

# Measures of New Zealand core inflation

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Assessing the strength of inflationary pressures is challenging. Headline inflation can be volatile due to temporary or idiosyncratic factors which are unrelated to the strength of domestic demand, or which are not expected to be repeated. Core inflation measures attempt to examine the component of inflation that is related to broad trends in economic conditions and pricing behaviour, and which is likely to be more persistent. There is no agreed upon 'best' approach to measuring core inflation, and each approach has various advantages and limitations. Some work best in some circumstances; some in others.

## 1 Introduction

The Policy Targets Agreement (PTA) specifies that the Reserve Bank's monetary policy target "shall be to keep future CPI inflation outcomes between 1 per cent and 3 per cent on average over the medium term, with a focus on keeping future average inflation near the 2 per cent target midpoint." Among the information the Bank often considers when examining the outlook for inflation are measures of core inflation. These measures attempt to examine the component of today's inflation rate that is related to broad trends in economic conditions and price setting behaviour (rather than temporary or idiosyncratic factors), and which is likely to be more persistent. By providing additional insights on current underlying pricing conditions, they provide a starting point for assessing the outlook for the medium-term trend of inflation. These measures are also useful from a perspective of central bank accountability, as they help outside observers to examine the Reserve Bank's past conduct of monetary policy in pursuit of the inflation target.

Estimates of core inflation can be calculated in a number of different ways. Each measurement approach has various advantages and limitations; some work best in some circumstances, and not so well in others. Consequently, there is no agreed upon 'best' approach to its measurement. It is unsurprising, then, that the use of these measures varies between and within countries.<sup>1</sup>

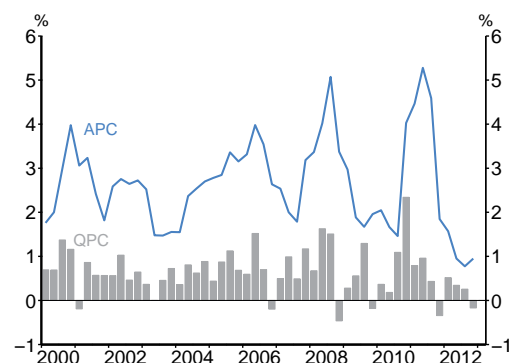
<sup>1</sup> For instance, external communications by policy makers in the United States have tended to focus on inflation excluding the effects of changes in the prices for food and fuel – a measure of core inflation that is widely understood by the public. However, to assist with the examination of inflationary pressures, the Federal Reserve Banks of Dallas and Cleveland also publish measures such as the trimmed mean of inflation. In Australia, the Reserve Bank regularly publishes trimmed mean, weighted median and CPI excluding volatile items measures.

This article discusses various core inflation measures and how we use them in the economic analysis that feeds into New Zealand monetary policy.

## 2 The concept of core inflation

Inflation can be volatile, especially on a quarter-to-quarter basis (figure 1). Often, volatility in headline inflation results from sharp changes in the prices of a small number of goods or services, and may be unrelated to the strength of economic activity or underlying trends in price setting behaviour more generally (for instance, sharp movements in the CPI are often a result of geopolitical conditions that result in volatility in the price of petrol and diesel). Such volatility can obscure the more general trend in the price level - providing little information about the outlook for inflation.

Figure 1  
Headline CPI



Source: Statistics NZ.

Measures of core inflation attempt to adjust for volatility in headline inflation, allowing the more general trend in prices to emerge. While there is no single definition of core inflation, such measures generally

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assume that overall inflation is made up of an underlying component (that is determined by broad economic conditions, and public and business expectations of the pricing climate), as well as a more volatile component that reflects idiosyncratic influences on some prices.<sup>2</sup> By abstracting from the idiosyncratic movements in prices, core inflation measures are able to highlight the persistent or generalised component of inflation that is likely to be sustained over time (Holden, 2006).<sup>3</sup> Consequently, such measures provide a useful starting point for assessing the outlook for inflation. Core measures are also likely to be useful for examining the factors that influence households' and businesses' inflation expectations, which can be important determinants of wage and price setting behaviour.

Core inflation measures are also useful for central banks' external communications, and for those attempting to monitor and hold to account the performance of central banks in pursuit of their inflation targets. These measures allow policy makers to identify things that influence headline inflation, while distinguishing them from the underlying pricing trends that typically form the basis of monetary policy decisions. Such measures can be particularly helpful at buttressing the credibility of a central bank's inflation target at times when the rate of headline inflation is strongly affected by sharp, but temporary, price changes.

For the purposes of accountability and communications, it is desirable that a core inflation measure be understood by the general public (Wynne, 1999). However, more complex measures may be useful for analytical and forecasting purposes.

Research has highlighted a number of characteristics that core inflation measures will ideally display.<sup>4</sup> Among the most salient for monetary policy are:

- that they provide an accurate gauge of persistent inflationary pressures. Monetary policy is generally focused on the underlying trend in prices. Indeed, in New Zealand clause 3(a) of the PTA notes that it is "the medium-term trend of inflation, which is the focus of the policy target." Consequently, to help ensure policy is set appropriately, monetary authorities need to be able to distinguish between those price movements that are temporary and those that will be sustained over time.
- that the measure is less volatile than headline inflation. This allows the underlying trend in price changes to be examined more closely than when using headline inflation alone.
- that they provide a timely indication of inflationary pressures. To be most useful for policy purposes, measures should be coincident or lead headline inflation, rather than lag it.

### 3 Core inflation measures

There are numerous approaches to the measurement of core inflation. Here we outline some of them.

#### Cross sectional measures

The weights assigned to individual items in the CPI basket are based on households' spending patterns. However, not all prices will be informative about the underlying strength of inflationary pressures, as some will display a high degree of volatility. Consequently the weighting scheme used in the CPI may not be appropriate for measuring core inflation. Cross-sectional measures of core inflation attempt to address this difficulty by identifying sources of temporary volatility in the CPI, and adjusting the weights of such items when calculating the rate of inflation (Wynne, 1999).

The most widely used cross sectional measures of inflation are exclusion measures. Exclusion measures remove the prices for particular components of the CPI from the calculation of inflation, with the same items removed each period. The excluded prices tend to be those that are prone to large fluctuations, or that tend to change as a result of conditions unrelated to domestic demand

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<sup>2</sup> Rogers (1998) and Wynne (2008) provide summaries of various theoretical motivations that underpin measures of core inflation.

<sup>3</sup> Richards (2006) notes that while core inflation measures may be useful indicators of the persistent component of inflation over short periods, we would not necessarily expect them to have leading indicators for longer forecasting horizons. Instead, over longer horizons, inflation is determined by the fundamental economic conditions, including monetary policy.

<sup>4</sup> For instance, Rogers (1997 and 1998), Wynne (1997), Clark (2001) and Roberts (2005).

pressures. For instance, in New Zealand domestic prices for fresh fruit and vegetables are often influenced by climatic conditions here, and in Australia (which is a major source for many of our imports). A bad summer might send tomato prices soaring, but most probably prices will normalise once the weather does.

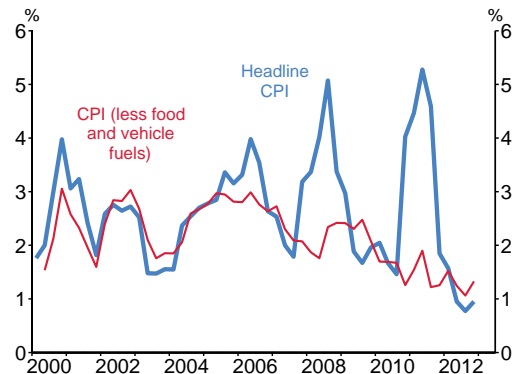
Exclusion measures are widely used by central banks, as well as other analysts and policy makers internationally (such as the IMF and OECD). Commonly used measures typically exclude prices for food and energy. These measures are simple to construct and are easily understood by the public. Such measures can be very useful for highlighting the direct effect of specific price movements on overall inflation, particularly those that monetary policy may not be able to offset (for instance, sharp increase in fruit and vegetable prices due to poor weather). Nevertheless, they have a number of limitations when examining trends in inflation:

- Exclusion measures remove price changes for only a select group of goods and services. In a given period these may not be the items that contributed to volatility in CPI.
- The average rate of inflation in the overall CPI may be, for a time, systematically different from the average rate in a given exclusion measure. For instance, during much of the past decade headline inflation in New Zealand has been higher than inflation excluding food and energy costs (figure 2), in large part due to increases in petrol prices over this period. Such differences are a concern when necessities such as food and fuel are excluded from the measure of core inflation. These items typically account for a large share of households' spending and could reasonably be expected to be reflected in households' expectations of future inflation.<sup>5</sup>
- Changes in the prices for individual goods and services, even those that can be volatile, may still in part be a result of changes in demand pressures in the economy. As a result, their exclusion from core inflation

<sup>5</sup> In New Zealand, food and energy prices (including motor vehicle fuels) account for approximately 25 percent of the CPI. A survey by UMR in 2002 highlighted that New Zealand consumers focus more on necessities such as food when thinking about inflation, rather than discretionary spending items such as televisions.

measures may inadvertently discard information that is of interest for monetary policy when assessing the strength of underlying inflationary pressures.

Figure 2  
Headline CPI and CPI excluding food and vehicle fuels  
(annual)



Source: Statistics NZ, RBNZ estimates.  
Note: CPI excluding food and vehicle fuels has been adjusted for the increase in GST in 2010.

Rather than routinely excluding prices for a particular set of goods or services, it can be more informative to adjust for unusual price movements, large or small, up or down, in a general manner. This allows us to develop a measure of underlying inflation that captures the general trend in price changes.

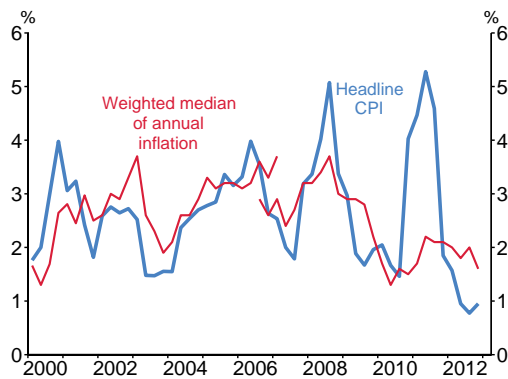
One approach is to adjust the measured inflation rate to by removing the effect of specific price changes each quarter that are considered to be one-off shocks. Such an approach has been used previously by the Reserve Bank, with items such as changes in government charges and sharp changes in commodity prices removed from the CPI when calculating "underlying" inflation. As the price changes that were removed were viewed as one-offs, they could be expected to have only a temporary impact on the measured inflation rate. However, the basis for such ad hoc adjustments and the extent of the adjustment to the price index can be somewhat arbitrary (Rogers, 1998). The Bank no longer publishes this measure of core inflation, but at times we still note the impact of specific price movements or events such as the 2010 increase in the rate of GST.

Rather than making ad hoc adjustments, it is possible to systematically adjust the CPI to account for volatile

price movements in a given quarter. Two commonly used approaches to doing this, sometimes referred to as 'limited influence' measures, are the trimmed mean and weighted median measures of core inflation.<sup>6</sup>

- To calculate weighted median inflation (figure 3), percentage changes in all components of the CPI are multiplied by their respective weights and then ranked. The weighted median is the rate of price change that half of all weighted price movements are below, and half are above.
- In each period, the trimmed mean (figure 4) removes the weighted price changes for a number of items from the CPI based on their volatility, and calculates a weighted average of the remaining price changes. For instance, the 10 percent trimmed mean measure excludes the CPI components with the largest and the smallest 5 percent of price changes, with the change in each component adjusted by its respective weight in the CPI.

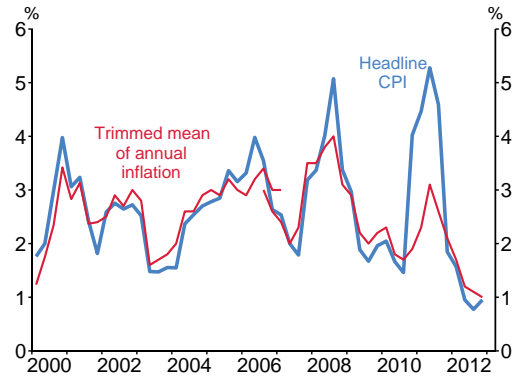
Figure 3  
Headline CPI inflation and weighted median inflation  
(annual)



Source: Statistics NZ.  
Note: There is a structural break in the weighted median inflation measure in 2006 due to changes in CPI regimen. The weighted median measure has been adjusted for the increase in GST in 2010.

<sup>6</sup> As shown in figures 3 and 4, there are structural breaks in the weighted median and trimmed mean core inflation series in 2006. These breaks resulted due to large changes in the basket used to measure the CPI. Changes to the CPI basket are necessary over time to ensure that the CPI remains an accurate gauge of spending by households. However, large changes can complicate the assessment of core inflation in real time as we are comparing prices for differing baskets of goods and services before and after the change occurs. While such changes can have a marked impact on measures such as the weighted median and trimmed mean, they will also affect other measures of core inflation.

Figure 4  
Headline CPI inflation and trimmed mean inflation  
(annual)



Source: Statistics NZ.  
Note: There is a structural break in the weighted median inflation measure in 2006 due to changes in CPI regimen. The trimmed mean measure has been adjusted for the increase in GST in 2010.

Computationally, these measures are relatively simple, and hence they can be estimated in a timely manner when the CPI is published. In addition, as they adjust for both very large and very small price changes, limited influence measures tend to be less volatile than headline inflation. These measures are also less likely than exclusion measures to suffer from a persistent bias when estimating the underlying rate of inflation. Richards (2006) notes the appeal of such measures over the past decade as China and a number of other economies in Asia have accounted for an increasing share of global economic activity. This development has resulted in increased demand for commodities such as oil. But at the same time, the price of manufactured consumer goods (which are major exports from many of these economies) has declined. Exclusion measures of core inflation adjust only the first of these conditions, potentially underestimating the degree of inflationary pressures. In contrast, limited influence measures are theoretically better able to adjust for the combination of effects this change has had on the economic environment.

Some practical caveats need to be allowed for when using limited influence measures. While they tend to be less volatile than headline inflation, they may still be volatile. In addition, Holden (2006) found that the weighted median has tended to be a biased estimator of headline

inflation in New Zealand. Furthermore, Motley (1997) notes that such measures may lag the turning point in inflation more generally.<sup>7</sup>

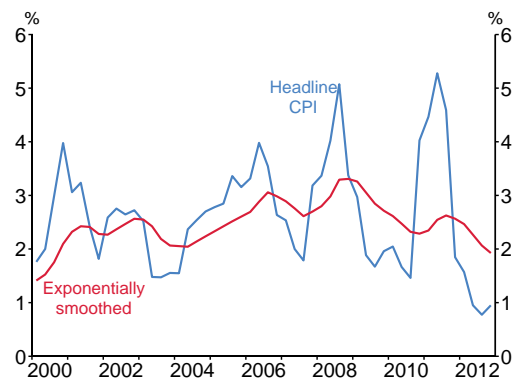
### Time series measures

The various measures discussed so far focus on excluding volatility in the CPI on a period-to-period basis. However, we are often more concerned with underlying trends in inflation than with short-term volatility. In addition, attempts to exclude volatile price changes from the calculation of inflation may inadvertently exclude information about the strength of economic conditions and the underlying state of pricing pressures. Time series measures of core inflation offer a way of dealing with this concern. Rather than excluding volatility from the CPI, time series measures focus on identifying persistent contributors to changes in the price level.

Simple time series measures of core inflation involve the averaging of inflation over several quarters. For instance, Cogley's (2002) exponentially smoothed measure is a weighted average of historical inflation, with more recent outturns given a higher weight. A version of this measure based on New Zealand data is shown in figure 5. Averaging approaches allow volatile movements up and down to balance out, limiting the influence of noisy price changes on estimates of underlying inflation. In addition, such specifications will respond to changes in the mean of inflation over time, and hence should capture that component of inflation that is likely to be persistent (Holden, 2006). However, the use of averaging means that these measures are backwards looking. Consequently, they tend to lag movements in the CPI, significantly reducing their usefulness for policy makers. This was a particular concern in New Zealand in 2005/2006, and again in 2012.

Other time series approaches to the measurement of core inflation can involve econometric modelling. Such approaches develop estimates of core inflation that explicitly account for how economic conditions are affecting the underlying pricing pressures (for instance, Quay and

Figure 5  
Headline CPI inflation and exponentially smoothed inflation  
(annual)



Sources: Statistics NZ, RBNZ estimates.

Note: The exponentially smoothed measure has been adjusted for the increase in GST in 2010.

Vahey (1995) model core inflation in the United Kingdom in relation to the strength of industrial output). Estimates of core inflation developed using such approaches depend on the features of the model that is used, and different approaches will provide differing estimates. In addition, historical estimates of core inflation from models may be revised over time, as models are often re-estimated when new data become available. The possibility of such revisions needs to be taken into account when monetary authorities use core inflation measures as an input for decision making.

### Variance-adjusted approaches<sup>8</sup>

Variance-adjusted measures of core inflation combine cross sectional and time series information. They look at the variation among components of the CPI over time and put a lesser weight on those components that do not reflect the general trend in the CPI. The weighting of the components in the price index evolves over time as the volatility of each component changes (Wynne, 1999).

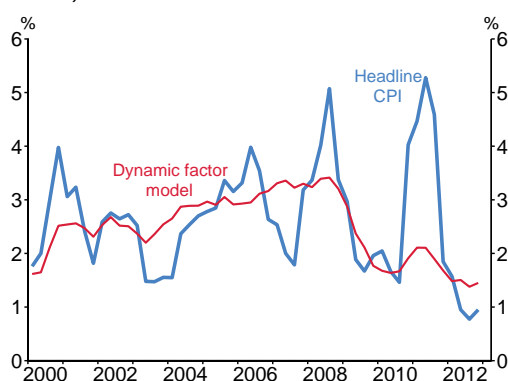
Variance-adjusted measures of core inflation used by the Bank have made use of factor modelling techniques (sometimes referred to as a principal components analysis).<sup>9</sup> Core inflation estimates developed using this approach tend to be smooth and unbiased, without lagging

<sup>7</sup> The accuracy and volatility of core inflation measures is influenced by the frequency of the price changes being examined (for instance, annual or quarterly price changes). The Bank has typically focused on annual measures of core inflation. Such measures tend to be less volatile and are consistent with the specification of our price stability target.

<sup>8</sup> Other variance adjusted approaches to measuring core inflation in the US and Australia are discussed in Wynne (1997) and Gillitzer and Simon (2006) respectively.

changes in the headline CPI (figure 6). In New Zealand, such measures have proven to be useful analytical tools, capturing the persistent trend in inflation. Notably, these measures have highlighted the strong influence that non-tradable inflation has on underlying inflationary pressures in New Zealand (Kirker, 2010). While non-tradable goods and services account for around half of the CPI, they account for around two thirds of the variance in core inflation. This is significant from a monetary policy perspective as, non-tradable inflation is strongly influenced by domestic economic conditions, including the stance of monetary policy. In contrast, tradable inflation tends to be more strongly influenced by global conditions and changes in the New Zealand dollar.<sup>10</sup>

Figure 6  
Headline CPI inflation and dynamic factor model inflation  
(annual)



Source: Statistics NZ, Reserve Bank of New Zealand.

Note: The dynamic factor model measure has been adjusted for the increase in GST in 2010.

Approaches such as factor models are computationally more complex than the other core inflation measures discussed here. In addition, the weights assigned to CPI components in factor model estimates are based on statistical analysis of how prices behave over time, rather than on a particular item's share of household spending. Consequently, the weights underlying factor estimates are often not easily interpretable, and identifying the drivers of core inflation may not be a simple task. Furthermore,

while such measures are very useful for monetary policy analysis, they may not be easily understood by the public. Consequently, they may not be as useful for external communication as simpler approaches like exclusion measures.

As with other approaches that involve estimation, historical estimates of core inflation from the factor model are revised when new data become available. However, Giannone and Matheson (2006) note that in New Zealand this has not dramatically affected the predictive power of the indicator, though they do find that the indicator's historical estimates have tended to be modestly revised up over time.<sup>11</sup>

## 4 Core inflation and New Zealand's monetary policy

New Zealand's monetary policy is focused on maintaining stability in the general level of prices, with the target measure defined in terms of the all groups CPI. The target is forward looking, focusing on the average rate of inflation over medium term horizons, and monetary policy affects inflation only with a lag. Thus, when accounting for our past performance, and when thinking about the implications of what is going on now for future inflation, the Bank does not focus solely on headline inflation.

Core inflation measures provide useful tools to assist the Bank when examining economic conditions and pricing behaviour. In particular, they allow us to better estimate the strength of inflationary pressures that are likely to influence future inflation outcomes.

For instance, if inflation is increasing as a result of increases in domestic demand, it may be appropriate to tighten monetary policy to dampen real activity and the related inflationary pressures. In such circumstances, headline and core inflation are likely to provide similar indications regarding the strength of underlying inflationary pressures.

<sup>9</sup> Details on factor model measures of core inflation for New Zealand, including their calculation, can be found in Giannone and Matheson (2006) and Kirker (2010).

<sup>10</sup> Although the prices of non-tradable goods will largely reflect domestic factors, global conditions and the New Zealand dollar may affect the domestic costs of inputs and the strength of domestic trading conditions.

<sup>11</sup> The initial estimates of annual core inflation from the Bank's factor models have tended to be revised up by around 0.1 to 0.2 ppts over time. Kirker (2010) notes that this may have been contributed to by the increase in the average rate of inflation over the past decade. While further revisions will occur over time, it is not clear that such revisions will be in one direction or that they will be material.

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However, near-term inflation may vary for a range of reasons that monetary policy typically would not respond to. For instance, in the event of a temporary supply shock, such as a disruption to international oil markets, headline inflation would increase temporarily and then moderate as the shock passes. If monetary policy tried to affect the direct inflationary impact of such developments, it would be near-impossible (pass-through from world oil prices to retail petrol prices is very fast) and would accentuate the related disruptions to real activity (Roger, 1998). In such circumstances, core inflation measures are likely to be a more accurate gauge of the underlying trend in inflation that is related to domestic demand conditions. Trends in this component are likely to be more enduring than those in headline inflation, and are more likely to be responsive over time to changes in monetary policy. Understanding the strength in these underlying pressures is also important as while monetary policy is focused on price stability, the Bank aims to avoid unnecessary volatility in output, interest rates and the exchange rate in pursuit of price stability.

Core inflation measures also allow influences on historic inflation outcomes to be examined, and help to explain the judgements that underlie monetary policy decisions. This is especially useful during periods of increased volatility in inflation, as they help to look behind the noise and – by focusing on the underlying trends – help to signal the credibility of a monetary authority's inflation target (Roger, 1998). For instance, between December 2007 and December 2008 headline inflation in New Zealand rose to levels above the Bank's target band. During this period, the Bank reduced the Official Cash Rate in response to the downside risks for economic activity as global conditions and the domestic house market weakened. Our external communications over this period noted the downside risks for activity, and highlighted that increases in headline inflation were contributed to by strong increases in food and fuel prices, the effects of which were expected to be temporary. Similarly, in 2010/2011 when an increase in the rate of GST resulted in a sharp increase in headline inflation, the Bank's external communications noted that wage and price setters should focus on underlying inflation, which remained contained.<sup>12</sup>

The Bank's use of core inflation measures as discussed above accords closely with the intent of clauses 3(a) and 3(b) of the PTA. These clauses note that there may be variation in the annual rate of inflation as a result of factors whose impact could be expected to be temporary. In the event of such volatility, these clauses direct the Bank to respond in a manner consistent with its medium-term target. In practice, this means that the Bank does not respond to the direct inflationary effect of short-term volatility in prices. Instead, the Bank accounts for any impact that such fluctuations in headline inflation have on inflation expectations (as this may affect medium-term wage and price setting behaviour) and sets policy in accordance with economic conditions more generally.

When looking at core inflation, the Bank considers a range of different measures.<sup>13</sup> This reflects the various advantages and limitations of the different approaches discussed above, and allows us to develop a broad understanding of inflationary pressures. Historically, we have focused on limited influence measures (such as the trimmed mean), as well as variance-adjusted measures such as the sectoral factor model. However, other approaches, such as exclusion measures, have been useful at times when trying to examine the effect of particular influences on inflation, such as the increase in the rate of GST in 2010. No one measure ever tells the full story, and all these methods of analysing the inflation rate itself are still only one element in the rich mix of information we use in analysing the outlook for inflation, including regular discussions with businesses, financial institutions, government agencies and unions.

Moreover, while the Bank makes considerable use of core inflation measures and other information, they always work from, and need to be related back to, headline inflation. Not only is the monetary policy target defined in terms of future headline inflation, but volatile CPI outcomes can themselves matter for policy, especially if that volatility is spilling over (which it typically does not) into the price

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<sup>12</sup> For instance, see the Reserve Bank's September 2011 *Monetary Policy Statement* at page 2.

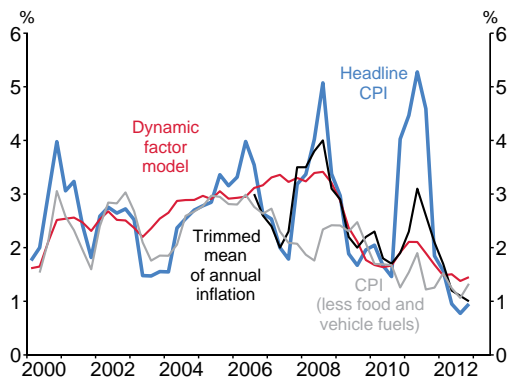
<sup>13</sup> Some of the measures regularly examined by the Bank are included in table B of the Bank's quarterly *Monetary Policy Statement* and can be found at <http://rbnz.govt.nz/statistics/econind/a3/data.html?sheet=2>.

and wage-setting behaviour, and consumption and other spending decisions, of firms and households.

Core inflation measures are informative when examining New Zealand inflation at present. Headline inflation has fallen to low levels, with the CPI increasing by only 0.9 percent in the year to December 2012 (figure 7). In part, this low rate of inflation is a result of sharp movements in the prices of fruit and vegetables. Exclusion measures, while having a number of limitations when assessing inflationary pressures in general, provide a useful diagnostic tool for examining the impact of such price movements on overall inflation.

Changes in the prices of fruit and vegetables over the past year have been strongly influenced by climatic conditions offshore. Consequently, at least some of the current softness in food prices is likely to be temporary, and could be expected to reverse as supply conditions

Figure 7  
Headline CPI inflation and core inflation measures  
(annual)



Sources: Statistics NZ, Reserve Bank of New Zealand.

Note: There is a structural break in the weighted median inflation measure in 2006 due to changes in CPI regimen. All measures except headline CPI exclude-GST.

normalise. Consistent with the PTA, the Bank has not responded to the direct effects of such influences on inflation. Instead, as noted in the December 2012 *Monetary Policy Statement*, the Bank has focused on medium-term inflationary pressures, the assessment of which is, in part, informed by measures of core inflation. Measures such as the trimmed and dynamic factor model suggest that while underlying inflationary pressures are low, they are not as low as headline inflation in isolation would suggest.

## 5 Conclusion

New Zealand's monetary policy is focused on ensuring stability in prices over the medium term. Monetary policy works only with a lag, and a range of idiosyncratic or temporary shocks can complicate the interpretation of inflation outturns. To assist with understanding what inflation outturns are telling us, the Bank makes use of core inflation measures. Such measures try to look through the temporary volatility in prices, so that we can examine the strength of the underlying pressures in the economy. These measures are also useful for examining a central bank's performance in pursuit of an inflation target. There are many approaches to measuring core inflation, each with various advantages and limitations. Consequently, instead of focusing exclusively on a single measure, we make use of a number of different approaches to gauge core inflation.

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