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December 2007

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MPRA Paper No. 6092, posted 05 Dec 2007 15:21 UTC

# Federal Reserve Information During the Great Moderation

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November 2007

*Forthcoming Journal of the European Economic Association*

## Abstract

Using data from the period 1970-1991, Romer and Romer (2000) showed that Federal Reserve forecasts of inflation and output were superior to those provided by commercial forecasters. In this paper, we show that this superior forecasting performance deteriorated after 1991. Over the decade 1992-2001, the superior forecast accuracy of the Fed held only over a very short time horizon and was limited to its forecasts of inflation. In addition, the performance of both the Fed and the commercial forecasters in predicting inflation and output, relative to that of “naive” benchmark models, dropped remarkably during this period.

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# 1 Introduction

Staff forecasts of macroeconomic developments over the coming year or two play a crucial role in monetary policy deliberations at all central banks. In particular, transcripts of Federal Open Market Committee (FOMC) meetings show that the so-called “Greenbook” forecasts provided by the staff of the Federal Reserve Board have regularly formed the basis for the Fed’s policy discussions.

One important justification for the attention paid to the Greenbook forecasts has been provided by Christina and David Romer (2000). Using forecasts up to 1991, the Romers showed that the Fed staff’s predictions for inflation and output are statistically unbiased and dominate private sector forecasts: In general, they found little evidence that projections can be improved by adding private sector forecasts to the Greenbook forecast. In light of the large amount of staff resources devoted to this activity, the Romers finding of the superiority of the Greenbook forecasts must have been heartening to central bank economists. The finding, however, had implications that went well beyond this. For instance, the Romers presented evidence that private sector forecasts of inflation reacted positively to monetary tightenings because analysts believe the Fed reveals some of its superior information about inflation through these actions. Importantly, they note that the Fed’s superior information about inflation may also explain why long-term interest rates tend to rise when monetary policy tightens.

In this paper, we revisit the informational content of Greenbook forecasts, using an updated dataset that contains the staff forecasts and realized outcomes up to 2001:Q4. There are a number of motivations for this exercise.

The first motivation is that the nature of macroeconomic forecasting has changed dramatically during the period since the end of the sample in the Romer study. It is well known that the Great Moderation has led to dramatic reductions in the volatility of macroeconomic series. Less well-known, however, is that this reduction in volatility has substantially reduced the forecastable element of macroeconomic fluctuations. D’Agostino, Giannone and Surico (2006) have shown that the ability of various time series models, as well as the SPF and Greenbook forecasts, to out-perform naive time series models, has declined. We confirm and update these results for Greenbook and SPF forecasts and show that the  $R^2$ s associated with Greenbook and private sector forecasts have also dropped substantially.

The second motivation is that the period since 1991 has seen a number of important changes in the Fed’s operating procedures, with substantial improvements in external communications and transparency. This is important because it allows us to explore further the reasons for the forecasting advantage found by the Romers. The explanation stressed by the

Romers was that the Fed had an advantage over the private sector due to the substantial numbers of staff it devotes to its forecast exercise. However, the possibility that the Fed staff had an insider advantage—related to knowing the likely future path of policy or the amount of inflation likely to be tolerated—is an obvious alternative. With this alternative in mind, it seems likely that the increased transparency adopted in more recent times has provided less room for such an advantage. Indeed, we show that the period since 1991 has indeed seen a dramatic decline in the accuracy of Greenbook forecasts relative to private sector. While there is still evidence for Fed superiority over the very near term, there has been a steady erosion over time in the Fed’s forecasting advantage at a horizon of one year, which corresponds to the type of horizon that central banks usually have in mind when making policy decisions. This finding may help to explain the so-called interest rate “conundrum” of recent years whereby long-term rates no longer seem to rise in response to monetary policy tightenings.<sup>1</sup>

The contents of the rest of the paper are as follows. Section 2 describes our dataset. Section 3 discusses the decline in forecastability of both output and inflation for both Fed and private sector forecasts. Section 4 documents the evidence for the erosion of the Fed’s forecasting advantage. Section 5 concludes with some interpretations of our results and pointers for future directions of research.

## 2 Data Description

We consider predictions for real output and its deflator from the Greenbook and from the private sector, as defined by the Survey of Professional Forecasters (SPF). Our dataset contains forecasts made during every quarter from 1974:Q4 to 2001:Q4 of both current quarter ( $h = 0$ ) values as well as future horizons ranging up to four quarters ahead ( $h = 4$ ). For each of the steps ahead, the forecasts relate to the annualized quarter-on-quarter growth rate of real output and its deflator. In other words, our  $h = 4$  forecast horizon refers to the actual quarter-on-quarter rate of inflation one year later, not the four-quarter change in inflation over the subsequent year.

The SPF was originally introduced by the American Statistical Association and the National Bureau of Economic Research and is currently maintained by the Philadelphia Fed. The survey is conducted at the end of the second month of each quarter and gathers together forecasts from numerous private sector analysts: For our calculations, we use the median of the individual forecasts.

Greenbook forecasts are prepared for FOMC meetings, which take place roughly every

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<sup>1</sup>Chairman Greenspan first raised this issue in his February 2005 Humphrey-Hawkins testimony. See also Bernanke’s (2006) discussion.

six weeks. As with the SPF, our data on Greenbook forecasts come from the Philadelphia Fed. For quarters that contained multiple Greenbook forecasts, the dataset uses the forecast closest to the middle of the quarter. The Greenbook forecasts are made publicly available with a five-year delay, thereby implying that our sample of forecasts ends in the 2001:Q4.

In addition to the forecasts, our dataset contains the “true” realized values of the relevant series. Since data are continuously revised, for each quarter several measures of inflation and output are available. Following Romer and Romer (2000), we consider as true the figures published after the next two subsequent quarters using data taken from the Philadelphia Fed’s real-time data set.<sup>2</sup> The measure of output is Gross National Product (GNP) until 1991 and Gross Domestic Product (GDP) from 1992 onwards. Our sample starts at 1974:Q4 because prior to this date the Greenbook forecasts were not always available up to the fourth quarter horizon. To make the exercise comparable we select the same starting point also for the SPF forecasts.

### 3 Forecasting During the Great Moderation

We first evaluate the performance of the Greenbook and SPF forecasts over the sub-samples 1974:4-1991:4 and 1992:1-2001:4. The end date of first coincides with that used by Romer and Romer (2000). We evaluate forecasts using the Mean Squared Forecast Error (MSFE), which is defined as:

$$MSFE_{t_0}^{t_1}(i, h, j) = \frac{1}{(t_1 - t_0 + 1)} \sum_{t=t_0}^{t_1} (\hat{\pi}_{h,t}^{i,j} - \pi_{t+h}^i)^2$$

where  $\hat{\pi}_{h,t}^{i,j}$  are the forecasts made at time  $t$  from source  $j \in (GB, SPF)$  at horizon  $h = 0, \dots, 4$  for variable  $i \in (Y, P)$ , where  $Y$  refers to output and  $P$  to inflation;  $t_0$  and  $t_1$  are the first and last point in the sub-samples. Finally,  $\pi_{t+h}^i$  is the “true” realized value for variable  $i$  at time  $t + h$ .

In light of the significant efforts that go into both the Greenbook and private sector forecast exercises, we also follow D’Agostino, Giannone and Surico (2006) by considering the performances of these forecasts relative to “naive” time series models, which we label  $\hat{\pi}_{h,t}^{i,naive}$ . Because inflation is more persistent than output growth, our naive forecasts differ for these two variables. For output growth, our naive forecast is the prevailing sample average of the (annualized quarter on quarter) growth rate of real output, thus assuming that the forecasting model for the level of real output is a random walk with drift. For

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<sup>2</sup>The SPF and Greenbook forecasts and also the real-time datasets are all available at <http://www.phil.frb.org/econ/forecast/index.html>. Note also that for the final year of forecasts in 2001, our dataset includes the subsequent realized values that were published in 2002 and 2003.

inflation, our naive forecast is the average over the previous four quarters of (annualized quarter on quarter) inflation. This model, which has been used as a benchmark by Atkeson and Ohanian (2001), can be interpreted as implying a random walk model for the year-over-year inflation. Real-time data—as available to the forecasters when predictions were made—are used to construct these forecasts.

The results from these exercises are reported in Table 1. The left side of the table reports results for the sample 1974:4-1991:4, with the first column reporting the MSFEs for our naive models and the second and third columns reporting the ratio of MSFEs for the Greenbook and SPF to the MSFEs for the naive models. This statistic can be thought as a measure of predictability:

$$PRED_{t_0}^{t_1}(i, h, j) = \frac{MSFE_{t_0}^{t_1}(i, h, j)}{MSFE_{t_0}^{t_1}(i, h, naive)}$$

The right side of the table reports the same results for the sample 1992:1-2001:4. The  $p$ -values are for the null hypothesis that the Greenbook or SPF forecasts can be considered statistically equal to the forecasts of the naive models.

The most striking result from Table 1 is the substantial reduction in MSFE errors for all forecasts in the later sample. MSFEs for the naive forecasting models for both output and inflation have fallen by between one-fifth and one-third. The MSFEs of the non-model forecasts have also fallen substantially. These reductions reflect the dramatic fall in the volatility of both output and inflation during the Great Moderation. Figure 1, which reports the values of output growth and inflation from the current vintage of national accounts, illustrates how output growth in particular shows less extreme movements than prior to the mid-1980s. Figure 2 reports rolling ten-year standard deviations for quarter-on-quarter percentage changes in real output and its deflator, further illustrates the remarkable decline in volatility.<sup>3</sup>

Table 1 also confirms the findings of D’Agostino, Giannone and Surico (2006) relating to the changes over time in the non-model forecasts relative to the naive forecasts. While the judgmental forecasts were always superior to the naive forecasts during the earlier sample, and often statistically significantly so, this is often not the case during the later sample. For inflation, the Fed’s forecasts during the earlier sample were always statistically significantly better than the naive model, but this advantage eroded in the second period, with the Greenbook forecasts not being statistically significantly better. The SPF forecasts for inflation were superior to the naive model during the first sample but are worse at all horizons apart from the current quarter.

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<sup>3</sup>The dates on the  $x$ -axis are the mid-points of the rolling samples, and so end at 1996:Q4.

The results for GDP show that forecasts based on the prevailing average of GDP growth, which used to be generally inferior to the SPF and Greenbook forecasts, outperform them in the second sample for all horizons apart from the current quarter. Remarkably, Greenbook forecasts for output growth over 1992:Q1-2001:Q4 are significantly *worse* than the forecasts from the naive model.

## 4 Superior Fed Information?

We next update perhaps the key regression in the Romer and Romer (2000) study, which tests whether the Greenbook forecasts contain information beyond that contained in the SPF forecasts (and also whether the SPF forecasts contain information beyond that in the Greenbook forecasts). Specifically, we estimate the following regression:

$$\pi_{t+h}^i = \alpha_h^i + \beta_{SPF,h}^i \hat{\pi}_{h,t}^{i,SPF} + \beta_{GB,h}^i \hat{\pi}_{h,t}^{i,GB} + \varepsilon_{h,t}^i$$

Federal Reserve forecasts provides additional information if and only if the coefficient  $\beta_{GB,h}^i$  is statistically different from zero. The results from these regressions are reported in Table 2.

Before discussing the coefficients from these regressions, the goodness-of-fit statistics are worth noting. These figures present a picture that is somewhat counter-intuitive. In one sense forecasting has become easier: The magnitude of forecasts errors for output and inflation have declined substantially. However, Table 2 shows that in another important sense, forecasting has become harder: The  $R^2$ s associated with the combined Fed and SPF forecasts have declined dramatically. One way to illustrate how this combination can arise is through the following simple example. Consider the AR(1) model

$$y_t = \rho y_{t-1} + \epsilon_t$$

Ceteris paribus, a reduction in volatility associated with smaller shocks will increase the  $R^2$  associated with this model. However, the changes in macroeconomic volatility associated with the Great Moderation have not just involved a reduction in the size of shocks but also a reduction in the *persistence* of the series, in this case, this implies a decline in  $\rho$ . Taking our two samples of 1974:Q4-1991:Q4 and 1992:Q1-2001:Q4, the  $\rho$  coefficient from AR(1) regressions fell from 0.27 to 0.12 for output growth and from 0.84 to 0.32 for inflation. Recall that the unconditional long-run variance in this example is  $\frac{\sigma_\epsilon^2}{1-\rho^2}$  so declines in  $\rho$  will reduce volatility. But they will also reduce the importance of the predictable element and thus the  $R^2$ . Consider the extreme case of  $\rho = 0$ . In this case, the reduction in volatility associated with lower persistence also means that the series has become white noise and thus has become completely unforecastable. The fact that a forecast of output growth

based on the estimated sample average—a model with an  $R^2$  of zero because it does not explain any of the variation around this average—beats most of the Greenbook and SPF forecasts during the latter period shows that this example is actually not too extreme.

Turning to the coefficients in Table 2, the most notable pattern is a decline in the Fed’s apparent informational advantage over private sector forecasters. Consider first the case of inflation. The regressions ending in 1991:Q4 show the Fed forecasts of inflation at horizons  $h = 3$  and  $h = 4$  (key horizons for monetary policy decisions) to be highly statistically significant. However, in the later sample, the Fed forecasts at these horizons are not statistically significant. In the case of output, there is an even more extreme pattern of Fed forecasts becoming worse. Most notably, the Greenbook forecasts at horizons  $h = 4$  go from being positive and significant to being significantly negative!

One concern about these results could be that they reflect the outcome from one, possibly unrepresentative, sample. Figure 3 addresses this by reporting  $t$ -statistics for Greenbook and SPF forecasts from rolling ten-year samples, starting with the sample 1974:Q4 to 1983:Q3 and ending with our later sample of 1991:Q1 to 2001:Q4. The upper panel shows the  $t$ -statistics from the inflation regressions. They show that positive and significant  $t$ -statistics for the Greenbook forecast for almost all samples with mid-points up to the early-1990s. However, after that point there is a steady decline in the  $t$ -statistics associated with the Fed forecasts and a corresponding increase in the  $t$ -statistics for the SPF forecasts. The standard errors for these coefficients changed little, so these patterns reflect changes in the underlying coefficients. The lower panel of Figure 1 reports the results for real output; these show an even stronger pattern of declining performance for the Fed forecasts, with the Greenbook coefficients gradually swinging from the early 1990s onwards from significantly positive to significantly negative.

Despite this systematic decline in the performance of Greenbook forecasts at a one-year horizon, Table 2 and Figure 4 report that the Fed has generally maintained its informational advantage when it comes to predicting the current quarter’s values of inflation and output. The advantage for inflation has remained steady in recent years while there is some evidence of a weakening of the advantage in forecasting current output.

That the Fed still has an advantage in projecting current-quarter figures is perhaps not too surprising. The Federal Reserve Board involves a large number of its staff economists in the Greenbook forecast exercises, with many working as sector analysts specializing in forecasting narrow areas. In relation to projecting current-quarter GDP, these staff will usually have access to some of the various monthly statistical releases that are used by the Commerce Department to construct their estimate of GDP, as well as a host of other high-frequency indicators such as payroll data and industrial production. With all



this information available, as well as the ability to incorporate information on occasional weather-related disasters or major strikes, one might expect a larger team of analysts to produce a better forecast. This type of information also helps explain why the judgmental forecasts for output can still beat the naive sample-average model. The surprise here is that, given the amount of Fed and private-sector resources spent on analyzing such information, these forecasts still can't beat the sample-average model when forecasting next quarter's GDP.<sup>4</sup>

The fact that the Fed's near-term advantage in forecasting inflation is more significant than its advantage in forecasting output is also a little surprising. The GDP deflator is largely based on two public data releases, the CPI and PPI, which are as available to private-sector forecasters as to Fed analysts. The advantage likely reflects the detailed level of disaggregation at which the Fed's price team constructs its near-term forecasts, as well as its diligence in keeping track of the month-to-month inflationary implications of once-off events such as changes in state sales taxes or motor vehicle purchase incentives.<sup>5</sup> While the Fed's price forecasting team surely deserves full credit for this performance, it is not clear that this advantage matters too much for the formulation of monetary policy.

## 5 Discussion of Results

What explains the difference between our results relating to the current quarter and one-year horizon? Romer and Romer (2000) assigned the credit for the Fed's superior performance at all horizons to their large specialized staff. The Fed has retained an advantage in projecting the current quarter and, as just noted, it is this type of forecast that likely benefits most from large staff numbers. However, that the Fed has lost its advantage in forecasting farther out suggests that the large and specialized staff may not have provided a complete explanation for the original results and that other factors may have been at work.

One potential explanation for our results relates to the increased anti-inflationary credibility of the Fed. By raising interest rates during the late 1980s and thus inducing the 1990-1991 recession, the Fed achieved an additional step down inflation from the post-Volcker era (see Figure 1) and firmly enhanced its inflation-fighting credentials. Members of the FOMC also became more explicit in their public statements about their commitments to maintaining a low and steady rate of inflation. This regime change has likely meant that

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<sup>4</sup>One reason is that these forecasts often account for the "payback" next quarter associated with once-off changes due to weather, strikes or inventory buildups and drawdowns.

<sup>5</sup>At this point, full disclosure requires us to admit that the latter co-author on this paper is a former member of the Fed price forecasting team!

Fed and private-sector forecasts are on a more level playing field with regards to assessing the future path of monetary policy. Whereas prior to the 1990s, Fed insiders may have had an advantage in understanding how much inflation the FOMC was willing to tolerate over the coming years, there is now little room for doubt about the Fed's commitment to maintain inflation close to its implicit two percent target over the medium term.

Another potential explanation is that the increase in transparency since the early 1990s has reduced the Fed staff's insider advantage in helping it forecast inflation. This increase in transparency started in February 1994 with the introduction of an explicit statement that the Fed would be intervening to raise the Fed funds rate. Subsequent years saw the announcement of an explicit Fed funds target as well as the introduction of post-meeting statements to communicate the FOMC's view on macroeconomic developments. It seems likely that these changes in communication policy have allowed private sector forecasters to understand the Fed's assessment of the macroeconomy and incorporate this into their own forecasts, thus reducing the room for superior performance for Greenbook forecasts.

Our findings also shed some additional light on the so-called interest rate conundrum of recent years, when increases in short-term interest rates failed to have much effect on longer-term rates. As Romer and Romer (2000) noted, if there is uncertainty about the long-run path of inflation and the Fed staff has superior information, then tighter monetary policy may be a signal of an increase in inflation over the medium term. However, if inflation expectations are anchored and the Fed staff does not have superior information about the inflation outlook than the private sector, then there is little reason to react in this fashion to tightenings. Indeed, with inflation expectation anchored and monetary tightening likely to be short-lived, one should perhaps not expect long rates to move much in response to increases in short-term interest rates.

A final point to note is that our results provide one new way of seeing how the Fed has contributed to the Great Moderation. Prior to the onset of this moderation, there was a substantial amount of predictable volatility in the economy. But much of this predictable volatility, particularly for inflation, was only predictable to insiders at the Federal Reserve itself. The period since the 1990s has seen the reduction of this additional element of predictable volatility and this can be seen as having contributed to the overall reduction in volatility.

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Table 1: Relative MSFE Performance

<i>Period 1974:4–1991:4 (Inflation)</i>				<i>Period 1992:1–2001:4 (Inflation)</i>		
<i>h</i>	<i>MSFE RW</i>	<i>GB/RW</i>	<i>SPF/RW</i>	<i>MSFE RW</i>	<i>GB/RW</i>	<i>SPF/RW</i>
<i>0</i>	3.19	0.44 (0.01)	0.50 (0.02)	0.63	0.62 (0.18)	0.85 (0.44)
<i>1</i>	3.94	0.41 (0.01)	0.56 (0.02)	0.68	1.01 (0.97)	1.16 (0.37)
<i>2</i>	4.74	0.46 (0.00)	0.55 (0.01)	0.76	0.71 (0.16)	1.17 (0.32)
<i>3</i>	5.34	0.37 (0.00)	0.58 (0.02)	0.88	0.68 (0.06)	1.12 (0.50)
<i>4</i>	6.51	0.38 (0.00)	0.62 (0.04)	0.93	0.76 (0.21)	1.18 (0.21)

<i>Period 1974:4–1991:4 (GDP Growth)</i>				<i>Period 1992:1–2001:4 (GDP Growth)</i>		
<i>h</i>	<i>MSFE RW</i>	<i>GB/RW</i>	<i>SPF/RW</i>	<i>MSFE RW</i>	<i>GB/RW</i>	<i>SPF/RW</i>
<i>0</i>	18.86	0.38 (0.01)	0.41 (0.01)	4.30	0.87 (0.62)	0.85 (0.48)
<i>1</i>	16.69	0.78 (0.25)	0.71 (0.10)	4.47	1.03 (0.86)	1.03 (0.86)
<i>2</i>	13.48	0.79 (0.22)	0.89 (0.45)	4.53	1.16 (0.24)	1.00 (0.98)
<i>3</i>	13.29	0.91 (0.57)	0.86 (0.15)	4.57	1.23 (0.11)	1.06 (0.37)
<i>4</i>	12.14	0.80 (0.13)	0.89 (0.38)	4.48	1.29 (0.01)	1.06 (0.33)

Notes: Second and fifth columns report the MSFE of the Naive model. Third, fourth, sixth and seventh columns report the ratio between the MSFE of the GB and SPF forecasts to the MSFE of the naive model. P-values are in parenthesis, they refer to the null hypothesis,  $H_0 : c_h^{i,j} = 0$ , in the following regression:  $(\hat{\pi}_{h,t}^{i,j} - \pi_{t+h}^i)^2 - (\hat{\pi}_{h,t}^{i,naive} - \pi_{t+h}^i)^2 = c_h^{i,j} + u_{h,t}^{i,j}$ .

Table 2: Tests of Superior Fed Information

<i>Period 1974:4–1991:4 (Inflation)</i>					<i>Period 1992:1–2001:4 (Inflation)</i>			
<i>h</i>	$\alpha_h^P$	$\beta_{SPF,h}^P$	$\beta_{GB,h}^P$	$R^2$	$\alpha_h^P$	$\beta_{SPF,h}^P$	$\beta_{GB,h}^P$	$R^2$
<i>0</i>	-0.21	0.38*	0.63***	0.82	-0.09	0.20	0.71***	0.54
<i>1</i>	0.04	-0.07	1.03***	0.75	0.71	-0.22	0.75**	0.17
<i>2</i>	-0.36	0.25	0.78***	0.65	-0.03	-0.05	0.92*	0.26
<i>3</i>	-0.37	-0.13	1.18***	0.69	-0.10	0.39	0.45	0.20
<i>4</i>	-0.20	-0.53***	1.57***	0.65	0.37	0.34	0.28	0.10

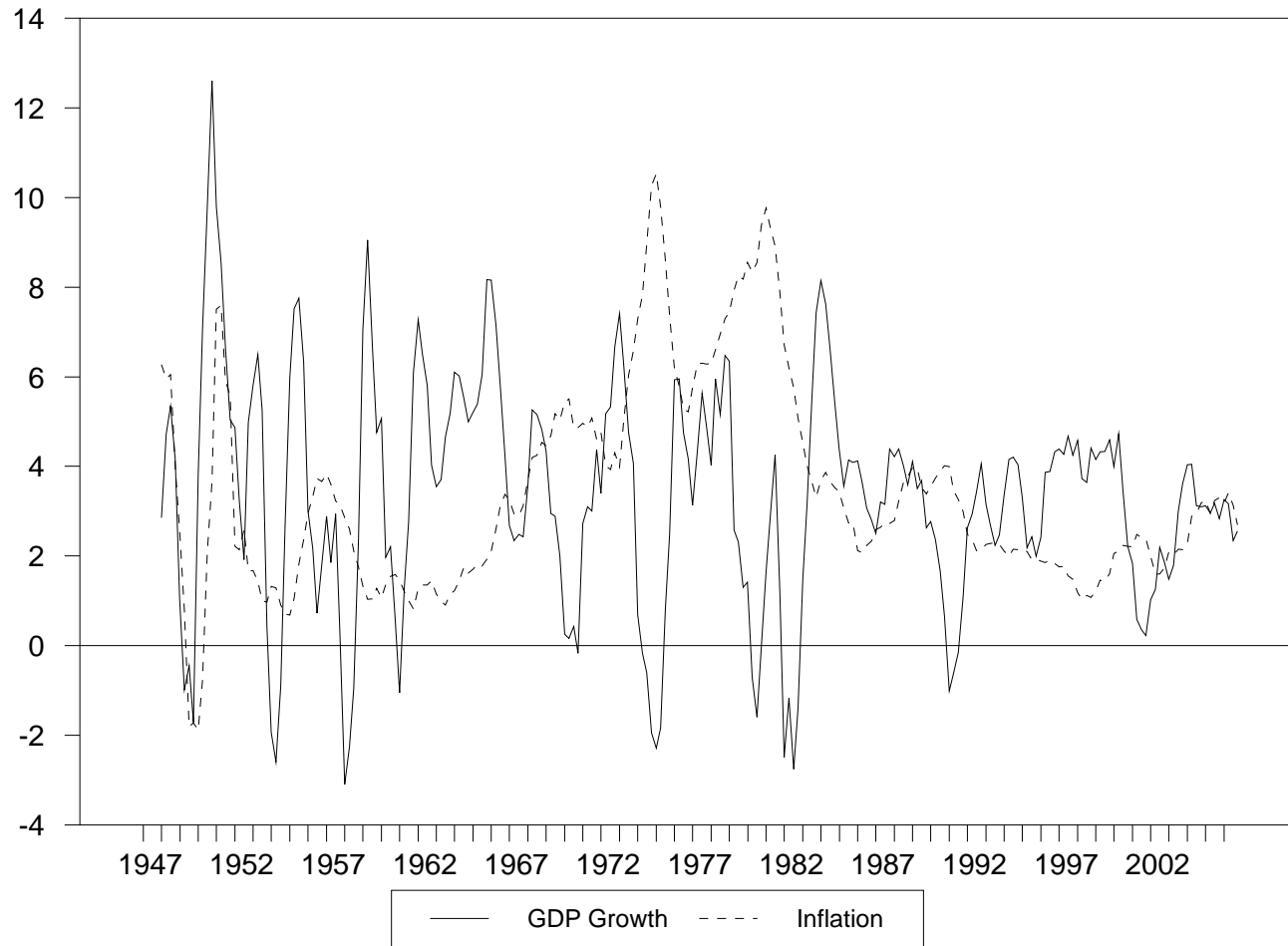
  

<i>Period 1974:4–1991:4 (GDP Growth)</i>					<i>Period 1992:1–2001:4 (GDP Growth)</i>			
<i>h</i>	$\alpha_h^Y$	$\beta_{SPF,h}^Y$	$\beta_{GB,h}^Y$	$R^2$	$\alpha_h^Y$	$\beta_{SPF,h}^Y$	$\beta_{GB,h}^Y$	$R^2$
<i>0</i>	0.26	0.14	0.83**	0.60	1.99*	-0.33	0.86**	0.23
<i>1</i>	0.44	0.69	0.15	0.25	3.78***	-1.34**	1.26**	0.11
<i>2</i>	0.72	-0.13	0.85**	0.19	3.59***	-0.03	-0.09	0.00
<i>3</i>	-0.52	0.73*	0.28	0.15	4.63***	-0.25	-0.27	0.03
<i>4</i>	-0.75	0.36	0.76	0.19	5.03***	0.28	-0.97*	0.12

Notes: Estimated equation:  $\pi_{t+h}^i = \alpha_h^i + \beta_{SPF,h}^i \hat{\pi}_{h,t}^{i,SPF} + \beta_{GB,h}^i \hat{\pi}_{h,t}^{i,GB} + \varepsilon_{h,t}^i$ ,  $h$  is the horizon. \* Significant at 10%, \*\* Significant at 5%, \*\*\* Significant at 1%.

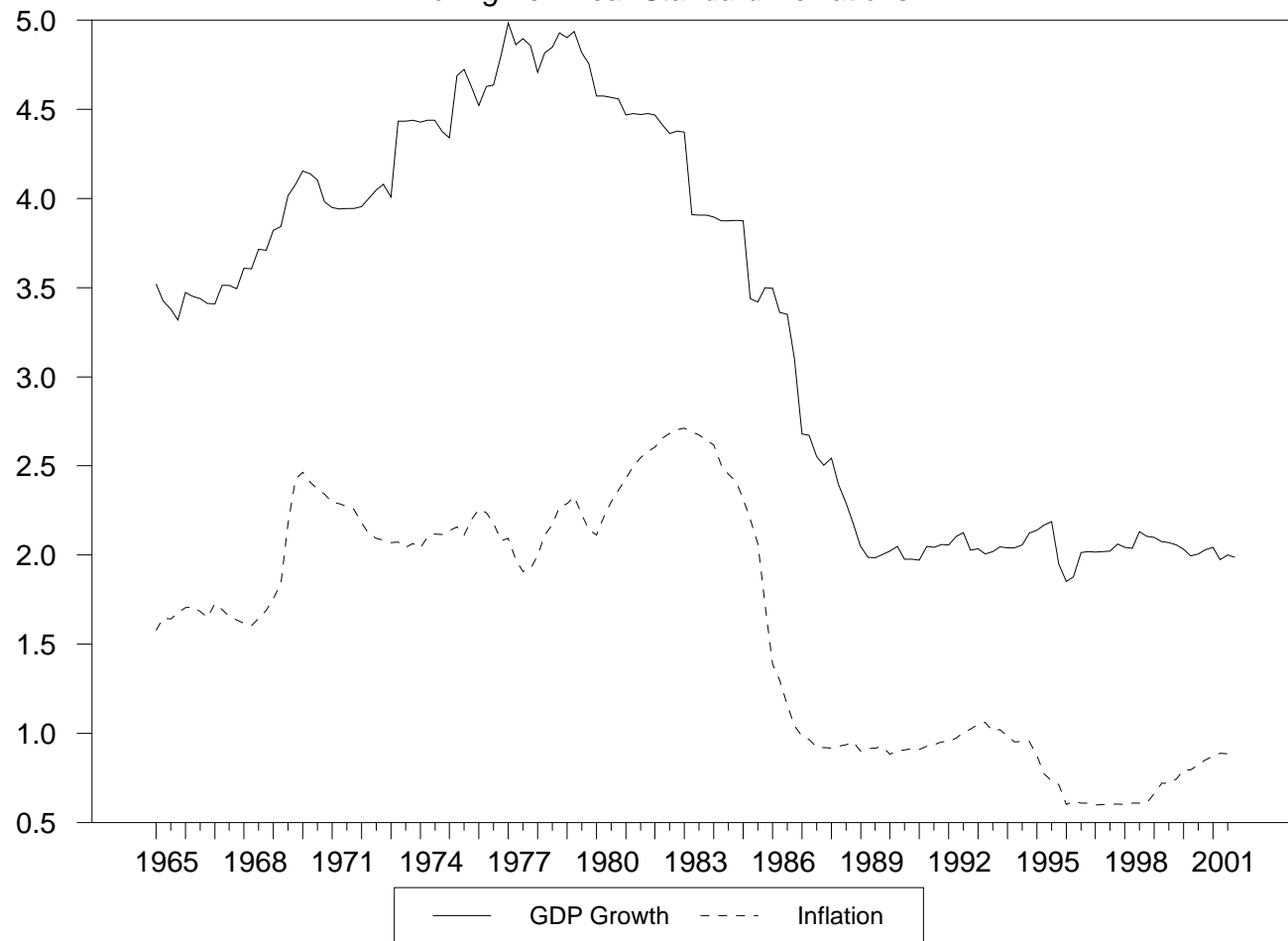
**Figure 1**

*Year-over-Year US GDP Growth and Inflation*



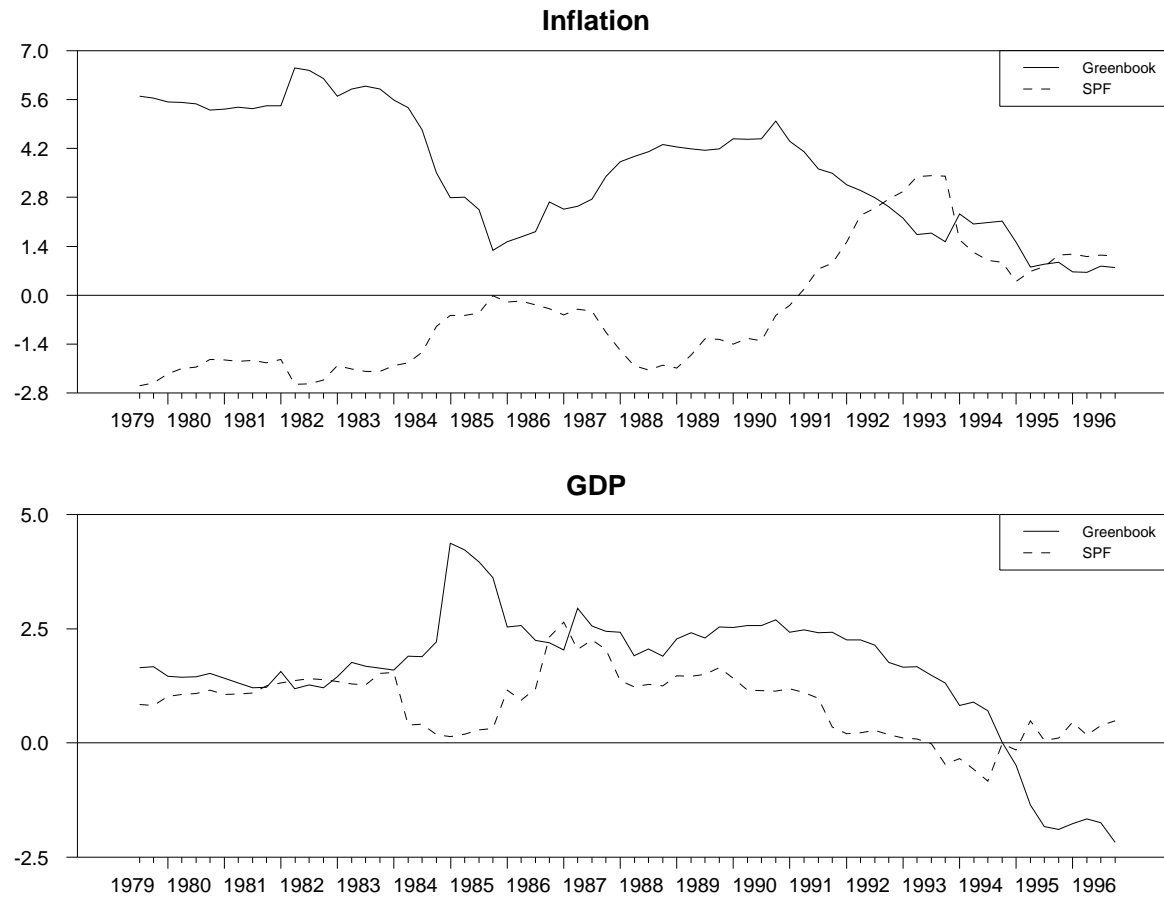
**Figure 2**

*Rolling Ten-Year Standard Deviations*



### Figure 3

*T-Statistics from Rolling Regressions: Four-Quarter-Ahead Forecasts*



## Figure 4

*T-Statistics from Rolling Regressions: Current Quarter Forecasts*

