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Identification of Inflation–Unemployment

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Identification of Inflation-Unemployment Tradeoffs in the 1970s

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Preliminary

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This note constitutes an extended version of comments made at the Carnegie-Rochester Conference on Public Policy meeting of November, 1993. I am indebted to Bob King, Allan Meltzer, and Mark Watson for helpful discussions.

In an ingenious and stimulating paper, which draws on important prior work of their own,[1] King and Watson (1994) have (along with more substantive contributions) provided a "revisionist" historical account of econometric analyses of Phillips-curve phenomena--i.e., of issues involving the inflation-unemployment tradeoff. A substantial amount of attention is properly devoted to the once-prominent question of whether a long-run tradeoff exists; whether, that is, the permanent maintenance of a higher inflation rate would permanently induce less unemployment. In discussing the historical account, King and Watson distinguish two positions, associated with Keynesian and monetarist economists,[2] and then add a third real business cycle (RBC) position for the sake of comparison. The difference between econometric results obtained and promoted by Keynesians and monetarists is ascribed to different assumptions used to provide identification of the dynamic structural relationship. In particular, King and Watson suggest that Keynesians and monetarists made crucially different assumptions about exogeneity that led to different choices of dependent and explanatory variables in estimated regression relationships.[3]

The purpose of the present note is to argue that, from a historical perspective, the King-Watson account is seriously inaccurate. Both Keynesian and monetarist economists relied upon the same identification assumptions and estimated Phillips relations with the same dependent and explanatory variables. Then when Lucas, Sargent, and other rational-expectations proponents entered the fray, they introduced an issue pertaining to identification of expectational values that was critical for the long-run tradeoff issue, but did not introduce new identification arguments regarding short-run dynamics. In sum, the King-Watson reinterpretation of history is, like many revisionist analyses, basically unwarranted.[4] The following paragraphs will seek to establish these points.

In order to describe the issues with any clarity, it will be useful to have at hand a schematic macroeconomic model. Consider, then, the following system in which y_t, p_t, and m_t denote the logarithms of aggregate output, the price level, and the money stock, respectively:

$$(1) \qquad \Delta p_t = \alpha_0 + \alpha_1 y_t + \alpha_2 y_{t-1} + \alpha_3 \Delta p_t^e + u_t \qquad |\alpha_2| < \alpha_1 > 0, 0 < \alpha_3 \leq 1$$

$$(2) \qquad y_t = \beta_0 + \beta_1 (m_t - p_t) + \beta_2 y_{t-1} + v_t. \qquad \beta_1 > 0, \ |\beta_2| < 1.$$

Here equation (1) represents the dynamic Phillips relation between inflation and unemployment, for we assume (throughout this note) that the unemployment rate is negatively correlated with y_t, to a very high degree.[5] A lagged value of y_t is included to reflect the possibility of some adjustment-cost dynamic aspects to the relationship while Δp_t^e reflects an expected or anticipated inflation rate. Finally, the disturbance u_t reflects omitted random components of suppliers' behavior. Equation (2) is, by contrast, an aggregate demand relation in which the quantity demanded in period t depends upon prevailing levels of real money balances, with dynamic effects again represented by y_{t-1}. The disturbance term v_t reflects random components of buyers' behavior. The disturbances u_t and v_t are white noise but may be mutually correlated contemporaneously.

Assuming that $|\alpha_2/\alpha_1| < 1.0$, the absence of a long-run tradeoff between Δp_t and y_t requires, of course, that α_3 equals unity. Consequently, various researchers sought to test this hypothesis, the natural rate hypothesis (NRH),[6] by estimating the parameters of the structural equation (1) and determining whether or not α_3 was significantly different from 1.0. An early and well-known example was Gordon (1970); somewhat earlier but less well-known were the studies of Solow (1968, 1969). In all of these studies a distributed lag of past values of Δp_t was used to proxy for Δp_t^e; let us write the implied expectational relation as

$$(3) \qquad \Delta p_t^e = w_1 \Delta p_{t-1} + w_2 \Delta p_{t-2} + \ldots .$$

The weights $w_1, w_2, \ldots$ were assumed by Gordon and Solow to sum to 1.0. Thus (1) could be operationally implemented by including a distributed lag of Δp_{t-j} values and taking the sum of their coefficients as an estimate of α_3.[7]

Sargent (1971) and Lucas (1972) recognized, however, that if expectations are formed rationally then it is entirely possible that the weights in a rational forecasting relation of the form (3) might sum to less than 1.0, in which case the sum of the Δp_{t-j} coefficients in an estimated version of (1) would not provide a consistent estimate of α_3. Suppose, for example, that the actual univariate process for Δp_t is

$$(4) \qquad \Delta p_t = \delta_1 \Delta p_{t-1} + \delta_2 \Delta p_{t-2} + \varepsilon_t,$$

with ε_t white noise and with $\delta_1 + \delta_2$ equal to 0.6. Then the Solow-Gordon procedure would yield an estimate of α_3 of about 0.6 even if the true value is 1.0 (provided that expectations are in fact rational). That something much like this is what was in fact going on has been suggested by Sargent (1976b), McCallum (1987), Alogoskoufis and Smith (1991), and others.

All of the foregoing is well known and is not, I believe, a source of dispute with King and Watson. Where disagreement begins to arise is with regard to the difference between the Keynesian procedure of Gordon and Solow and that utilized by monetarist analysts. According to King and Watson, the Keynesian studies estimated supplier behavior as shown in formulation (1), i.e., with Δp_t the dependent variable, because they assumed y_t to be exogenous to Δp_t and therefore uncorrelated with the disturbance u_t. Monetarists, by contrast, did not take y_t to be exogenous in (1) and so estimated it in the form

$$(1') \qquad y_t = a_0 + a_1 y_{t-1} + a_2 \Delta p_t + \Delta a_3 \Delta p_t^e + u_t',$$

where $a_1 = -\alpha_2/\alpha_1$, $a_2 = 1/\alpha_1$, $a_3 = -\alpha_3/\alpha_1$, and with the NRH expressed as $a_2 + a_3 = 0$. It is this claim that is, I contend, historically incorrect.

In discussing this contention it is necessary to distinguish between the

original "monetarist" economists--including Friedman, Brunner, Meltzer, and others to be mentioned shortly--and rational-expectations analysts such as Lucas, Sargent, and Barro. Considering first the monetarists, there is a slight difficulty in collecting evidence relating to their procedures because Friedman, Brunner, and Meltzer engaged in time series econometric analysis very rarely.[8] But evidence is available, if one searches a bit, because there were significant and directly relevant studies conducted by other influential members of the monetarist camp including Anderson and Carlson (1970, 1972), Laidler (1972), and Parkin (1973). Furthermore, a collection of six empirical studies of the inflation process was conducted under the sponsorship of Brunner and Meltzer, with scope and procedures determined in collaborative sessions. Five of these studies were published in Volume 8 of the Carnegie-Rochester Conference Series in Public Policy (Brunner and Meltzer, 1978).

An examination of the nine monetarist studies just listed reveals that all of them conform to the same basic framework as described above for the Gordon (1970) and Solow (1968, 1969) studies. In particular, all nine of these monetarist studies utilize Δp_t as the dependent variable in a relation basically of form (1), not (1'). Furthermore the issue of identification was not raised in any explicit manner that would reveal differences relative to Keynesian analyses. The only significant specificational differences stem from the inclusion of some additional variables, pertaining to taxes or other institutional details, and alternative measures of "excess demand" variables utilized in place of y_t or the unemployment rate.

Why then, one might ask, did the monetarist studies tend to find estimates of α_3 much closer to 1.0 than the 0.5 - 0.6 values estimated by Gordon and Solow? Clearly, the answer may be different for the various studies and in some cases may depend upon the particular variables utilized.

But it is also true that the monetarist studies were conducted somewhat later than those of Gordon and Solow, which is of relevance because estimated autoregressive (AR) models of Δp_t were by then yielding parameter estimates that implied larger values for Σw_j. This tendency is documented in Table 1, where Σw_j values are reported for AR(5) models estimated over sample periods beginning with 1954.1 and ending with the fourth quarter of each year from 1966 through 1980.[9] As can readily be seen, the Σw_j values obtained fell well below 1.0 through the end of the 1960s, but then began to climb to the vicinity of 0.85 - 0.90. The latter values would yield estimates of α_3 close to its true value, according to the Sargent-Lucas hypothesis, whereas the lower values would not.

Even more telling, perhaps, than our examination of the nine monetarist studies mentioned above is the evidence provided by a comprehensive review of empirical work through 1974 in Laidler and Parkin's "Inflation: A Survey" (1975). Considerable attention is devoted to relevant methodological and econometric issues--including the Sargent-Lucas point--but there is no mention of alternative identification assumptions utilized by Keynesians and monetarists.

Now let us turn to studies conducted by the second group of critics of the Keynesian position, the rational-expectations analysts. The studies mentioned most prominently by King and Watson are Sargent (1976a) and Barro and Rush (1980). In both of these, the Phillips equations estimated are basically of the form (1′), rather than (1)--i.e., are expressed with y_t rather than Δp_t as the dependent variable. As an empirical matter, this switch of the dependent and regressor variables will yield quite different estimates of the short-run (i.e., single period) tradeoff magnitude. In particular, the estimated value of a_2 will be much smaller than an estimate of the same magnitude but based on (1) and calculated as $1/\alpha_1$. And the

Table 1

Coefficient Sums, AR(5) Model for Δp_t

Sample Period: 1954.1 - indicated date

Final Date, 4th Qtr. of	Sum of Coefficients in Estimated AR(5)
1966	0.3872
1967	0.2861
1968	0.5641
1969	0.6947
1970	0.7040
1971	0.7807
1972	0.7399
1973	0.8792
1974	1.0162
1975	0.8975
1976	0.8516
1977	0.8575
1978	0.8781
1979	0.8891
1980	0.9212

Note: p_t is log of GNP deflator, SA. Constant term included in AR model.

switch may also lead in practice to different estimates of the long-run tradeoff. But in principle the switch does not imply any difference in results, in the following sense. If y_t and Δp_t are viewed as jointly dependent endogenous variables, then neither (1) nor (1′) is appropriate for ordinary least squares estimation: an instrumental variable (IV) or some other simultaneous equations procedure is needed to obtain estimator consistency. Of course different results might again be forthcoming from (1) and (1′) even with IV estimation. But such an outcome would indicate that the equation is mispecified or the instruments are illegitimate, if the sample size is large enough for asymptotic distribution theory to be relevant.

It is not the case, furthermore, that all rational-expectations analysts used formulation (1′). My own studies (McCallum 1975, 1976) relied on formulation (1) even though they were expressly designed to take account of the Sargent-Lucas point about the effect on the estimate of α_3, and thus the long-run tradeoff, of the possibility that Σw_j is less than 1.0. Interestingly, taking account of that point raised my estimated value of α_3 from about 0.4 to 0.8 in the case of the United States and from about 0.4 or 0.7 to 0.75 or 0.9 for the United Kingdom (depending on the wage index used).[10]

Returning to the issue of identification, it will be useful to distinguish two aspects. The first of these is the Sargent-Lucas point, mentioned above, which concerns the proxy for expected inflation whereas the second aspect concerns the basic identification of supplier behavior as distinct from that of demanders, an issue that would remain even if inflation expectations were directly observed. With regard to the latter aspect, it is my impression that treating y_t as exogenous in (1) was not the method of identification used in the Keynesian studies (or, given the argument above,

the monetarist studies). To the extent that y_t was recognized as jointly determined with Δp_t, the problem was viewed as one of potential simultaneous-equation bias, not as a loss of identification. The manner in which identification was ostensibly obtained relied upon variable exclusion restrictions; even if y_t and Δp_t are jointly dependent in (1), that equation's basic identification will be not be lost if (1) excludes at least one predetermined variable that is important elsewhere in the system. In the model (1) - (3), m_t is excluded from (1) and is treated as a predetermined variable. That last assumption is actually dubious, to put it mildly, but it was made by all parties to the dispute in the 1970s, including the rational expectations analysts.

Indeed, there was not much concern over identification during the 1960s and 1970s because the usual way of formulating models--which did not rely on optimizing general equilibrium analysis but instead applied theoretical presumptions to the model "one equation at a time"--almost always led to equation systems with lots of excluded predetermined variables for most equations. Of course it is now realized that there are (at least) two very weak links in this identification scheme, both of which were brought to the profession's attention principally by Sims (1980). First, lagged endogenous variables cannot legitimately be counted as predetermined unless there is some basis for a priori knowledge concerning the degree of serial correlation in the model's disturbance terms.[11] Second, coherent general equilibrium theorizing tends to suggest that the relevant predetermined variables should be much the same for most of the model's equations. Recognition of these points certainly makes 1970s-style identification highly dubious. But that does not imply that Keynesian and monetarists differed in their practice. It is my contention that they did not, to any substantial extent. Of course the monetarists accepted the Lucas-Sargent point about the identification of

expectational magnitudes much more promptly than did most Keynesians, but that is another matter. The fact that Sims (1980) attacked the credibility of identification via exclusion restrictions, and did not mention different identification schemes for Keynesians and monetarists, provides another piece of evidence in favor of the interpretation presented above.[12]

Thus my conclusion is that the King-Watson revisionist account of identification restrictions utilized by tradeoff researchers during the 1970s is historically misleading. That conclusion does not, of course, imply any necessary disagreement with substantive--as opposed to history-of-thought--aspects of their analysis.

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Footnotes

[1]Specifically, their "Testing Long Run Neutrality" (1992), one major message of which has also been delivered by Fisher and Seater (1993).

[2]Actually, King and Watson sometimes refer to the latter as the monetarist-rational expectations group. In the argument below, I will treat monetarists and rational-expectationists separately.

[3]The relevant discussion appears primarily in King and Watson's sections 3.1, 3.2, 3.3, and 4.1, with 3.4 - 3.7 also of some importance.

[4]This argument does not imply, of course, that the identification scheme used by King and Watson is uninteresting or implausible, but only that it was not used historically. It cannot, that is, explain why Keynesians and monetarists of the 1970s reached differing conclusions.

[5]This assumption, termed Okun's Law, was extremely common in the research of the day.

[6]It is possible to distinguish between two related but distinct hypotheses. One, which I call the NRH, postulates that there is no type of monetary policy behavior that can keep output permanently high (and unemployment permanently low). The second, termed the accelerationist hypothesis, is that output (unemployment) can be kept permanently high (low) only by a permanently accelerating rate of inflation. The latter is due to Friedman (1966) (1968) and Phelps (1962); the former to Lucas (1972).

[7]Solow assumed that $w_j = \lambda w_{j-1}$ with $0<\lambda<1$ and relied upon a truncation of the infinite series for estimation, trying various values of λ. This "adaptive expectations" case can be implemented instead, of course, by elimination of the unobservable Δp_t^e and estimation of λ.

[8]Exceptions include Meltzer (1964) and Friedman and Meiselman (1963), neither of which were concerned with the inflation-unemployment tradeoff.

[9]In those estimates a fifth-order AR specification was used because for many of the samples the fifth lag term was the last to enter with a t statistic in excess of 1.0.

[10]The sample periods are 1952.1 - 1970.4 for the U.S. (McCallum, 1976) and 1956.1 - 1971.4 for the U.K. (McCallum, 1975).

[11]This part of Sims's argument relies on the analytical results of Hatanaka (1975).

[12]Also relevant is the fact that identification is scarcely mentioned in the 700 page presentation by Duesenberry, Fromm, Klein, and Kuh (1965) of the Brookings model or in Griliches' (1968) critical review.

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