THE FED AND THE NEW ECONOMY

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Abstract

This paper seeks to understand the behavior of Greenspan's Federal Reserve in the late 1990s. Some authors suggest that the Fed followed a simple "Taylor rule," while others argue that it deviated from such a rule because it recognized that the "New Economy" permitted an easing of policy. We find that a Taylor rule based on inflation and unemployment does break down in the late 1990s. However, the Fed's behavior appears stable once one accounts for the falling NAIRU of the period. A rule based on inflation and the deviation of unemployment from the NAIRU captures the Fed's behavior through the entire period from 1987 to 2000.

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By Laurence Ball and Robert R. Tchaidze*

Starting with John Taylor (1993), a large literature argues that monetary policy under Alan Greenspan is well-explained by a simple reaction function. Interest rates rise when inflation rises, and fall when there is greater economic slack. Estimates of such a reaction function produce high R^2 s for the Greenspan era. Observers such as N. Gregory Mankiw (2001) conclude that monetary policy is predictable based on inflation and aggregate slack, and that there is little role for other variables or for judgement about the economy.

This view conflicts, however, with historical accounts of policy in the late 1990s – the "New Economy" era. Many authors suggest that Greenspan's Fed deviated from its normal behavior because it recognized changes in the economy, such as higher productivity growth. In particular, it held interest rates steady despite a booming economy and falling unemployment that normally would have triggered a tightening. Alan Blinder and Janet Yellen (2001) call this behavior "forbearance"; explaining it, they say, is "an important question for macro-historians." Journalist Bob Woodward (2000) makes the point more dramatically: Alan Greenspan is "the innovative technician who spotted productivity growth in the 1990s and refused to raise interest rates when the traditional economic models and theories cried out for it."

This paper asks whether the Fed's behavior can really be explained by a simple Taylor rule, or whether it deviated from such a rule in the late 1990s. And if it did deviate, then why? As Milton Friedman (2001) has asked, "does Alan Greenspan have an insight into movements in the economy and the shocks that other people don't have?"

We investigate these issues by estimating Taylor rules for two parts of Greenspan's tenure at the Fed, the "old economy" period from 1987 through 1995 and the "new economy" period from 1996 through 2000. We begin in Section I with a particularly simple version of the rule proposed by Mankiw: the federal funds rate depends on the inflation rate and the unemployment rate. For the old-economy period, this rule explains Fed behavior well: the $\overline{R}^2$ is 0.94. But the rule breaks down after 1995. The interest rates chosen by the Fed are lower than those implied by the old-economy rule by amounts that increase over time to over 200 basis points. This result confirms Blinder and Yellen's story of Fed forbearance in the face of falling unemployment.

Section II presents our explanation for the Fed's behavior: it held interest rates down because it observed a fall in the NAIRU (the non-accelerating-inflation rate of unemployment). The proper measure of economic slack is the deviation of unemployment from the NAIRU; a Taylor rule that simply includes unemployment is misspecified if the NAIRU changes over time. We reestimate the Taylor rule from the previous section with the correct variable, using a NAIRU for each point in time based on estimates by leading economists. This modification makes little difference for the pre-1996 period, because the NAIRU series is almost constant. Starting in 1996, however, consensus estimates of the NAIRU fell steadily. This implies greater slack in the economy, and so the Taylor rule predicts lower interest rates. In this case, the predictions of the old-economy rule are close to the Fed's actual behavior through 2000. Once a changing NAIRU is taken into account, there is little evidence that the Fed shifted its behavior in response to the New Economy.

Section III presents our conclusions.

I. A SIMPLE TAYLOR RULE

Following Mankiw (2001), we examine Taylor rules based on unemployment and inflation. Most Taylor rules in the literature use the output gap rather than unemployment as a measure of economic slack. We have experimented with both variables, however, and find that unemployment produces better-fitting Taylor rules.[1]

In this section, we use the unemployment rate as our slack variable without adjusting for changes in the NAIRU. Mankiw argues that a Taylor rule based on the raw unemployment rate provides a good explanation for the behavior of Greenspan's Fed. Extending Mankiw's analysis, we examine the stability of the rule over the old- and new-economy parts of Greenspan's tenure. We define the former as beginning in 1987:4, the first full quarter of Greenspan's chairmanship, and ending in 1995:4. The new-economy period begins in 1996:1 and ends in 2000:4. Following Ball and Robert Moffitt (2001), we date the beginning of the new economy at 1996 because productivity growth accelerated in that year. Note that we exclude 2001, when the economy entered a recession (the post-New Economy?). The Fed's reaction to this downturn is left for future research.

We examine Taylor rules based on two different measures of inflation. The first is the growth rate of the implicit GDP deflator (IPD), which is used by Taylor (1993, 1999). The second is the growth of the CPI excluding food and energy (CPIX), which is used by Mankiw. These two variables produce roughly the same goodness of fit overall, but they produce noticeably different predictions for interest rates in certain periods. For each of the two price indices, we define inflation for quarter t as the percentage change in the index from t-4 to t.

Table I presents estimates of the Taylor rule: we regress the nominal federal funds rate on a constant, unemployment, and inflation. The results for the pre-1996 sample show how a simple rule can explain Fed behavior: the $\overline{R}^2$ is 0.94 for both measures of inflation. We find that a one-percentage-point rise in inflation leads the Fed to increase the funds rate by 1.4 or 1.6 points, which raises the real funds rate by 0.4 or 0.6. A one-point rise in unemployment leads the Fed to reduce the funds rate by 1.6 or 2.0 points. This response to slack is stronger than that found in most previous work, reflecting the fact that unemployment has greater explanatory power for the funds rate than the output gaps used by others.[2]

The results are quite different for the period from 1996 through 2000. The $\overline{R}^2$'s fall to 0.53 and 0.66, the unemployment coefficients are much lower than before, and in one case the inflation coefficient drops below one. Comparing the estimated Taylor rules for the old- and new-economy periods, there is strong evidence of a shift in behavior. Wald tests for stability of all the coefficients produce p-values of 10^{-4} and below.

Figures 1 and 2 show the breakdown of the Taylor rule graphically. In each Figure, the solid line gives the path of the real federal funds rate, defined as the nominal rate minus inflation, for the entire Greenspan era. Inflation is measured with the CPIX in Figure 1 and with the deflator in Figure 2. The dashed lines in the Figures are predicted values for the real interest rate arising from the Taylor rule. We use the estimated rules for the pre-1996 period; thus the dashed lines are in-sample fitted values through 1995 and out-of-sample forecasts thereafter. The results through 1995 confirm the good fit of the old-economy Taylor rule. But the Fed diverged from that rule after 1995: the predicted interest rates grow steadily but the actual interest rates stay low. For the CPIX, the divergence between the predicted and actual rate peaks at 236 basis points in 1999:1; for the deflator, the peak is 212 basis points in 2000:1.

These results are easy to understand. The unemployment rate fell from 5.6 percent in 1995 to 4.0 percent in 2000. Inflation was fairly steady, so falling unemployment produced a rise in the predicted interest rate. But the Fed did not raise the actual rate by much – it "forebore." For some reason, the Fed did not feel the need to respond to falling unemployment with the tightening implied by its earlier policy rule.

II. A TAYLOR RULE WITH A TIME-VARYING NAIRU

If the NAIRU changes over time, the proper measure of economic slack is the deviation of unemployment from the NAIRU. Here we examine Taylor rules based on this variable.

A. Measuring the NAIRU

The first step is to find estimates of the NAIRU for the Greenspan era. We have examined estimates from both academic researchers and government agencies. Since we are interested in understanding the evolution of Fed policy, we seek NAIRU estimates for each point in time made at that point in time. That is, like Athanasios Orphanides (2001) and Tchaidze (2001), we seek "real-time" estimates of economic slack that policymakers could have observed. As discussed below, our real-time NAIRU estimates for the late 1990s are moderately higher than current estimates for that period. The fall in the NAIRU that researchers now identify was not fully recognized while it was happening.

In the academic literature, the most prominent estimates of the NAIRU are those of Robert Gordon and of Douglas Staiger, James Stock, and Mark Watson. These authors derive time-varying NAIRUs from data on actual unemployment and inflation. They use techniques such as the Kalman filter that allow them to distinguish movements in the NAIRU from transitory shocks to the

Phillips curve. We use the work of Gordon and of Staiger et al. as our primary sources of NAIRU estimates. We also examine estimates from the Council of Economic Advisors and the Congressional Budget Office, which presumably are based on more judgmental procedures. As discussed below, these government estimates of the NAIRU are fairly close to those of academics.

We would like to have real-time estimates of the NAIRU from Gordon and Staiger et al. every quarter. We do not have these data, but we can approximate them based on papers written by these authors at various times. A given Gordon or Staiger et al. paper presents a NAIRU series that extends up to the most recent quarter for which data are available. The NAIRU for the last quarter is a real-time estimate because it is not based on information beyond the quarter. By pooling the papers of Gordon or of Staiger et al., we obtain real-time estimates of the NAIRU from the same source in selected quarters. We use linear interpolation to produce NAIRU estimates between these quarters. The interpolated series are our best guess of the real-time NAIRU estimates that would exist if Gordon or Staiger et al. had written papers every quarter rather than periodically.

Specifically, in a series of articles starting in the 1980s, Gordon suggests that the NAIRU is constant at 6.0%. The last such article was written in December 1994 (Gordon, 1994); thus we set Gordon's real-time NAIRU at 6.0% through 1994:4. Gordon then produced several papers on time-varying NAIRUs (1997, 1998, 2002). Using the last estimate from each, we obtain NAIRUs of 5.6 in 1996:2, 5.54 in 1998:2, and 5.17 in 2000:4. We linearly interpolate starting in 1994:4 to obtain a "Gordon real-time NAIRU series." Similarly, based on Staiger et al. (1997a), we set these authors' real-time NAIRU at 6.18 through 1994:4. Based on Staiger et al. (1997b, 2001) we obtain 5.7 in 1995:4 and 4.50 in 2000:1; we interpolate and assume the NAIRU is constant after 2000:1. Note that both the Gordon and Staiger et al. series decline monotonically after 1994, although the fall is somewhat larger for the latter.[3]

B. Taylor-Rule Estimates

We now estimate the Taylor rule with unemployment replaced by the deviation of unemployment from the NAIRU. In our regressions, we measure the NAIRU by the average of the Gordon and Staiger et al. estimates. This average is constant at 6.09 through 1994:4 and then declines to 4.84 in 2000:4.

Table II presents the results. For the pre-1996 period, the Taylor rule coefficients are close to those for our constant-NAIRU specification in Table I; this reflects the fact that the NAIRU series does not vary until the last year of the old-economy period. For 1996-2000, the results are mixed. The coefficients on unemployment more than double for this period when the time-varying NAIRU is subtracted. But the $\overline{R}^2$'s are similar to those for the constant-NAIRU specification, and there is still evidence of instability across the two periods. The Wald test for stability of the three coefficients produces p-values of 0.02 and 0.001 for the two inflation measures. These p-values are orders of magnitude larger than those for the constant-NAIRU case, but they still provide strong evidence of instability.

Despite this statistical result, the instability of the Taylor rule is much smaller in economic terms when we allow a time-varying NAIRU. We can see this from Figures 3 and 4, which parallel Figures 1 and 2 for the constant-NAIRU case. Once again, we plot fitted values for the interest rate over the Greenspan era based on the pre-1996 policy rule. This time, the predicted interest rates after 1996 do not diverge greatly from the actual interest rates: the Fed did about what one would expect based on its earlier behavior. Note that the modest divergences from predicted behavior that do occur are usually in the negative direction. Policy in the late 90s appears a bit tighter than the policy predicted by the Fed's earlier rule.

These results suggest the following interpretation of Fed behavior. Policymakers realized that the right measure of slack is the deviation of unemployment from the NAIRU. During the late 1990s, they observed that the NAIRU fell. Like Gordon and Staiger et al., they inferred this from the evolution of inflation and actual unemployment. Perhaps policymakers did this informally, or perhaps members of the Fed staff estimated the NAIRU using techniques similar to those of Gordon and Staiger et al. – or simply read these authors' papers as they were written. In any case, the falling NAIRU implied greater economic slack, which meant that the Fed's Taylor rule did not produce a major tightening.

C. NAIRUs Revealed by Interest Rates

Here we tell our story in a different way. Suppose the Fed follows a stable Taylor rule. The coefficients are those of the constant-NAIRU rule estimated for the pre-1996 period. As we have seen, this rule diverges from actual behavior in the late 90s if the NAIRU stays fixed. But any divergence can be eliminated by assuming the right change in the NAIRU. If the predicted interest rate with a constant NAIRU exceeds the actual interest rate by an amount x, the rule fits perfectly if the NAIRU falls by x divided by the coefficient on unemployment. We use this method to find a series starting in 1996 for the fall in the NAIRU relative to the pre-96 level. We then set the pre-96 NAIRU at 6.09 percent to obtain a series of NAIRU levels. This series shows what the Fed must have believed the NAIRU to be during the late 90s if it were exactly following its pre-96 rule.

In Figure 5, the dashed lines present implicit NAIRU series derived this way; there are two series corresponding to our two price indices. For comparison, the Figure also presents real-time NAIRU series from other sources. We include the Gordon and Staiger et al. series described above, and series from the Congressional Budget Office and Council of Economic Advisors. The CBO and CEA series are constructed from annual publications by these agencies (we construct a quarterly series by interpolation).

In Figure 5, all the NAIRU series decline over the late 90s. Not surprisingly, there are significant differences in the series from different sources. The key result is that the two implicit paths for the Fed do not stand out as above or below the other paths. The beliefs about the NAIRU needed to rationalize the Fed's behavior are in the same ballpark as the beliefs expressed by others.

Finally, Figure 6 compares the Fed's implicit NAIRU series to current rather than real-time estimates of the NAIRU. For three of our four NAIRU sources, historical series are available in recent publications (Gordon, 2002; Staiger et al., 2001; CBO, 2001). During the first half of the new-economy period, from 1996 through mid-1998, these series lie somewhat below the Fed's NAIRU series. Thus the Fed, like outside experts, appears to have underestimated the fall in the NAIRU while it was occurring.

III. CONCLUSION

A combination of low unemployment, low inflation, and strong growth made the 1990s "The Fabulous Decade" (Blinder and Yellen). Exogenous events such as the productivity speedup help explain this experience. Yet observers also give credit to the policymaking of the Federal Reserve, and especially its chairman -- the man called "Maestro" by Bob Woodward, or "Almighty Alan Greenspan" by the Economist (2000).

How has Greenspan achieved his success? Journalists such as Woodward and Business Week's Dean Foust (1997) suggest that the Fed chairman has a unique approach to policy. He examines a vast number of data series and directs his staff to produce new ones. He talks frequently with business leaders to spot changes in the economy. His decades of forecasting experience make him adept at synthesizing all this information. He is intellectually flexible, and therefore recognized the New Economy before others did.

Mankiw argues that these aspects of Greenspan's behavior cannot be too important, because in the end the Fed simply follows a Taylor rule. We find that the rule followed by Greenspan is a bit more sophisticated than the one suggested by Mankiw: it accounts for changes in the NAIRU. However, various government agencies and academics do roughly as well as Greenspan in measuring the NAIRU. These include researchers who derive the NAIRU entirely from the behavior of unemployment and inflation; they use no exotic data series or insights from CEOs.

Thus the Fed's success in the 90s appears to result from a simple rule that could be replicated by future policymakers, even if they do not possess Alan Greenspan's special skills. This is good news for the 21st century.

NOTES

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1. We have replaced the unemployment rate with the deviation of output from its long-run level, as measured by the Hodrick-Prescott filter. For the sample from 87:4 to 95:4, this reduces the $\overline{R}^2$ from 0.94 to 0.78 or 0.82, depending on our choice of price index. When both unemployment and the output deviation are included in the rule, only unemployment is statistically significant.

2. If we assume an Okun's Law coefficient of two, then a one percent fall in output produces an interest-rate rise of 3.2 or 4.0 points. These effects are much larger than the output coefficient of 0.5 proposed by Taylor (1993) or the 0.8 estimated by Taylor (1999).

3. For each paper, we use the results for what appears to be the authors' primary specification. Gordon produces NAIRU series for different price indices; we use the series based on the GDP deflator. For Staiger et al. (1997), we use a specification in which the NAIRU is assumed to be constant from 1990 through 1994.

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Table 1: A Simple Taylor Rule

Sample	**1987:4 -- 1995:4**		**1996:1 -- 2000:4**	
Price Index	**CPIX**	**IPD**	**CPIX**	**IPD**
Constant	12.48 (1.29)	11.09 (1.31)	5.03 (0.87)	5.63 (0.76)
Inflation	1.38 (0.15)	1.63 (0.16)	1.86 (0.45)	0.92 (0.25)
Unemployment	1.95 (0.21)	1.63 (0.20)	0.86 (0.18)	0.39 (0.09)
$\overline{R}^2$	0.94	0.94	0.53	0.66

Note: HAC standard errors are in parentheses.

Table 2: A Taylor Rule with a Time-Varying NAIRU

Sample	**1987:4 -- 1995:4**		**1996:1 -- 2000:4**	
Price Index	**CPIX**	**IPD**	**CPIX**	**IPD**
Constant	0.98 (0.72)	1.47 (0.70)	-0.31 (1.40)	3.23 (0.44)
Inflation	1.29 (0.17)	1.54 (0.20)	2.01 (0.51)	1.00 (0.23)
Unemployment – NAIRU	2.00 (0.22)	1.67 (0.21)	1.68 (0.46)	0.81 (0.15)
$\overline{R}^2$	0.93	0.93	0.49	0.70

Note: HAC standard errors are in parentheses.

Fig.1 Performance of a Pre-1996 Taylor Rule (Constant NAIRU, CPIX)

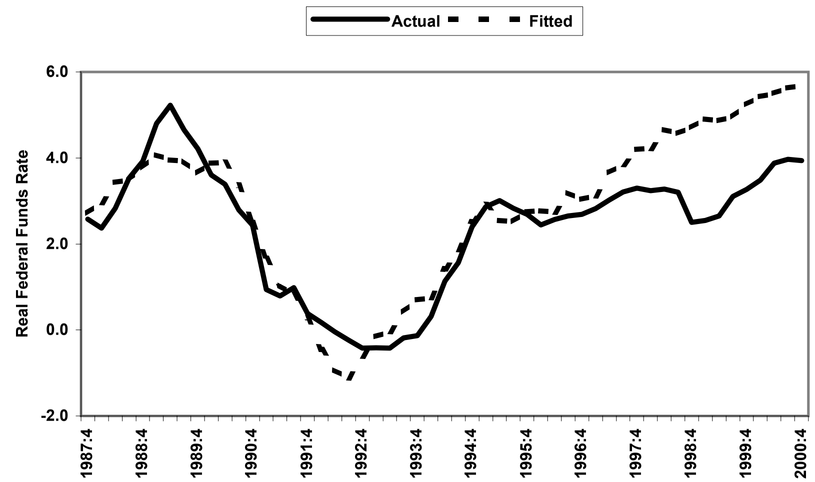

Fig.2 Performance of a Pre-1996 Taylor Rule (Constant NAIRU, IPD)

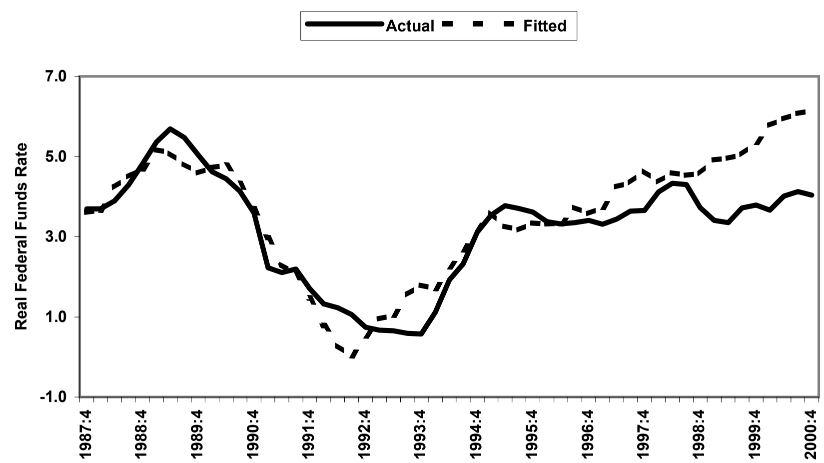

Fig.3 Performance of a Pre-1996 Taylor Rule (Time-Varying NAIRU, CPIX)

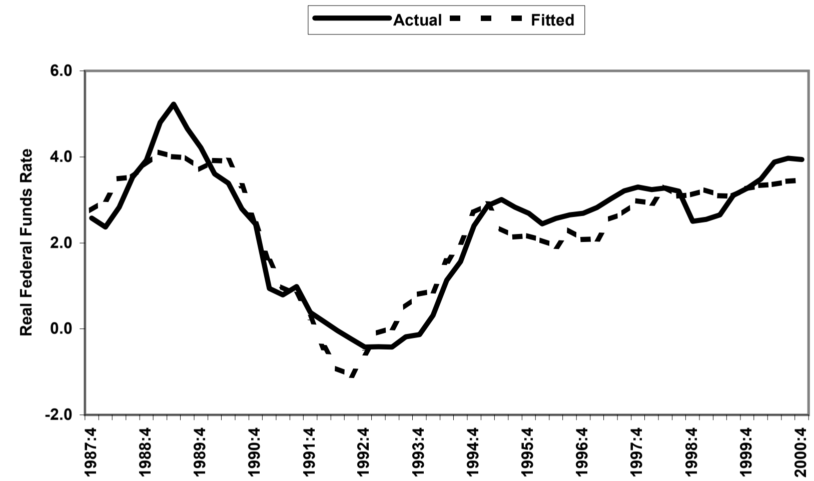

Fig.4 Performance of a Pre-1996 Taylor Rule (Time-Varying NAIRU, IPD)

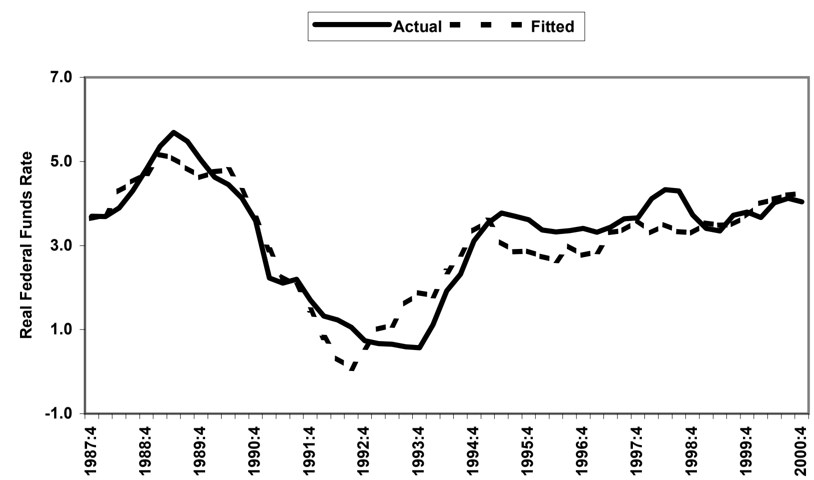

Fig.5 The Fed's Implicit NAIRU and Real Time Estimates

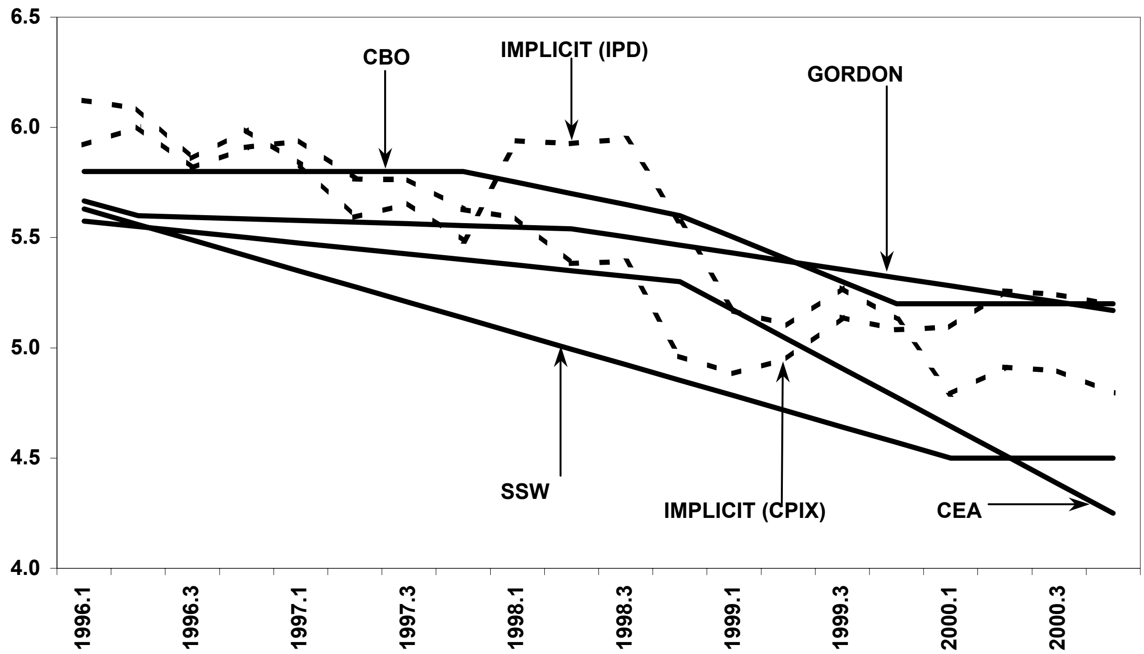

Fig.6 The Fed's Implicit NAIRU and Ex Post Estimates