Forecast Errors Before and During the Great Moderation

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1. Introduction

Since the mid-1980s the U.S. economy has experienced a Great Moderation. Both GDP growth and inflation volatility have declined significantly. Figures 1 and 2 show real GDP growth and inflation over the past 60 years. Margaret M. McConnell and Gabriel Perez-Quiros (2000) found that the most likely break point for GDP volatility is the first quarter of 1984. James A. Kahn, McConnell and Perez-Quiros (2002) find a break in inflation volatility at about that same time although the relative smoothness of inflation post-1984 is not unprecedented (inflation was relatively smooth in the 1950s as well). The standard deviation of annualized GDP growth from 1947 through 1983 was nearly 5%.[1] From 1984 through 2008 the standard deviation of annualized real GDP growth was 2.2%. Similarly, the standard deviation of inflation (annualized growth of the GDP deflator) from 1947 through 1983 was 3.3%. From 1984 through 2008 the standard deviation of inflation has been 1.05%.

The decline in GDP and inflation volatility provides a natural experiment to investigate how forecasts of growth and inflation respond to changes in the underlying distributions of those variables. We address the following questions. 1) How large was the decline in forecast errors? 2) Did forecast accuracy improve relative to the decline in volatility of growth and inflation? 3) Did forecasters respond to the Great Moderation?

1. The standard deviations shown in Figures 1 and 2 were computed from the annualized growth rates of quarterly GDP (Figure 1) and the GDP deflator (Figure 2) over the two sub-samples: 1947-1983 and 1984-2008. The standard deviation bands shown in Figures 1 and 2 were computed by adding and subtracting the calculated standard deviations from the respective means of the two series for each sub-sample.

We investigate these questions by looking at changes in forecast accuracy for the Survey of Professional Forecasters (SPF) and the Federal Reserve's Greenbook forecast.[2]

We find that the absolute value of forecast errors for both the Survey of Professional Forecasters and the Federal Reserve fell significantly during the Great Moderation. At most forecast horizons the decline was 50% or more. We also find that the dispersion of forecasts in the Survey of Professional Forecasters dropped significantly during the Great Moderation. We argue that the drop in dispersion indicates that forecasters did in fact respond to the Great Moderation by changing their forecasts. The decline in the dispersion of forecasts was roughly coincident with the onset of the Great Moderation. Finally, we find that forecast accuracy relative to the decline in volatility did not improve.

In section 2 we review the literature on the Great Moderation. Section 3 describes the data. Section 4 presents evidence on the improvement in forecast performance during the Great Moderation. Section 5 looks at the change in forecast performance relative to the reduction in the volatility of GDP growth and inflation. Section 6 presents the results from an endogenous break point test and section 7 concludes.

2. Literature Investigating the Sources of the Great Moderation

The Great Moderation in both growth and inflation are clearly evident from Figures 1 and 2. But the causes of the Great Moderation are still debated. In general, researchers classify causes of the Great Moderation into three categories: good luck, improved policy and structural change (Stock and Watson, 2003). By "good luck"

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2. The forecasts we use in this study are the Greenbook forecasts which are prepared by the staff of the Board of Governors and are therefore sometimes referred to as the staff forecasts to differentiate them from the forecasts presented by the members of the FOMC. See Gavin and Mandal (2001) for a comparison of private sector and FOMC forecasts.

researchers mean smaller shocks to the economy. Improved policy generally refers to improved monetary policy. Structural change means that the propagation mechanism which translates shocks into business cycle fluctuations has changed in a way that leads to smaller fluctuations.

McConnell and Perez-Quiros (MPQ) and more recently Davis and Kahn (2008) attribute the decline in GDP volatility to structural change. They show that the decline in GDP volatility was due mainly to a decline in the volatility of durable goods output, which resulted from improved inventory management. Kim, Nelson and Piger (2003) find that the Great Moderation was more broadly based than durable goods output suggesting that policy could have played an important role in the Great Moderation. Stock and Watson (2003) investigate several sources of the Great Moderation. They find that improved policy accounted for 20-30% of the moderation in GDP. Identifiable good luck accounts for another 20-30% of the moderation and unidentifiable good luck accounts for the rest (40-60%).

Another issue discussed in the literature is whether the moderation was due to a change in the propagation mechanism or the size of shocks feeding into an unchanging propagation mechanism. Recent work by Gali and Gambetti (2009) and Ramey and Vine (2006) suggests that the propagation mechanism did change. In contrast, Stock and Watson (2003), Justiniano and Primiceri (2006) and Arias et al. (2006) find that the propagation mechanism has remained stable but the shocks got smaller starting in the early to mid 1980s.

3. Data

We use three sources of data to measure the decline in forecast errors that occurred with the onset of the Great Moderation. The first source is the Survey of Professional Forecasters (SPF)[3], the second source is the Federal Reserve's Greenbook forecasts, which are released with a 5-year lag and the third is a set of forecasts produced by a sequence of ARMA models that serve as our benchmark forecasts. The sample of forecasts from the Survey of Professional Forecasters covers the period 1968.4 through 2008.4. The sample of forecasts from the Greenbooks covers the sample 1965.11 through 2002.12. The Greenbook forecasts are prepared for each FOMC meeting (12 meetings per year prior to the early 1980s and 8 meetings per year since that time). For the forecast error comparisons we use the common sample period of 1968.11 through 2002.12.

Our variables of interest are quarterly real output growth and quarterly inflation. We investigate the change in forecast accuracy for horizons 1 through 4 quarters ahead. Although the unit of analysis is the same in all three datasets, that is, quarterly forecasts, the frequency at which we observe those forecasts does differ across the three datasets. The SPF forecasts are produced quarterly, the ARMA forecasts are produced monthly and the Greenbook forecasts are produced just prior to each FOMC meeting.

Our forecast errors are computed using the real-time measures of real output growth and inflation (see Croushore and Stark, 2001). Our real-time measures are the first final revisions published by the Bureau of Economic Analysis at the end of the third

3. The SPF was previously called the ASA-NBER survey of forecasters from 1968 to 1990. The Federal Reserve Bank of Philadelphia took over the survey in 1990. See Croushore and Stark (2001) for a complete description of the SPF. We use both the median and the individual forecasts from the SPF.

month following the end of each quarter.[4] We define the forecast errors as the difference between the real time actual observation and the forecast of that observation. Real output growth is measured as the annualized growth of real GNP before 1992 and real GDP afterwards. Inflation is the annualized growth of the GNP deflator prior to 1992, the GDP deflator between 1992 and 1996 and the GDP chain-weighted price index after 1996. These changes in measures of real growth and inflation match the changes in the variables that the Federal Reserve and SPF were forecasting.

4. Forecast Errors Before and During the Great Moderation

We begin by looking at the absolute value of the median forecast error from the SPF before and after the onset of the Great Moderation. According to MPQ, the Great Moderation began in the first quarter of 1984. We measure the average of the median error before and during the Great Moderation by estimating the following regression:

$$|error_t| = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \varepsilon_t \qquad (1)$$

where,

$D_{1t} = 1$ for t $\leq$ 1983:4

0 for t > 1983:4

$D_{2t} = 0$ for t $\leq$ 1983:4

1 for t > 1983:4

Table 1 shows the results for the absolute value of the median SPF errors for forecast horizons 1-4.[5] The results in Table 1 show that the absolute value of the median forecast error dropped by half in most cases (by more than half in some cases) and the

4. These real-time measures are also referred to as the 90-day measures.
5. We obtained similar results for the absolute value of the mean but chose to focus on the median because the Jarque-Bera test strongly rejected normality in the cross-sectional distribution of the SPF data.

decrease was statistically significant in all cases.[6] The reduction in forecast errors is about the same across all 4 horizons.

Table 2 shows the results for the absolute value of the forecast error for horizons 1 to 4 for the Federal Reserve Greenbook forecasts. The values for the forecast errors of the Fed are similar to the values for the average forecast errors for the median SPF. In addition, like the SPF, the Fed's forecast errors dropped significantly with the onset of the Great Moderation, in many cases by half or more. And, like the SPF, the Fed's forecast performance, by this measure, improved almost equally at all forecast horizons.

Our benchmark forecast model is a recursively estimated ARMA model. We identified and estimated a separate ARMA model for each real-time monthly data set starting in 1968.11 and continuing through 2002.12. The specification for each model is based on the minimum Schwartz Information Criterion (SIC) statistic.[7] Table 3 shows the results for the absolute value of the ARMA forecast errors. The ARMA errors are uniformly larger than both the Fed errors and the SPF's errors before the onset of the Great Moderation. The percentage decline in the size of the errors ranges from 55% to 60%, only slight larger than the percentage declines in the SPF and Fed errors. A particularly large drop occurred at the 1-quarter horizon for real output growth. Prior to 1983 the ARMA forecast error for 1-quarter ahead growth was almost 4% and after 1984.1 that error dropped 58% which is 12 percentage points larger than the drop in SPF errors and 14 percentage points larger than the drop in Fed errors. During the Great

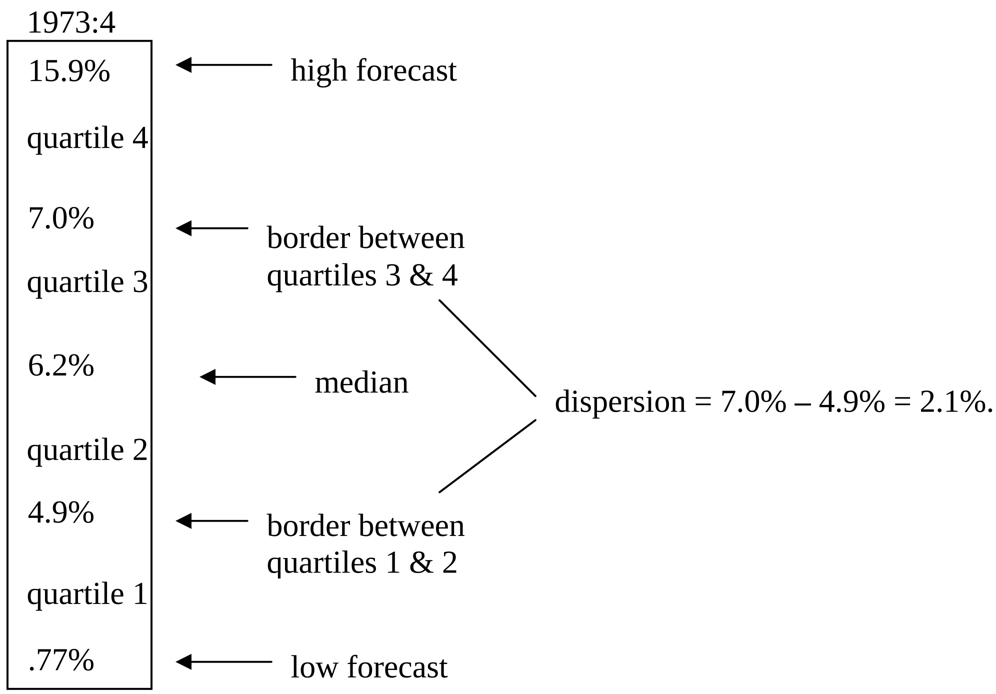
6. All hypotheses tests were conducted using Newey-West (1987) standard errors, which are consistent in the presence of unknown forms of serial correlation and heteroskedatsicity.
7. We examined ARMA models from ARMA(0,0) to ARMA (8,8) when selecting a specification for each time period.

Moderation the sizes of the ARMA forecast errors are nearly identical to the SPF and Fed errors.

Figures 3 and 4 summarize the information contained in Tables 1 through 3. The horizontal axis in each figure shows the source of the forecast and the forecast horizon. For example, SPF2 is the 2-quarter ahead forecast produced by the Survey of Professional Forecasters. The vertical axis in Figures 3 and 4 measure the pre and post-1984 averages of the absolute forecast errors. These averages are the coefficient estimates from Tables 1-3 where α_1 is the pre-1984 average absolute forecast error and α_2 is the post-1984 average absolute forecast error. The graphical depiction of these average absolute forecast errors provides a visual impression of the dramatic decline in those errors after the onset of the Great Moderation.

An advantage of the SPF dataset is that it can provide information on changes in the cross-sectional dispersion of forecasts over time. Table 4 shows the results of estimating equation (1) by replacing the absolute error as the dependent variable with a measure of the cross-sectional dispersion of forecasts at each point in time. We chose to measure the cross-sectional dispersion by taking the difference between the upper third quartile and lower first quartile of the forecast errors in each quarter. Again, we chose this measure instead of the standard deviation of forecasts errors because the forecast errors are not normally distributed. The diagram below illustrates our calculation for the 1-quarter ahead forecasts of inflation for 1973:4. We first ordered the forecasts from high to low and divided the forecasts into quartiles. We then subtracted the forecast at the border between the 3rd and 4th quartile from the forecast at the border between the 1st

and 2nd quartile to compute the dispersion of forecasts for that quarter. For 1973:4, the dispersion measure was 7.0% – 4.9% = 2.1%.



The results in Table 4 indicate that the dispersion of forecast errors for growth decreased significantly at all forecast horizons with the onset of the Great Moderation. The dispersion of inflation forecasts dropped at horizons 1 and 4, but the decline at horizon 2 is not significant and the decline at horizon 3 is only marginally significant. In percentage terms, the drop in the dispersion of growth forecasts across forecast horizons are nearly identical (45-50%). For inflation, the decline in dispersion is mixed: the 1 and 4 quarter horizon dispersion dropped by 23%. The dispersion of inflation forecast errors declined by 15% at the 2-quarter ahead horizon and 16% at the 3-quarter ahead horizon.

Figures 5 and 6 display the results contained in Table 4 in graphical form. The horizontal axis in each figure shows the forecast horizon for which the dispersion of forecast errors is measured. For example, disp3 is the average dispersion of 3-quarter ahead forecast errors across participants in the Survey of Professional Forecasters. The vertical axis in Figures 5 and 6 measure the pre and post-1984 averages of the dispersion of forecast errors. These averages are the coefficient estimates from Table 4 where α_1 is the pre-1984 average dispersion of forecast errors and α_2 is the post-1984 average dispersion of forecast errors. As can be seen in Figure 5, the dispersion of real output growth forecast errors dropped dramatically with the onset of the Great Moderation. Prior to the Great Moderation, the dispersion of forecast errors ranged from 1.90 percentage points to 2.03 percentage points. With the onset of the Great Moderation, the dispersion of real growth forecast errors declined between 90 and 100%. Figure 6 shows the much smaller decline in the dispersion of inflation forecasts, perhaps reflecting the fact that the average dispersion of inflation forecasts prior to 1984 was already significantly smaller than the average dispersion of real output growth forecast errors. Despite being visually less dramatic than the decline in the dispersion of real output growth forecast errors, the decline in inflation forecast errors at horizons 1 and 4 was statistically significant. One implication of the reduction in dispersion after 1984 is that median forecasts of output growth and inflation are better representative of consensus forecasts since the onset of the Great Moderation.

5. Has Forecast Performance Improved Relative to the Change in Volatility?

Although the absolute value and dispersion of forecast errors declined during the Great Moderation, the economy was, in some sense, easier to forecast because both growth and inflation were less volatile. An interesting question, therefore, is whether forecast errors fell relative to the change in the volatility of output growth and inflation.

To investigate whether forecast errors fell relative to the reduction in the volatility of growth and inflation we constructed an h-step ahead normalized forecast error

$$NE_t^h = \frac{\left|error_t^h\right|}{\sum_{i=-2}^{2} \frac{|ARMA\ error_{t-i}^h|}{5}} \qquad (2)$$

where $\sum_{i=-2}^{2} \frac{|ARMA\ error_{t-i}^h|}{5}$ is a centered 5-month moving average of the *h*-step ahead ARMA forecast error from our benchmark model. The numerator of equation (2) contains the *h*-step ahead forecast error for either the SPF or the Greenbook. Thus, the normalized error controls for the degree of difficulty in forecasting (the forecastability) as defined by the ARMA model.

Tables 5 and 6 show the results from estimating equation (1) replacing the dependent variable with the normalized error, NE_t^h for the SPF and the Fed respectively. The results of both tables suggest that forecasting did not improve relative to the reduction in the volatility of the economy.[8] In most cases the normalized error, NE_t^h increased slightly (but not significantly). In those few cases where NE_t^h fell, the reduction was insignificant as well.

Figures 7 and 8 summarize the results in Tables 5 and 6. The horizontal axis in each figure shows the source of the forecast and the forecast horizon. For example SPF2 is the 2-quarter ahead forecast produced by the Survey of Professional Forecasters,

8. We estimated our model using two alternative benchmark forecasts for our normalization: a naïve benchmark (the lagged value of the series) and ARIMA specifications that are well established in the literature. For inflation, we used an IMA(1,1) (Stock and Watson, 2007) and for real GDP growth we used an AR(1) (Campbell and Mankiw, 1987). The results using these alternative benchmarks support our conclusion that the absolute value of the forecast errors relative to the benchmark forecast did not decline with the onset of the Great Moderation. In the case of real output growth forecasts produced by the Federal Reserve, using the naïve benchmark, the absolute value of forecast errors actually increased relative to the benchmark with the onset of the Great Moderation. These additional results are available upon request from the authors.

normalized by our benchmark forecast error. The vertical axis in Figures 7 and 8 measure the pre and post-1984 averages of the absolute forecast errors, relative to the benchmark. These averages are the coefficient estimates from Tables 5 and 6 where α_1 is the pre-1984 average absolute forecast error and α_2 is the post-1984 average absolute forecast error. The graphical depiction of these average absolute forecast errors relative to the benchmark shows no reduction in forecast errors relative to the change in forecastability of the economy after 1984.

6. Endogenous Break Point Tests

The results presented in Tables 1-6 assume that the Great Moderation started in the first quarter of 1984. However, it is certainly possible that the response of forecasters to the break in volatility does not correspond to the actual break in volatility. In this section we present results from an endogenous break point test to determine the timing of forecasters' response to the Great Moderation.

In order to detect a change in forecaster behavior, we must look at the timing of the decrease in the cross-sectional dispersion of forecast errors. Table 7 reports the results of searching endogenously for the break point in the interquartile dispersion series. We estimated equation (1) with the interquartile dispersion as the dependent variable over each sample split beginning in 1975:3 (to allow enough degrees of freedom) and ending with 2002:12. Table 7 reports the date at which the split most likely occurred based on the likelihood ratio statistic.[9]

The decline in the dispersion of output growth forecasting errors appears to have occurred in the early 1980s (except for the 2-quarter-ahead horizon for real output

9. The p-values are computed using Hansen's (2000) "fixed regressor bootstrap" procedure.

growth). Similarly, the dispersion of inflation forecast errors decline in the early-to-mid-1980s. Thus, it appears that forecasters adjusted their forecasts almost contemporaneously with the onset of the Great Moderation in the United States.

The Great Moderation in the United States began in the mid-1980s. Similar moderations occurred elsewhere, but the timing varies considerably. Mills and Wang (2003) find that the most appropriate break point in the U.K. is 1993. In Canada, the stabilization occurred in the late 1970s. In Germany the break point is around 1974. Italy's break point is closest to the U.S. one, occurring in 1982. The French break point occurs around 1979, and the Japanese break is around 1976. Although several empirical studies confirm that the break in U.S. volatility occurred in the mid-1980s, there is much less agreement about the break points in volatility. For example, Summers (2005) finds a reduction in output volatility in Canada in the late 1980s, France and Japan in the mid-1970s, Germany in the early 1970s, the U.K. and Italy in the early 1980s and Canada in the late 1980s. Stock and Watson (2005), using a different empirical methodology, find a reduction in output volatility in France in the late 1960s, Germany in the early 1990s, and Canada in the early 1990s. Their results for the U.K. and Italy were similar to those found by Summers. Betancour, et. al (2006) find that developing countries experienced Great Moderations in the mid-1990s.

Forecasters of U.S. economic conditions certainly account for the economic conditions of other countries, especially those with which the U.S. engages in significant trade. Moderating conditions elsewhere in the world could therefore have influenced the decline in the dispersion of forecasts of U.S. output growth and inflation that we have documented here. However, the fact that the identified dates of moderation outside of the

U.S. varies considerable suggests that forecasters of the U.S. economy in the early to mid-1980s did not observe a uniform reduction in foreign output growth and inflation and therefore were unlikely to have been significantly influenced by moderating conditions outside of the U.S. when calculating their forecasts.

7. Summary and Conclusion

U.S. growth and inflation volatility dropped significantly in the mid-1980s. The empirical evidence presented in this paper shows that forecast errors dropped in absolute size, but forecast errors normalized for the size of economic fluctuations remained roughly unchanged. The cross-sectional dispersion of forecasts fell in conjunction with the onset of the Great Moderation, which is consistent with a change in forecaster behavior in response to the Great Moderation.

The reduction in forecast errors that accompanied the onset of the Great Moderation, presumably could translate into improved policymaking, which could provide further moderation. With the recent global financial crisis and recession, it will likely be several years before that hypothesis can be thoroughly tested.[10] Our finding that forecaster behavior changed in response to the Great Moderation, and with one exception, without substantial lag, suggests that forecasters were able to identify the onset of the Great Moderation in nearly real-time. To the extent that private sector forecasters provide information, which moves the economy to its rational expectations equilibrium, this quick response on the part of private sector forecasters is suggestive of a mechanism by which the economy may return quickly to the rational expectations equilibrium in response to a change in the distribution of shocks hitting the economy. But although the

10. A recent article by Todd E. Clark (2009) suggests that the current economic downturn does not necessarily mark an end to the Great Moderation.

Great Moderation did provide a natural experiment with which to evaluate forecaster response, it is merely one observation of such a response. A thorough test of the response of forecasters to changes in the economy would require a much larger sample of identifiable changes in the distribution of shocks driving real output growth and inflation.

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Table 1
Pre and Post 1984:1 Mean Absolute Forecast Errors
Survey of Professional Forecasters - Median
November 1968 – December 2002

Forecast Error for	Pre-1984:1 Mean (α_1)	Post-1983:4 Mean (α_2)	Difference in Means (α_1-α_2)	$\bar{R}^2$	SE of Regression	N = obs
y_{t+1}	2.99** (.35)	1.62** (.13)	1.37** (.37)	.11	1.91	137
y_{t+2}	3.51** (.40)	1.68** (.13)	1.82** (.42)	.15	2.16	137
y_{t+3}	3.51** (.43)	1.67** (.16)	1.83** (.45)	.13	2.35	137
y_{t+4}	3.63** (.45)	1.68** (.15)	1.95** (.48)	.15	2.23	132
π_{t+1}	1.81** (.19)	.84** (.07)	.96** (.20)	.18	1.00	137
π_{t+2}	2.06** (.24)	.91** (.08)	1.15** (.26)	.18	1.20	137
π_{t+3}	2.24** (.28)	1.01** (.09)	1.23** (.29)	.17	1.32	136
π_{t+4}	2.50** (.33)	1.04** (.09)	1.46** (.34)	.20	1.42	132

Notes:
Where $t+h$ is the h-quarter ahead forecast error for real GDP growth (y) and inflation (π).
Newey-West standard errors are in parentheses below the coefficient estimates
** indicates significant at the 0.01 level
* indicates significant at the 0.05 level
† indicates significance at the .10 level

Table 2
Pre and Post 1984:1 Mean Absolute Forecast Errors
Federal Reserve Greenbook Forecasts
November 1968 – December 2002

Forecast Error for	Pre-1984:1 Mean (α_1)	Post-1983:4 Mean (α_2)	Difference in Means (α_1-α_2)	$\bar{R}^2$	SE of Regression	N = obs
y_{t+1}	3.01** (.35)	1.67** (.12)	1.33** (.36)	.10	2.00	314
y_{t+2}	3.20** (.38)	1.68** (.15)	1.51** (.41)	.11	2.17	310
y_{t+3}	3.44** (.46)	1.74** (.15)	1.70** (.49)	.10	2.50	293
y_{t+4}	3.08** (.37)	1.68** (.16)	1.40** (.41)	.09	2.21	265
π_{t+1}	1.52** (.19)	.73** (.06)	.80** (.20)	.12	1.05	315
π_{t+2}	1.76** (.25)	.75** (.06)	1.02** (.26)	.15	1.22	311
π_{t+3}	1.83** (.29)	.76** (.06)	1.07** (.30)	.15	1.29	294
π_{t+4}	1.88** (.33)	.75** (.07)	1.13** (.34)	.14	1.39	266

Notes:
Where $t+h$ is the h-quarter ahead forecast error for real GDP growth (y) and inflation (π).
Newey-West standard errors are in parentheses below the coefficient estimates
** indicates significant at the 0.01 level
* indicates significant at the 0.05 level
† indicates significance at the .10 level

Table 3
Pre and Post 1984:1 Mean Absolute Forecast Errors
ARMA models
November 1968 – December 2002

Forecast Error for	Pre-1984:1 Mean (α_1)	Post-1983:4 Mean (α_2)	Difference in Means (α_1-α_2)	$\bar{R}^2$	SE of Regression	N = obs
y_{t+1}	3.98** (.46)	1.67** (.15)	2.31** (.49)	.14	2.78	410
y_{t+2}	4.13** (.41)	1.79** (.15)	2.33** (.44)	.18	2.46	410
y_{t+3}	4.00** (.47)	1.79** (.16)	2.20** (.50)	.15	2.58	410
y_{t+4}	3.99** (.43)	1.78** (.15)	2.21** (.46)	.16	2.47	410
π_{t+1}	2.32** (.27)	1.07** (.09)	1.32** (.28)	.17	1.44	410
π_{t+2}	2.58** (.28)	1.06** (.08)	1.52** (.29)	.19	1.53	410
π_{t+3}	2.88** (.31)	1.10** (.07)	1.78** (.32)	.24	1.56	410
π_{t+4}	2.94** (.33)	1.19** (.08)	1.75** (.34)	.21	1.67	410

Notes:
Where $t+h$ is the h-quarter ahead forecast error for real GDP growth (y) and inflation (π).
Newey-West standard errors are in parentheses below the coefficient estimates
** indicates significant at the 0.01 level
* indicates significant at the 0.05 level
† indicates significance at the .10 level

Table 4
Pre and Post 1984:1 Mean Interquartile Dispersion
Survey of Professional Forecasters - Median
November 1968 – December 2002

Forecast Error for	Pre-1984:1 Mean (α_1)	Post-1983:4 Mean (α_2)	Difference in Means (α_1-α_2)	$\bar{R}^2$	SE of Regression	N = obs
y_{t+1}	1.99** (.10)	1.09** (.05)	.91** (.11)	.43	.52	137
y_{t+2}	1.87** (.08)	1.08** (.06)	.79** (.09)	.41	.47	137
y_{t+3}	1.90** (.08)	1.04** (.05)	.87** (.09)	.46	.47	137
y_{t+4}	2.03** (.08)	1.02** (.05)	1.01** (.09)	.56	.44	132
π_{t+1}	1.20** (.08)	.93** (.04)	.27** (.09)	.07	.49	137
π_{t+2}	1.14** (.10)	.97** (.04)	.17 (.11)	.02	.47	137
π_{t+3}	1.12** (.09)	.94** (.04)	.18† (.10)	.03	.45	137
π_{t+4}	1.23** (.08)	.95** (.04)	.28** (.09)	.10	.40	137

Notes:
Where *t+h* is the *h*-quarter ahead forecast error for real GDP growth (y) and inflation (π).
Newey-West standard errors are in parentheses below the coefficient estimates
** indicates significant at the 0.01 level
* indicates significant at the 0.05 level
† indicates significance at the .10 level

Table 5
Pre and Post 1984:1 Mean Normalized Absolute Forecast Errors
Survey of Professional Forecasters - Median
November 1968 – December 2002

Forecast Error for	Pre-1984:1 Mean (α_1)	Post-1983:4 Mean (α_2)	Difference in Means (α_1-α_2)	$\bar{R}^2$	SE of Regression	N = obs
y_{t+1}	.95** (.14)	1.10** (.09)	-.14 (.17)	-.001	.87	136
y_{t+2}	.89** (.07)	1.03** (.08)	-.14 (.11)	.004	.65	136
y_{t+3}	.91** (.07)	1.01** (.10)	-.10 (.11)	-.001	.65	136
y_{t+4}	.94** (.08)	1.01** (.09)	-.08 (.12)	-.004	.70	131
π_{t+1}	1.03** (.13)	.90** (.07)	.13 (.14)	.000	.76	136
π_{t+2}	.94** (.10)	.94** (.08)	-.001 (.13)	-.007	.67	136
π_{t+3}	1.00** (.15)	1.02** (.10)	-.02 (.18)	-.007	.87	135
π_{t+4}	1.07** (.16)	.87** (.07)	.20 (.17)	.009	.76	131

Notes:
Where $t+h$ is the h-quarter ahead forecast error for real GDP growth (y) and inflation (π).
Newey-West standard errors are in parentheses below the coefficient estimates
** indicates significant at the 0.01 level
* indicates significant at the 0.05 level
† indicates significance at the .10 level

Table 6
Pre and Post 1984:1 Mean Normalized Absolute Forecast Errors
Federal Reserve Greenbook Forecasts
November 1968 – December 2002

Forecast Error for	Pre-1984:1 Mean (α_1)	Post-1983:4 Mean (α_2)	Difference in Means (α_1-α_2)	$\bar{R}^2$	SE of Regression	N = obs
y_{t+1}	.94** (.11)	1.15** (.09)	-.20 (.15)	.010	.86	310
y_{t+2}	.93** (.12)	1.02** (.09)	-.08 (.15)	.000	.86	307
y_{t+3}	.98** (.09)	1.14** (.12)	-.16 (.15)	.004	.92	287
y_{t+4}	.84** (.07)	1.03** (.09)	-.19 (.12)	.013	.71	262
π_{t+1}	.80** (.07)	.86** (.07)	-.06 (.10)	.000	.64	306
π_{t+2}	.77** (.08)	.77** (.05)	.008 (.09)	-.003	.52	303
π_{t+3}	.77** (.11)	.76** (.06)	.01 (.13)	-.003	.66	285
π_{t+4}	.75** (.11)	.67** (.05)	.08 (.12)	.001	.58	258

Notes:
Where $t+h$ is the h-quarter ahead forecast error for real GDP growth (y) and inflation (π).
Newey-West standard errors are in parentheses below the coefficient estimates
** indicates significant at the 0.01 level
* indicates significant at the 0.05 level
† indicates significance at the .10 level

Table 7
Endogenous Breakpoint Test
Interquartile Dispersion
Survey of Professional Forecasters

Dispersion of Forecast Error for	Break Date	p-value
y_{t+1}	1983.2	.000
y_{t+2}	1990.11	.000
y_{t+3}	1983.8	.000
y_{t+4}	1981.11	.000
π_{t+1}	1982.8	.000
π_{t+2}	1982.8	.000
π_{t+3}	1985.11	.000
π_{t+4}	1986.5	.000

Notes: the p-values were computed by the “fixed-regressor bootstrap method” described in Hansen (2000).