ARTICLES

Measuring core inflation

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Under the Policy Targets Agreement, the Reserve Bank is required to keep future CPI inflation outcomes between 1 percent and 3 percent on average over the medium term. The headline CPI inflation rate provides some information on the strength of current and future inflation pressures, but can often be clouded by temporary fluctuations. Core inflation measures attempt to abstract from these temporary fluctuations to better inform us of the underlying trends in inflation. This article outlines a number of criteria that can be used to assess the relative merits of possible measures of core inflation. It then analyses a range of alternative core inflation measures against these criteria and draws some conclusions as to which measures might best serve as core inflation indicators in New Zealand.

1 Introduction

Inflation is commonly defined as the rate at which the general level of prices is increasing. However, the Consumers Price Index (CPI) measure of inflation will not always reflect the underlying trend increase (or decrease) in prices. This may be because a temporary shock (such as a sharp movement in oil prices or a change in indirect taxes) causes a significant short-term fluctuation in the CPI inflation rate, or because of limitations in the sampling methods used to construct the CPI. In addition, prices for some items in the CPI may be sampled infrequently (eg, at a single point in the quarter in question), which can make the measured price movement noisy.

Core inflation measures attempt to abstract from temporary shocks and measure the component of inflation that is likely to be sustained over time.[1] In order to help gauge inflation pressures, many central banks consider a variety of measures of 'core' (or 'underlying') inflation. Most central banks, or the statistical agency of the country in question, regularly publish a range of such measures.

The Reserve Bank looks at a number of core inflation measures, and reports some of these in its *Monetary Policy Statements* (*MPS*). However, historically, the Reserve Bank's use of core inflation measures has been rather ad hoc. This article summarises recent work done by the Reserve Bank on core inflation measures for New Zealand.

The next section reviews different types of core inflation measures. Section 3 then discusses what properties we would wish to see in an ideal measure of core inflation, noting that there are tradeoffs involved.[2] Section 4 discusses potential core inflation measures for New Zealand and explains how each of these measures performs in terms of these properties. The article concludes by discussing how the Reserve Bank intends to use these core inflation measures, noting that they are just one of many tools used to analyse inflation pressures.

2 Measures of core inflation

The literature has put forward a variety of methods for deriving core inflation measures. Traditional methods include simply taking a moving average of measured inflation. More popular with central banks have been methods that down-weight or zero-weight some components of measured inflation. Such methods include trimmed means and weighted medians.

A trimmed mean is the weighted mean of the middle part of the ranked distribution of CPI component price movements, where each component is assigned its CPI weight. For example, the 10 percent trimmed mean is calculated by removing the highest and lowest 5 percent of the percentage price movements and then taking the weighted mean.

A weighted median is the percentage price movement of the component in the middle of the ranked distribution of

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1 However, there is no generally agreed definition of core inflation.

2 Roberts (2005) provides a more in-depth discussion of core inflation measures and properties.

CPI component price movements, where each component is assigned its CPI weight.

Core inflation measures that permanently exclude particular components from the headline inflation rate have also been popular among central banks. An example is the 'CPI excluding food and energy, which is constructed by the Bureau of Labor Statistics in the US.

The use of core inflation measures differs across countries, with some central banks putting significant weight on core inflation measures, and others paying less attention to them. The Reserve Bank of Australia publishes a seasonally adjusted weighted median, a 30 percent trimmed mean, and a CPI excluding volatile items (fruit, vegetables and petrol) on its website.[3] The Bank of Canada and US Federal Reserve also look at exclusion measures of core inflation.[4]

The popularity of trimmed means, weighted medians and exclusion measures stems from their timeliness and the ease of computation. Exclusion measures are also reasonably easy to understand. However, all of these measures are difficult to justify theoretically. For example, theory gives no guidance on how much of a trim to take when constructing a trimmed mean measure. It is also difficult to justify the exclusion approach to measuring core inflation because there is no theory that says that the components excluded (such as food and energy) do not matter for inflation. Sustained increases in energy prices, for example, could become an integral part of a country's inflation process.

More recently, measures with stronger theoretical foundations have been developed. Quah and Vahey (1995) aimed to measure the component of inflation that "has no medium- to long-run impact on real output" (Quah and Vahey (1995), p1130). They did this by identifying disturbances that shift potential output (such as productivity shocks) using a Vector Autoregression (VAR) system. The influence of these shocks on measured inflation was then removed to give a core inflation measure. Since aggregate demand can be quite volatile, the resulting core inflation series can often look bumpy.

Cogley's (2002) exponentially smoothed (ES) measure of core inflation is based on the theory of adaptive expectations and by construction, responds strongly to 'sustained' movements in the general price level (see box 1). However, since adaptive expectations are backward looking, the measure typically lags headline CPI.

The factor model is a relatively new way of estimating core inflation (see Forni, Reichlin and Veronese (2005) and Kapetanios (2004)). The factor model aims to use the common price variation within the components of the CPI to down-weight those components that do not reflect the general tendency of all CPI components – that is, those components whose price movements are not pervasive historically are down-weighted. Thus, the factor model measure removes the influence of the noisy (idiosyncratic) component of inflation. Unfortunately, because the estimated common component of inflation is essentially a weighted average of all the CPI component price movements – and the weights can be positive or negative – the factor model's estimates of core inflation have no easy interpretation.

Box 1
Calculation of the exponentially smoothed (ES) measure

The ES measure of core inflation can be written:

$$\mu_t = \phi\Sigma_j(1-\phi)^j\pi_{t-j}$$

where μ_t is the ES measure at time t, $0 \leq \phi \leq 1$ is an adaptive expectations adjustment parameter which reflects the backward looking learning process, and π_{t-j} is measured inflation (usually CPI inflation) at time t-j.

Because $0 \leq \phi \leq 1$, the ES measure is a weighted mean of the lagged values of measured inflation, where the most recent outturn has the highest weight. Therefore, an ES measure should pick up movements in the mean of inflation and hence the component of inflation that is likely to be sustained over time.

[3] See www.rba.gov.au/Statistics/measures_of_cpi.html

[4] The Bank of Canada core measures are detailed at: www.bankofcanada.ca/en/rates/indinf/cpi_def_en.html. The US Federal Reserve reports their core inflation measures in their six-monthly Monetary Policy Report to Congress. This can be found on their website: www.federalreserve.gov/boarddocs/hh/

3 Characteristics of a core inflation measure

There has been extensive discussion in the literature around the characteristics that a measure of core inflation should exhibit.[5] Some of the key characteristics put forward are:

a. simplicity;

b. picking up persistent changes in inflation;

c. leading or being coincident with measured inflation (ie, not lagging measured inflation);

d. unbiased indication of measured inflation;

e. smoothness (eg, having a low variance); and

f. low prediction error for measured inflation.

Why would we want a core inflation measure to display these characteristics? The second characteristic (picking up persistent changes in inflation) follows directly from what we want a core inflation measure to be – a measure of the component of general price increase that is sustained over time. In addition, because we want a core inflation measure to abstract from temporary shocks, it should be smooth relative to measured (CPI) inflation, which is subject to short-term fluctuations.

Ideally, a core inflation measure should be an unbiased indicator of measured inflation. A core inflation measure that gave a biased indication of measured inflation would need to be mean-adjusted to be of any use. A core inflation measure should also, ideally, be a good predictor of measured inflation, because we want it to measure the rate at which the general level of prices is increasing.

We want a core inflation measure to give us timely information on the general rate of inflation. Therefore, a core inflation measure should at least be coincident with measured inflation. A core inflation measure that tended to lag movements in actual CPI inflation would not be particularly useful as an indicator of turning points in inflation pressures. Finally, it is desirable that a core inflation measure be reasonably simple. A simple core inflation measure will help maintain the central bank's credibility by being easy for the public to understand and for other organisations to replicate.

Note that there are trade-offs between some of these characteristics. For example, a very smooth core inflation measure may predict inflation badly. Therefore, an outright winner in terms of all of these characteristics is unlikely.

4 Potential core inflation measures for New Zealand

Until recently, core inflation measures used by the Reserve Bank have predominantly been variations of trimmed means, weighted medians and exclusion measures. Therefore, in general, the Reserve Bank's core inflation measures have not had a strong theoretical grounding. Our research efforts over the past year have focused on core inflation measures that have a stronger theoretical basis. A measure based on Cogley's (2002) ES measure and a factor model measure are two potential core inflation measures for New Zealand that may have stronger theoretical foundations.[6]

We have tested five core inflation measures already in use by the Reserve Bank along with an ES measure and factor model measure against some of the characteristics mentioned in section 3. Brief descriptions of these measures are in table 1, overleaf.

We compared each of the candidate core inflation measures against characteristics a to e above. We do not consider characteristic f (low prediction error) because this is typically just the converse of smoothness.

Unbiasedness and smoothness are discussed in terms of whether the measures have a similar mean to and a lower standard deviation (less variability) than CPI inflation over the 1992Q1 to 2006Q3 period.

How well a core inflation measure reflects persistent inflation pressures can be judged by looking at inflation over the past 15 years. Inflationary pressures increased sharply in 1994 as economic activity accelerated, and then ebbed away gradually over the next five years. Ideally, a core measure

[5] Papers that discuss desirable characteristics of a core inflation measure include Roger (1997 and 1998), Wynne (1999), Dixon and Lim (2004), and Roberts (2005).

[6] We do not construct a VAR measure (based on Quah and Vahey (1995)), as our intention is to find core inflation measures based only on CPI data, rather than more model-based measures.

Table 1

Candidate core inflation measures

Core measure	Description
Weighted median CPI	The weighted median quarterly price movement of all the CPI components.
Trimmed mean CPI	The mean of the middle 90 percent of the ranked distribution of CPI quarterly price movements.
CPI ex. food, petrol and government charges	Food, petrol and government charges are permanently excluded from the CPI.
CPI ex. housing	Rents, home ownership, professional services, property maintenance services, and real estate services are permanently excluded from the CPI.
Non-tradables	Includes goods and services produced in New Zealand that face little or no direct foreign competition.
ES measure	Cogley's ES measure calculated using New Zealand CPI data.*
Factor model	The common component of inflation is estimated from all the CPI classes for which we have data going back to 1992Q1.**

* We use a slightly different adaptive expectations adjustment parameter to Cogley's.

** 96 of the 105 classes currently in the CPI are included (classes include, eg, meat and poultry, men's clothing, and life insurance). Note that Statistics New Zealand reduced the number of disaggregate CPI series that are made available to the public from more than 250 to 105 with the release of the 2006 regimen in September. While the analysis of the dynamic factor model of core inflation presented in Gianonne and Matheson (2006) is conducted with the 2002 regimen, the results remain robust when replicated using the 2006 regimen (using fewer CPI series).

should pick up this increase in inflation and then gradually decrease.

There was another marked inflationary impulse in the second half of 2000. However, the increase was relatively short-lived, with inflation falling back within the inflation target in the middle of 2001. As this 2000 inflationary spike was more transitory than the 1994 episode, a core inflation measure should ideally respond in a more muted fashion.

Related to the characteristic of picking up persistent inflation pressures is characteristic c. A core inflation measure may pick up persistent changes in inflation, but if it does this with some lag to CPI inflation, then the measure will not be particularly useful.

How the candidate cores perform

Four of the seven measures (the weighted median, CPI excluding food, petrol and government charges, CPI excluding housing, and non-tradables) perform badly in terms of the desired characteristics (see table 2). Although all four of these measures are simple to construct and understand, they have not done well at capturing persistent inflation movements, and in most cases have been biased and/or not smooth.

The other three measures (the trimmed mean, ES measure, and factor model) performed much better. In what follows, we discuss how each of these measures performed against characteristics a to e.

Table 2

Assessment of poor core inflation candidates*

Core measure	Simple	Picks up persistent changes in inflation	Unbiased	Smooth
Weighted median	✓	Poor to average	×	✓
CPI ex. food, petrol and government charges	✓	Poor	✓	×
CPI ex. housing	✓	Poor	×	×
Non-tradables	✓	Poor	×	×

* Characteristic *c* has not been included in this table because these measures often do not follow CPI inflation very closely, making it difficult to tell whether the measures lead, are coincident with, or lag CPI inflation.

The trimmed mean (10 percent trim)

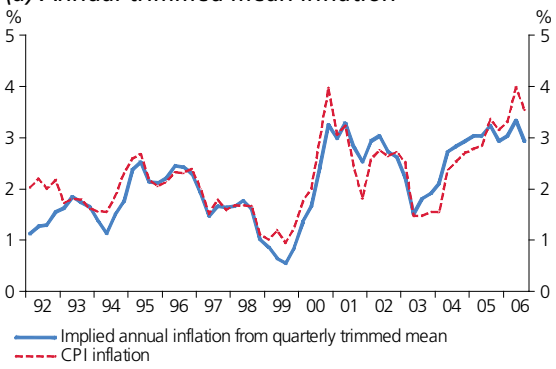
The trimmed mean is reasonably simple to construct and understand. It also appears to be an unbiased indicator of CPI inflation, with the time series mean very similar to CPI inflation. The standard deviation of the trimmed mean is very similar to the CPI standard deviation, suggesting that it fails to strip out sufficient transient components of inflation. Taking a greater trim may strip out more of the transient components of inflation. However, over the past four years, even a 30 percent trim has failed to remove substantial short-term noise.[7]

The trimmed mean was slightly slower to pick up in 1994 than headline CPI inflation and then followed CPI inflation down over the next five years. In 2000, the trimmed mean picked up at the same time as headline CPI inflation, and again tracked CPI inflation very closely.

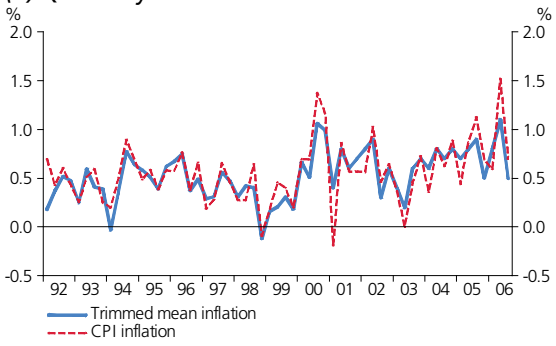
Figure 1

Trimmed mean inflation

(a) Annual trimmed mean inflation



(b) Quarterly trimmed mean inflation



[7] We focus on the 10 percent trim, as this is the trim the Reserve Bank has traditionally used. Statistics New Zealand now publishes a range of trims, but these are only available back to December 2001.

The ES measure

The ES measure is significantly smoother than CPI inflation, having a standard deviation of quarterly movements about a third the size of the CPI equivalent. The ES measure is also unbiased, with a mean very close to the mean of CPI inflation.

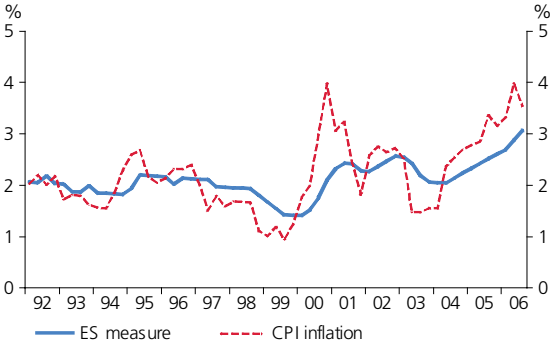
The ES measure adjusted slowly to pick up the increases in inflation in both 1994 and 2000, as one might expect from a measure based on adaptive expectations. In the mid-1990s episode, the ES measure reflected the sustained inflationary pressures through the subsequent couple of years. For the 2000 inflation spike, which was more transitory (relative to the inflation target), the ES measure indicated little movement in core inflation. The ES measure is also reasonably easy to construct and understand.

The lagging nature of the ES measure is probably its main disadvantage. In constructing the ES measure, a parameter choice needs to be made that affects how smooth and backward looking the measure is. The parameter could be chosen to make the ES measure less backward looking, but this would also make the measure less smooth.

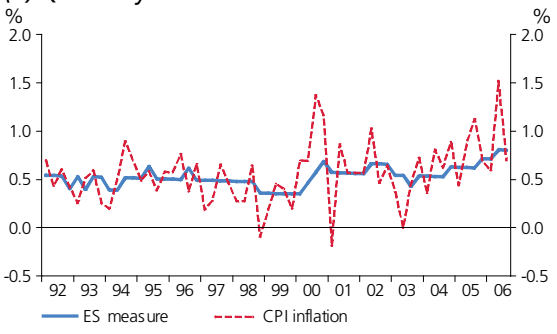
Figure 2

ES inflation

(a) Annual ES inflation



(b) Quarterly ES inflation



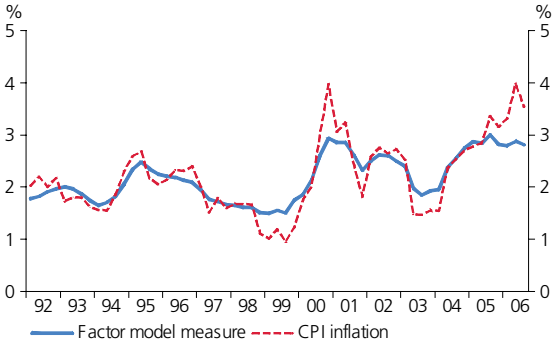
The factor model

Like the ES measure, the factor model measure is significantly smoother than CPI inflation. However, the factor model measure performed better than the ES measure at reflecting persistent inflation pressures in 1994 and 2000. In 1994, the factor model measure increased with headline CPI inflation, but not by the same extent. The factor model measure then gradually fell over the next few years. The factor model measure also picked up gradually in 2000 and, once again, did not increase to the same extent as headline CPI.

The factor model measure appears to be unbiased. However, one concern in using the factor model measure is that it is not as easily understood by the public as the other measures.[8] The measure is technically demanding to construct, making it hard for other users to replicate.

Figure 3

Factor model core inflation



Summary of results

Table 3 ranks how the candidate core measures perform against each of the characteristics, where 1 is the best and 3 is the worst. In some cases, it is difficult to differentiate between the performance of two or three measures, so they are given equal rankings.

Clearly, none of the measures is an outright winner in terms of all the characteristics. Although the trimmed mean is simple and unbiased, it does not do well at picking up changes in persistent inflation and is not very smooth. The ES and factor model measures are better at picking up changes in persistent inflation (although the ES measure lags CPI inflation) and are much smoother. Determining which measure is the 'best' is somewhat subjective, as it depends on what characteristics are believed to be most important.

5 Conclusions

Core inflation measures can help inform us of the underlying trends in inflation. However, they are only one of many tools that can be used to analyse inflation. The Bank uses a range of other tools, such as models and indirect indicators of inflation, in conjunction with core inflation measures to get a better gauge of inflation pressures.

In light of our work on core inflation measures, we think it is sensible to narrow down our list of core inflation measures to some degree. To this end, we believe that the trimmed mean, ES, and factor model measures of core inflation form a good group of core inflation measures for the Reserve

Table 3

Characteristics of core inflation candidates

Core measure	Simple	Picks up persistent changes in inflation	Leads or coincident	Unbiased	Smooth
Trimmed mean	1	3	1	1*	3
ES measure	1	2	3	1	1
Factor model	3	1	1	1	2

[8] In addition, unlike the other measures we have discussed, the factor model measure is subject to revision. More discussion of the revisions can be found in Giannone and Matheson (2006).

Bank to focus on. However, the Reserve Bank does not intend to focus on a single measure or target any measure of core inflation.

At the time of writing (November 2006), these three measures of core inflation suggest that the underlying level of inflation is somewhere around 2.8 to 3.1 percent – near the top of the Reserve Bank's 1 to 3 per cent target band.

From the December 2006 *MPS*, table 3.1 in Chapter 3 will include the ES and factor model measures discussed in this article. In addition, these measures will be made available on the Reserve Bank's website (www.rbnz.govt.nz) in the Statistics section and will be updated on the day of each CPI release.

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