ALTERNATIVE EXPLANATIONS FOR THE "GREAT INFLATION"

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Abstract. This paper develops a simple optimizing model to characterize the monetary policy pursued by the Federal Reserve. The model parameters are estimated for the period of high inflation in the 1970s and the estimates are used to quantify the impact of misperceptions of the natural rate of unemployment on average inflation during this period. The results point to a relatively small role for misperceptions; instead, the high inflation of the 1970s is attributed to a high inflation target. One explanation for the high inflation target is the fact that the political environment at the time was especially intolerant of even modestly high rates of unemployment.

The 1970s witnessed the longest and most severe peacetime inflation in U.S. history. By contrast, since the early 1980s the U.S. inflation rate has been relatively low and stable. What accounts for this difference? One view, put forth by Clarida, Gali and Gertler (2000) – hereafter referred to as CGG – and others, attributes the improvement in inflation performance to the Federal Reserve's adoption of a superior monetary policy rule. CGG estimate a Taylor rule (Taylor, 1993) for the Federal Reserve before and after 1979. They find that since 1979 the Fed's policy rule has been stabilizing in the sense that the federal funds rate has been increased more than one-for-one with any increase in expected inflation. Prior to 1979, on the other hand, policy was destabilizing, which left the economy vulnerable to an increase in inflation due to self-fulfilling expectations.

An alternative view – referred to here as the "misperceptions" view – is put forth by Orphanides (2000a, 2000b, 2002). Orphanides argues that the Federal Reserve's policy appears unstable only ex post; at the time, given the data the Fed had to work with, the Fed's policies would have been seen as stabilizing. Orphanides (2002) shows this by estimating Taylor rules for the 1970s using "real-time" data and the Fed's Greenbook forecasts of inflation and unemployment. He finds that when estimated with this data the Taylor rule was actually stabilizing during the 1970s. In fact, the actual path of the federal funds rate during this period was similar to that produced by the original version of Taylor's rule applied to real time data.[1] At the same time, however, the Fed seems to have systematically underestimated the natural rate of unemployment and inflation during this time period, resulting in an overly inflationary policy despite the existence of a stable policy rule.

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[1] The original Taylor rule, with the unemployment gap substituted for the output gap, is $i=r^*+\pi^*+\beta(\pi-\pi^*)+\gamma(u^*-u)$, where i is the federal funds rate, π is the inflation rate, u is the unemployment rate, r* is the natural real rate of interest, π^* is the target inflation rate, and u* is the natural unemployment rate. Using an Okun's law coefficient of 3, Taylor's rule sets $\beta=\gamma=1.5$ and $\pi^*=r^*=2$.

These two perspectives on the Great Inflation have important implications for the current debate over the design of monetary policy rules. One intepretation of CGG's work – suggested by CGG themselves – is that the improvement of the policy rule was a result of advances in macroeconomic theory that impressed on policymakers the absence of a long-run tradeoff between inflation and unemployment and the importance of expectations and policy credibility. This interpretation would suggest that the experience of the 1970s is unlikely to repeat itself. The Fed can continue to use monetary policy to stabilize both inflation and unemployment without fear of a severe inflation problem in the future, as long as it continues to adhere to the Taylor principle. By contrast, Orphanides argues that given the Fed's inability to accurately estimate the natural rate of unemployment, a return to high inflation is always possible even under a stable Taylor rule as long as the Fed targets the unemployment rate. Better outcomes could be achieved, he argues, if the Fed abandoned the Taylor rule's twin goals of stable prices and stable unemployment and concentrated exclusively on price stability.

This paper extends previous studies of the causes of the Great Inflation in two important ways. First, rather than model monetary policymakers as following an "instrument rule" of the type assumed by CGG and Orphanides, this paper assumes an optimizing monetary policymaker. An optimizing policymaker, as Svensson (2003) points out, pursues a "targeting rule" in the form of an Euler equation containing forecasts of inflation and unemployment rather than an instrument rule. Second, estimates of the model are used to calculate the magnitude of the effect of misperceptions on inflation and to test for a change in the Fed's preferences after 1979.

As Svensson argues, the use of an optimizing monetary policy framework rather than a Taylor rule has several advantages. The assumption of an optimizing central bank is consistent with the now-standard approach to macroeconomics which grounds relationships like the IS and

Phillips curves in optimizing behavior on the part of the public. Furthermore, in practice, central banks do in fact tend to frame their decisions as targeting rules – specifying a desired range for inflation and/or growth, for example – rather than instrument rules. Of course, something like a Taylor rule can be derived as a reduced form relationship by combining the optimal decision rule with an aggregate demand equation. But for standard models such as the one in this paper, the result is different in significant ways from the Taylor rules estimated by CGG, Orphanides, and others.[2] Finally, as a reduced form relationship the Taylor rule may be subject to instability as a result of changes in the structure of the economy. This is particularly problematic when the objective is to compare monetary policy before and after 1979.

Section 1 reviews some of the evidence for the misperceptions view of the Great Inflation in order to motivate the empirical work that is the central contribution of this paper. Section 2 presents an optimizing model of monetary policymaking in which the Federal Reserve chooses combinations of expected inflation and unemployment to minimize a loss function subject to a Phillips curve. Using the Fed's Greenbook forecasts of inflation and unemployment as well as an alternative set of forecasts derived from a vector autoregression, I estimate the parameters of the loss function, including the implied inflation target. I assess the ability of the model to fit the inflation and unemployment data in order to judge whether monetary policy during the 1970s can reasonably be characterized as the outcome of optimizing behavior. Since optimal monetary policy implies a stabilizing policy rule (as CGG (1999) show), this has direct bearing on the CGG's (2000) main finding. Section 3 uses the results from section 2 to compute the impact of misperceptions on inflation in the 1970s. I show that misperceptions can account for at most a small fraction of the difference between average inflation in the 1970s and 1980s-90s. Section 4

[2] In particular, the modified Taylor rule implied by the optimizing model used in this paper has the Fed responding to a weighted average of expected future inflation rates and unemployment rates, the weights being functions of the Phillips curve and preference parameters. This was shown in an earlier version of this paper.

then estimates the model for the post-1979 sample and uses the results to propose an alternative explanation for the Great Inflation. The results are also used to predict how much inflation would rise today if the Fed underestimated the natural rate of unemployment to the same extent as it apparently did in the 1970s. Section 5 concludes.

1. Circumstantial evidence in favor of the misperceptions theory

Figures 1 through 4 marshal some circumstantial evidence for the misperceptions view from the Federal Reserve's Greenbook forecasts. The Greenbook, which is prepared by the Federal Reserve's staff economists in preparation for every FOMC meeting, contains forecasts of the GNP deflator, the unemployment rate, and other variables. The forecasts are typically made for the current quarter and from four quarters to nine quarters ahead. Greenbook forecasts of the GNP deflator from 1966 on were taken from the FRB Philadelphia website, as were Greenbook forecasts of unemployment from 1978 on. Greenbook forecasts of unemployment prior to 1978 were made available by the Board of Governors of the Federal Reserve. For each quarter, the forecasts used here correspond to those for the FOMC meeting nearest to the middle of the quarter.[3]

In these figures and throughout the paper, I define the period of high inflation in the U.S. as beginning around 1965 and ending in 1979:2 (see Boschen and Weise (2003) for a discussion of the "start dates" for inflation episodes in the U.S. and other OECD countries). Data for 1979:3 to 1984:4 are included in the figures for purposes of comparison. Figures 1 and 2 plot the actual level of the GNP deflator and unemployment rate as well as the corresponding Greenbook forecasts. The forecasted levels of the deflator are those implied by the Greenbook forecasts of

[3] In a few cases the Greenbook associated with mid-quarter FOMC meetings did not contain sufficiently long-range forecasts; in these cases forecasts are drawn from Greenbooks for meetings closer to the end of the quarter.

inflation rates, setting the estimated level in the quarter before the forecast date equal to the actual value. Forecasts made in the first quarter of each year for quarters 1 to 4 are shown. Figures 3 and 4 are similar to figures in Orphanides (2002). They show the average inflation rate and unemployment rate for the current and succeeding three quarters, in the actual data and according to the Greenbook forecasts. Gaps in the forecast series correspond to periods in which three-quarter-ahead forecasts were not presented in the Greenbook. Figure 4 also shows two estimates of the natural rate of unemployment. The "actual" natural rate is estimated as a two-sided 10 year moving average using the latest data available, while the "real-time" estimate of the natural rate is computed as a one-sided backward-looking 10 year moving average of the unemployment rates.[4] While the actual process by which the Fed estimated the natural rate of unemployment during this period is unknown, it seems likely that a moving average of the data is a reasonable approximation to whatever technique was actually in use.

Figures 1 and 3 show that the Fed substantially underestimated inflation at various times during the period of high inflation, notably in 1968-69 and 1973-74. By contrast, from 1980-84 the Fed's forecasts exceed the actual level on average. Over the entire period 1969:1-1979:2, the Fed's three quarter ahead forecast of inflation averages 0.95 percentage points below the actual level. The Fed underestimates inflation by an average of 1.24 percent from 1969:1 to 1972:4, by 2.61 percent from 1973:1 to 1974:3, and by 0.25 percent from 1974:4 to 1979:2. By contrast, in the disinflationary period from 1979:3 to 1984:4, the Fed overestimates inflation by an average of 0.87 percentage points.

Unanticipated oil price shocks surely account for much of the underestimation of inflation in 1973-74. But Figures 2 and 4 show that the Fed's unemployment forecasts appear to

[4] Because revisions to the unemployment series are relatively small, there is very little difference between a one-sided moving average of real-time unemployment rates and a one-sided moving average of unemployment rates from the latest available data.

be roughly unbiased over the 1969-79 period, and on target even in 1973-74. Orphanides (2002) takes this as evidence that while the Fed was able to meet its targets for real activity through skillful management of interest rates, it miscalculated the impact of its policies on inflation because it underestimated the natural rate of unemployment. Figure 4 shows that the "actual" natural rate is significantly higher than the "real-time" natural rate: if policymakers estimated the natural rate as something like a moving average of past observed unemployment rates, which seems as good an approximation as any to the Fed's actual estimation procedure, they would have underestimated the natural rate by an average of 1.04 percentage points from 1969:1 to 1979:2.

One caveat in interpreting the Greenbook forecasts is that they are typically constructed on the assumption of a continuation of current interest rates. Thus when the Greenbook forecasts understate the true inflation rate, this could reflect a conscious easing of policy rather than a mistaken forecast. If this were the dominant phenomenon, we would expect to see the Fed consistently overestimating unemployment at the same time that it underestimated inflation. Since this is not the case, the story told by Orphanides would seem to be the best interpretation of the data.

While the Fed seems to have mis-estimated the natural rate of unemployment during the 1970s, the question whether this mis-estimation can explain all or most of the high inflation of the period remains unanswered. Orphanides (2000a) offers a rough estimate of the magnitude of the effect of the effect. Suppose the Fed follows the Taylor rule

$$i_t=r^*+\pi^*+\beta(\pi_t-\pi^*)+\gamma(u^*-u_t) \tag{1}$$

where i_t is the federal funds rate, π_t is the inflation rate, u_t is the unemployment rate, r* is the natural real rate of interest, π^* is the target inflation rate, and u* is the Fed's estimate of the natural rate of unemployment. Let the actual natural rate of unemployment be u^n and $u^* = u^n+\eta$, where η is the error in the Fed's estimate of the natural rate. Then (1) can be rewritten

$$i_t = r^*+\pi^*+\beta(\pi_t-\pi^*)+\gamma(u^n-u_t)+\gamma\eta \tag{2}$$

On average over sufficiently long periods of time $i = r^*+\pi$ and $u = u^n$, so

$$(\beta-1)(\pi-\pi^*)+\gamma\eta = 0 \tag{3}$$

or $\pi-\pi^* = -\gamma/(\beta-1)\eta$. So if $\pi^* = 2$, $\eta = -1.5$ (the Fed underestimates the natural rate by 1.5 percentage points), and $\gamma = \beta = 1.5$, then $\pi = 6.5$ percent, which is very close to the average of 6.3 percent over the period 1969:1 to 1979:2. Thus, he argues, the misperceptions theory can in principle explain all of the high inflation of the 1970s.

An optimizing central bank, however, will not obey a Taylor rule such as that in equation 1. Suppose the Federal Reserve sets its monetary policy instrument to achieve unemployment and inflation rates in order to minimize the loss function[5]

$$L_0 = \frac{1}{2}\sum_{t=0}^{\infty}\left[\alpha(\pi_t-\pi^*)^2+(1-\alpha)(u_t-u^*)^2\right] \tag{4}$$

[5] For simplicity I assume perfect foresight here.

subject to the Phillips curve equation

$$\pi_t = \kappa-\lambda(u_t-u^n)+\phi\pi_{t-1}+\varepsilon_t \tag{5}$$

The solution to the central bank's problem can be found using the Lagrangian method: the central bank solves

$$\min_{\{\pi_t, u_t\}} \sum_{t=0}^{\infty} \{\frac{1}{2}[\alpha(\pi_t - \pi^*)^2 + (1-\alpha)(u_t - u^*)^2] + \psi_t(\pi_t + \lambda(u_t - u^n) - \phi\pi_{t-1} - \varepsilon)\} \tag{6}$$

where ψ_t is the Lagrange multiplier associated with equation 5. Differentiating with respect to π_t and u_t yields the first order conditions

$$\alpha(\pi_t-\pi^*) + \psi_t - \phi\, \psi_{t+1} = 0$$

$$(1-\alpha)(u_t-u^*) + \lambda\psi_t = 0 \tag{7}$$

Combining these equations gives us the central bank's Euler equation:

$$\alpha(\pi_t - \pi^*) - \frac{1-\alpha}{\lambda}[(u_t - u^*) - \phi(u_{t+1} - u^*)] = 0 \tag{8}$$

As above, define $u^*=u^n+\eta$. Then (8) becomes

$$\alpha(\pi_t - \pi^*) - \frac{1-\alpha}{\lambda}[(u_t - u^n) - \phi(u_{t+1} - u^n)] + \frac{(1-\alpha)(1-\phi)}{\lambda}\eta = 0 \tag{9}$$

Now assuming that over long periods of time u= u^n, the inflation bias is given by

$$(\pi - \pi^*) = -\frac{(1-\alpha)(1-\phi)}{\alpha\lambda}\eta \tag{10}$$

The inflation bias is proportional to the error in estimating the natural rate, with the factor of proportionality a function of the slope of the Phillips curve, the relative weight attached to inflation and unemployment in the central bank's loss function, and the degree of inflation persistence. The inflation bias introduced by underestimation of the natural rate disappears as the weight on unemployment in the central bank's loss function goes to zero and as the inflation persistence parameter approaches one. Thus to determine the effect of misperceptions of the natural rate on inflation it is necessary to estimate the parameters of the Phillips curve along with those of the central bank's loss function. This task is taken up in the next section.

2. Estimation of central bank preferences

In this paper central bank preferences are estimated from a model like the one described by equations (4) and (5) in a two-step method. In the first step, the Phillips curve is estimated by OLS. In the second step, the Phillips curve coefficients are taken as given and inserted into equation (9). Equation (9) is then estimated using nonlinear least squares to produce estimates of α and π^*. Since the estimates of the key parameters, α and π^*, depend on the estimates of the Phillips curve, it is important to specify a Phillips curve that provides a good fit to the data. An extension of equation (5) variants of which are often used in empirical work (see, e.g. Rudebusch (2001)) fits the data nicely:

$$\pi_t = \kappa - \lambda \tilde{u}_{t-1} + \phi_1 \pi_{t-1} + \phi_2 \pi_{t-2} + \phi_3 \pi_{t-3} + \phi_4 \pi_{t-4} + \delta z_t + \varepsilon_t \tag{11}$$

where z_t is the percentage change in oil prices from the middle of period t-4 to the middle of period t and $\tilde{u}_t = u_t - u_t^n$ is the unemployment gap. In addition to the extra lags on inflation, equation (11) differs from equation (5) in two important respects: the natural rate of unemployment is time-varying rather than constant, and unemployment affects inflation with a one-period lag. Table 1 presents estimates of equation (11) over the period 1961:2-1979:2 using quarterly data from the S&P/DRI database on CD-ROM (January 2003). The inflation rate is defined as 400 times the change in the log of the GDP deflator (S&P/DRI mnemonic GDPD), the unemployment rate is the civilian unemployment rate (LHUR), the oil price inflation variable is 100 times the change in the log of the producer price index for crude petroleum from period t-4 to period t (PW561), and the natural rate of unemployment is approximated using a two-sided ten year moving average as above. As shown in the table, the unemployment gap has a negative and statistically significant effect on inflation, while increases in the price of oil have a positive and significant effect. The model explains 82.5 percent of the variation in inflation over the period and there is no evidence of serial correlation in the residuals as evidenced by the Breusch-Godfrey test.

To solve the model consisting of equations (4) and (11) – which I refer to as the standard model – we set up the Lagrangian as before:

$$\min_{\{\pi_{t+1},u_t\}} E_0 \sum_{t=0}^{\infty} \{\tfrac{1}{2}[\alpha(\pi_t - \pi^*)^2 + (1-\alpha)\tilde{u}_t^{\,2}] + \psi_t[\pi_t + \lambda\tilde{u}_{t-1} - \phi_1\pi_{t-1} - \phi_2\pi_{t-2} - \phi_3\pi_{t-3} - \phi_4\pi_{t-4} - \delta z_t - \varepsilon_t]\} \tag{12}$$

In this model the timing of the Fed's actions and their effect on the economy is important. I assume that at each period t, the Fed takes a policy action based on information available at the end of period t-1 that affects the unemployment rate in period t, and therefore inflation in period t+1.[6] Consequently the Fed controls its forecast of the unemployment rate in period t as well as its forecast of the inflation rate in period t+1. The first order conditions for this problem are

$$\begin{aligned} &(1-\alpha)E_{t-1}\tilde{u}_t + \lambda E_{t-1}\psi_{t+1} = 0 \\ &\alpha(E_{t-1}\pi_{t+1}-\pi^*)+E_{t-1}\psi_{t+1}-\phi_1 E_{t-1}\psi_{t+2}-\phi_2 E_{t-1}\psi_{t+3}-\phi_3 E_{t-1}\psi_{t+4}-\phi_4 E_{t-1}\psi_{t+5} = 0 \end{aligned} \tag{13}$$

Combining these equations produces the Euler equation

$$\alpha\lambda(E_{t-1}\pi_{t+1}-\pi^*)-(1-\alpha)[E_{t-1}\tilde{u}_t -\phi_1 E_{t-1}\tilde{u}_{t+1}-\phi_2 E_{t-1}\tilde{u}_{t+2} -\phi_3 E_{t-1}\tilde{u}_{t+3}-\phi_4 E_{t-1}\tilde{u}_{t+4}] = 0 \tag{14}$$

Equation (14) is estimated by assigning values for λ and the ϕ_i's from Table 1 and then using nonlinear least squares to produce estimates of α and π^*. Forecasts of inflation and the unemployment gap ($E_{t-1}\pi_{t+1}$, $E_{t-1}\tilde{u}_t$, etc.) are drawn from the Greenbooks. The forecasts of the unemployment gap are computed by taking the difference between the Greenbook forecast of unemployment and the “real time” estimate of the natural rate discussed above.

[6] Equivalently, we could assume the Fed takes a policy action in period t-1 based on information available at the end of period t-1 that affects unemployment in period t.

As mentioned above, one potential problem with using the Greenbook forecasts to estimate equation (14) is that the forecasts are typically made contingent on no change in monetary policy. Thus if in a given period the Fed is confronted with new information that calls for a substantial change in policy, the forecasted inflation and unemployment rates do not necessarily represent the Fed's intended levels of inflation and unemployment, and we would not expect equation (14) to hold. I therefore run a parallel set of regressions that use forecasts of inflation and unemployment from a vector autoregression in place of the Greenbook forecasts. Specifically, at each period t I run a vector autoregression using the previous ten years of data (the sample ends in period t-1). The VAR includes four lags of the inflation rate and unemployment rate (defined above), as well as the federal funds rate (FYFF) and the spread between the interest rate on ten-year Treasury bonds (FYGT10) and three-month Treasury bills (FYGM3). The four-quarter percentage change in oil prices (defined above) is included as an exogenous variable. The VAR is then used to construct forecasts of inflation and unemployment for periods t to t+4. As with the Greenbook forecasts, the forecasted unemployment gap is the difference between the forecasted unemployment rate and the "real time" estimate of the natural rate. Running the VAR on ten years of data ending one quarter prior to the date at which the forecast is made preserves the "real time" nature of the forecasts that is a feature of the Greenbook forecasts.[7] Assuming the federal funds rate is the Fed's monetary policy instrument, the use of dynamic VAR forecasts incorporates monetary policy actions expected over the forecast horizon, unlike the Greenbook forecasts.

The first two columns of Table 2 show the results of estimation of equation (14) using the two alternative forecast variables. Four-quarter ahead Greenbook forecasts are available from

[7] The VARs are estimated using the latest updated data from the S&P/DRI rather than from "vintage" data used by some researchers (e.g. Croushore and Stark (2001)). Any differences between forecasts derived from this data and those derived from vintage data are likely to be small.

1969:1 on with some quarters of missing data in the early 1970s, so the sample period is 1969:1-1979:2. The results show that the Fed gave roughly equal weight to inflation and unemployment during this period: the estimate of α is 0.546 in the regression using Greenbook forecasts and 0.434 in the regression using VAR forecasts. The estimated inflation target is rather high, 5.247 in the regression using Greenbook forecasts and 5.947 in the regression using VAR forecasts. (By comparison, average actual inflation over this period was 6.3 percent and average forecasted inflation was 6.0 percent).

The model's "goodness of fit" can be assessed by comparing the forecasted unemployment and inflation rates with the forecasts implied by the model. That is, we use the model estimates to construct a path for $E_{t-1}\tilde{u}_t$ based on forecasts of inflation and unemployment. Likewise, we can construct a path for $E_{t-1}\pi_{t+1}$ based on forecasts of unemployment. Figure 5 shows the results of this exercise. The model tracks the unemployment gap, whether measured using the Greenbook or VAR forecasts, fairly well. That is, given the expected inflation rate and expected future unemployment rates, the model's prediction of the Fed's choice of unemployment rate is close to the actual forecast. This is not the case with the inflation forecasts, however. In fact, the two series appear to be negatively correlated. One is forced to conclude that the standard model does not provide a satisfactory account of the Federal Reserve's behavior in the 1970s.

To better account for movements in the inflation rate, I propose an alternative model of monetary policy making, which I refer to as the "partial adjustment" model. In this model each period the Federal Reserve's target rate of inflation is a weighted average of a long-run inflation target and the previous period's inflation rate. That is, the Fed's loss function takes the form

$$L = \frac{1}{2} E_0 \sum_{t=0}^{\infty} \left[\alpha(\pi_t - \pi_t^*)^2 + (1-\alpha)\tilde{u}_t^{\,2}\right]$$

$$\text{where } \pi_t^* = \theta\pi_{t-1} + (1-\theta)\pi^* \qquad (15)$$

This model assumes that the Fed distinguishes between its short run and long run inflation targets, which seems to be a plausible characterization of Fed behavior. This specification justifies a gradualist or "opportunistic" approach to disinflation such as occurred in the 1980s and 1990s. Solving the Fed's new optimization problem in the same way as above yields the Euler equation

$$\begin{aligned}&\alpha\lambda[(E_{t-1}\pi_{t+1} - \pi_t^*) - \theta(E_{t-1}\pi_{t+2} - E_{t-1}\pi_{t+2}^*)]\\ &\quad -(1-\alpha)[E_{t-1}\tilde{u}_t - \phi_1 E_{t-1}\tilde{u}_{t+1} - \phi_2 E_{t-1}\tilde{u}_{t+2} - \phi_3 E_{t-1}\tilde{u}_{t+3} - \phi_4 E_{t-1}\tilde{u}_{t+4}] = 0\end{aligned} \qquad (16)$$

The estimates of α, θ, and π^* from equation (16) are reported in the last two columns of Table 2. The estimates of the long-run inflation target are little changed from the standard model. The partial adjustment parameter, θ, is large and statistically significant. The incorporation of partial adjustment of the inflation target increases the estimated value of α substantially. The fit of this model is a vast improvement over that of the standard model, as shown by a comparison of the sum of squared residuals and log likelihoods in the two models. The improvement in fit is also illustrated in Figure 6, which is constructed in the same way as Figure 5. The partial adjustment model brings the fitted values of the inflation forecast much more closely in line with the actual forecasts, at the cost of some deterioration in the fit to the unemployment forecast data. Despite its simplicity, the model's predictions are not far out of line with the actual forecast data. The satisfactory fit of the model together with the ability to reject the hypothesis that the weight on inflation in the Fed's loss function is zero (see Table 2) suggests – contrary to CGG – that the Federal Reserve was pursuing a stabilizing, optimizing monetary policy during the 1970s.

3. The effect of misperceptions on average inflation, 1969-1979

The results in Table 2 can be used to assess the quantitative impact of misperceptions of the natural rate of unemployment on the average rate of inflation during the period of high inflation. The total extent of the Federal Reserve's misperception of the unemployment gap can be decomposed as

$$E_{t-1}\tilde{u}_t - \tilde{u}_t = (E_{t-1}u_t - u_t) - (E_{t-1}u_t^n - u_t^n) = \xi_t - \eta_t \tag{17}$$

where $\xi_t \equiv E_{t-1}u_t - u_t$ is the Fed's misperception of the actual rate of unemployment (the difference between the Fed's forecast and the actual rate) and $\eta_t \equiv E_{t-1}u_t^n - u_t^n$ is the Fed's misperception of the natural rate of unemployment (here, the difference between the one-sided and two-sided moving average estimates of the natural rate). Let ξ be the average misperception of the actual rate of unemployment over the period and η be the average misperception of the natural rate over the period. Assume that over the period 1969:1-1979:2 the actual unemployment gap is zero on average.[8] For the standard model, substituting equation (17) into equation (14) and setting the actual unemployment gap equal to zero gives us a relationship between the deviation of inflation from its target and the extent of misperceptions of the unemployment gap:

[8] In fact the average unemployment gap (the actual rate minus the two-sided moving average) is –0.07, that is, seven one-hundredths of a percentage point.

$$(\pi\text{-}\pi^*) = \beta(\xi\text{-}\eta) \tag{18}$$

where $\beta = \frac{(1-\alpha)(1-\phi)}{\alpha\lambda}$ and $\phi = \sum_{i=1}^{4} \phi_i$. Performing the same manipulations using equation (16) instead of equation (14) gives us a similar formula for the partial adjustment model with $\beta = \frac{(1-\alpha)(1-\phi)}{\alpha\lambda(1-\theta)^2}$. Table 3 uses these formulas to quantify the impact of misperceptions on inflation during 1969:1-1979:2. The first row of Table 3 shows the estimates of β for each specification of the model using the estimates of ϕ and λ from Table 1 and the estimates of α and θ from Table 2. Depending on the model specification, for every one percentage point that the Federal Reserve overestimated the unemployment gap over the period, the inflation rate exceeds the target inflation rate by 0.324 to 0.871 percentage points. The total misperception of the unemployment gap over the period was 1.077 using the Greenbook unemployment forecasts and 1.039 using the VAR unemployment forecasts. This means that the total effect of misperceptions was to increase the average inflation rate by 0.325 to 0.907 percentage points above target. Almost all of the excess inflation is due to misperceptions of the natural rate (η) rather than misperceptions of the actual current rate of unemployment (ξ).

The calculations above suggest that misperceptions account for a relatively small amount of the excess inflation experienced from 1969-79 compared to, say, the period 1983-2002. The average inflation rate from 1969-79 was 6.3 percent while the average rate from 1983-2002 was 2.5 percent. My calculations attribute at most 0.9 percent, or less than a quarter, of the difference in inflation rates to misperceptions. Given the values of ϕ, θ, and λ estimated above, according to the partial adjustment model α would have to be as low as around 0.14 to explain the entire difference in inflation rates. This raises the question, what did account for the difference in inflation rates before and after 1979?

4. Federal Reserve preferences since 1979

This section replicates the analysis of Fed policy in the previous section for the period since 1979 in an attempt to explain the difference in inflation experience in the U.S. before and after 1979. Table 4 shows the results of estimation of the Phillips curve for the period 1979:3-2002:3. The estimates suggest some structural change between the two periods; specifically, unemployment and changes in oil prices have a smaller impact on inflation in the later sample, and inflation is more persistent (ϕ=.911 in the later period, versus .764 in the earlier period). Table 5 presents estimates of the Fed's preference parameters over the period 1983:1-1997:4 (the period 1979:3-1982:4 is regarded as a period of transition between monetary policy regimes and is therefore excluded; Greenbook forecasts are not available after 1997:4). The estimates show a large increase in the weight the Fed assigns to inflation in its loss function: in the standard model, the estimate of α rises from 0.55 to 0.88 when Greenbook forecasts are used and from 0.43 to 0.89 when VAR forecasts are used; in the partial adjustment model, α rises from 0.85 to 0.97 when Greenbook forecasts are used and from 0.71 to 0.99 when VAR forecasts are used. The long-run inflation target also seems to have fallen dramatically, from over 5 percent in the 1969-79 period to between 2.01 and 3.31 percent in the later period.

These results can be used to decompose the difference in average inflation rates between the two time periods. Equation (18) says that the average inflation rate in a given period is composed of the target inflation rate and the effect of misperceptions of the unemployment gap. Table 6 uses this framework and the methods described in reference to Table 3 to quantify these effects. The first thing to note about Table 6 is the very small effect of misperceptions in the later sample. The unemployment gap was underestimated over this period by an average of 0.66 percentage points using Greenbook forecasts and 0.71 percentage points using VAR forecasts, primarily because the real-time estimate of the natural rate of unemployment was about 0.69 percentage points above the ex post estimate, which would have tended to reduce inflation. However, the estimates of β are much lower during the 1983-97 period, ranging from .014 to .076 across the four model specifications. The value of β is reduced relative to the earlier period because of the larger values of α and ϕ, while the smaller value of λ has the effect of increasing β.

The key number to be explained in Table 6 is the difference in average actual inflation rates in the two periods, 6.27 percent in 1969-79 versus 2.79 in 1983-97, or 3.48 percentage points of excess inflation. The standard model with Greenbook forecasts accounts for 2.59 percentage points of the excess inflation. Of this, 2.00 percentage points is due to a higher inflation target in the earlier period and 0.59 percentage points is due to misperceptions. The numbers are very similar for the partial adjustment model with Greenbook forecasts. The models using VAR forecasts overestimate the difference in inflation during the two periods (4.63 percentage points under the standard model and 4.69 percentage points for the partial adjustment model). The majority of the difference is again attributed to a higher inflation target in the earlier period, leaving a relatively small role for misperceptions.

It is somewhat unsatisfying to argue that the high inflation of the 1970s was due to the Fed's having a preference for high inflation. This explanation raises the question, why did the Fed have a high inflation target in the 1970s, and why was it lowered in the 1980s? It is probably not the case that the Fed believed that five percent inflation was optimal in the 1970s, and then determined that two percent was optimal in the 1980s. One piece of evidence against this view is the Congressional testimony of Arthur Burns (1977, p. 225), chairman of the Fed in the early 1970s:

> "…despite heartening progress over the past two years, inflation is still proceeding at a troublesome rate almost everywhere. In 1976, consumer prices in this country rose about 5 per cent. This was down from 7 per cent in 1975 and 12 per cent in 1974. But our businessmen as well as other citizens fear that the continuation of even a 5 per cent rate of inflation may be incompatible with the attainment of durable prosperity."

Even Congress in the Humphrey-Hawkins Amendment of 1978 called for "reducing the rate of inflation…to not more than 3 per centum" within five years; a clear indication that the 6.8 percent inflation rate that prevailed from 1977 to 1978 was well in excess of Congress' long-run target.[9]

One explanation for the higher estimated inflation target in the 1970s is that the estimate reflects not a higher target for inflation, but a lower target for unemployment. Suppose that the Fed seeks to hold unemployment not to its estimate of the natural rate, but to some value below this. This is the classic inflation bias problem introduced by Kydland and Prescott (1977) and Barro and Gordon (1983). Let the Fed's unemployment target by $E_{t-1}u_t^n - \nu$, $\nu>0$, so the Fed's period loss function (in the standard model) is $L_t = \frac{1}{2}[\alpha(\pi_t - \pi^*)^2 + (1-\alpha)(\tilde{u}_t + \nu)^2]$. With these preferences the Fed's Euler equation becomes

$$\alpha\lambda(E_{t-1}\pi_{t+1} - \pi^*) \\ -(1-\alpha)[E_{t-1}\tilde{u}_t - \phi_1 E_{t-1}\tilde{u}_{t+1} - \phi_2 E_{t-1}\tilde{u}_{t+2} - \phi_3 E_{t-1}\tilde{u}_{t+3} - \phi_4 E_{t-1}\tilde{u}_{t+4}] - (1-\alpha)(1-\phi)\nu = 0 \quad (19)$$

[9] Title 15, Chapter 21, Section 1022a(b)(2) of the U.S. Code. Significantly, the text continues "Provided, That policies and programs for reducing the rate of inflation shall be designed so as not to impede achievement of the goals and timetables specified in clause (1) of this subsection for the reduction of unemployment," namely a four percent unemployment rate among individuals 16 years old and older.

Grouping the constant terms together we have

$$- [\alpha\lambda\pi^*+(1-\alpha)(1-\phi)\nu] + \alpha\lambda E_{t-1}\pi_{t+1} \\ -(1-\alpha)[E_{t-1}\tilde{u}_t -\phi_1 E_{t-1}\tilde{u}_{t+1} -\phi_2 E_{t-1}\tilde{u}_{t+2} -\phi_3 E_{t-1}\tilde{u}_{t+3} -\phi_4 E_{t-1}\tilde{u}_{t+4}] = 0 \quad (20)$$

It is apparent from equation (20) that π^* and ν are not separately identified. Above, identification was achieved by setting $\nu=0$, but it could just as easily have been achieved by setting π^* equal to some constant. Taking steady state values, and accounting for misperceptions of the current actual and natural rates of unemployment as we did before, equation (20) becomes

$$\pi = \pi^*+\beta(\xi-\eta+\nu) \quad (21)$$

where β is defined as in equation (18) above (an analogous equation holds for the partial adjustment model). It follows that if we take $\pi^*=2$ as the Fed's long-term inflation target, the estimates $\nu=0$, $\pi^*=\hat{\pi}^*$ reported in Table 2 are observationally equivalent to $\nu=(1/\beta)(\hat{\pi}^*-2)$, $\pi^*=2$. That is, if we estimated the models as in Table 2 but setting $\pi^*=2$, we would get values for ν equal to 6.45 for the standard model with Greenbook forecasts, 4.99 for the standard model with VAR forecasts, 10.70 for the partial adjustment model with Greenbook forecasts, and 4.35 for the partial adjustment model with VAR forecasts. With $\pi^*=3$, we get values for ν equal to 4.46, 3.72, 7.61, and 3.20 according to the model specification. Given that the average real-time estimate of the natural rate over this period was about 5 percent, this implies that – assuming the

Fed's long-run inflation target was 2-3 percent – the Fed acted as if it was consciously aiming at an unemployment rate near zero or even negative.

Even observers as critical of Fed policy in the 1960s-70s as DeLong (1997) would not argue that the Fed consciously aimed at zero unemployment. [10] More likely, the zero estimated unemployment target reflects an unaccounted for political constraint facing the Fed. DeLong describes in great detail the lack of a political mandate during the 1970s for the high unemployment that would have been necessary to bring inflation under control, the most obvious manifestation of which was the intense pressure from the Nixon Administration to maintain low unemployment prior to the 1972 election. The estimates provided here suggest that this political pressure – or something like it – that pushed the Fed's implicit unemployment target down is a more likely cause of the Great Inflation than misperceptions of the natural rate.

Finally, what of Orphanides' argument that similar misperceptions of the natural rate of unemployment could cause inflation to become a problem again under the current monetary policy rule? Suppose the natural rate, currently estimated to be around five percent, were to rise to six percent without the Fed's being aware of it. Based on the estimates of β given for the 1983-97 period referenced above (which range from .014 to .076), the effect on inflation would be minimal. There seems to be room for the Fed to maintain or even increase attention to its independent unemployment target.

5. Summary and conclusions

This paper has investigated whether misperceptions of the natural rate of unemployment could have caused the Great Inflation of the 1970s. While previous studies have modeled

[10] DeLong cites Samuelson and Solow's (1960) "nonperfectionist's goal" of 3 percent unemployment as a lower bound for the Fed's target unemployment rate.

monetary policy using a Taylor rule, this paper assumes monetary policymakers choose combinations of inflation and unemployment to minimize a quadratic loss function. The result is that the Fed follows a “targeting” rule rather than an “instrument” rule. The targeting rule and the Phillips curve are estimated with an approach that restricts the information set of the policymakers at each date to the macroeconomic data that actually would have been available to them at that date. Estimates of the model lead to the following conclusions.

The targeting rule provides a reasonably good fit to the data on inflation and unemployment for the U.S. during the period 1969-79. Contrary to the view expressed in CGG (2000) that monetary policy was unstable during this period, policymakers behaved like inflation targeters, albeit with a slow rate of convergence to the long-run inflation target relative to policymakers in the 1980s and 1990s.

The Federal Reserve seems to have consistently underestimated the natural rate of unemployment during the 1970s. While we do not have direct evidence of the Fed’s natural rate target and only estimates of the actual natural rate, it is fair to assume that the Fed believed the natural rate was around 5 percent during the 1970s whereas the actual rate averaged around 6 percent. In principle, this would have caused the Fed to pursue overly expansionary policies that would have caused inflation systematically to exceed the inflation target.

Estimates of the model, however, suggest that a mistake of this magnitude would not have been sufficient to explain the actual high rates of inflation that prevailed from 1969-79. While the weight on inflation in the Fed’s loss function is estimated to be in the range of .70 to .85 (in the partial adjustment model), the weight would have had to be as low as .15 in order for misperceptions of the natural rate to account for the entire difference between average inflation in the 1970s versus the 1980s-90s.

The cause of high inflation in the 1970s appears instead to be due to a higher inflation target. This high inflation target probably reflects not a preference for higher inflation, but a desire to maintain unemployment below even reasonable real-time estimates of the natural rate. I speculate that this desire is in turn a reflection of the political environment of the time.

The Fed's current policy rule does not leave us susceptible to a repeat of the Great Inflation due to misperceptions of the natural rate of unemployment. The estimated weight on inflation in the Fed's loss function is higher than it was in the 1970s. In the event of an unanticipated increase in the natural rate that resulted in an increase in inflation, policymakers would react strongly enough to prevent inflation from getting out of control. In fact, the Fed today behaves very much like a strict inflation targeter, assigning essentially no independent weight to unemployment fluctuations. The Fed could adopt a less strict inflation targeting rule without fear of the misperceptions problem discussed by Orphanides.

On the other hand, to the extent that the Great Inflation was a result of the political environment of the 1970s it could be repeated regardless of the policy rule adopted by the Fed. It is easy to imagine circumstances under which the president, Congress, and the public once again become intolerant of unemployment rates high enough to keep inflation stable and demand that the Fed pursue an excessively expansionary monetary policy. While nominally independent, the Fed might – as it did in the 1970s – yield to political pressure rather than see its autonomy stripped from it. Absent a constitutional amendment – and even this might not be sufficient– no policy rule, even a strict inflation targeting rule, could guarantee that the experience of the 1970s would not be repeated.

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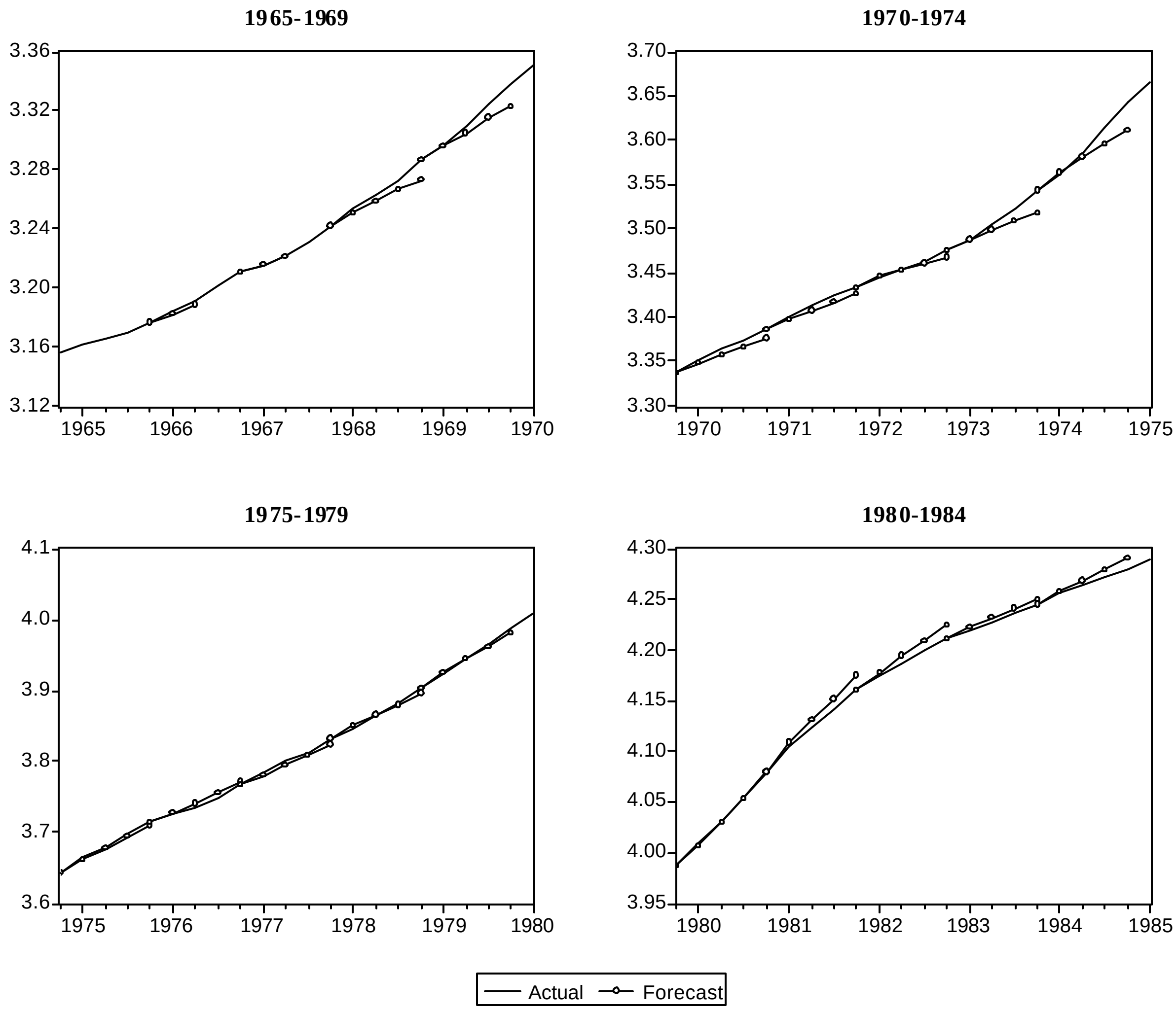
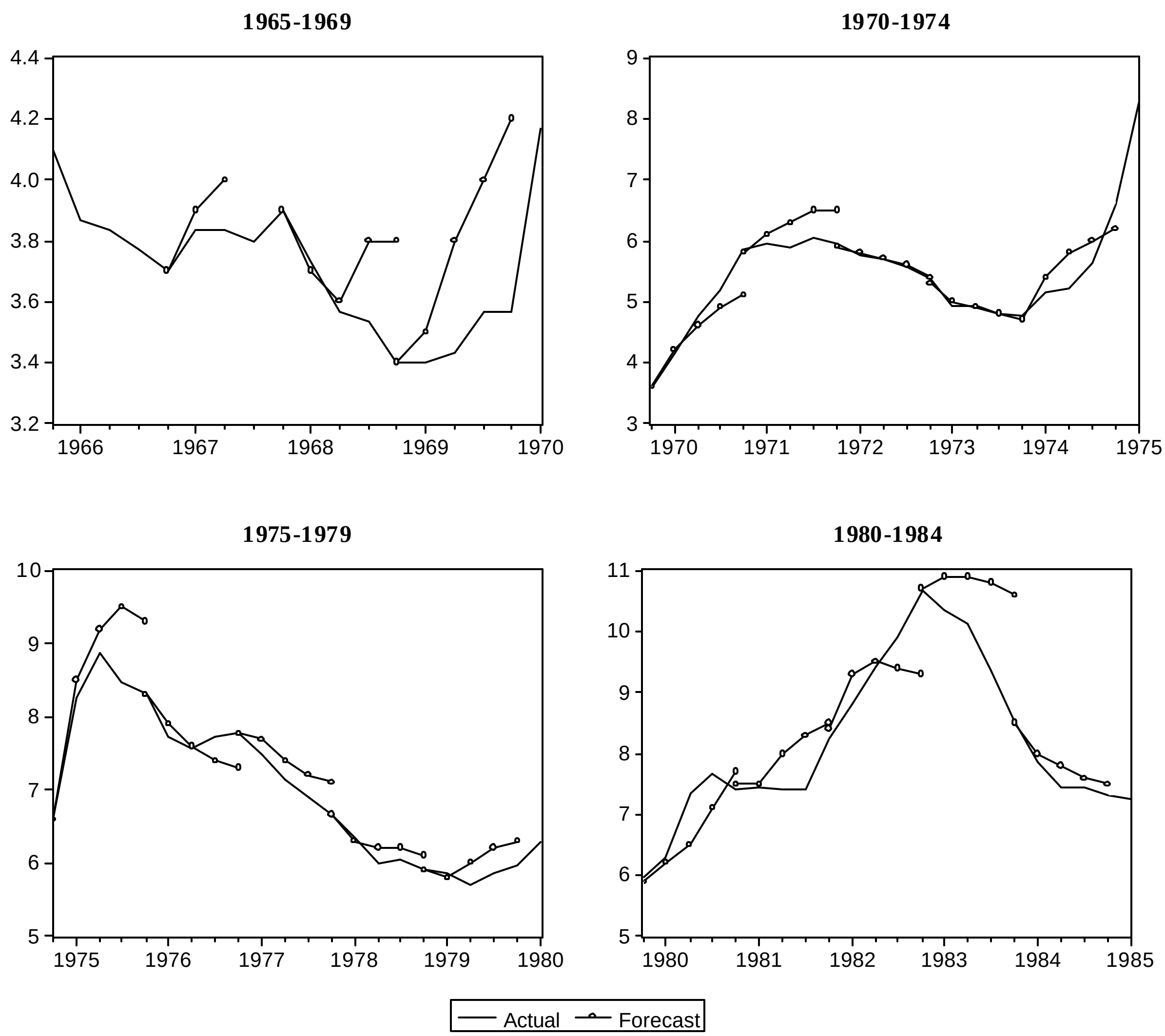
Figure 1. GNP deflator, actual versus Greenbook forecast, 1965-1984.



Actual: GNP deflator, from DRI macro database, January 2003.

Forecast: Each forecast series takes the price level in the quarter preceding the date of the forecast as known. Forecasted price levels are the levels implied by the Greenbook forecasts of the GNP deflator inflation rate. Forecasts made in the first quarter of each year for quarters 1 to 4 are shown. Forecasts taken from the Greenbook for the FOMC meeting nearest to the middle of the first quarter.

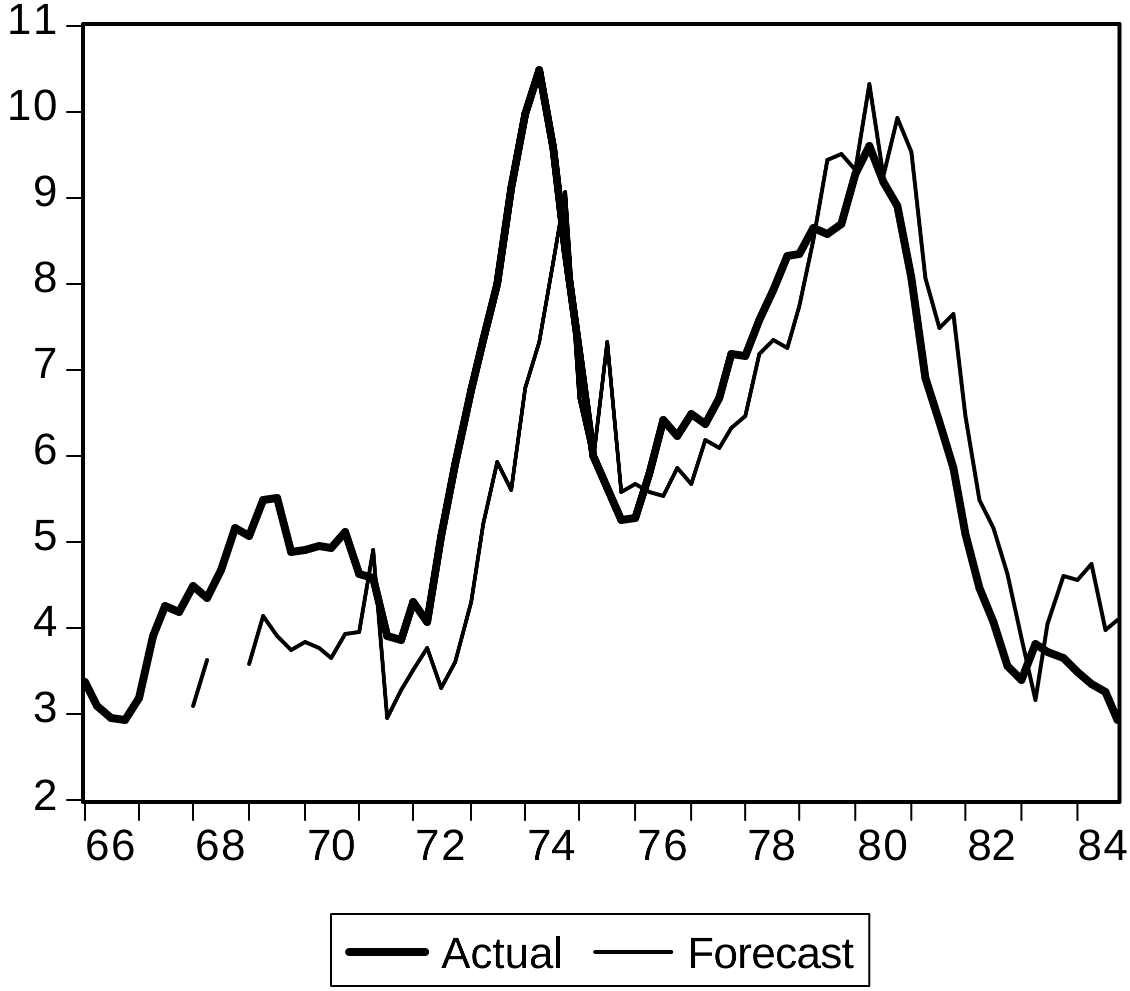
Figure 2. Unemployment rate, actual versus Greenbook forecast, 1965-1984.



Actual: Civilian unemployment rate, from DRI macro database, January 2003.

Forecast: Each forecast series takes the unemployment rate in the quarter preceding the date of the forecast as known. Forecasts made in the first quarter of each year for quarters 1 to 4 are shown. Forecasts taken from the Greenbook for the FOMC meeting nearest to the middle of the first quarter.

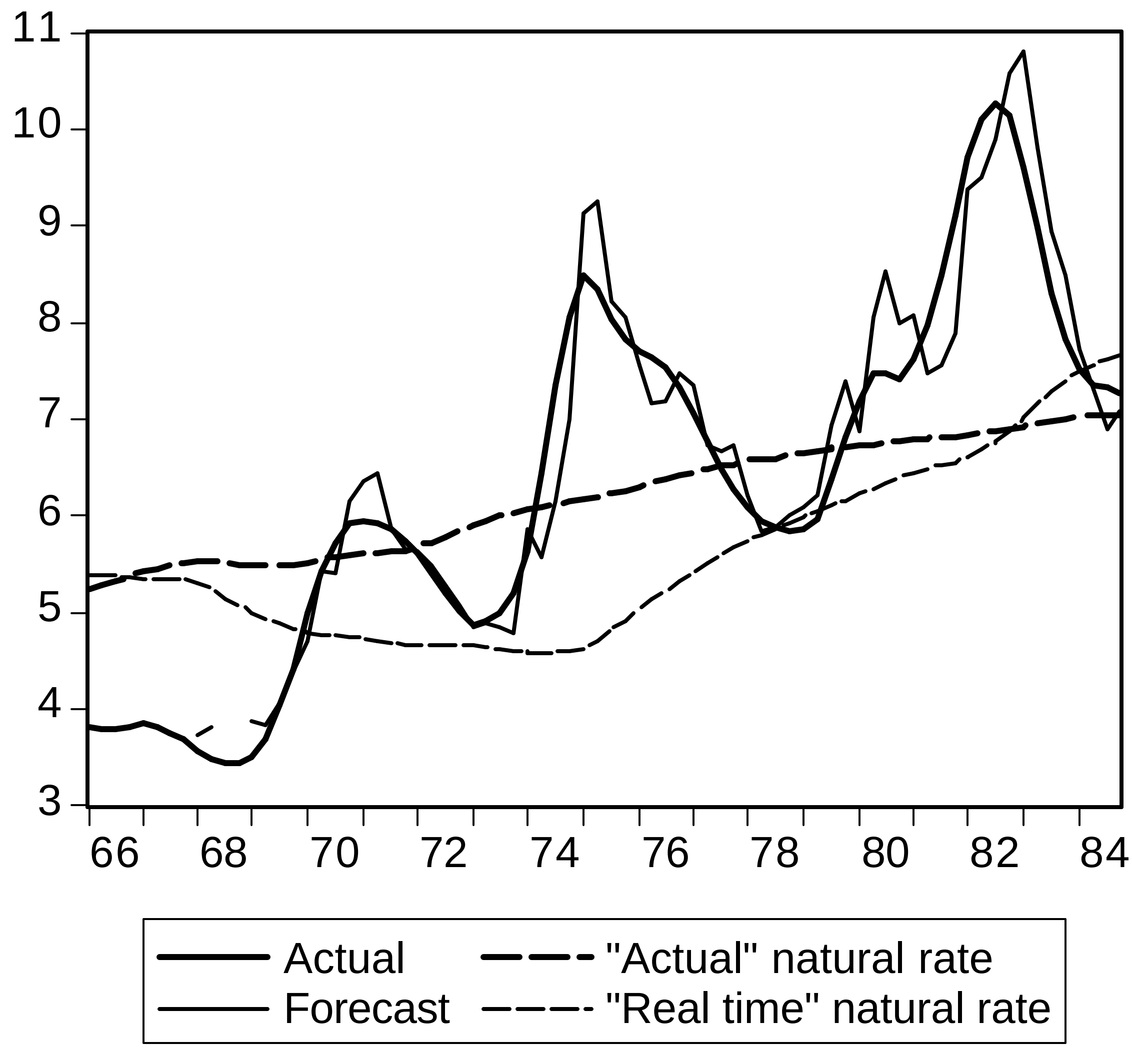
Figure 3. GNP deflator inflation rate, actual and Greenbook forecast.



Actual: Percent change in GNP deflator from end of period t-1 to end of period t+3.

Forecast: From Greenbook for FOMC meeting nearest to middle of quarter. Forecasted percent change in GNP deflator from end of period t-1 to end of period t+3.

Figure 4. Unemployment rate, actual versus Greenbook forecast, 1965-1984.



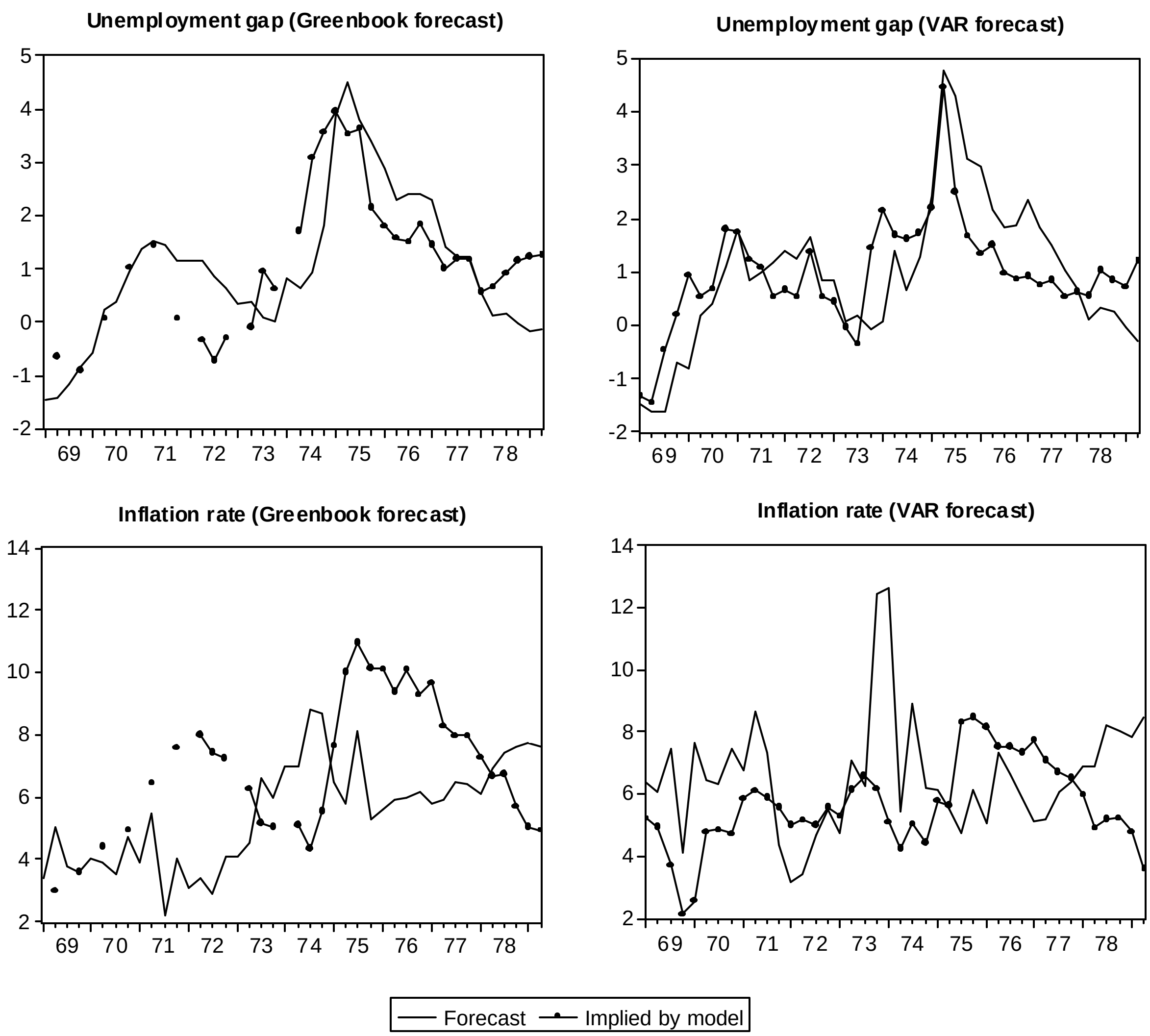
Actual: Average civilian unemployment rate from period t-1 to period t+3.

Forecast: From Greenbook for FOMC meeting nearest to middle of quarter. Average forecasted civilian unemployment rate from period t-1 to period t+3.

"Actual" natural rate: computed as 10-year two-sided moving average of actual civilian unemployment rate.

"Real-time" natural rate: computed as 10-year backward moving average of actual civilian unemployment rate.

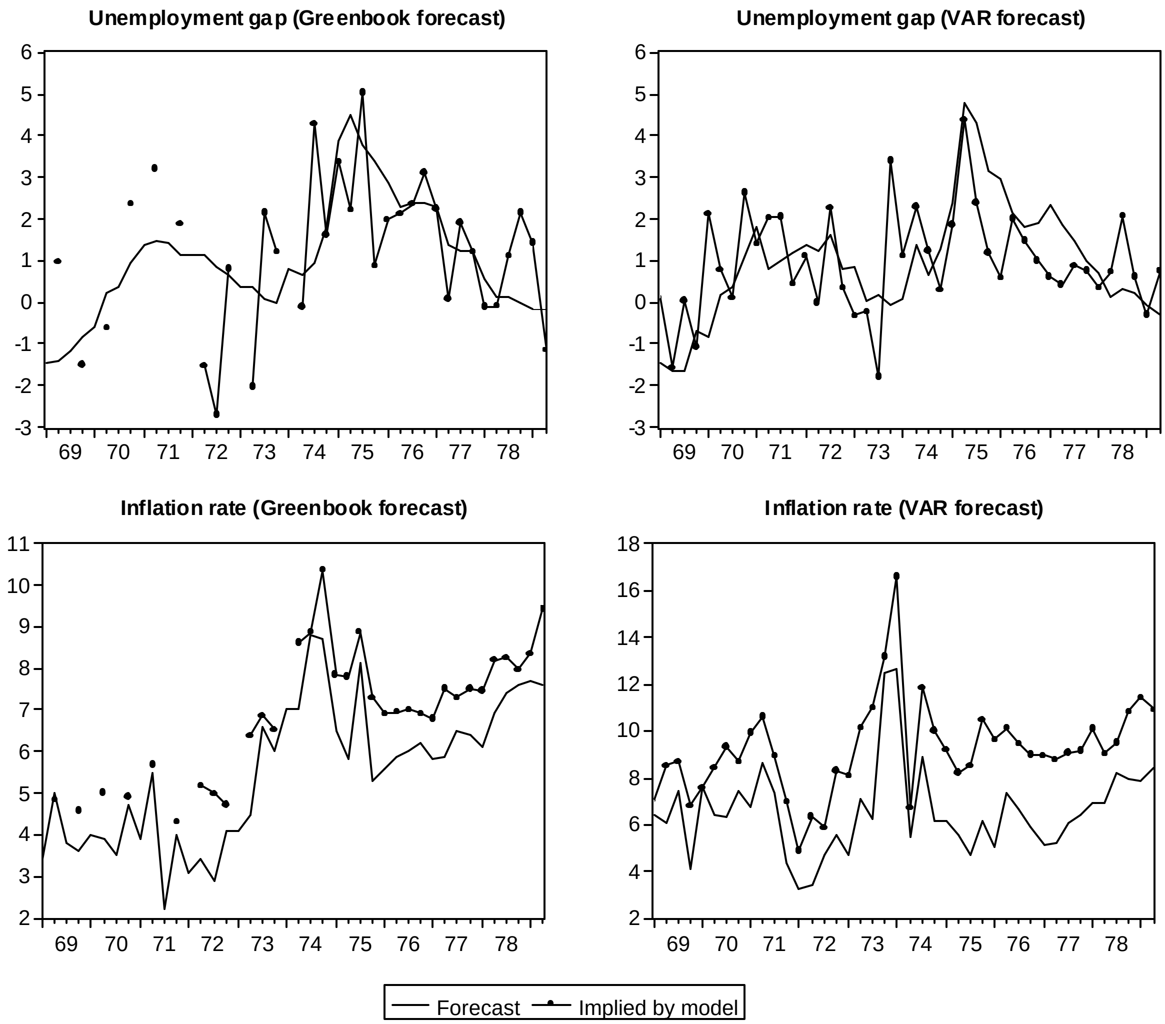
Figure 5. Fitted values for inflation and unemployment gap, standard model, 1969-79.



Forecast: One-quarter-ahead inflation forecast, current-quarter unemployment gap forecast from Greenbook or VAR.

Implied by model: Fitted values from equation (14). For unemployment gap, actual (Greenbook or VAR forecast) data used for inflation rate and future unemployment gaps. For inflation rate, actual (Greenbook or VAR forecast) data used for current and future unemployment gaps.

Figure 6. Fitted values for inflation and unemployment gap, partial adjustment model, 1969-79.



Forecast: One-quarter-ahead inflation forecast, current-quarter unemployment gap forecast from Greenbook or VAR.

Implied by model: Fitted values from equation (14). For unemployment gap, actual (Greenbook or VAR forecast) data used for inflation rate and future unemployment gaps. For inflation rate, actual (Greenbook or VAR forecast) data used for current and future unemployment gaps.

Table 1. Estimated Phillips Curve, 1961:2-1979:2 (t-statistics in parentheses).

$$\pi_t = \underset{(0.302)}{0.848} - \underset{(0.118)}{0.390} * \tilde{u}_{t-1} + \underset{(0.120)}{0.345} * \pi_{t-1} + \underset{(0.125)}{0.043} * \pi_{t-2}$$

$$+ \underset{(0.125)}{0.051} * \pi_{t-3} + \underset{(0.111)}{0.325} * \pi_{t-4} + \underset{(0.016)}{0.057} * z_t + \varepsilon_t$$

# observations	73
R^2	0.825
Breusch-Godfrey test:	
$T \times R^2$ (p-value)	2.517
	(0.642)

Table 2. Estimated Euler equation, 1969:1-1979:2 (t-statistics in parentheses).

	Standard model		Partial adjustment model	
	Greenbook forecasts	VAR forecasts	Greenbook forecasts	VAR forecasts
α	0.546	0.434	0.848	0.708
	(0.092)	(0.086)	(0.063)	(0.079)
π^*	5.247	5.947	5.467	5.786
	(0.445)	(0.525)	(0.462)	(0.857)
θ	--	--	0.422	0.465
			(0.054)	(0.097)
No. observations	33	42	33	42
Sum squared residuals	6.138	7.085	1.877	5.751
Log likelihood	-19.073	-22.221	0.482	-17.841

Notes:

Euler equation estimated by nonlinear least squares in second step of two-step procedure. Phillips curve coefficients set to estimated values in Table 1.

Standard model:

$$\alpha\lambda(E_{t-1}\pi_{t+1}-\pi^*)-(1-\alpha)[E_{t-1}\tilde{u}_t-\phi_1 E_{t-1}\tilde{u}_{t+1}-\phi_2 E_{t-1}\tilde{u}_{t+2}-\phi_3 E_{t-1}\tilde{u}_{t+3}-\phi_4 E_{t-1}\tilde{u}_{t+4}] = 0.$$

Partial adjustment model:

$$\alpha\lambda[(E_{t-1}\pi_{t+1}-E_{t-1}\pi_{t+1}^*)-\theta(E_{t-1}\pi_{t+2}-E_{t-1}\pi_{t+2}^*)]-(1-\alpha)[E_{t-1}\tilde{u}_t-\phi_1 E_{t-1}\tilde{u}_{t+1}-\phi_2 E_{t-1}\tilde{u}_{t+2}-\phi_3 E_{t-1}\tilde{u}_{t+3}-\phi_4 E_{t-1}\tilde{u}_{t+4}]=0.$$

$$\pi_t^* = (1-\theta)\pi^*+\theta\pi_{t-1}$$

Table 3. Effect of misperceptions on inflation in standard and partial adjustment model, 1969:1-1979:2.

	Standard model		Partial adjustment model	
	Greenbook forecasts	VAR forecasts	Greenbook forecasts	VAR forecasts
Marginal effect of misperceptions (β)	0.503	0.791	0.324	0.871
Misperception of unemployment gap (ξ-η)	1.077	1.039	1.077	1.039
Misperception of actual rate (ξ)	0.037	-0.001	0.037	-0.001
Misperception of natural rate (η)	-1.040	-1.040	-1.040	-1.040
Total effect of misperceptions β(ξ-η)	0.505	0.824	0.325	0.907
Effect of misperception of actual rate ($\beta\xi$)	0.019	-0.001	0.012	-0.001
Effect of misperception of natural rate ($\beta\eta$)	0.523	0.823	0.337	0.906

Notes:

$E\tilde{u} - \tilde{u} = \xi - \eta$, $\xi \equiv Eu - u$, $\eta \equiv Eu^n - u^n$. $\beta = \frac{(1-\alpha)(1-\phi)}{\alpha\lambda}$ (standard model); $\beta = \frac{(1-\alpha)(1-\phi)}{\alpha\lambda(1-\theta)^2}$ (partial adjustment model). $\phi = \sum \phi_i$ = 0.764 from Table 1.

Table 4. Estimated Phillips Curve, 1979:3-2002:3 (t-statistics in parentheses).

$$\pi_t = \underset{(0.173)}{0.151} - \underset{(0.090)}{0.156} * \tilde{u}_{t-1} + \underset{(0.107)}{0.483} * \pi_{t-1} + \underset{(0.114)}{0.026} * \pi_{t-2}$$

$$+ \underset{(0.114)}{0.256} * \pi_{t-3} + \underset{(0.112)}{0.145} * \pi_{t-4} + \underset{(0.003)}{0.005} * z_t + \varepsilon_t$$

# observations	93
R^2	0.866
Breusch-Godfrey test:	
$T \times R^2$ (p-value)	3.333
	(0.504)

Table 5. Estimated Euler equation, 1983:1-1997:4 (t-statistics in parentheses).

	Standard model		Partial adjustment model	
	Greenbook forecasts	VAR forecasts	Greenbook forecasts	VAR forecasts
α	0.882	0.889	0.967	0.995
	(0.046)	(0.080)	(0.036)	(0.042)
π^*	3.246	2.193	3.311	2.008
	(0.110)	(0.265)	(0.165)	(0.710)
θ	--	--	0.326	0.573
			(0.057)	(0.088)
No. observations	60	60	60	60
Sum squared residuals	0.791	3.008	0.422	0.773
Log likelihood	44.712	4.651	63.567	45.402

Notes:

Euler equation estimated by nonlinear least squares in second step of two-step procedure. Phillips curve coefficients set to estimated values in Table 3.

Standard model:

$$\alpha\lambda(E_{t-1}\pi_{t+1}-\pi^*)-(1-\alpha)[E_{t-1}\tilde{u}_t-\phi_1 E_{t-1}\tilde{u}_{t+1}-\phi_2 E_{t-1}\tilde{u}_{t+2}-\phi_3 E_{t-1}\tilde{u}_{t+3}-\phi_4 E_{t-1}\tilde{u}_{t+4}] = 0.$$

Partial adjustment model:

$$\alpha\lambda[(E_{t-1}\pi_{t+1}-E_{t-1}\pi_{t+1}^*)-\theta(E_{t-1}\pi_{t+2}-E_{t-1}\pi_{t+2}^*)]-(1-\alpha)[E_{t-1}\tilde{u}_t-\phi_1 E_{t-1}\tilde{u}_{t+1}-\phi_2 E_{t-1}\tilde{u}_{t+2}-\phi_3 E_{t-1}\tilde{u}_{t+3}-\phi_4 E_{t-1}\tilde{u}_{t+4}]=0.$$

$$\pi_t^* = (1-\theta)\pi^*+\theta\pi_{t-1}$$

Table 6. Decomposition of change in average inflation, 1969-79 versus 1983-97.

	Standard model					
	Greenbook forecasts			VAR forecasts		
	1969-79	1983-97	Difference	1969-79	1983-97	Difference
Inflation target	5.247	3.246	2.001	5.947	2.193	3.754
Effect of misperceptions	0.542	-0.050	0.592	0.822	-0.051	0.873
Predicted inflation rate	5.789	3.196	2.593	6.769	2.142	4.626
Actual inflation rate	6.274	2.790	3.484	6.274	2.790	3.484
	Partial adjustment model					
	Greenbook forecasts			VAR forecasts		
	1969-79	1983-97	Difference	1969-79	1983-97	Difference
Inflation target	5.467	3.331	2.136	5.786	2.008	3.778
Effect of misperceptions	0.349	-0.028	0.377	0.905	-0.011	0.916
Predicted inflation rate	5.816	3.303	2.513	6.691	1.997	4.694
Actual inflation rate	6.274	2.790	3.484	6.274	2.790	3.484

Notes:

Inflation target as estimated in Tables 2 and 6. Effect of misperceptions calculated as in Table 3. Predicted inflation rate is inflation target plus effect of misperceptions. Actual inflation rate is average over period.