Inflation forecast errors: preliminary findings

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Editor's note:

This was one of the first pieces of research completed. It aimed to clearly delineate the statistical properties of our CPI forecasts.

CPI inflation forecast errors

Executive summary

This paper examines the Reserve Bank's performance when forecasting quarterly CPI inflation between 1992 and 2002. We find that:

- On average, the Reserve Bank's forecasts of headline CPI inflation for the current quarter and 1 quarter ahead have been unbiased. The same is true for forecasts of CPI inflation excluding interest costs (CPII).
- The Reserve Bank has consistently under-predicted inflation for medium to long term horizons. Our mean forecast errors for quarterly headline and CPII inflation 2 to 10 quarters ahead are negative and significantly different from zero.
- Medium-term forecasts of inflation for both measures of inflation have tended to under-predict actual quarterly inflation by approximately 0.2 per cent.

1 Introduction

The Reserve Bank periodically reviews its forecasting performance. This allows us to check our understanding of the economy and potentially to improve our forecasting efforts. This paper examines our forecasting performance in relation to CPI inflation.

We examine quarterly headline CPI inflation between September 1992 and September 2002, and CPI inflation excluding interest costs (CPII) between December 1994 and September 2002.[1] In September 1999 headline inflation was redefined to exclude interest rate costs. This means that in recent periods it has been equivalent to CPII inflation. Where there was sufficient data under each regime, we tested for a structural break following this change. No evidence was found to support the existence of such a break in the series.

Forecasting performance is assessed in terms of forecast bias (as measured by the mean forecast error) and by the size of forecast errors (as measured by the mean absolute forecast error and the root mean squared forecast error). Details of how these statistics are calculated are presented here. Forecast are defined as 'forecast minus actual'. Hence, a positive mean forecast error reflects a tendency to over-predict the rate of inflation, while a negative error reflects a tendency to under-predict it.

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[1] This is the furthest back that our data sets could reliable be extended using quarterly data. Where possible they were checked against the Reserve Bank's *Monetary Policy Statements*. This paper focuses on quarterly rates of inflation. Previous Reserve Bank studies have focused on quarterly forecasts of annual inflation. However, examining quarterly forecasts of annual inflation may be problematic due to overlapping observations. The effect of overlapping observations is to carry forecasting errors forward. For example, if an unexpected shock occurs that causes inflation to be higher than expected in March 2000, this will be reflected in the annual inflation figures for the year to March, June, September and December 2000. Hence focusing on quarterly forecasts of annual inflation may introduce serial correlation into forecast errors (St Clair, 2000). The use of quarterly inflation rates aims in part to avoid this difficulty.

The remainder of this paper is structured as follows: Section 2 examines our forecasts of quarterly headline inflation. Section 3 examines our forecasts of CPII inflation. In section 4 we examine whether the Reserve Bank's forecast performance has changed since its move to a new forecasting methodology and the Forecasting and Policy System (FPS) model in 1997. Section 5 concludes.

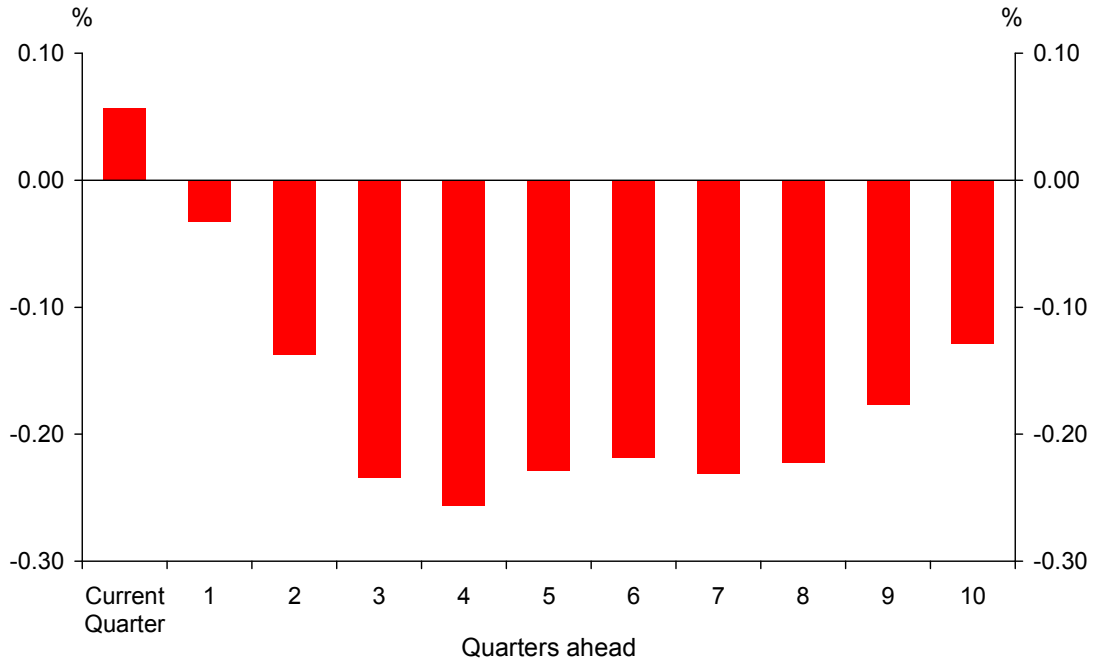
2 Forecast errors for headline inflation

Figure 2.1 and table 2.1 summarise findings for the Reserve Bank's forecasts of quarterly headline inflation. On average we have not consistently under- or over-estimated headline inflation for the current quarter and 1 quarter ahead. We have, however, consistently under-estimated headline inflation 2 to 10 quarters ahead.[2] This is most pronounced with respect to our forecasts of inflation 3 to 8 quarters ahead. Our forecasts of inflation 1 year ahead have, on average, been 0.26 percentage points lower than actual inflation. Our 2 year ahead forecasts have, on average, been 0.22 percentage points lower than actual inflation.

There is less evidence of bias in our forecasts of headline inflation for longer horizons (9 and 10 quarters ahead) than for our forecasts of medium-term inflation. However, it should be borne in mind that it is difficult to prove bias in more variable samples.

As expected, the size of the Reserve Bank's forecast errors (as measured by the MAE and RMSE) is greater for medium- to long-term forecast horizons than for short-term horizons.

Figure 2.1
Mean forecast errors and RMSEs: quarterly headline inflation (September 1992 to August 2002)



[2] Our mean inflation forecast errors 2 to 8 quarters ahead are significantly different from zero at the 5 per cent level. Nine and 10 quarters ahead our mean inflation forecast errors are significantly different from zero at the 10 per cent level.

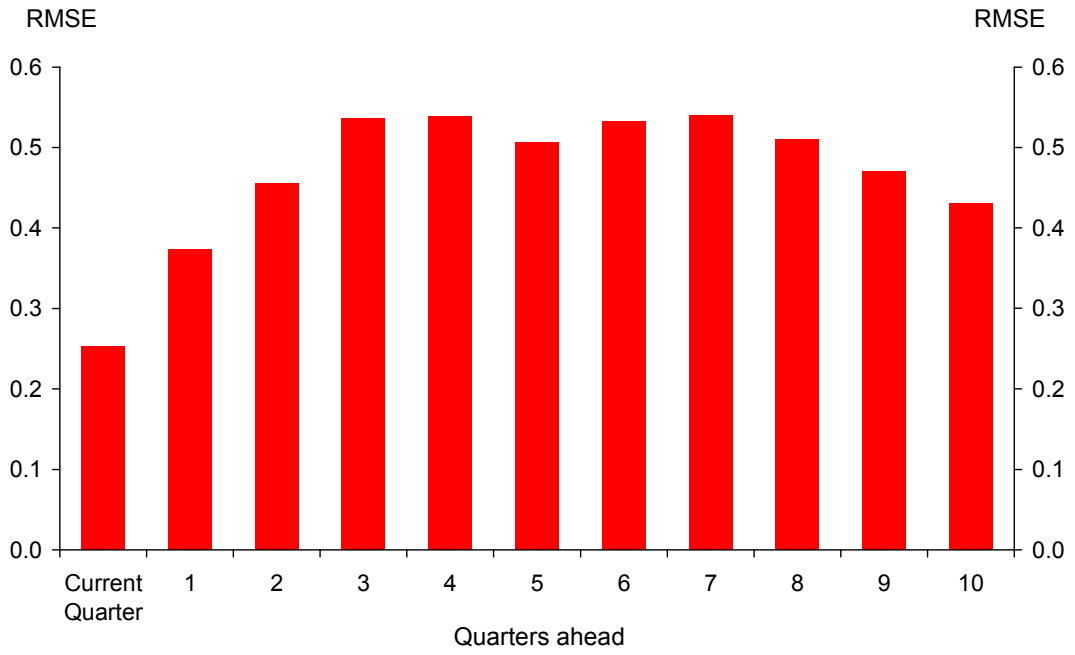


Table 2.1
Forecast error summary statistics: quarterly headline inflation (September 1992 to August 2002)

Quarters ahead	Mean Errors	RMSE	Observations
Current Quarter	0.06	0.25	41
1	-0.03	0.37	40
2	-0.14**	0.46	39
3	-0.23***	0.54	38
4	-0.26***	0.54	37
5	-0.23***	0.51	36
6	-0.22**	0.53	35
7	-0.23**	0.54	34
8	-0.22**	0.51	33
9	-0.18*	0.47	32
10	-0.08*	0.43	27

Notes:
Asterisks indicate the significance with which the null hypothesis:
Mean Forecast Error = 0 can be rejected:
*** = Significant at the 1 per cent level
** = Significant at the 5 per cent level
* = Significant at the 10 per cent level

The findings of our current examination are consistent with previous research conducted within the Reserve Bank. Although this prior work has focused primarily on the size of our forecast errors, it also examined bias. Studies done in 1998 and 2001 suggested that we have not consistently under or over-estimated near-term inflation, but do indicate that we have tended to under-predict headline inflation in the medium term, particularly one-year ahead.[3]

[3] St Clair, R and N Yates (2001), "A comparison of inflation and output forecasts of the New Zealand Economy," *Reserve Bank of NZ Memorandum*; Brook, A and S Young (1998), "GDP and inflation forecast errors and their role in the last business cycle," *Reserve Bank of NZ Memorandum*.

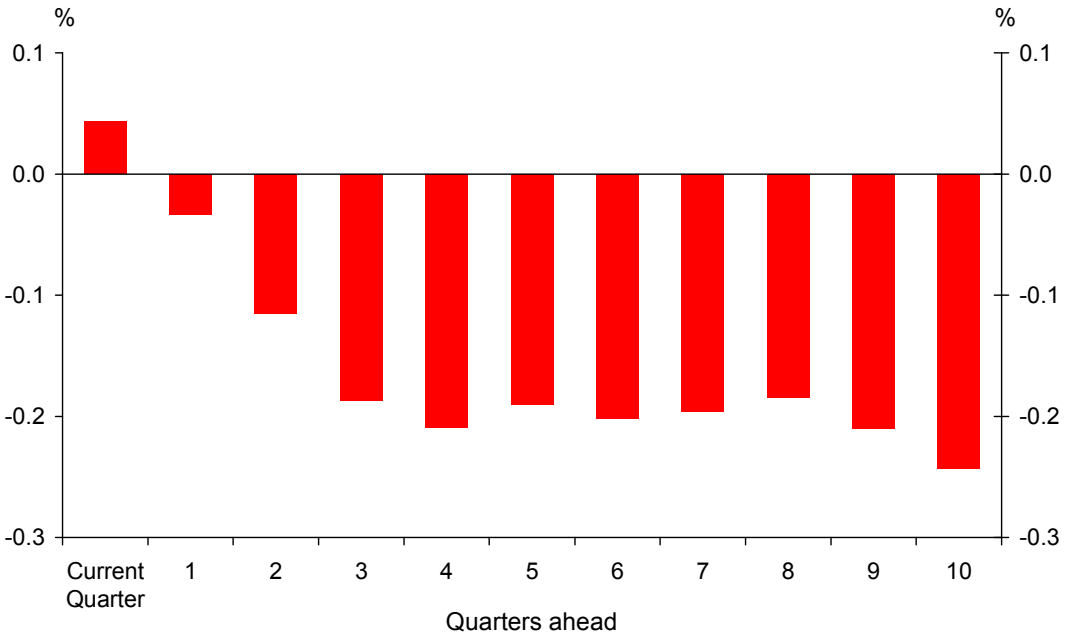
A smaller bias was found in a sample starting in 1989 (0.2 per cent 1-year ahead, for example), a period which includes some of the disinflationary period. When this period is omitted, findings are similar to ours.

To examine whether there has been any change in our forecasting performance over time, we use a rolling three-year sample of our forecast errors and examine the errors for each sub-period. We find that, except for a period in the mid-1990s corresponding to the Asian crisis,[4] the amount of bias in our forecasts of headline inflation has remained fairly constant over time for all forecasting horizons considered. There is tentative evidence that the size of our forecast errors for the current quarter and 1 quarter ahead horizon may have been growing over the sample period. For other forecast horizons, the size of our forecast errors has remained relatively constant.

3 Forecast errors for CPI inflation excluding interest costs

The Reserve Bank's forecasts of CPI inflation excluding interest costs (CPII) for the current quarter and 1 and 2 quarters ahead have not, on average, been consistently under or over-estimated. We have, however, consistently under-estimated CPII inflation 3 or more quarters ahead.[5] On average, our forecasts for these horizons have been approximately 0.2 percentage points lower than actual inflation. Summary statistics are presented in figure 3.1 and table 3.1. Both the MAE and RMSE indicate that our forecast errors are larger for long forecasting horizons than for shorter ones.

Figure 3.1
Mean forecast errors and RMSEs: Quarterly CPII inflation forecast errors (December 1994 to September 2002)



4 During the Asian crisis the amount of bias in our forecasts of headline inflation 2 or more quarters ahead appears to be smaller, but the errors for this period are not significantly different from forecast errors over the rest of the sample period.

5 Mean forecast errors for these horizons are significantly different from 0 at the 5 per cent level or better.

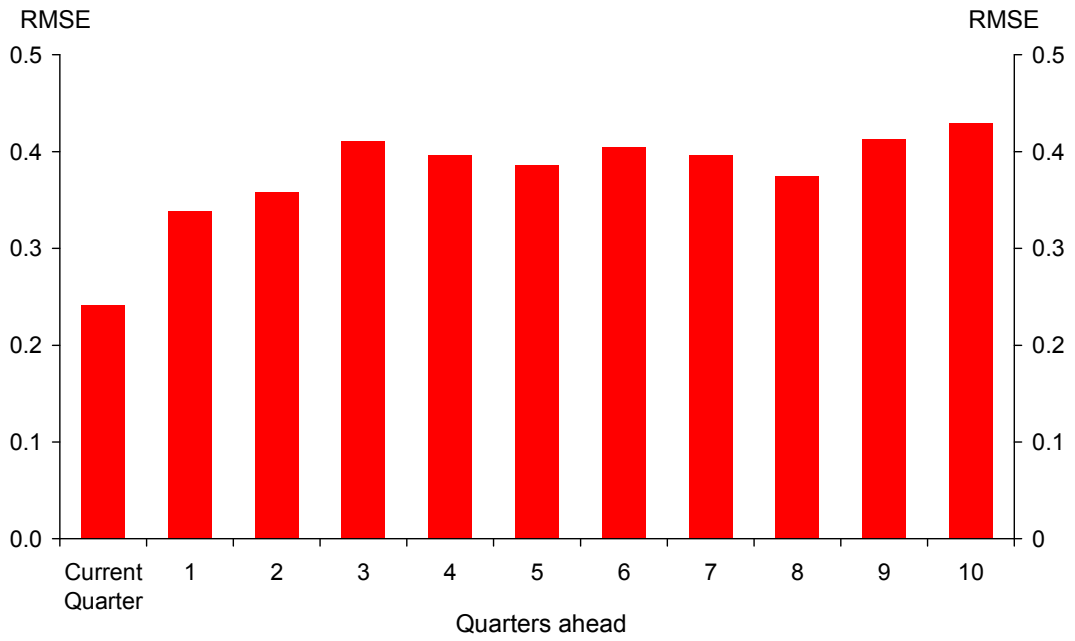


Table 3.1
Forecast error summary statistics: Quarterly CPII inflation: (December 1994 to August 2002)

Quarters ahead	Mean Errors	RMSE	Observations
Current Quarter	0.04	0.24	32
1	-0.03	0.34	31
2	-0.12*	0.36	30
3	-0.19***	0.41	29
4	-0.20***	0.40	28
5	-0.19***	0.39	27
6	-0.20***	0.40	26
7	-0.20***	0.40	25
8	-0.18**	0.37	24
9	-0.21***	0.41	23
10	-0.24***	0.43	20

Notes:
Asterisks indicate the significance with which the null hypothesis:
Mean Forecast Error = 0 can be rejected:
*** = Significant at the 1 per cent level
** = Significant at the 5 per cent level
* = Significant at the 10 per cent level

A rolling three-year sample of our forecast errors is used to examine whether there has been any change in our forecasting performance for CPII inflation over time. Mean forecast errors for the current quarter and 1 to 2 quarter ahead horizons have remained relatively constant and unbiased over time. The mean forecast errors for CPII inflation 3 or more quarters ahead are unbiased at the beginning of the sample period but appear to have become increasingly negative over time. The size of our forecast errors for all horizons has been growing over the sample period.

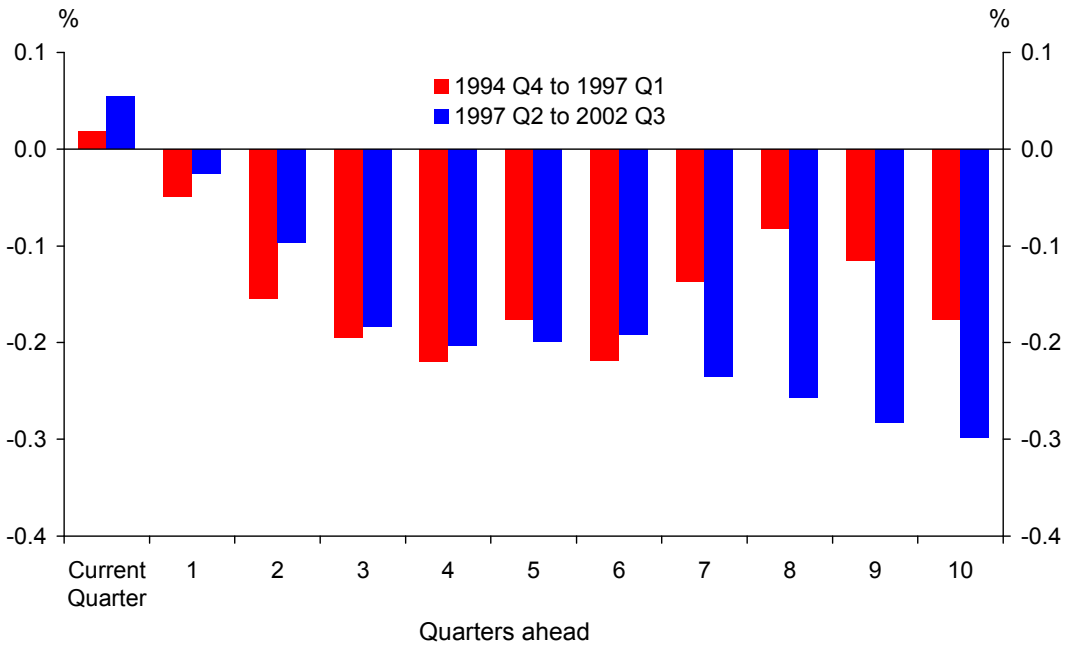
However, a note of caution is necessary here. The three-year rolling sample period used to examine the forecast errors for CPII inflation begins during the Asian crisis. During this period (but not before or following it) our forecasts of headline inflation appeared to be unbiased. The mean forecast errors for headline and underlying inflation have shown similar trends over time. Hence it is likely that the decline in mean forecast errors for CPII inflation is not systematic, but rather due to particular events in the sample period. A longer sample period is needed to confirm this. It is probable that, except for the effects of the Asian crisis, the negative bias observed in mean forecasts of CPII inflation has remained negative, though not worsened.

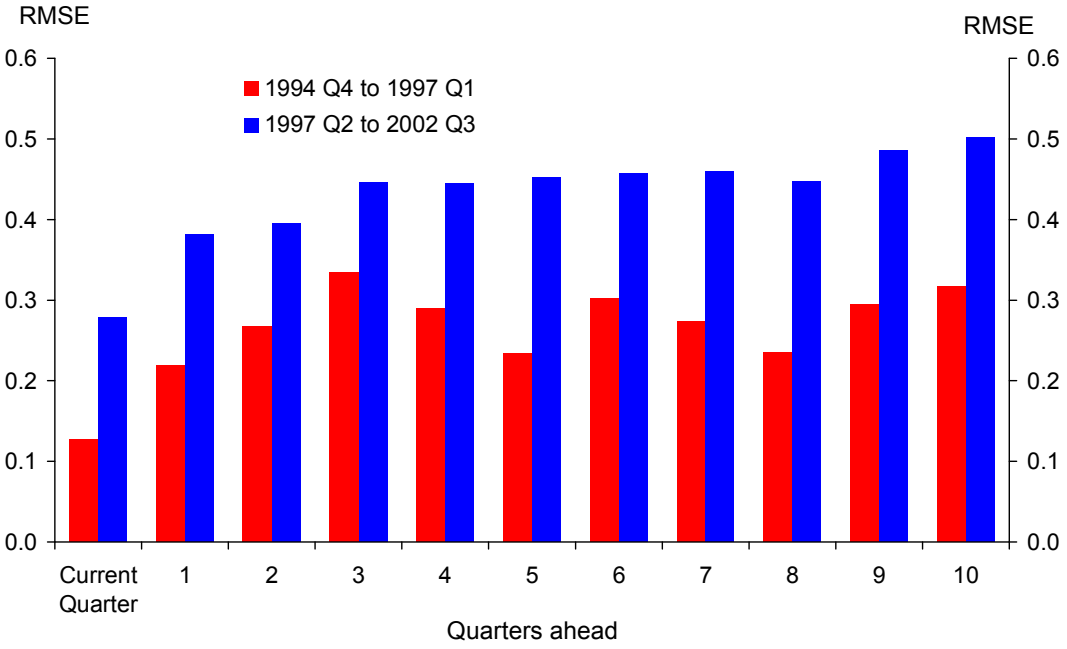
4 The effect of regime changes on analysis of forecasting performance

Until March 1997 the Reserve Bank's macroeconomic forecasts contained a technical assumption of no change in monetary policy settings. This was intended to provide the motivation for monetary policy decisions, rather than necessarily the most realistic forecast. For example, monetary policy decisions could then be justified in terms of "if we do not act, inflation will breach the target band". With the introduction of the FPS model in June 1997 we shifted to a 'conditional policy response' approach to forecasting, which asks the question "what do we have to do with monetary policy to achieve inflation outcomes consistent with the Policy Targets Agreement agreed with the Government", given anticipated economic conditions. Although separating the effects of forecasting technique from the impact of economic events is well-nigh impossible, we briefly examine whether this change in forecasting methodology may have affected our CPII inflation forecasting performance.

Figure 4.1 presents our mean forecast errors and the RMSE for each forecasting regime. For short- to medium-term forecast horizons our forecasting performance was similar (in terms of bias and accuracy) under both forecasting methodologies. However, for longer horizons, our forecasting performance has been less accurate since the move to conditional policy response forecasts. Caution is needed when interpreting our findings as they are likely to be strongly influenced by sample period events including the Asian crisis and two droughts during the conditional policy response period.

Figure 4.1
Mean forecast errors and RMSEs: Quarterly CPII inflation forecast errors (December 1994 to March 1997 and June 1997 to August 2002)





5 Conclusion

For both headline and CPII inflation our findings indicate that, on average, the Reserve Bank has not tended to over- or under-predict near term inflation. However, on average we have underestimated inflation for medium term horizons (this includes inflation one to two years ahead).

The amount of bias in our forecasts of headline inflation has remained fairly constant over time for all forecasting horizons considered. The size of our forecast errors for the current

quarter and 1 quarter ahead horizon has been growing over the sample period. For other forecast horizons, the size of our forecast errors has remained relatively constant.

For CPII inflation, mean forecast errors for the current quarter and 1 and 2 quarter ahead horizons have remained relatively constant and unbiased over time. However, there is weak evidence to suggest that the mean forecast errors for CPII inflation 3 or more quarters ahead have become increasingly negative over the sample period.[6] The size of our forecast errors has also grown over time for all forecasting horizons, but it would be misleading to attribute this to the change in forecasting methodology without more robust analysis.

[6] Since headline and CPII measures are the same after September 1999, the difference from the headline measure reflects the shorter sample period for CPII.