Inflation forecasts and core inflation measures: Where is the information on future inflation?

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ABSTRACT: This paper brings together several strands of the inflation literature. Specifically, this paper uses the forecast from a random walk model of inflation as a benchmark to test and compare the forecast performance of several alternatives including the Greenbook forecast by the Fed staff, the Survey of Professional Forecasters median forecast, lagged CPI inflation minus food and energy, lagged CPI weighted median inflation, and lagged CPI trimmed mean inflation. The Greenbook forecast was found in previous literature to be a better forecast than other private sector forecasts. Our results indicate that both the Greenbook and the Survey of Professional Forecasters median forecasts of inflation and lagged core inflation measures may contain better information than forecasts from a random walk model. The Greenbook's superiority appears to have declined against other forecasts and lagged core inflation measures.

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1. Introduction

This paper examines the information content of forecasts of inflation and measures of core inflation for the Consumer Price Index (CPI). Forecasts of inflation and core inflation measures are often used by both policy makers and the public to gauge underlying price pressures in the economy. The previous literature considers pieces of this question but none compare the Greenbook forecast, Survey of Professional Forecasters (SPF) forecast and lagged core inflation measures (minus food and energy, weighted median and trimmed mean). This paper expands on the work of Ang, Bekaert and Wei (2007) who find that the median forecast of the SPF was better than a variety of models, even some complicated ones[1] and Faust and Wright (2011) who find that subjective forecasts such as the Blue Chip, SPF and the Greenbook are superior to their simple benchmark for several measures of inflation.[2]

Studies of forecasts of inflation often use either the GNP/GDP deflator, CPI or Personal Consumption Expenditure Price Index (PCEPI). The Federal Reserve's Greenbook and the SPF's survey did not contain forecasts for the PCEPI until 2000 and 2007, respectively. Therefore, previous studies examining forecasts focus either on the GNP/GDP deflator or CPI. This study uses the CPI since there is a fairly long time series available and the Cleveland Fed has calculated both the weighted median and trimmed mean CPI inflation rates for many years.

This paper provides an analysis of the forecasting ability of forecasts such as the Greenbook and SPF and backward-looking measures of core inflation by comparing the forecast errors from these to forecast errors based on the forecast from a random walk model of inflation suggested by Atkeson and Ohanian's (2001) research. Additionally, this paper combines the literature on forecasts and core inflation by testing whether Greenbook forecasts do still contain

[1] They did not consider the Greenbook forecasts.
[2] The benchmark model is an autoregressive (AR) model, an AR(1) model, for the first difference of consumer price index with a fixed slope coefficient.

superior information about future inflation over SPF forecasts and backward-looking measures of core inflation.

Specifically, we test which measures predict future inflation better over various time horizons. Although we expect monetary policy to have its biggest impact on inflation between one to two years, we examine both near-term and medium-term horizons for three reasons. First, we follow the previous literature. Ang, Bekaert and Wei (2007) examine the one-year ahead forecast and Romer and Romer (2000) examine quarterly inflation rates from zero to eight quarters ahead. Second, the SPF does not forecast more than four quarters ahead so comparisons are limited if we consistently choose a longer time horizon. Third, there are data limitations given the construction of the Greenbook forecasts, which we discuss further in section 4.[3]

The previous literature on core inflation often suggests that core inflation should track trend inflation (defined in various ways) and forecast future inflation (over various time horizons).[4] Wynne (2008) discusses that many papers in the core inflation literature consider a good measure of core inflation to be one that captures monetary inflation. Since the Greenbook is released with a five-year lag, the public would like to find an alternative measure that performs similarly to the Greenbook so that the public can use that measure to gauge what future monetary policy might be.

To evaluate the candidate measures we examine the mean squared forecast error (MSFE) of each candidate and determine if the candidate performs better than two possible benchmarks (random walk forecast or Greenbook forecast). While we do compare the performance of the point forecasts of the Greenbook and SPF with the performance of the core inflation measures for the individual 0- to 8- quarter ahead time horizons, this comparison is somewhat unfair.

[3] In total we have five possible candidate measures: Greenbook forecast, SPF forecast, inflation minus food and energy, weighted median inflation, and trimmed mean inflation. The data are discussed further in section 4.
[4] See Detmeister (2011) for an extensive review of both of these properties.

These core inflation measures are meant to provide the tendency of inflation in the medium term not for a specific quarter in the future. The more meaningful comparisons for these core inflation measures are those that compare a sufficiently long average future time period not those at specific time leads.

When using the forecasts from a random walk model as the benchmark, the results consistently demonstrate that the random walk forecast is not a better forecast. The lagged core inflation measure that performs the weakest against the random walk forecast is the CPI minus food and energy which suggests that using less food and energy as core inflation may be misleading about the future tendency of prices. When using the Greenbook forecast as the benchmark, the forecast in the Greenbook is usually indistinguishable from those generated from the lagged core inflation measures. These results provide additional evidence that the random walk model is no longer the best forecast of future inflation and that the Greenbook may no longer have complete superiority as a forecast over private sector forecasts or lagged core inflation measures.

Section 2 discusses the previous literature on forecasts and core inflation. Section 3 describes the data and Section 4 examines the empirical results. Finally, section 5 concludes.

2. Previous literature on forecasts and core inflation

Romer and Romer's (2000) paper examines if there is additional information in the Greenbook inflation (GNP deflator) forecasts over commercial forecasts. They compare the Greenbook inflation forecast to the Blue Chip forecast, DRI (Global Insight) forecast, and the Survey of Professional Forecasters forecast. They find that the Greenbook does contain

additional information over that contained in commercial forecasts and that the weight that should be placed on the Greenbook forecast is generally close to one.[5]

Gavin and Mandal (2001) examine the relationship between the Greenbook and Blue Chip forecasts and the inflation forecast of the GDP deflator given by the Fed's chairman's twice yearly Congressional testimony. They find that the Greenbook is a better forecast than the Blue Chip but that both are similar to the forecast given in the Congressional testimony, which is the central tendency of the forecasts given by the Federal Open Market Committee (FOMC) members.

Atkeson and Ohanian (2001) study Greenbook forecasts as well. They evaluate the usefulness of Phillips Curves for forecasting inflation (GNP/GDP deflator). They find that Phillips Curve models are not more accurate than a naïve model (random walk). In addition, they compare the naïve model to the Greenbook forecasts and find that the errors from each are about the same over 1984-1996 period.

Smith (2004) shows that the weighted median CPI inflation rate is a better forecast of future inflation than lagged inflation and the traditional core inflation measure, inflation minus food and energy. Smith (2004) uses both in-sample prediction and simulated out-of-sample forecasting.

Carroll (2003) models inflation expectations of households and professionals. In a preliminary exercise, he shows that the SPF forecast does have additional information above what is contained in lagged inflation. He expands the set of lagged inflation measures to include the CPI minus food and energy and the CPI weighted median but he does not examine the Greenbook forecasts.

[5] Romer and Romer (2000) discuss in a footnote that they also examine the information in the CPI forecasts and find that there is additional information in the Greenbook forecast over what is contained in commercial forecasts but they do not examine the forecasting ability of core inflation measures.

More recently, Ang, Bekaert and Wei (2007), Croushore (2010) and Faust and Wright (2011) examine the forecasting ability of surveys (Blue Chip, SPF, Livingston) and the Greenbook and find that they are difficult to beat when compared to a variety of forecasting models. The focus of these papers is mainly on how data releases and revisions affect forecasting ability. This is not a concern in this paper since the CPI is unrevised or as Faust and Wright (2011, pg 8) state, "data revisions are trivial" to the CPI. While all of these measures have been investigated in various papers, this paper combines the previous literature and addresses the question of where is the information on future inflation.

3. Data

The data are publicly available and we use quarterly inflation rates as monthly observations as in Romer and Romer (2000). We obtain price indices of the CPI and CPI minus food and energy (CPIX) from the Bureau of Labor Statistics website. The weighted median CPI inflation rate (CPIMED) and trimmed mean CPI inflation rate (CPITRIM) are from the website of the Federal Reserve Bank of Cleveland. For both we take the monthly inflation rates and compute a price index. From this price index, we then obtain the inflation rates.[6] The inflation forecasts are the median forecasts of the CPI inflation rate from the Survey of Professional Forecasters and CPI forecasts from the Greenbook; both are available from the Federal Reserve Bank of Philadelphia. We use the Greenbook data through 2005. In addition, earlier work by Smith (2005) indicates that the best core inflation measure varies across monetary policy regimes; therefore, the sample starts in 1984.[7]

[6] A procedure similar to the one in Romer and Romer is followed to calculate the inflation rates for the inflation measures. The annualized quarterly inflation rates are calculated from the quarterly averages of the price indices. The data are at a monthly frequency. Each month in a given quarter has the same inflation rate. See Romer and Romer (page 434) for more details.

[7] The sample start in 1984 coincides with the start of the Great Moderation and the end of the Volcker disinflation.

We use matched data so the number of observations varies by horizon. In our sample, there are 88 observations for the SPF forecasts (four per year), 176 observations for the Greenbook forecasts (eight per year) and 264 observations for the three lagged core inflation measures (12 per year). For the forecast comparison tests when including both the SPF and Greenbook there are only 58 matched observations at the 0- to 4-quarter ahead horizons so those are the observations used for all those comparisons. Similarly, at the 5-quarter ahead horizon there are 128 matched observations. Since the SPF does not forecast past 4 quarters ahead, the matching is based on the availability of the Greenbook forecasts. The number of observations for the remaining time horizons depends on the availability of the Greenbook forecasts and at 6-, 7- and 8-quarter ahead forecast horizons there are 114, 82 and 50 observations, respectively.[8] For the forecast comparison tests using average inflation over either 0 to 4 quarters or 0 to 8 quarters, there are 54 observations.[9]

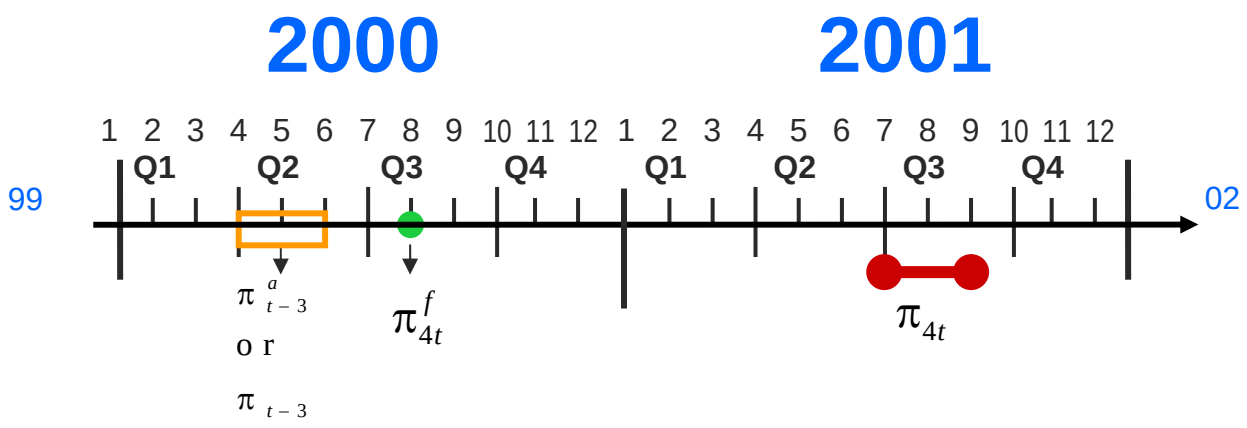
4. Empirical Analysis

We analyze the forecasting accuracy using forecast comparison tests with two different benchmarks: the forecast from the random walk model (RW) of inflation and the Greenbook forecast. We forecast the quarterly inflation rate h-quarters ahead where $h = 0$ to 8. We specify the forecast from the random walk model as the previous quarter's CPI inflation rate.[10] We use the Greenbook forecast, the SPF forecast and lagged values of CPIX, CPIMED and CPITRIM as forecasts. For the SPF and Greenbook, the forecasts are made at time t with t-3 information for quarter h where $h = 0$ to 4 or 8, respectively.

[8] The number of quarters forecast in the Greenbook varies based on when it is published during the calendar year.
[9] For the forecast comparison tests we use a common sample; therefore, the number of observations is limited by the number of the Greenbook forecasts or Survey of Professional Forecasters forecasts.
[10] This random walk model is similar to the one used by Faust and Wright (2011) but different than Atkeson and Ohanian's (2001). In their paper, they are forecasting over the next four quarters not a specific h-quarter ahead forecast so they use inflation over the previous four quarters as the naïve model.

Understanding the timing of the data is important. Using the August 2000 FOMC meeting as our observation point, the diagram shows the timing of the forecasts and the lagged inflation measures. In this example, the forecaster is trying to predict the quarterly inflation rate four quarters ahead (π_{4t}). The candidates are the forecast from the random walk model (π_{t-3}), the lagged core inflation measures (π^{a}_{t-3}), the Greenbook forecast and SPF forecast (π^{f}_{4t}) generated in August 2000.[11] The forecasts (π^{f}_{4t}) only use inflation releases through June. Therefore, no candidate has an informational advantage.

Diagram 1: Timing



Caption: The green dot indicates the month in which both the Greenbook and SPF forecasts are made. The red barbell indicates the quarter being forecast. The orange rectangle indicates the latest inflation information that is used for the forecast from the random walk model and the core inflation measures. It is also the latest information available for forecasters to use to generate their forecasts.

In our tables, we report the relative mean squared forecast errors of the alternative model to that of the benchmark model (random walk) and the associated modified Diebold-Mariano test statistics.[12] There are several conclusions that we draw from table 1A. First, the Greenbook and SPF forecasts perform better than the RW at some time horizons (significantly better at the 5%

[11] Recall due to the construction of the inflation and core inflation data the same quarterly inflation rate is recorded for each month in a given quarter and the data are quarterly rates recorded as monthly observations.
[12] See Diebold and Mariano (1995) and Harvey et al. (1998) for details.

level in 4 out of 9 horizons and marginally better at the 10% level in two more horizons, and significantly better at the 5% level in 3 out of 5 horizons and marginally better at the 5% level in one more horizon, respectively). Second, the CPIX performs poorly against the RW (only marginally significant in 2 out of 9 horizons). Third, the CPIMED and the CPITRIM perform better than the RW at a greater number of time horizons (5 out of 9 horizons and 6 out of 9 horizons, respectively) than the Greenbook forecasts. Interestingly, at longer time horizons, the CPIMED and CPITM are better forecasts. Since they are not meant to be forecasts of specific time horizons in the future, we examine the forecasting performance of the CPIMED and CPITM over the averages of the 0-4 and 0-8 quarters in tables 2A and 2B to understand these measures' ability to track trend inflation.

When the Greenbook is the benchmark as in table 1B, the forecast accuracy comparison test provides evidence that the Greenbook forecast is significantly superior to the SPF forecast and lagged core inflation measures in the current quarter but not in other quarters indicating that the Greenbook forecasts may have lost their forecasting advantage. The CPIX is often thought of as the best measure of core inflation since it strips out the volatile food and energy components. Paying attention to the CPIX may not provide good information about the tendency of prices in the medium run given that its relative MSFE is higher than the relative MSFE of the CPIMED and CPITRIM at all horizons.

There may be a large amount of noise (due to shocks) in the quarter-over-quarter inflation rates. These shocks may hit one quarter and then be reversed the next. By averaging the quarterly forecasts, the quarter-to-quarter fluctuations are smoothed out and the forecast may perform well over the entire forecast horizon since the high frequency noise is removed even if the forecasts further out perform poorly. We look at the average inflation rate which is the

average CPI inflation up to *h* quarters (either $h = 4$ or 8)[13], the random walk model forecast is defined as the average of the previous *h* quarters' inflation based on the CPI, similar to the specifications in Atkeson and Ohanian(2001), and Stock and Watson(2007). We average the quarterly Greenbook forecasts from h=0 to h=4 (or h=8) and we average the quarterly SPF median forecast from h=0 to h=4. For the CPIX, CPIMED or CPITRIM, we use the latest quarterly core inflation rate as this is the best estimate of the price tendency over these time horizon averages.

In tables 2A and 2B, we observe the random walk forecast is statistically worse than both the forecasts (Greenbook and SPF) and is indistinguishable from the lagged core inflation measures for predicting average inflation up to 4 quarters in the future. For the 0 to 8 quarters average, the random walk model is statistically similar to the Greenbook forecast and lagged core inflation forecasts. The Greenbook is statistically superior to the lagged CPIX at the 5% level, marginally superior to the CPITRIM and statistically similar to CPIMED and SPF forecast at predicting average inflation up to 4 quarters. In addition, the Greenbook is not superior to the lagged core inflation measures when averaging up to 8 quarters. Over the current year the Greenbook forecast still seems to maintain some of its informational advantage but it appears to diminish in the next year.

Generally, for monetary policy purposes, the Fed wants a forecast of inflation over the next year or two; however we are constrained by the forecasts that are available in the SPF and Greenbook[14]. The average forecast analyzed above may provide a proxy. In addition, we analyze the forecast accuracy of the annual forecasts from the Greenbook and the SPF, lagged

[13] In other words, in the case of h=4, we average the five quarterly inflation rates from the current quarter (h=0) to the 4-quarter ahead (h=4).

[14] The SPF produces annual forecasts for the current year and one year ahead. The Greenbook produces annual forecasts given as the percent change from four quarters earlier for the current year and one to two years ahead depending on the month of the Greenbook. These are the data for the forecast comparisons in table 3.

year-over-year core inflation and lagged year-over-year inflation versus the forecast from the random walk model. The results presented in table 3 demonstrate that once this smoothing of the inflation data takes place the forecast from the random walk model is statistically indistinguishable from the Greenbook and SPF forecasts and lagged core inflation measures.

Overall, these results suggest that the forecasts from the random walk model do not provide as much information about future inflation as the Greenbook forecasts, the SPF forecasts or lagged core inflation measures. With respect to the Greenbook forecasts, we find they are not more informative than the SPF forecasts, contrary to the findings of Romer and Romer (2000), and limited influence estimators such as the CPIMED and CPITRIM are statistically indistinguishable from the Greenbook forecasts. These results are in line with our prior that core inflation measures specifically the weighted median and trimmed mean are not meant to be near-term forecasts. Rather, they are meant to provide information on the tendency of prices in the medium run and our results confirm that they do. In addition, these results suggest some convergence of forecasts, which may be due to less variation in inflation during the Great Moderation, or perhaps professional forecasters have learned about the goals and targets of the Fed through greater Fed transparency.[15]

5. Conclusions

This paper examines the forecast accuracy of forecasts of the CPI inflation rate from the Greenbook, the Survey of Professional Forecasters, and lagged core inflation measures versus the forecast from a random walk model. We find that the forecasts from a random walk model are poor and that the Greenbook forecasts no longer consistently maintain their information advantage. We also conclude that some core inflation measures such as the weighted median and trimmed mean do provide valuable information about the tendency of prices in the medium

[15] See Gamber and Smith (2009) for a more detailed analysis of this question.

run similar to the information in the Greenbook forecasts. Finally, we cannot state that the Greenbook forecast is consistently better than the SPF median forecast.

The significance of these results is that they may provide the public with a way to proxy the Fed's staff forecast, which is used for monetary policy decisions. When the public understands the medium-term inflation pressures there may be greater anticipation and understanding of monetary policy, which enhances policy effectiveness. In addition, having a proxy of the Fed's staff inflation forecast can help anchor longer run inflation expectations which again can provide policy makers more latitude to affect the real economy.

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Table 1A: Forecasts Accuracy Comparison: RW is the benchmark, Common sample		
Horizon=0 (Sample=58)	RMSFE	D-M test statistics
Greenbook	0.21	3.18**
CPIX	0.95	0.24
CPIMED	0.80	1.12
CPITRIM	0.75	1.60
SPF	0.27	3.10**
Horizon=1 (Sample=58)		
Greenbook	0.56	2.11**
CPIX	0.80	1.42
CPIMED	0.67	2.20**
CPITRIM	0.67	2.38**
SPF	0.59	2.53**
Horizon=2 (Sample=58)		
Greenbook	0.55	1.34
CPIX	0.75	0.85
CPIMED	0.60	1.31
CPITRIM	0.60	1.46
SPF	0.55	1.40
Horizon=3 (Sample=58)		
Greenbook	0.58	2.15**
CPIX	0.70	1.64
CPIMED	0.60	2.17**
CPITRIM	0.62	2.28**
SPF	0.55	2.31**
Horizon=4 (Sample=58)	RMSFE	D-M test statistics
Greenbook	0.66	1.77*
CPIX	0.76	1.33
CPIMED	0.66	2.00**
CPITRIM	0.67	2.12**
SPF	0.67	1.70*
Horizon=5 (Sample=128)		
Greenbook	0.67	1.94*
CPIX	0.78	1.78*
CPIMED	0.66	2.30**
CPITRIM	0.71	2.32**
Horizon=6 (Sample=114)		
Greenbook	0.78	1.21
CPIX	0.98	0.16
CPIMED	0.76	1.61
CPITRIM	0.78	1.64
Horizon=7 (Sample=82)		
Greenbook	0.61	2.13**
CPIX	0.74	1.82*
CPIMED	0.56	2.92**
CPITRIM	0.60	2.87**
Horizon=8 (Sample=50)		
Greenbook	0.81	1.25
CPIX	0.84	0.66
CPIMED	0.76	1.87*
CPITRIM	0.74	2.30**

Note: RMSFE is defined as the relative mean squared forecast errors (MSFE) of the alternative model w.r.t. the MSFE of the random walk model.
** indicates significance at the 5% level and * indicates significance at the 10% level.

Table 1B: Forecasts Accuracy Comparison: Greenbook is the benchmark, Common sample		
Horizon=0 (Sample=58)	RMSFE	D-M test statistics
CPIX	4.43	-2.63**
CPIMED	3.74	-2.59**
CPITRIM	3.49	-2.65**
SPF	1.26	-1.84*
Horizon=1 (Sample=58)		
CPIX	1.44	-1.28
CPIMED	1.21	-0.82
CPITRIM	1.20	-0.88
SPF	1.06	-0.42
Horizon=2 (Sample=58)		
CPIX	1.37	-1.72*
CPIMED	1.10	-0.50
CPITRIM	1.09	-0.47
SPF	0.99	0.06
Horizon=3 (Sample=58)		
CPIX	1.19	-1.48
CPIMED	1.03	-0.33
CPITRIM	1.06	-0.59
SPF	0.95	0.58
Horizon=4 (Sample=58)	RMSFE	D-M test statistics
CPIX	1.16	-1.39
CPIMED	1.00	0.03
CPITRIM	1.01	-0.11
SPF	1.01	-0.13
Horizon=5 (Sample=128)		
CPIX	1.17	-1.36
CPIMED	0.99	0.09
CPITRIM	1.06	-0.61
Horizon=6 (Sample=114)		
CPIX	1.24	-2.39**
CPIMED	0.97	0.26
CPITRIM	1.00	0.05
Horizon=7 (Sample=82)		
CPIX	1.21	-1.84*
CPIMED	0.91	0.77
CPITRIM	0.98	0.19
Horizon=8 (Sample=50)		
CPIX	1.03	-0.14
CPIMED	0.94	0.59
CPITRIM	0.91	1.13

Note: RMSFE is defined as the relative mean squared forecast errors (MSFE) of the alternative model w.r.t. the MSFE of the Greenbook forecasts.
** indicates significance at the 5% level and * indicates significance at the 10% level.

Table 2A: Forecasts Accuracy Comparison: RW is the benchmark, Common sample		
Horizon=0-4 average (Sample=54)		
Greenbook	0.57	1.88*
CPIX	1.05	-0.22
CPIMED	0.81	1.06
CPITRIM	0.80	1.18
SPF	0.57	2.22**
Horizon=0-8 average (Sample=54)		
Greenbook	0.95	0.15
CPIX	1.30	-1.41
CPIMED	0.78	1.43
CPITRIM	0.79	1.42
Note: RMSFE is defined as the relative mean squared forecast errors (MSFE) of the alternative model w.r.t. the MSFE of the random walk model. ** indicates significance at the 5% level and * indicates significance at the 10% level.		

Table 2B: Forecasts Accuracy Comparison: Greenbook is the benchmark, Common sample		
Horizon=0-4 average (Sample=54)		
CPIX	1.83	-2.41**
CPIMED	1.41	-1.62
CPITRIM	1.40	-1.86*
SPF	0.99	0.07
Horizon=0-8 average (Sample=54)		
CPIX	1.36	-1.17
CPIMED	0.82	0.67
CPITRIM	0.83	0.69
Note: RMSFE is defined as the relative mean squared forecast errors (MSFE) of the alternative model w.r.t. the MSFE of the random walk model. ** indicates significance at the 5% level and * indicates significance at the 10% level.		

Table 3: Forecasts Accuracy Comparison: year over year, RW is the benchmark,		
Sample 1990-2005(common sample with 40 observations)		
	RMSFE	D-M test statistics
Greenbook	0.99	0.04
CPIX	1.07	-0.27
CPIMED	0.86	0.51
CPITRIM	0.86	0.54
SPF	0.97	0.10
Note: RMSFE is defined as the relative mean squared forecast errors (MSFE) of the alternative model w.r.t. the MSFE of the random walk model.		