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Comment

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1. Introduction

Cogley and Sargent have provided a provocative and innovative contribution on an important problem, understanding the history of inflation in the United States and the evolving role of monetary policy in that history. They make many points in their rich paper, some empirical and some methodological.

In this discussion, I focus on four of their most salient empirical findings:

1. The persistence of the postwar inflation process has evolved over the past four decades. In the 1960s, inflation was mean-reverting; in the 1970s and early 1980s, it was highly persistent; and in the past ten to fifteen years it has been mean-reverting, as it was in the 1960s. This view is widely shared—for example, it has also been made by Taylor (1999) and by Brainard and Perry (2000)—and it seems to reflect conventional wisdom across a wide spectrum of views of monetary policy.
2. There is a positive correlation between the level of inflation, as measured by its low-frequency component, and its persistence. This is essentially an implication of the first point, because inflation was low in the 1960s, high in the 1970s and early 1980s, and low again during the 1990s.
3. The inflation process has been unstable, not just as measured by its persistence, but also over its entire spectrum or, equivalently, all its autocorrelations.
4. The reduced-form backward-looking Phillips curve relating inflation to lagged inflation and a measure of real economic activity (in Cogley and Sargent, the unemployment rate) has been unstable over the past four decades.

Cogley and Sargent draw several conclusions from these and related empirical findings. The most immediately relevant for policy bears on Taylor's (1999) warning that the decline in the persistence of inflation might induce revisionism by policymakers, who might return to the belief that there is an exploitable long-run trade-off between unemployment and inflation. The meat of Taylor's warning is that this revisionism—perhaps a better term is recidivism—would lead to the same mistakes and the same bad outcomes that it did in the 1960s and early 1970s. In this, Cogley and Sargent's message is the same as in Sargent's (1999) monograph on the history of U.S. inflation as elaborated on by Cho, Williams, and Sargent (2001).

Most of this discussion is devoted to presenting various pieces of empirical evidence that suggest that the foregoing four empirical findings are less clear-cut than Cogley and Sargent make them out to be. Specifically, I shall present evidence, based on hypothesis tests, confidence intervals, and median-unbiased estimates, that:

1. Inflation persistence has been roughly constant, and high, over the past 40 years in the United States.
2. Therefore, there is no correlation between the level of inflation and its persistence.
3. The autocorrelations of inflation are stable—at least, one cannot reject this hypothesis.
4. The reduced-form Phillips curve is stable, once one allows for a time-varying NAIRU, or if one interprets it not just as a relation between the unemployment rate and the rate of inflation, but more broadly as a relation between real economic activity and inflation.

These conclusions are quite at odds with Cogley and Sargent's, and this raises an interesting econometric question as to why my evidence is so different than theirs. The answer, not surprisingly, lies in differences between Cogley and Sargent's Bayesian methods and my frequentist methods.

2. *Evaluating Cogley and Sargent's Empirical Results*

Cogley and Sargent use a sophisticated nonlinear multivariate procedure to characterize inflation dynamics. The methods used here are simpler and univariate, but get at the same issues. The inflation data I consider are for the GDP deflator, quarterly from 1959:I to 2000:IV, although the results are robust to using other inflation measures.

2.1 PERSISTENCE OF INFLATION

There are a variety of ways to measure persistence, none perfect. The measure I consider is the largest root of an autoregressive representation of inflation. Cogley and Sargent's emphasis is on measurement, not testing, so to make this analysis parallel I consider median-unbiased estimates of the largest autoregressive root of inflation, constructed by inverting the augmented Dickey–Fuller statistic using the procedure developed in Stock (1991). This procedure produces confidence intervals for the largest root as well.

Recursive median-unbiased estimates of the largest AR root and 90% confidence intervals for this root are plotted in Figure 1 [these estimates are based on AR(4) models estimated recursively using all the data from 1959:I through the date indicated on the horizontal axis]. The striking feature of this plot is the stability of the estimates. Because the number of observations increases with the terminal date, the confidence intervals are tighter towards the end of the sample than at the beginning. At all dates since 1976, these intervals include one (the 90% confidence interval is briefly *above* one in 1975), and the recursive median-unbiased estimate is typically just less than one.

The recursive estimates in Figure 1 use all the historical data through the terminal date, and this might miss changes in persistence towards the end of the sample. Figure 2 therefore plots rolling median-unbiased estimates of the largest AR root and the associated 90% confidence interval for AR(4) models estimated using 12 years of data terminating at the date on the horizontal axis. The median-unbiased point estimates and confidence intervals evidently are quite noisy—not surprisingly, because each estimate is based on just 48 observations, quite few for performing inference about large autoregressive roots. Still, the evidence is striking (and is robust to changing the inflation series, the window length, and the number of lags). With one brief exception for the samples ending near 1994, the 90% confidence intervals contain a unit root, and the median-unbiased estimate, while variable, exceeds one almost as often as it is less than one. Notably, the median-unbiased estimate exceeds one early in the sample, for 12-year periods ending in 1972 through 1976, and late in the sample, for 12-year periods ending in 1997 through 2000.

2.2 RELATION BETWEEN PERSISTENCE AND THE LEVEL OF INFLATION

The results in Figure 2 suggest that there will be no particular relation between the level of inflation and its persistence as measured by the rolling median-unbiased AR root, because this root is estimated to be

Figure 1 RECURSIVE MEDIAN-UNBIASED ESTIMATE AND 90% CONFIDENCE INTERVAL FOR LARGEST AR ROOT

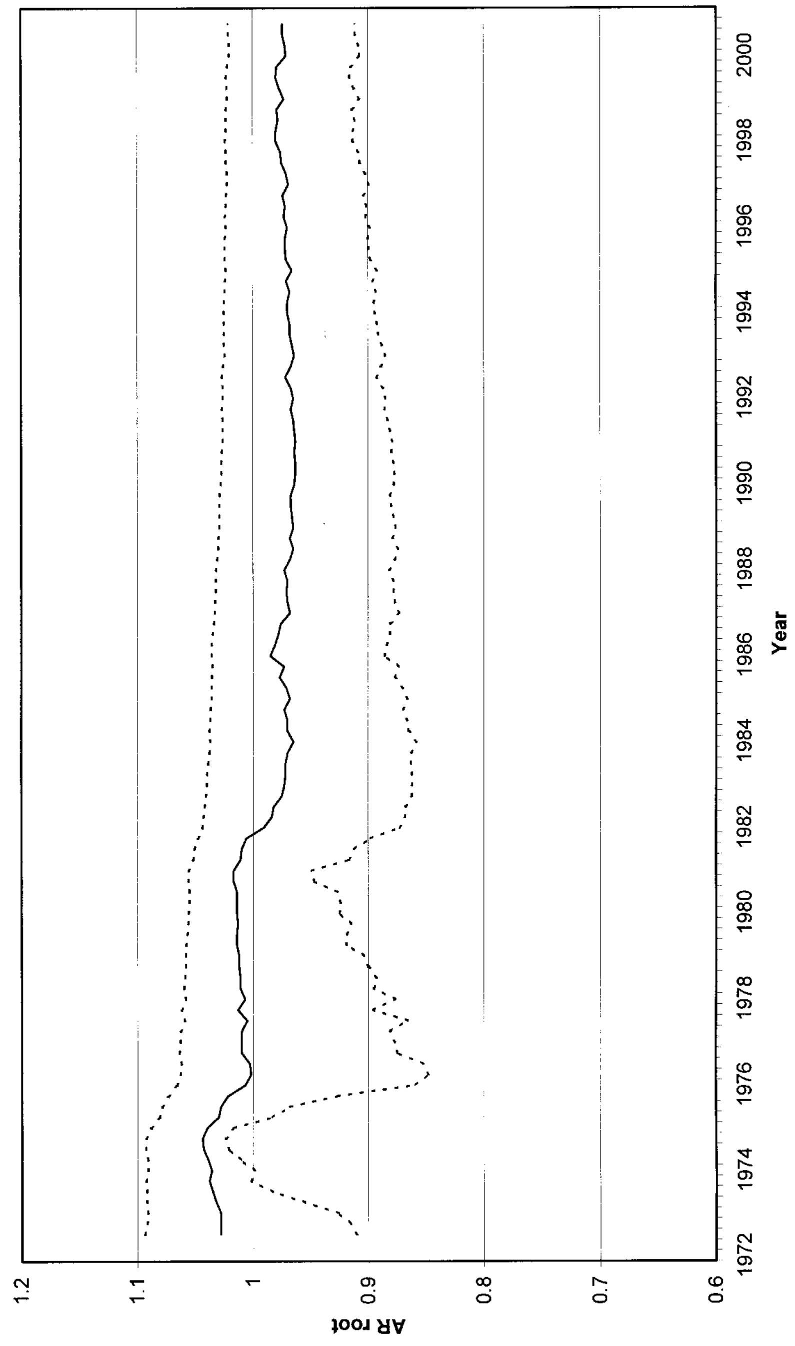
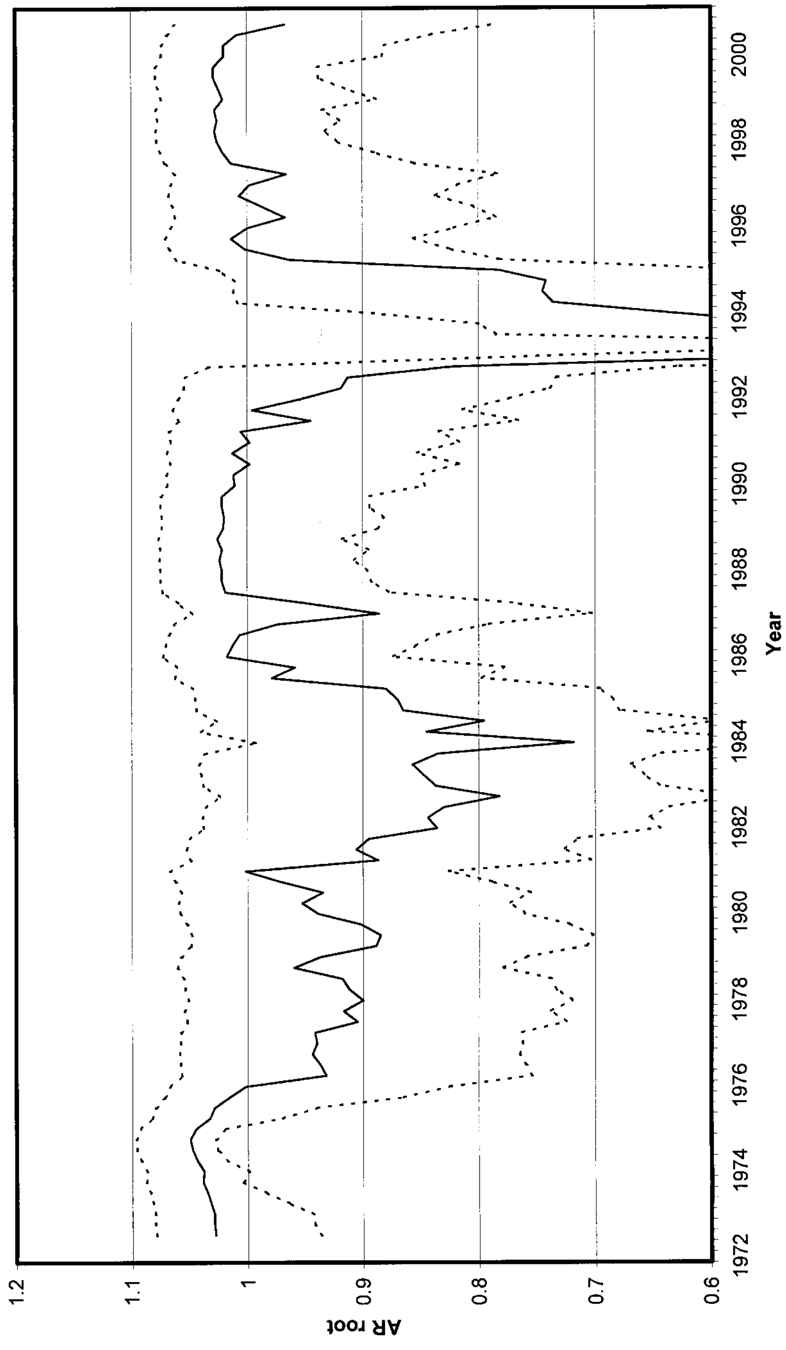


Figure 2 ROLLING MEDIAN-UNBIASED ESTIMATE AND 90% CONFIDENCE INTERVAL FOR LARGEST AR ROOT



essentially one throughout this sample. This is in fact the case; the correlation between the running mean of inflation and the rolling estimate of the largest AR root in Figure 2 over the same 12 years is −0.035.

2.3 INSTABILITY OF INFLATION AT HIGHER FREQUENCIES

Cogley and Sargent examine instability of inflation dynamics, both short- and long-run, via spectral estimates implied by their time-varying VAR. Here, I consider a more tightly parametrized approach and ask whether there appears to have been a break in the parameters of a univariate AR(5) model of the inflation rate. This is readily examined using the Quandt likelihood-ratio (or "sup-Wald") test for parameter stability. Although this test is designed around a single break, it is powerful against slow parameter evolution and multiple breaks as well. A technical issue is that the critical values need to hold when the largest root is one or nearly so; I handle this by using the critical values appropriate if the largest root is in fact one, taken from Banerjee, Lumsdaine, and Stock (1992), rather than the critical values appropriate when the largest root is well less than one. The test, implemented with conventional 15% trimming, fails to reject the hypothesis of parameter stability at the 10% significance level. However, using CPI inflation and different lag specifications can yield a significant break at the 10%, but not 5%, level, with the estimated break date in 1981. This evidence suggests that, on the whole, the inflation process has been stable, although there might have been some changes in its short-run dynamics between the first and the second half of the sample.

2.4 INSTABILITY OF THE PHILLIPS CURVE

Whether the backward-looking Phillips curve, interpreted as the relation between inflation, its lags, and current and past values of the unemployment rate, is unstable has attracted much attention. The evidence I provide here is borrowed from Staiger, Stock, and Watson (2001), who investigate the stability of the backward-looking Phillips relation of the type investigated by Gordon (1997, 1998).

A subdebate in this area has been whether the natural rate of unemployment should be estimated as the low-frequency component of the unemployment rate [the approach advocated by Hall (1999) and adopted by Cogley and Sargent] or whether it should be estimated off an estimated drift in the intercept of an empirical Phillips curve [the approach adopted by King, Stock, and Watson (1995), Gordon (1997, 1998), Staiger, Stock, and Watson (1997), and others].

Staiger, Stock, and Watson (2001) adopt Hall's and Cogley and Sargent's approach and estimate the natural rate by applying a lowpass filter to the unemployment rate. Because the natural rate is estimated using only the univariate unemployment rate, it is possible to test separately for drift in intercept of the Phillips curve and for drift in the slope coefficient; the NAIRU is the sum of the estimated natural rate and the rescaled estimated intercept drift. Thus the NAIRU and the natural rate are separately identified. Their conclusion is that in fact these two series are very close to each other empirically, typically within a few tenths of a percentage point of unemployment. The hypothesis that there is no intercept drift in the Phillips curve, specified as the deviation of the unemployment rate from its univariate long-run trend, cannot be rejected at the 10% significance level. In practice, then, there appears to be little difference between estimates of the natural rate based on the Hall's and Cogley and Sargent's idea of the long-run trend in the unemployment rate and the alternative approach of estimating the time-varying NAIRU from intercept drift in the Phillips curve.

Staiger, Stock, and Watson (2001) also test for drift in the slope of the Phillips curve and cannot reject the null that the slope is stable.

Another way to see whether the Phillips curve has been stable is to see how it has performed for forecasting. Interpreted broadly, the Phillips relation links changes in the rate of inflation to economic activity, of which the unemployment rate is but one measure. In their comparisons of models for forecasting inflation, Stock and Watson (1999, 2001) consider several versions of the backward-looking Phillips curve, each based on different activity measures. They conclude that several activity measures have produced reliable and useful inflation forecasts, at least as measured by pseudo-out-of-sample forecast comparisons with benchmark autoregressive models. These include a composite index of real economic activity constructed using a large number of income and output measures, as well as simpler single measures such as the rate of capacity utilization. Based on these broader measures of output, the backward-looking Phillips curve has been a reasonably reliable and stable predictive relation over the past three decades.

3. Why Do the Bayesian and Frequentist Results Differ?

These conclusions are quite different than Cogley and Sargent's, and the obvious question is, why? There are many differences between my methods and theirs: theirs are Bayesian and multivariate, mine are frequentist and mainly univariate. I believe, however, that there are two main sources of these differences: their prior leads them away from finding persistence, and their specification, by forcing all the time variation to occur through the dynamics rather than through the innovation variances, confuses changes in persistence with changes in volatility.

These views are informed by the recent study by Pivetta and Reis (2001), who compare the frequentist analysis of inflation persistence of the previous section, Cogley and Sargent's Bayesian method, and a more conventional time-varying parameter model of the type used by Brainard and Perry (2000). Although their analysis remain preliminary at the time of writing this comment, Pivetta and Reis' (2001) results suggest that Cogley and Sargent's importance sampling plays an important role in biasing (from a frequentist perspective) their estimates away from a unit root. This forces their posterior to have a low mean persistence, even if the true persistence (from a frequentist perspective) is quite large. The problem that Cogley and Sargent confront is a difficult one, and even among Bayesian econometricians there appears to be no consensus about the best way to place a prior on large autoregressive roots (see the special issue of *Econometric Theory* in 1994 on Bayesian approaches to unit-root inference and in particular the survey article by Uhlig, 1994).

The problem of confounding persistence and volatility is especially important, and Cogley and Sargent recognize this issue. Their persistence measures are based on the spectrum at frequency zero, but this can change either because the persistence has changed or because the entire spectrum has shifted, that is, the volatility of the process has changed. One does not need fancy tests to see that the volatility of the inflation process has changed greatly over the postwar period: the 1960s and 1990s were times of quiescent low inflation, the 1970s and early 1980s, of volatile high inflation. Because the integral of the spectrum is the variance, on using the height of the spectrum as a measure of persistence, quiescence becomes low persistence, and volatility becomes high persistence.

4. *Implications and Conclusions*

The evidence in Figures 1 and 2 suggests that inflation has been highly persistent for the past three decades, and stably so. My interpretation of the widespread view—that of Brainard, Perry, Taylor, Cogley, and Sargent—is that this confuses volatility with persistence. Inflation was low and stable in the 1960s and 1990s, but this does not mean that it was low and mean-reverting.

Whether or not the persistence of inflation has evolved, one implication of this discussion is that we need additional investigations of the statistical properties of Cogley and Sargent's method before adopting it for widespread use as a tool for data description.

Finally, let me turn to Taylor's warning, for here I agree with Cogley and Sargent. The fact is that many monetary economists believe inflation to have become less persistent, and this view must be reckoned with. To the extent that this view is held (correctly or not) by policymakers or advisors and to the extent that it encourages a revisionist perspective on the natural rate, then it does raise concerns about inadvertently repeating the inflationary mistakes of the past.

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Discussion

Tom Sargent responded to the discussants by saying that his view of events differed fundamentally from theirs. While they believed in conditional heteroscedasticity of shocks, he believed in changing decision rules. He explained that the authors were inspired by a graph of inflation over three centuries, which showed a clear break around 1970.