
The relationship between inflation expectations survey data and inflation

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Inflation expectations play an important role in shaping the inflation consequences of economic activity. Hence, they are of special importance for monetary policy. Survey measures of inflation expectations are available, but whether they are a good representation of true beliefs is a moot point. Survey measures of inflation expectations often do not track well with realised inflation rates, sometimes producing large forecast errors. Indeed, survey measures of inflation expectations often tend to track better with current or past inflation than with future inflation, raising questions as to their usefulness as proxies for true expectations.

This article examines the relationship between surveyed inflation expectations and inflation in New Zealand since inflation stabilised in the early 1990s. It turns out that while survey data may be inaccurate predictors of the level of inflation, they can still provide useful directional information regarding near-term inflationary pressures. Survey data can be used to supplement other economic indicators, giving a better indication of future inflation.

1 Introduction

Expectations play an important role in economic activity. Many of the actions of households, firms and policy-makers are dependent on how they expect economic conditions to evolve.

Inflation expectations are of special importance for inflation-targeting central banks. They underlie economic decisions such as the setting of prices and wages, and can influence consumption and investment decisions. Through such decisions, inflation expectations can feed directly and indirectly into inflation itself.

The conduct and effects of monetary policy are also influenced by inflation expectations. If economic agents believe that the central bank will act to control inflation if it begins to deviate from the goals of monetary policy, their inflation expectations are more likely to be anchored at levels consistent with the aim of price stability. In such circumstances, the setting of prices and wages will tend to be in accordance with the target level of inflation and less responsive to temporary fluctuations in inflation. This allows the central bank to substantially ignore short-term volatility in prices and to take a more medium-term approach to controlling inflation.

In contrast, the maintenance of price stability is likely to be more difficult if inflation expectations are not consistent with the aims of monetary policy. In such circumstances,

expectations of higher inflation are likely to be reflected in higher wage demands and prices, and may lead to a bringing forward of consumption expenditure, exacerbating inflationary pressures. Controlling inflation in such an environment may require monetary policy to be conducted more aggressively, as the central bank must also convince sceptical wage and price setters that the price level will be stable.

Additionally, interest rates that are set or influenced by monetary policy will have different effects on behaviour depending on people's expectations of inflation. The higher inflation is expected to be over the life of financial contracts, the lower the real cost or return associated with a given (nominal) interest rate, and vice versa.

Unfortunately, inflation expectations are not directly observable. Instead, expectations must be inferred in some manner. One of the most common ways of doing this is to use surveys. Surveys of inflation expectations ask respondents what they expect inflation will be at some future date.

However, it is not clear that responses to surveys actually reflect the true expectations on which respondents base their decisions. It seems from a casual glance at the survey measures that expectations survey data may reflect current and past economic conditions, rather than being truly forward-looking.

This article examines the relationship between inflation and survey data on expected inflation in New Zealand. It focuses on the period of stable inflation in New Zealand, beginning in late 1991. It turns out that while survey data may be inaccurate predictors of the level of inflation, they do contain information regarding near-term inflationary pressures. That is, the survey data provide information on factors in the economic environment that may influence how the level of inflation changes. This information can be used to supplement other economic indicators, providing a better indication of future inflation in the not-too-distant future.

The remainder of this article is structured as follows. Section 2 examines whether survey data are forward-looking and whether they provide accurate estimates of future inflation. Section 3 examines why different groups give different responses to surveys of expectations. Section 4 examines whether survey data can be used to improve predictions of future inflation. Section 5 concludes.

2 Are survey data related to past, present or future inflation?

Economists have long questioned the use of surveys of inflation expectations to represent true inflation expectations and to predict future inflation. This is largely because survey measures of inflation expectations tend not to track well with realised inflation (Bryan and Venkatu, 2001a). It seems that survey data may reflect current and past conditions, rather than being truly forward-looking.¹ To examine the use of inflation expectations survey data in New Zealand, we begin by examining these criticisms.

This article examines data from five New Zealand surveys of inflation expectations. Three of these surveys focus on the inflation expectations of business people and professional economists:

- Reserve Bank of New Zealand Survey of Expectations (RBNZ Survey) – A quarterly survey of business leaders and those who are influential in their fields of activity.

There are approximately 200 respondents.

- AON Economist Survey – A quarterly survey of 15 senior economists from private companies and financial institutions.²
- National Bank Business Outlook (NBBO) Survey – A monthly survey of (approximately) 1500 of the National Bank of New Zealand's business clients.

The remaining two surveys focus on the expectations of consumers:

- Marketscope Survey - The Reserve Bank sponsors three questions in ACNielsen's regular 'omnibus' telephone surveys. This is a quarterly survey of 1000 randomly selected households.
- Westpac-McDermott-Millar Consumer Confidence Survey – A telephone survey of 1500 randomly selected householders conducted on a quarterly basis.

All of these surveys focus on expectations of annual inflation one year ahead.³

In the 1970s and 1980s, inflation in New Zealand tended to be both higher and more volatile than it has been since the introduction of the Reserve Bank of New Zealand Act 1989. At times when inflation is very volatile, the accuracy of inflation expectations survey data is likely to be low. New Zealand has now experienced a prolonged period of price stability. The accuracy of inflation expectation surveys can be expected to have improved since the achievement of price stability in New Zealand. In order to be relevant to current circumstances, we examine survey data only over the period of price stability - September 1991 to March 2003.

Inflation expectations survey data, inflation and the Reserve Bank's forecasts of Consumer Price Index excluding interest costs (CPII) inflation over this period are displayed in figure

1. The survey data and RBNZ forecasts focus on the one-

² For survey data to be comparable they must be measured at similar dates to ensure that respondents had access to similar information when forming their expectations. If data recorded at dissimilar times are compared, then the resulting inferences may not be valid. For this reason two observations were excluded from the AON survey data as these observations were recorded at times that were not directly comparable to the other survey data.

³ Some of the surveys also focus on horizons other than one year ahead. This article focuses on the one-year-ahead expectations data.

¹ See for example Chadwick and Dickens (2002).

Figure 1
Bank forecasts, survey data and inflation



Note: Survey data and forecasts are shown at the horizons on which they focus.

year ahead horizon. They are displayed with a one-year lag so that they appear at the forecast horizons they relate to.

The pronounced decline in the variability of inflation that occurred following the introduction of the Reserve Bank of New Zealand Act has been accompanied by reduced volatility in inflation expectations data. From figure 1 we see that inflation expectation survey data have tended to remain fairly stable around their respective means since the early 1990s. This might indicate that successive inflation targets have been credible, although the fact that surveyed inflation expectations have averaged above the mid-point of inflation target ranges (more so for consumers than business people) introduces some doubt about this. It may also simply indicate that inflation itself has been stable.

If the surveyed expectations are not forward-looking, but instead reflect perceptions of current conditions, more stable inflation will automatically lead to more stable reported expectations. This alternative explanation is reinforced by indications that forecast errors from each of the surveys tend to follow movements in actual inflation, as explored further in the next section.

2.1 Are survey data forward-looking?

In figure 1 the survey data are displayed at the forecast horizon to which they relate – one year after the date they were measured. There are indications that survey measures of inflation expectations are influenced by the level of inflation at the time the survey is taken. This is more obvious in the surveys of business people, particularly following the spikes in inflation in 1995 and 2000, which are reflected in the survey data. This suggests that there is an “adaptive” element to inflation expectations – i.e. inflation expectations are influenced by recently observed values.

However, even if inflation expectations are related to contemporaneous or past inflation outcomes, this does not necessarily mean that they are not forward-looking to at least some degree.⁴ Indeed, over the sample period there is little statistical evidence to suggest that changes in inflation

precede changes in survey data in a *systematic* manner. There is, however, some evidence indicating that changes in several of the survey data series precede changes in inflation. Further, Basdevant (2003) shows that inflation expectations in New Zealand may be a combination of backward- and forward-looking behaviour. Basdevant also suggests that the way economic agents form inflation expectations may be changing over time and that expectations may be becoming increasingly “rational”. (Rational expectations assume that survey respondents make use of all available information when forming expectations. This includes information about current and *prospective* actions of policy-makers.)

To look at the relationship between survey data and inflation more closely we use correlations. As it is unclear whether survey data are backward- or forward-looking, we consider how strongly the data are correlated with inflation up to four quarters earlier and up to eight quarters in the future.

One difficulty when examining the inflation expectations survey data is determining an appropriate inflation measure to use as a benchmark. The three surveys of business people explicitly focus on CPI inflation. The two surveys of consumers do not specify upon which inflation measure they focus. However, data from all of the surveys bear stronger relationships with more stable measures of inflation, such as the “CPI excluding interest costs” (CPII) or “target-measure” inflation, than with the more volatile headline CPI inflation series.⁵ Survey data are likely to have a stronger relationship to more stable inflation measures because of the relative stability of inflation expectations in New Zealand since the early 1990s and also because of the inherent difficulty in predicting volatile series such as headline inflation.

When looking at correlations between survey data and inflation, we have used headline, CPII and target-measure inflation. The correlations between the survey data and CPII inflation are presented in table 1. Darker regions in the table indicate a stronger correlation. Qualitatively, the results are

⁴ Even if survey respondents do consider past inflation outcomes when forming expectations, they may still be forward-looking. Survey respondents may use information on past inflation to develop their expectations of future inflation.

⁵ Target-measure inflation refers to the inflation measure on which the Reserve Bank has focused when conducting monetary policy. The target measure has changed over time. It is defined as underlying inflation until the September quarter 1997, CPIX for the December 1997 quarter until June quarter 1999 and CPI inflation (excluding interest rates) thereafter.

Table 1
Correlations between survey data and CPII inflation (September 1991 to March 2002)

Horizon (Quarters)	RBNZ Survey	Marketscope survey	AON survey	Westpac survey	NBBO Survey
-4	0.07	-0.07	-0.07	-0.02	0.21
-3	0.26	0.06	-0.03	0.03	0.39
-2	0.43	0.26	0.16	0.02	0.61
-1	0.69	0.47	0.36	0.18	0.81
0	0.80	0.52	0.49	0.32	0.79
1	0.76	0.51	0.53	0.39	0.62
2	0.66	0.38	0.50	0.28	0.48
3	0.49	0.21	0.39	0.01	0.28
4	0.32	0.07	0.30	-0.22	0.07
5	0.24	-0.07	0.29	-0.46	-0.05
6	0.13	-0.16	0.21	-0.47	-0.20
7	-0.02	-0.20	0.15	-0.41	-0.32
8	-0.15	-0.21	0.05	-0.35	-0.39

robust to the measure of inflation used, though the strength of the correlations with headline inflation is lower.

Data from all of the surveys are only weakly correlated with inflation at the four quarters-ahead horizon on which they purportedly focus. Instead, they tend to be more strongly correlated with inflation in the current quarter and one and two quarters ahead.

Most of the surveys tend to be more strongly correlated with future inflation than with past inflation. The only exception to this pattern is the NBBO Survey, which has a stronger correlation with past inflation.

These findings suggest that survey data may be only slightly forward-looking, and that they may provide information regarding near-term inflation outcomes, rather than inflation at the four-quarter-ahead horizon upon which they purport to focus.⁶

2.2 Accuracy of survey data

Having identified some degree of relationship between surveyed inflation expectations and realised inflation rates, it is interesting to explore how close that relationship is. One way of approaching this is to examine how accurately survey data predict future inflation.

To evaluate the accuracy of survey data with respect to realised future inflation, both the existence of bias and also the size of the resulting forecast errors matter:

- Bias examines whether the survey data consistently under- or over-predicts actual inflation. This is assessed using the mean error.
- Even if unbiased, survey data may not be accurate predictors of inflation. Hence it is important to consider also the typical size (or magnitude) of the resulting forecast errors. Two commonly used measures are calculated: the mean absolute error (MAE) and the root mean square error (RMSE). The following discussion focuses on the size of errors as measured by the MAE.

Details on how these formulae are calculated are presented in appendix 1.

Forecast errors are defined as "*Prediction minus Actual*." Hence, a positive mean error reflects a tendency for a survey to over-predict the level of inflation, while a negative mean error reflects a tendency to under-predict.

Two additional benchmarks of forecasting performance are also considered. The forecasting performance of the survey data are compared with naive forecasts of inflation (i.e. forecasts that assume no change from the current level of inflation).⁷ The survey data are also compared with the Reserve Bank's own forecasts of inflation.

⁶ We are examining expectations of annual inflation that are measured at a quarterly frequency. Hence, our forecasting horizons overlap. Because of these overlapping horizons, the survey data may appear forward looking when in fact they are not. We verified that the data were forward looking using the approach proposed by Granger (1969).

⁷ This is examined using the Theil Inequality Coefficient (TIC). The TIC compares the size of forecasts errors from the survey data to those that would result from no change forecasts of inflation. Details of the TIC's calculation are presented in appendix 1.

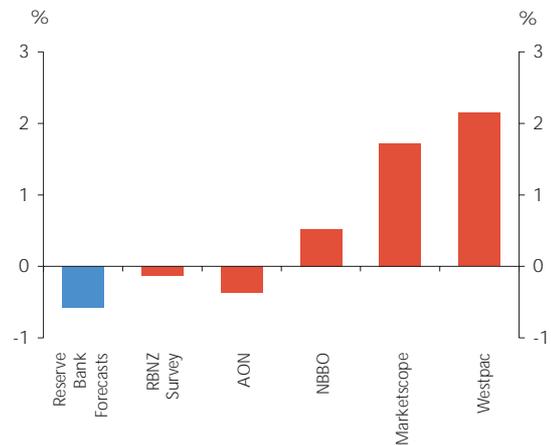
As noted earlier, survey data bears a stronger relationship to CPII inflation than to headline inflation. Hence CPII inflation has been used as a benchmark against which to compare the inflation expectations data. Findings regarding accuracy are qualitatively similar when the data are compared to headline inflation (though the size of the resulting errors tends to be higher when the survey data are compared to headline inflation measures than when the survey data are compared to CPII inflation).

All of the surveys considered focus on annual inflation four quarters ahead. Appendix 2 and figures 2 and 3 summarise our findings regarding the accuracy of survey data. What is noticeable in figures 2 and 3 is that data from business people, particularly those from the RBNZ and AON surveys, are substantially more accurate than data from consumers.

- The RBNZ Survey is the most accurate of all the surveys considered. It provides unbiased estimates of inflation four quarters ahead. The mean error from this survey is -0.1 percentage points. Ignoring the sign of the error, the average size of the errors from this survey is 0.5 percentage points. Data from this survey out-perform naïve forecasts of inflation four quarters ahead.
- Data from the AON Economist Survey are statistically biased towards under-prediction of CPII inflation. However, the mean error from this survey is relatively low at -0.4 per cent.⁸ The average size of the errors from this survey is 0.6 percentage points. This survey also outperforms naïve forecasts of inflation four quarters ahead.
- The RBNZ Survey of Expectations and the AON Economist Survey are not significantly different from each other in terms of bias or size of errors.
- Inflation expectations data from the NBBO Survey have significantly over-predicted inflation four quarters ahead by 0.5 percentage points on average over the sample period. The average size of errors from this survey is 0.8 percentage points. The performance of this survey is similar to that of a naïve forecast of inflation.

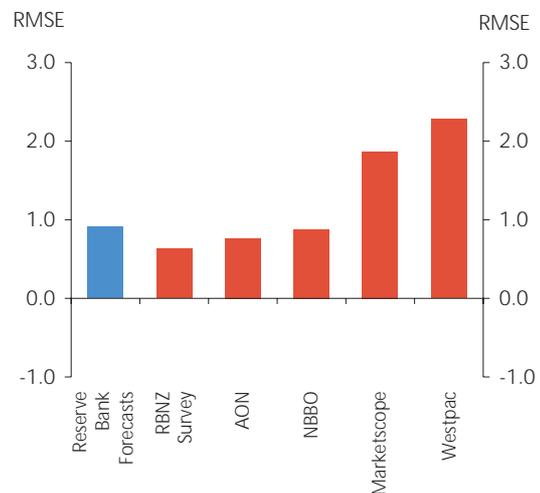
- The Marketscope Survey, which surveys consumers, is inaccurate, and on average significantly over-estimates the level of inflation one year ahead by 1.7 percentage points. The average size of its errors is also 1.7 percentage points. Data from this survey do not outperform naïve forecasts of inflation.
- The Westpac-McDermott-Millar Consumer Survey also focuses on consumers. On average, it has significantly over-estimated the level of inflation by more than 2 percentage points. The average size of the errors also exceeds 2 percentage points. Data from this survey do not outperform naïve forecasts of inflation.

Figure 2
Mean errors (September 1991 to March 2003)



Note: Reserve Bank forecasts are examined between December 1994 and March 2003

Figure 3
Root mean square errors (September 1991 to March 2003)



Note: Reserve Bank forecasts are examined between December 1994 and March 2003

⁸ When AON Survey data is compared to headline inflation, we do not find statistical evidence of bias.

- Predictions of future inflation from both the Marketscope and Westpac-McDermott-Millar Consumer surveys have been significantly more biased and have significantly larger average forecast errors than do the surveys of business people. The performance of the two consumer surveys is similar, though the Marketscope Survey does produce slightly smaller errors.

2.3 Comparing survey data to Reserve Bank forecasts

It is informative to consider how the accuracy of survey data compares to other predictions of inflation. The benchmark used for comparison is the Reserve Bank's own forecasts of CPII inflation over the period December 1994 to March 2003.⁹ Ranchhod (2002) compared the inflation forecasting performance of the Reserve Bank to that of eight leading professional New Zealand forecasters. This work showed that over a similar sample period, only one forecaster had more accurate published forecasts than the Reserve Bank at the one-year-ahead horizon. This indicates that the Reserve Bank's forecasts are a suitable benchmark for assessing the relative performance of survey data.

Between December 1994 and March 2003, the Reserve Bank's forecasts significantly under-predicted CPII inflation four quarters ahead. The mean error was -0.6 percentage points and the average size of the errors was 0.8 per cent. This under-prediction resulted largely from events specific to the period examined (McCaw and Ranchhod, 2002). Hence, a comparison between survey data and the Reserve Bank's forecasts is useful only in a historical sense, unless history repeats itself.

Over this same period data from the RBNZ Survey were significantly less biased and produced significantly smaller errors than did the Reserve Bank's forecasts of CPII inflation.

- The difference in mean errors was 0.5 percentage points. The difference in the average size of errors was 0.3 percentage points.
- These differences reflected a tendency among RBNZ survey respondents to believe that inflation four quarters

ahead would remain higher than the Reserve Bank's forecasts suggested.¹⁰

The performance of the AON and NBBO surveys was not significantly different from that of the Bank's forecasts (though the accuracy of these two surveys is different from each other).

- The AON Survey's mean error is slightly lower than that resulting from Reserve Bank forecasts.
- While the Reserve Bank's forecasts tended to under-predict inflation, the NBBO tended to over-predict. However, the average sizes of the resulting errors are not significantly different.

The Bank's forecasts are more accurate than data from the Marketscope and Westpac-McDermott-Millar surveys.

These findings indicate that, at least in a relative sense, survey data from business people, while not accurate predictors of future inflation, may not perform as poorly as is often believed.

3 The differing response patterns of consumers and business people

As discussed, survey data from business people have tended to be less biased and more accurate predictors of future inflation than survey data from consumers. The reasons for such differences may have important implications for the implementation of surveys and the use of the resulting data. To examine why such differences exist, it is useful to consider first the nature of the two respondent groups.

Business people are more likely than consumers to be familiar with economic activity and may have specialist knowledge in certain areas of business and finance. Such knowledge may allow them to form more accurate estimates of future

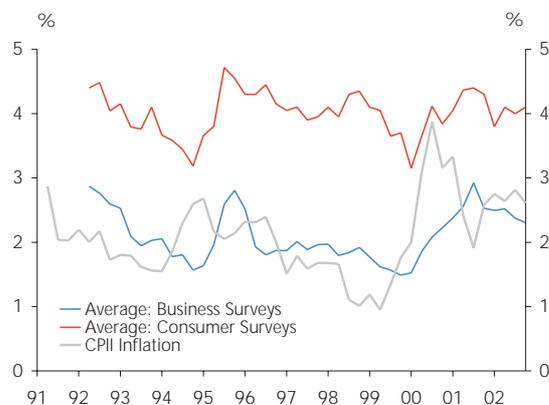
⁹ This is the period for which we have electronic records of CPII forecasts from the Reserve Bank

¹⁰ The Reserve Bank's forecasts of inflation for much of the sample were conditional on the assumption that monetary policy (interest rates) would operate in a particular manner that was expected to ensure inflation outcomes would remain inside the target bands for inflation. However, in reality, interest rates were lower than the Reserve Bank forecast (McCaw and Ranchhod, 2002, p17)

inflation. Business people are also more likely to be aware of the Reserve Bank's stated target band for inflation and previous inflation levels. This may influence the style of their responses to surveys of expected inflation. They may tend to give responses within the target band or responses that are similar to recent inflation outcomes.

The differing characteristics of business people and consumers may explain why there are differences in the accuracy (in terms of the size of forecast errors) of survey data from the two groups. However, it is still not immediately obvious that consumers should persistently over-predict the level of inflation. Nor is it obvious that they would over-estimate inflation by as much as they do. Such a tendency is perhaps more surprising given the public nature of inflation targets in New Zealand and the relative success in achieving and maintaining price stability. Figure 4 presents the quarterly average of expected annual inflation from the surveys of business people and the quarterly average from the surveys of consumers.

Figure 4
One year-ahead inflation expectations ¹¹



Notes: Survey data is presented for the quarter on which it focuses.

Earlier research has examined the public's perceptions of inflation and provides some possible reasons why consumers might tend to over-estimate inflation.¹² Consumers indicated that they do not necessarily view the aggregate CPI as an

accurate reflection of their personal inflation experiences.¹³ Instead they frequently believe that their own inflation experiences are higher than the aggregate CPI would suggest. In particular, consumers have indicated that they believe the prices of 'basics' such as food and doctors' fees are rising more quickly than CPI inflation. Price rises for these products were not perceived to have been balanced by falls in items such as electronics.

Such findings are not unique to New Zealand. The Federal Reserve Bank of Cleveland has found that the majority of consumers it surveyed were familiar with the CPI and how it was changing. However, they also found that consumers believed prices were rising at a faster rate than the aggregate CPI inflation rate indicated (Bryan and Venkatu, 2001b).

In New Zealand, surveys of consumers do not specify what measure of inflation they are examining. Instead they simply ask consumers what they expect future inflation will be. Hence, rather than being wholly inaccurate, one reason why consumers tend to over-estimate inflation might be that they are basing their responses to survey questions on subjective price experiences.¹⁴

To examine the effect subjective price experiences might have in New Zealand, data from the Marketscope and Westpac surveys were compared with CPI measures that excluded several categories of goods and services. It was hypothesised that consumers might have a better idea of inflationary pressures for goods that they frequently buy and that are not prone to shock price changes (rather than those goods that are infrequently purchased or are prone to shock price changes). However, re-weighting the CPI in this manner did not explain the level of bias that is observed in New Zealand surveys of consumers' expected inflation.

Work from the US has also considered the effects of subjective experiences on inflation expectations. The US Bureau of Labor Statistics has examined the effect of re-weighting the CPI to

¹¹ "Average: Business surveys" is the average of the RBNZ, AON and NBBO surveys. "Average: Consumer surveys" is the average of the Marketscope and the Westpac McDermott-Miller Confidence surveys.

¹² URM Research (on behalf of the Reserve Bank of New Zealand) (2002).

¹³ Of course, no measure of inflation will perfectly reflect the experiences of all members of society. The CPI is weighted to reflect the annual expenditure patterns of NZ resident households. The main source of expenditure information is the Household Economic Survey.

¹⁴ Carlson and Valev (1999) have found that the responses of consumers to surveys were influenced by their subjective experiences.

make it more representative of subjective price experiences.¹⁵ Their re-weighting did not have a large effect on the level of the CPI either. As is the case in New Zealand, the effect was not sufficient to explain the size of the observed over-prediction of inflation by US consumers (Bryan and Venkatu, 2001a).

These findings suggest that, while expectations may be affected by subjective experiences, consumers' tendency to over-predict inflation is unlikely to result solely from subjective inflation experiences.

This leaves some uncertainty regarding why consumers tend to over-estimate inflation. Consumers' responses to qualitative research indicate that price increases have a stronger influence on perceptions than do declines. And consumers may have a tendency to overstate the extent of price increases. But these explanations are only suggestive and somewhat unsatisfactory. They imply that consumers may not have well formed views on which to base many economic decisions that are dependent of expectations of future inflation (Bryan and Venkatu, 2001a).

4 Does survey data provide useful directional information regarding future inflation?

Survey data may still be useful even if they are not accurate predictors of the *level* of inflation. In a forecasting environment, we are interested in whether survey data can help to supplement other economic indicators to provide a more accurate forecast of inflation. In this respect, what is necessary for survey data to be useful is that they provide an indication of the evolution of inflationary pressures in the economy, if not the level of inflation itself. Inflationary

¹⁵ CPI weights are usually based on the expenditure of all households on particular categories of goods and services. As a result the CPI may be a better reflection of those who spend more (typically those on higher incomes). The alternative weighting system considered by the US Bureau of Labor Statistics weighted each household's expenditure equally (Kokoski, 2000).

pressures are those factors in the economic environment that influence how the level of inflation changes.

This question is examined next. In the process, checks are made to see whether inflation expectation survey data provides clues as to the future direction of inflation that cannot be obtained from other sources, or from inflation itself. The forecast horizons at which survey data may be most useful is also examined.

4.1 Do survey data provide information regarding future inflation?

As we have found, inflation expectations survey data seem to be forward-looking, but only for quite short forecast horizons, and without much more accuracy than is the case for contemporaneous inflation. To what extent then do these results reflect the fact that inflation has some persistence – once inflation rises it tends to stay up, and vice versa – as opposed to the alternative that respondents can detect pressures on inflation before they are measured in the statistics? If the former, then the apparent forward-looking nature of survey data is illusory. If the latter, the information could be useful to forecasters.

To examine this, one can look at whether the survey data contribute useful information to simple models of future inflation that also include past inflation.^{16,17} If survey data only reflect current and past inflation, then they should provide little, if any, information beyond that provided by past inflation.

¹⁶ The estimated models of future inflation were based on past levels of inflation and other economic indicators including survey data. We do not have information on future horizons when forecasting. For instance, when looking four quarters ahead, we do not have information on the next quarter or two and three quarters ahead. Hence, when examining such horizons we have excluded such information from our models. No restrictions were imposed on the models. The stationarity of the variables used was checked.

¹⁷ In determining whether survey data were 'useful' we first examined the joint statistical significance of the survey data variables in each of the models we estimated. We then considered the size of the contribution survey data make to the explanatory power of the models (ie. the increase in adjusted R² when survey data is included in the model). We considered the survey data to be useful if they explained at least an additional 10 per cent of the variation in future inflation.

The inclusion of survey data in models of inflation allows us to take advantage of any forward-looking information the data contain. Given the uncertainty regarding which inflation measure survey data have the strongest relationship with, models of headline, CPII and target-measure inflation are considered. As it is unclear how forward-looking survey respondents are, the survey data are examined in relation to inflation one to eight quarters ahead.

Table 1 in appendix 3 shows the contributions survey data make to the explanatory power of the models (i.e. the increase in adjusted R^2 when survey data is included in the model).

In these simple models of inflation, survey data appears to be able to add useful explanatory information, giving a better indication of inflation for near-term horizons than does past inflation alone. That is, survey data may provide useful forward-looking information regarding future inflation for several near-term horizons.

- Survey data from the RBNZ and AON surveys provide useful information regarding CPII and target-measure inflation two to five quarters ahead.¹⁸ This is after accounting for information on past inflation. The largest improvements in forecast accuracy are at the four quarter-ahead horizon. At this horizon, the survey data contribute approximately 20 per cent additional explanatory power to the models of inflation.
- NBBO Survey data contributes some limited forward-looking information to our models. However, in a practical sense, the contribution of these data to our models of future inflation is very limited.
- Marketscope and Westpac-McDermott-Millar Survey data do not contribute useful information to the models of inflation at any of the horizons considered.
- In most cases, the survey data do not provide useful information regarding headline inflation. This is likely to reflect the higher volatility of the headline measure.

¹⁸ The results for the RBNZ survey are not statistically significant when examining CPII inflation five quarters ahead. However, at this horizon the survey data does make a sizeable (14 per cent) contribution to our model.

4.2 Do survey data provide information that we cannot get from other sources?

While survey data may provide forward-looking information regarding inflation, they may only provide information that could be obtained from other sources. Hence a tougher but more informative approach is to test whether the survey data can supplement information from other economic indicators (including past inflation) to give a better indication of future inflation.

To determine whether survey data can supplement other economic indicators, the models of future inflation are re-estimated with the inclusion of the real 90-day interest rate, the trade-weighted index (TWI) and the output gap.¹⁹ The additional contribution of survey data to forecasting future inflation can then be assessed more accurately.²⁰ Table 2 in appendix 3 shows the contributions survey data make to the explanatory power of the models (i.e. the increase in adjusted R^2 when survey data is included in the model).

It turns out that survey data can supplement other economic information to provide a better indication of future inflation. Survey data from the RBNZ, Marketscope and AON surveys provide useful forward-looking information regarding future CPII and target-measure inflation at several near-term horizons. These survey data provide additional explanatory information that is not provided by the other economic indicators described above.

- RBNZ Survey data contribute explanatory information to models of CPII inflation three to five quarters ahead and to models of target-measure inflation three quarters ahead.
- After accounting for other economic information, the Marketscope survey contributes useful forward-looking information to models of CPII inflation five and six quarters ahead. It also contributes useful forward-looking information to models of target-measures inflation three

¹⁹ The output gap measures the difference between the economy's current level of output and the estimated level of output that is thought to be consistent with not generating any inflationary or disinflationary pressures (McCaw and Ranchhod, 2002, p13).

²⁰ *Supra*, 17.

to five quarters ahead. These data contribute most to models of target inflation.

- When other economic information was not accounted for, the contribution of Marketscope Survey data to our models was relatively limited. Such findings may reflect that the variation in inflation is too great for survey data to explain on their own. However, the data are able to explain some of the variation in inflation that is not accounted for by the effects of interest rates, the TWI and the output gap.
- Data from the AON Survey provide information regarding CPII inflation three and four quarters ahead. This survey also provides information regarding target-measure inflation two to four quarters ahead. These data contribute most at the three quarters ahead horizon.
- Westpac-McDermott-Millar Survey data provide some forward-looking information regarding CPII inflation four quarters ahead.
- Data from the NBBO Survey add little explanatory information to any of the models of future inflation examined.
- None of the survey data add explanatory power to the models of headline inflation.

Overall, these findings indicate that, in spite of any inaccuracies, some of the data from surveys may still be useful indicators of near-term inflationary pressure. The surveys may provide information regarding future inflation that is not provided by other economic information, such as the output gap and TWI. Potentially such information may be more useful for forecasting than is traditionally believed.

5 Conclusion

In the current stable inflation environment, survey data may provide useful forward-looking information regarding near-term inflationary pressures, though possibly not at the intended horizons. Survey data may be useful indicators in spite of any inaccuracy in predicting the level of inflation. However, some uncertainty persists regarding the determinants of inflation expectations, particularly those obtained from consumers. Examining such determinants is

a difficult task but may provide valuable insights regarding the use of survey data.

It is important to remember that we have examined the relationship between survey data and inflation over the period of price stability in New Zealand. We cannot say whether the observed relationships would hold if inflation in New Zealand were to become persistently higher or more volatile. However, in the current environment, survey data do provide a useful source of information regarding future inflation.

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Appendix 1

Statistical Measures

Mean error (ME)

The mean error is calculated in the following manner

$$ME = \frac{1}{T} \sum_{t=1}^T (S_t^{t+4} - A_{t+4})$$

Where:

T = Number of observations

S_t^{t+4} = Survey data on inflation expectations
four quarters ahead

A_t = Actual inflation

The ME allows us to examine for the presence and direction of bias in survey data. A positive ME indicates that on average a survey tends to over-predict inflation, while a negative value would suggest that on average it under-predicts inflation. We examine whether the biases are significantly different from zero using t-tests.

Mean absolute error (MAE)

The mean absolute error is calculated in the following manner:

$$MAE = \frac{1}{T} \sum_{t=1}^T |S_t^{t+4} - A_{t+4}|$$

The MAE removes the effects of positive and negative errors and allows us instead to focus on the magnitude of errors. A MAE of 0 would indicate completely accurate predictions. This approach assumes that the seriousness of errors increases in a linear manner (e.g. a 2 per cent error is twice as serious as a 1 per cent error).

Root mean square error (RMSE)

The root mean square error is calculated in the following manner:

$$RMSE = \sqrt{\frac{1}{T} \sum_{t=1}^T (S_t^{t+4} - A_{t+4})^2}$$

The RMSE is an alternative means of examining the magnitude of errors. The RMSE measure assumes that larger errors are of greater importance than smaller ones; hence they are given a more than proportionate penalty. A RMSE of 0 would indicate completely accurate predictions.

Theil inequality coefficient (TIC)

The TIC is calculated in the following manner:

$$TIC = \frac{\sqrt{\frac{1}{T} \sum_{t=1}^T (S_t^{t+4} - A_{t+4})^2}}{\sqrt{\frac{1}{T} \sum_{t=1}^T (A_t - A_{t+4})^2}}$$

The Theil inequality coefficient allows for the performance of the inflation expectations survey data to be compared to naive (or random walk) predictions of inflation. Naive forecasts assume "no change" in the variable of interest between the current period and the target horizon. The above formula is used to calculate the TIC in relation to expected inflation four quarters ahead. A TIC of less than 1 is said to out-perform a naive forecast.

Appendix 2

Summary accuracy statistics for survey data (September 1991 to March 2003)

Comparison of four quarter ahead survey data to CPII inflation.

	Reserve Bank Forecasts	RBNZ Survey	AON Economist Survey	NBBO Survey	Market- scope Survey	Westpac- McDermott- Millar
Mean Error	-0.66**	0.04	-0.21	0.70*	1.89**	2.32**
Median	-0.62	0.11	-0.22	0.74	1.91	2.45
MAE	0.95	0.88	0.93	1.15	2.01	2.36
RMSE	1.22	1.13	1.20	1.39	2.27	2.63
TIC	0.78	0.75	0.78	0.92	1.50	1.74
Observations	40	43	41	43	43	43

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

Reserve Bank forecasts of CPII inflation are examined over the period December 1994 to March 2003.

Two observations were excluded from the AON survey data. Because of the times these observations were recorded, they were not comparable to the other survey data.

Appendix 3

Information regarding future inflation from survey data

Table 1

Contribution to adjusted R² when accounting for past inflation

Survey data focus on the four quarter ahead horizon.

Sample period for the AON Economist survey is July 1993 to March 2003. The sample period for all other surveys is September 1991 to March 2003.

Darker regions indicate those horizons where the survey data made larger contributions to the models of future inflation. Where the estimated relationship was not sensible a " - " has been placed.

Models of headline inflation

Contribution to adjusted R² when accounting for past inflation

Horizon (Quarters)	RBNZ Survey	Marketscope survey	AON survey	Westpac survey	NBBO Survey
1	0.04	-	0.01	-	0.02
2	0.10	-	0.05	-	0.06
3	0.05	-	0.02	-	0.04
4	0.05	-	0.05	-	0.00
5	-0.01	-	0.10	-	-
6	-	-	0.00	-	-
7	-	-	-0.07	-	-
8	-	-	-0.01	-	-

Models of CPII inflation

Contribution to adjusted R² when accounting for past inflation

Horizon (Quarters)	RBNZ Survey	Marketscope survey	AON survey	Westpac survey	NBBO Survey
1	0.08	0.01	0.07	-	0.03
2	0.20	-0.03	0.11	-	0.10
3	0.21	-	0.17	-	0.14
4	0.33	-	0.25	-	-
5	0.14	-	0.20	-	-
6	-0.01	-	-0.06	-	-
7	-	-	0.04	-	-
8	-	-	-	0.03	-

Models of target-measure inflation

Contribution to adjusted R² when accounting for past inflation

Horizon (Quarters)	RBNZ Survey	Marketscope survey	AON survey	Westpac survey	NBBO Survey
1	0.03	0.00	0.03	-	0.01
2	0.13	-0.02	0.14	-	0.08
3	0.16	-0.03	0.20	-	0.17
4	0.24	-0.05	0.28	-	-
5	0.16	-	0.21	-	-
6	-	-	0.01	-	-
7	-	-	-0.11	-	-
8	-	-	-0.04	-	-

Table 2

Contribution to adjusted R² when accounting for past inflation and other economic indicators

Survey data focus on the four quarter ahead horizon.

Sample period for the AON Economist survey is July 1993 to March 2003. The sample period for all other survey is September 1991 to March 2003.

Darker regions indicate those horizons where the survey data made larger contributions to the models of future inflation. Where the estimated relationship was not sensible a " - " has been placed.

Models of headline inflation

Contribution to adjusted R² when accounting for past inflation

Horizon (Quarters)	RBNZ Survey	Marketscope survey	AON survey	Westpac survey	NBBO Survey
1	0.01	0.00	-	0.02	0.02
2	0.01	-	-	-	-
3	-	-	-	-	-
4	-	-	-	-	-
5	-	-	0.07	-	-
6	-	-	-	-	-
7	-	-	-	-	-
8	-	-	-	-	-0.01

Models of CPII inflation

Contribution to adjusted R² when accounting for past inflation

Horizon (Quarters)	RBNZ Survey	Marketscope survey	AON survey	Westpac survey	NBBO Survey
1	0.05	0.00	0.05	0.03	0.01
2	0.08	-0.04	0.06	-0.01	-0.01
3	0.14	0.00	0.15	0.04	-
4	0.22	0.09	0.13	0.11	-0.06
5	0.10	0.15	0.09	0.01	-
6	0.01	0.14	-0.02	-0.03	-
7	-	0.00	-0.05	-0.05	-
8	-	-0.08	-0.03	-0.07	-

Models of target-measure inflation

Contribution to adjusted R² when accounting for past inflation

Horizon (Quarters)	RBNZ Survey	Marketscope survey	AON survey	Westpac survey	NBBO Survey
1	-0.01	0.01	0.06	0.00	-
2	0.05	0.02	0.10	-0.02	-
3	0.12	0.10	0.21	0.01	-
4	0.07	0.20	0.13	-0.03	-
5	0.02	0.20	0.05	-0.10	-
6	0.00	0.07	-0.08	-	-
7	-	-0.05	-	-	-
8	-	-	-0.08	-	-