of demand is entered through the level of the unemployment rate or some other economy-wide utilization rate, and perhaps its rate of change. The influence of supply is entered, at least in my work, through a set of changes in relative prices, the effective exchange rate, and effective tax rates, all defined so that when relative prices are constant and the exchange rate and tax rates are steady, the supply variables have a zero influence on inflation. Inertia enters through the influence of past inflation on current inflation, with the length of the lag and the sum of coefficients on past inflation left as an empirical question.

The long set of questions that a dynamic supply schedule is asked to address, and the triangle approach to thinking about that schedule, help to provide a perspective for responding to Fair's criticisms that my inflation equations are "too detailed" and "change so much from year to year." First, my equations have not changed in basic format, and have always included variables to represent demand, supply, and inertia. Second, over the years I have addressed each of the questions in the above list, and this leads to a research **tradeoff** between developing an equation with special features designed to address a particular question, e.g. price controls or flexible exchange rates, and the alternative of attempting to develop a single equation to address all questions. Such an equation, however useful, will strike as "too detailed" those who are interested in a smaller set of questions. Third, over the years, responses to the emerging data and to the suggestions of others have inevitably led to constructive changes, including collapsing a two-equation wage-price model into a single-equation reduced-form, and eliminating a variety of specially constructed variables that were originally developed for a **two-equation** wage-price model but

are no longer necessary within the context of a single reduced-form inflation equation.

**An assessment of Fair's model 2**

Fair's paper presents three models, each of which contains a separate wage and price equation. Model 1 expresses wages and prices in levels and 2 in rates of change, while 3 differs from 2 by imposing constraints that incorporate the no-long-run-tradeoff (NRH) hypothesis. Leaving aside the constrained model 3, which Fair rejects, there are three reasons to limit our discussion to model 2. First, in most other comparable research, including mine, the dependent variable is the rate of change of prices, not the level. Second, people and policymakers appear to care about the rate of change of prices, not the level of prices. Third, inside model 1 is a rate-of-change equation struggling to get out, since in both the price and wage equations the coefficient on the lagged dependent variable is greater than 0.9.

Fair presents his model in the form of separate wage and price equations, whereas my approach (1982) has been to specify the wage and price equations and then to convert them into a general reduced form before estimation. Here the complex task of comparing alternative specifications is simplified if we solve Fair's two-equation model and convert it into a single equation for the rate of change of prices. When the wage change-equation in model 2 is substituted into the price change equation, we obtain

$$(1) \quad \dot{p}_t = \theta_0 + \theta_1 \left[ \sum_{i=1}^4 (UR_{t-i}/4) \right] + \theta_2 \dot{p}_{t-1} + \theta_3 \left\{ \sum_{i=2}^8 [(4 - |5 - i|)/16] \dot{p}_{t-i} \right\} \\ + \theta_4 \left[ \sum_{i=1}^4 (\dot{D}_{t-i}/4) \right] + \theta_5 \left[ \sum_{i=1}^2 (\dot{p}_{t-i}^{IM}/2) \right],$$

where the notation follows Fair, except that

$$\dot{p}_t^{IM} = \log PIM_t - \log PIM_{t-1} \text{ and } D_t = \log(1 + d_t).$$

Equation (1) states that the inflation rate depends on four lagged values of the unemployment rate, UR, one lag of the dependent variable, a tent-shaped distribution on lags 2 through 8 of the dependent variable, four lagged values of changes in the employer Social Security tax rate, and two lagged values of changes in the import price deflator. The lag distributions on the unemployment rate, the tax rate, and the import deflator are all constrained to be rectangular. Note that the wage rate drops out of the

reduced form, since lagged wage changes do not appear in Fair's price equation. This aspect of Fair's model is the same as my approach and is supported by the data in both papers (see Gordon, 1982, Table 6).

Since from this point on we limit our discussion to the reduced-form equation 1, it is worthwhile pausing to consider several factors that make such reduced forms preferable to separate wage and price equations. First, separate wage and price equations cannot be distinguished as truly structural equations applying to behavior in particular markets. The behavior of wages, for instance, can be explained just as well by the GNP gap as by labor market variables like unemployment, suggesting that the wage equation does not provide us with any special insight about the working of labor markets. Second, the two-equation approach may be prone to simultaneous equations bias. Third, the use of separate equations led to an artificial separation of the variables that belong in each equation. For instance, the inflationary impact of the payroll tax or the Nixon wage controls depends not on just their coefficient in the wage equation, but also on the response of prices to that particular source of wage variation. Fourth, and perhaps most important, the specification of separate wage and price equations without any attention to the relation between the constant terms in these equations and the rate of productivity growth yields results like those in Fair's Table 3 that changes in nominal GNP growth yield not only permanent changes in the unemployment rate, but also permanent changes in the growth rate of the real wage. If productivity growth is exogenous, then Fair's simulations imply that monetary policy can cause labor's share in national income to veer off to zero or infinity.

Reduced-form equations like (1), as well as the more complex variants used in my work, should be viewed as a convenient characterization of the data rather than an attempt to describe structural behavior. Because the underlying structure may shift, the coefficients in the estimated equation may shift, so that any such single-equation approach should pay special attention to tests of the stability of coefficients across sub-intervals within the sample period.

Table 1 displays estimates of the separate wage and price equations of Fair's model 2 in columns 1a and 1b, and five alternative one-equation reduced forms for inflation in columns 2 through 6. Two differences in the choice of data distinguish the results in Table 1 from related equations that I have estimated (in 1982): The price variable here is the implicit price deflator for nonfarm output rather than the fixed-weight GNP deflator, and the official unemployment rate is used instead of Perry's weighted unemployment rate. Scanning down the left-hand side of the table, explanatory

variables are segregated among the "inertia," "demand," and "supply" categories. The number of lagged terms for each explanatory variable is indicated ("0" indicates the current value, "RD" indicates a rectangular distribution, "T" indicates a tent-shaped distribution as in equation 1, and "U" indicates that the lag coefficients are unconstrained.)

The bottom part of the table displays several summary coefficients and diagnostic checks. First is listed the sum of the coefficients on explanatory variables that are expressed as nominal rates of change, including lagged price changes, wage changes, and nominal import price changes. This is the relevant sum for tests of the long-run NRH (recall that a sum of unity confirms the NRH, but a sum significantly below unity does not reject the NRH, according to the asymmetry imposed by Sargent's argument). Next are two standard errors of estimate (S.E.E.), the first when the sample period terminates in 1984:I and the second for a termination date of 1980:IV. The subsequent line exhibits the F-ratio for a Chow test on a break in 1980:IV, a date of interest because of the 1981-83 disinflation that began thereafter. Finally, the last two lines display the mean error and root-mean-squared-error (RMSE) when the equation estimated through 1980:IV is subjected to a dynamic simulation for the 13 quarters ending in 1984:I.

Columns 1a and 1b reproduce exactly Fair's estimates of his two-equation model 2 (his Table 1), except that here all changes are expressed as annual percentage rates, replacing his inconsistent mixture of quarterly, annual, and semi-annual rates. This explains why our coefficient on lagged wage change in the price equation (column b) is exactly four times the coefficient listed in his table. Column 2 shows the estimate of the reduced-form, equation 1 above. Notable here are the low and insignificant coefficient on the unemployment rate, and the sum of coefficients on nominal explanatory variables of 0.84, significantly below unity (the relevant standard error is 0.08.).

The purpose of the remaining columns of Table 1 is to examine the robustness of Fair's rejection of the long-run NRH. As we shall see, minor changes in the specification of equation 1 raise the sum of coefficients on lagged nominal variables to unity. Second, evidence is provided to support the more detailed specifications of my inflation equations, namely the inclusion of additional supply variables. The first step in column 3 is to make two specification changes. The constrained rectangular distribution on lagged unemployment in line 8 is replaced by an unconstrained distribution, resulting in a substantial increase in the sum of coefficients, albeit not to the 5 percent significance level. Also the nominal import price change in

line 11 is replaced by the *relative* import price change in line 12, on the grounds that dynamic simulations of equations that take as exogenous a nominal rate of change (as do Fair's Tables 3 and 4) mix up relative and absolute price changes. Fair's approach leads him to conclude in his Table 3 that a permanent change in nominal GNP growth would lead **not only** to a permanent change in unemployment, but also to a continuous upward or downward movement in the real price of imports, analogous to his conclusion, previously pointed out, that such a shift in monetary policy would cause the real wage to go to zero or infinity.

We note that the two minor changes in moving from column 2 to 3 have another effect, and this is to raise the sum of coefficients on lagged nominal variables from 0.84 to 0.94, now insignificantly below unity. Another minor change in column 4 raises the sum to 1.01, and this is the addition of a single variable consisting of a rectangular distribution on the 9th through 12th lag of the dependent variable. While the sum of coefficients on this new variable (line 6) is not significant, it becomes significant in the next two columns in conjunction with other variables. The purpose of the extended specification in columns 5 and 6 is to judge the contribution of additional variables that are entered in my inflation equations. The first of these (line 13) is the change in the relative price of food and energy, a proxy for the impact of supply shocks on domestic inflation. Next is the change in the effective foreign exchange rate of the dollar (line 14), excluded from column 5 but included in column 6. As we shall see, this special treatment of the exchange rate is justified by the extraordinary shift in the economy's response to exchange rate changes before and after 1980:IV. Next in line 15 is the change in the effective minimum wage and the deviation of productivity growth from trend. The latter variable serves as an index of how cyclical changes in productivity growth are distributed between price and profit changes. A coefficient of zero would indicate that profits absorb all such cyclical productivity movements, with no price response to actual (as opposed to trend) unit labor cost. A coefficient of minus unity would indicate that price changes depend entirely on actual rather than trend unit labor cost and that profits are completely insulated from cyclical productivity movements. (The estimated coefficient of about -0.2 is very close to those reported in Gordon [1982], and earlier papers.)

The results in columns 5 and 6 suggest several general comments. First, most of the extra variables are significant, and an F test on the explanatory contribution of the extra variables passes at well beyond the 1 percent significance level. Second, the additional variables maintain the sum of coefficients on lagged inflation at between 0.99 and 1.01, consistent with the

NRH. Third, the additional variables result in an increase in the absolute value of the unemployment coefficient and hence a steeper short-run Phillips curve. Fourth, the additional variables lead to a substantial lengthening of the lag distribution on past inflation, signified by the larger and more significant coefficients on line 6.

The difference between column 5 and 6 is the presence of the exchange rate in the latter. This additional variable exhibits several signs of instability. Note that column 6 fits better through 1980:IV, but not when extended to 1984:I. The Chow test at the bottom of column 6 rejects stability. Most notably, the post-sample dynamic simulation performance of column 6 is abysmal, while that in column 5 is the best for any equation in Table 1.

Overall, there is a **tradeoff** among three alternative variables to represent the effect on aggregate U.S. inflation of supply shocks in the 1970s—changes in relative import prices, in the relative price of food and energy, and in the effective exchange rate. Any two of the three seem able to explain the data adequately through 1980, but in the 1981-83 period the exchange rate predicts much more disinflation than actually occurred. Why this structural shift occurred poses a challenge to specialists in international macroeconomics.

## Conclusion

There is insufficient space here to report numerous other intriguing issues that have been uncovered in the course of my empirical work on Fair's model. For instance, my previous **evidence that** Perry's weighted unemployment rate yielded more reliable estimates of the natural unemployment rate than the official unemployment rate seems to have evaporated in the 1981-83 period. Further, use of the nonfarm private deflator yields a considerably lower estimate of the natural rate of unemployment than the fixed-weight GNP deflator, posing a tricky problem for policymakers who would like to know at what unemployment rate inflation is likely to accelerate.

However, at a minimum, it is safe to conclude that there is no evidence whatsoever in Fair's data that conflicts with the Friedman-Phelps NRH, and that a detailed consideration of 'supply' variables and lag specifications may yield a modest payoff in our understanding of the U.S. inflation process.

**TABLE 1**  
**Alternative Specifications for**  
**Quarterly Rate of Change of Wages and Prices**  
**Sample Period: 1954:I-1984:I**

Variable Symbol	Code		Dependent Variable						
	Lags Incl.	for Lag Constraint	w	P	P	P	P	P	P
			(1a)	(1b)	(2)	(3)	(4)	(5)	(6)
1. Constant	0	—	5.58**	-1.04*	1.10	1.68*	2.21**	2.46**	2.34**
<i>Inertia</i>									
2. w	1-4	RD		0.58**					
3. p	1	—		0.29**	0.31*	0.38**	0.37**	0.14	0.13
4. $\dot{p}$	1-4	RD	0.70**						
5. $\dot{p}$	2-8	T			0.39**	0.56**	0.49**	0.49**	0.50**
6. $\dot{p}$	9-12	RD					0.14	0.36**	0.38**
<i>Demand</i>									
7. UR	0	—	-0.44**						
8. UR	1-4	RD			-0.09				
9. UR	0.4	U				-0.25	-0.39*	-0.44**	-0.43**
<i>Supply</i>									
10. (1id)	1-4	RD			0.25	0.56	0.47	0.83	0.72
11. $\dot{p}^I$	1-2	RD		0.12**	0.14**				
12. $\dot{p}^I - \dot{p}$	1-4	RD				0.14**	0.13**	0.09**	0.07
13. $\dot{p}^{EF} - \dot{p}$	0-4	RD						0.58*	0.59*
14. $\dot{x}$	0-3	RD							-0.05
15. EMW	0-4	RD						0.06*	0.06*
16. LPDEV	0	—						-0.19**	-0.18**
17. NIXON	0	—						-1.12	-1.57
18. NIXOFF	0	—						1.57	2.09*
Sum Nominal RHS Coeffs			0.70	0.99	0.84	0.94	1.01	0.99	1.01
S.E.E. to 1984:Q1			2.28	1.64	1.69	1.67	1.67	1.49	1.49
S.E.E. to 1980:Q4			2.20	1.64	1.71	1.69	1.68	1.49	1.40
Chow F, break 1980:Q4			1.54	1.06	0.84	0.84	0.79	1.00	2.01*
<i>Dynamic Simulation</i>									
Mean Error			1.72		1.02	2.43	1.62	0.97	3.76
RMSE			2.17		1.83	2.82	2.15	1.78	4.28

**Notes to Table 1:** Asterisks designate the 5 percent (\*) or 1 percent (\*\*) significance level of coefficients or sums of coefficients. A dot over a variable indicates that the variable is defined as a percentage change at an annual rate, calculated as the first difference of the log level multiplied by 400. "RD" indicates a rectangular distribution, that is, each of the coefficients for the lag lengths indicated is constrained to be the same, and the coefficient listed in the table is the sum of these identical coefficients. "T" indicates the sum of coefficients on a distribution constrained to follow

the "tent-shaped" distribution of the third term in equation (1) in the text. "U" indicates the sum of coefficients on an unconstrained lag distribution. The dynamic simulation errors reported in the bottom two lines use coefficients estimated for the period 1954:I-1980:IV and calculated predicted values for 1981:I-1984:I, taking all variables as exogenous but lagged wage and price changes, which are treated as endogenous and recalculated each quarter as the simulation proceeds. All variable symbols are as in Fair's paper, except for the following:

$p^{EF} - p$  is the percentage change in the fixed-weight deflator for personal consumption expenditures minus the percentage change in the fixed-weight deflator for personal consumption expenditures net expenditures on food and energy.

$x$  is the IMF effective exchange rate of the dollar.

EMW is the effective minimum wage.

LPDEV is the deviation of nonfarm private productivity from trend.

NIXON and NIXOFF are dummy variables for the Nixon price control period, 1971:III-1972:III and 1974:II-1975:I.

Construction of each of these variables is identical to the description in the notes to Gordon (1982), Table 2.

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