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**The Post–War U.S. Phillips Curve:
A Revisionist Econometric History**
Response to Evans and McCallum

Robert G. King and Mark W. Watson

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The Post-War U.S. Phillips Curve: A Revisionist Econometric History *Response to Evans and McCallum*

Robert G. King
University of Virginia and
Federal Reserve Bank of Richmond

Mark W. Watson
Northwestern University and
Federal Reserve Bank of Chicago

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1 Introduction

We thank Charles Evans and Bennett McCallum for their thoughtful comments on our paper. To put their comments into perspective and to make our reply more self-contained, we begin our response with a short summary of our main findings.

Our paper explores two notions of instability in the relationship between inflation and unemployment. The first is the traditional one, and concerns instability in the linkage between unemployment and inflation in the post-war U.S. data. We called this the *Phillips correlation* in our paper, and the paper presents a set of findings on these correlations. Specifically, the paper documents that the unemployment/inflation process was unstable over the post-war period, with a break occurring around 1970. There are two notable aspects of this instability:

- More instability is evident in inflation than in unemployment.
- More instability is evident in the low frequency components of the macroeconomic data than in other components.

We documented these instabilities in a variety of ways, including plots of components of the data (filtered to uncover trend, business cycle and irregular components), formal econometric tests for instability, and split-sample forecasting exercises. The analysis also uncovered certain characteristics of the process that appeared relatively stable:

- Much more modest changes in the inflation and unemployment correlations are evident over business cycle frequencies and at short-run forecasting horizons.

These results are documented in panel B of our Figure 2 and in our Figure 8, and underlie our claim that the Phillips correlation is alive and well at the business cycle frequencies.

The second notion of instability that we explore concerns the changing relative response of unemployment and inflation to aggregate demand shocks – a notion that we called the *Phillips curve trade-off*. We showed that the estimated value of this trade-off depends both on sample period and on the definition of aggregate demand shocks that serves to econometrically identify the model. It is in our presentation of these results that we have some differences of opinion with Evans and McCallum.

2 Response To Evans:

Evans's comments are focused on one important feature of the REM model, namely the non-zero value of the estimated long-run Phillips trade-off. While our point estimate of this trade-off is small in the REM model, it is statistically different from zero, and is large enough to warrant Evan's careful scrutiny.

As our paper shows, and Evans reminds the reader, the data clearly indicate a negative long-run correlation between inflation and unemployment. The key structural question is whether this correlation arises from common long-run movements in the variables associated with exogenous changes in money – potentially an exploitable trade-off – or merely reflects accommodative changes in money in response to long-run changes in unemployment associated with demographic or other real factors?

Evans carries out two exercises designed as specification checks for the REM model. First, he compares the estimated shocks from the REM identified model to two other series suggested as measures of exogenous changes in money or monetary policy. The first series is the set of indicator variables developed by Romer and Romer (1989); they suggested that these measure exogenous tightening of monetary policy. The second series is developed in Christiano, Eichenbaum and Evans (1994). It is constructed from VAR residuals in a six-variable model: specifically, the shock to the Federal Funds Rate, after conditioning on the contemporaneous values of employment, the price level and commodity prices. As Evans realizes, the problem with comparing these series is that it is like comparing Fruit A with Fruit B and Fruit C, without knowing which of the fruits is the apple, the orange or the banana. That is, all that can really be learned from the exercise is that the series are different; to learn more requires knowing that one of the series accurately represents exogenous changes in money. We are unwilling to concede that either of the other two series accurately measure exogenous changes in the money supply.¹

¹Criticisms of the Romer and Romer series in this regard are offered by Plosser (1989) and

Evans's second exercise focuses on potential omitted variable bias in the REM model. There is every reason to suspect that bias is present: the estimated REM model is predicated on only two structural shocks, assumed to be a nonsingular transformation of the one-step-ahead forecast errors in the bivariate VAR relating unemployment and inflation. Hansen and Sargent (1991), Lippi and Reichlin (1993) and others point to the potential pitfalls in such a specification (see Watson (1994) for a survey). Evans checks for this type of misspecification by including lags of other variables in the model, and comparing the estimated impulse response functions to those from the bivariate model. Our paper included one check of this sort, based on prior work by Gordon (1982, 1990b): we concluded that little changed when the model was augmented with a variable measuring the relative price of food and energy. Evans considers four additional variables, and the results are summarized in his Figure 2. It is clear from this figure that the estimated impulse responses do change as variables are added to the model, and undoubtedly some of the changes are statistically significant. Yet, we were impressed by the *stability* of the impulse responses shown in the first column of figures: there are essentially no changes on the inflation impulse responses, and the only changes in the unemployment responses occur at longer horizons. Thus our conclusion is that the estimated Phillips curve trade-off changes little as these variables are included, at least over the one to two year horizon. Evan's results do cast doubt on the long-run point estimates obtained from the REM model. In this regard it is useful to note that several alternative identifications yield estimates that are essentially zero. One of these is the an alternative monetarist identification, explored by Roberts (1993) and King and Watson (1992), that makes inflation respond only to ϵ_{dt} in the long run, thus corresponding to notion that long-run inflationary is a strictly monetary phenomenon.

3 Response to McCallum:

As McCallum stresses in his final paragraph, his comments are focused on our provocative title ("A Revisionist Econometric History") and not on the more "substantive" aspects of our paper. McCallum's contention is that, from the standpoint of history of thought, the evolution in the consensus view of the Phillips trade-off was caused by changes in the persistence of the inflation process, and not by changes in the assumptions used to identify the short-run trade-off parameter. We found McCallum's comments both thoughtful and interesting, particularly because of the major role that he played in the evolution of thought on the subject (for example, McCallum (1976)). Yet, we respectfully disagree with his contention, and offer the following remarks in defense of our title.

elsewhere. The identification assumptions employed by Christiano, Eichenbaum and Evans (1994) suffer from the same potential defects as those in the REM model.

3.1 How did Keynesians estimate the Phillips Curve?

There is no disagreement about how Keynesians estimated the structural Phillips curve. They ran regressions of the general form

$$\alpha_{\pi\pi}(L)\pi_t = \alpha_{\pi u}(L)u_t + \epsilon_{\pi t}. \quad (1)$$

This equation was sometimes augmented with additional explanatory variable, and the lags of prices were often interpreted as capturing “expected inflation.” Typically, these “price equations,” or more generally the equations in the “wage-price block,” were estimated by ordinary least squares.

From our perspective, the high water mark of the pre-rational expectations analysis of the Phillips curve was the Econometrics of Price Determination Conference held in October 1970. Papers from this important conference were published in a 1972 volume edited by Otto Eckstein. In his introduction to the volume, James Tobin explains the rationale for estimating the Phillips trade-off using regressions of the form given in equation (1) in terms of a specific exclusion restriction in Keynesian models of the era:

“aggregate demand determines unemployment, which can be taken as the semi-exogenous variable for the wage-price subsystem.”

That is, the econometric practice was based on an identification assumption, essentially about the magnitude of effects of price shocks, ϵ_{π} , on unemployment.

3.2 Was there a monetarist alternative?

In Milton Friedman’s (1971) “Monetary Framework,” he describes a two-stage determination of macroeconomic activity.² In this framework, nominal income (Y) is first determined by money demand (M^d) and money supply (M^s), with the latter treated as the main empirical determinant over short periods. Thus in Friedman’s model, nominal income can be taken to be exogenous over short periods. Second, Friedman indicates that a previously “missing equation” is needed to provide “a division of a change in nominal income between prices and output” (Friedman, 1971, p. 49). For this purpose, he suggests either of the following two equations:

$$\Delta \log(P_t) = \Delta \log(P_t^*) + \alpha[\Delta \log(Y_t) - \Delta \log(Y_t^*)] + \gamma[\log(y_t) - \log(y_t^*)]$$

$$\Delta \log(y_t) = \Delta \log(y_t^*) + (1 - \alpha)[\Delta \log(Y_t) - \Delta \log(Y_t^*)] - \gamma[\log(y_t) - \log(y_t^*)]$$

since the fact that $Y = Py$ implies that $\Delta \log Y = \Delta \log(y) + \Delta \log(P)$. (In this expression, the * denotes anticipated variables, each of which Friedman treated as formed adaptively).

²Friedman (1971) is reprinted, with discussion, in Gordon (1974).

In the terminology of section 3 of our paper, Friedman therefore argued that one could equivalently specify either a price adjustment equation or a supply curve. However, from an empirical point of view, the crucial point is that short-run is not necessarily captured by “the simple Keynesian assumption that all of the change in income is in output.” (Friedman, 1971, p. 50). Further, Friedman’s analysis suggested the strategy of estimating one of these equations using the rate of change of nominal national as an exogenous variable.

This strategy was implemented by Anderson and Carlson (1972), who estimated a “price equation” of the form:

$$\Delta \log(P_t) = d(L)[\Delta \log(Y_t) - GAP_{t-1}] + \lambda \Delta \log(P_t)$$

where GAP_{t-1} was defined as the discrepancy between the prior period’s real output and the full employment level of output. Taken together with other aspects of the St. Louis model, this empirical specification implemented Friedman’s theoretical view. Nominal income was proximately exogenous in the price equation, reflecting the fact that it was dominated by monetary factors. Importantly, the estimates of Anderson and Carlson (1972) implied that there was no long-run effect of a permanent expansion of money growth on unemployment.

This monetarist specification of Anderson and Carlson was sufficiently novel that it had substantial coverage in the Eckstein volume. The authors themselves drew a schematic of the operation of their model, highlighting that its channels differed from those of the traditional Keynesian model. They also produced a broad-based econometric critique of conventional price equation estimates, with sections headed “expectations,” “money,” and “simultaneity.” In the latter, they indicated that they disagreed strongly with the traditional Keynesian practice of treating unemployment as proximately exogenous. Further, the St. Louis alternative warranted extensive commentary in Tobin’s introduction (p. 12):

“The wage-price block of the St. Louis Model diverges from the other models in taking price inflation and unemployment to be jointly dependent on aggregate demand variables—money GNP and the Okun gap between potential and real output.”

“The St. Louis procedure may be preferable to the usual procedure.”

Thus, Tobin clearly points to differences in the exogeneity assumption of the (Monetarist) St. Louis Model and the (Keynesian) “other models” explored by other authors in the Eckstein volume. Further, the exogeneity assumption that Tobin mentions as standard (quoted in section 3.1 above), is precisely what we labelled “Traditional Keynesian” in our paper.³

³Our qualifier “Traditional” is important. Analysis of the output-inflation tradeoff in Gordon (1982), treats nominal rather than real output as exogenous. For more discussion of this, see Gordon (1990a,b).

Importantly, in the rational expectations estimates of the Phillips curve by Sargent [1976], the St. Louis method was taken to its logical conclusion: money was used as an instrumental variable for estimating the short-run linkage between unemployment and inflation. While it is possible to argue with the identifying assumption used by Sargent, his estimation method is appropriate for the model that he constructed: it leads to the short-run slope estimate that we use for our REM identification.

3.3 Why has the estimated Long-Run Trade-off Fallen?

We titled our paper “A Revisionist History of the Phillips Curve” because it shows that alternative assumptions about the short-run slope were important for the decline in the estimate of the long-run slope. Certainly, the increase in the persistence of inflation (documented in our paper and in McCallum’s comments) played an important role in the evolution of the consensus view about the long-run Phillips curve. But, it is not simply the increase in persistence that is responsible for the current view that there is a small long-run trade-off between inflation and unemployment. Instead, it is also the movement to the view that inflation and unemployment are simultaneously determined, being influenced by both supply and demand shocks, that is important for this decline.

One way of seeing this is to look again at the estimates in our Table 1. In each column, the estimated trade-off falls from the pre-1970 to the post-1970 sample. As our paper shows, this is a reflection of the increase in the persistence of inflation. But, suppose for a moment that mainstream macroeconomists had maintained the 1970 Gordon-Solow identifying assumption. From Table 1, their estimate of the long-run trade-off would have fallen from -1.3 to -0.6. That is, the traditional Keynesian identification implies that a current policy of raising the permanent inflation rate by 5% would bring about a 3% lower long-run unemployment rate.

We think that few macroeconomists now view a long-run trade-off of this size as reasonable. More “mainstream” results are given by the short-run identification that we term “rational expectations monetarist.” In the preceding section, we traced this identification to earlier monetarist roots, in the theoretical analysis of Friedman (1971) and the empirical analysis of Anderson and Carlson (1972). Thus, we think that there are two parts to the answer to the question, “what killed the long-run Phillips Curve in the U.S.?” First, the persistence of inflation increased, bringing into play the considerations developed by Lucas and Sargent. Second, mainstream macroeconomists shifted away from a traditional Keynesian identifying assumption that made unemployment (or real output) determined entirely by aggregate demand in the short-run.

References

- [1] Friedman, M.F. (1971). A Theoretical Framework for Monetary Analysis, NBER Occasional Paper 112, New York: NBER, distributed by Columbia University Press.
- [2] Gordon, R.J. (1974). *Milton Friedman's Monetary Framework: A Debate with His Critics*, Chicago: University of Chicago Press.
- [3] Hansen, L.P. and Sargent, T.J. (1991). Two Problems in Interpreting Vector Autoregressions, *Rational Expectations Econometrics* (ed.) L. Hansen and T.J. Sargent, Boulder. Co.: Westview.
- [4] Lippi, M and Reichlin, L. (1993). The Dynamic Effects of Aggregate Demand and Supply Disturbances : Comment, *American Economic Review*, **83**, 644-52.
- [5] McCallum, B.T. (1976). Rational Expectations and the Natrual Rate Hypothesis: Some Consistent Estimates, *Econometrica*, **44**, 43-52.
- [6] Plosser, C.I. (1989). Money and Business Cycles: A Real Business Cycle Interpretation, paper presented at the 14th Annual Economic Policy Conference, Federal Reserve Bank of St. Louis.
- [7] Tobin, J. (1972). The Wage-Price Mechanism: Overview of the Conference, *The Econometrics of Price Determination* (ed.) O. Eckstein. Washington, D.C.: Board of Governors of the Federal Reserve System.
- [8] Watson, M.W. (1994). Vector Autoregressions and Cointegration, *Handbook of Econometrics Vol. 4*, (ed.) R.F. Engle and D. McFadden, Amsterdam: North Holland.

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