

## Core Inflation Measures Produced in New Zealand

Paper presented at the 11th Ottawa Group conference,  
at Neuchâtel, Switzerland,  
27–29 May 2009

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**Acknowledgments:** Many thanks to Chris Pike, and those from the Reserve Bank of New Zealand who provided valuable comment on this paper, in particular, Christina Leung, Tim Hampton, and Troy Matheson.

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## **Abstract**

There are numerous ways of defining and measuring core inflation. Traditional methods include exclusion-based approaches and 'component' series. The latter breaks the Consumers Price Index (CPI) down into specific, or rather specified, components of the whole to decompose CPI price change.

Statistics New Zealand produces a range of exclusion-based series – including series excluding food and energy – and decomposition measures such as the goods and services components, tradable and non-tradable components, and the government charges and CPI excluding government charges component. Further, measures based on statistical techniques such as trimmed means and weighted percentiles, and a range of other distributional and contribution information, are compiled.

This paper outlines the methods used to compile these measures, their appropriate interpretation, and their relative merits and value in enhancing an understanding of inflationary pressures. The paper also outlines recent Reserve Bank of New Zealand research in defining and calculating additional core measures.

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## Introduction

Against the backdrop of developments in monetary policy towards targeting price stability via a range of acceptable price movements in a target index, analytical core inflation measures have been developed, calculated, and published. These aim to understand the source of general price pressures, and to distil the price signals for future inflation contained within the overall measure.

Such measures have traditionally been exclusion based. However, the development and introduction of statistical approaches such as trimmed means and weighted percentiles into the core inflation monitoring environment, has been led predominately by the Reserve Bank of New Zealand. Core inflation measures have been of wide interest in the monitoring of monetary policy in New Zealand, and have indeed played an important role in this regard.

This paper highlights the measures currently produced by Statistics New Zealand to assist in the Reserve Bank's monitoring of inflation, and its recent developments in core inflation measures. Most notable is the calculation and introduction of the factor model estimate, which is now included alongside other published measures of trend price change within the Reserve Bank's monetary policy publications.

Section 2 details the monetary backdrop to the development of core inflation measures. Section 3 gives an overview of the desirable properties and characteristics of core inflation measures. Sections 4, 5, 6 and 7 outline measures currently produced by Statistics NZ to aid understanding of core inflation. Section 8 provides an overview of some of the current measures used by the Reserve Bank to monitor core inflation, and recent developments in monitoring core inflation.

## New Zealand developments in, and monetary policy backdrop to, core inflation

It was the introduction of the Reserve Bank Act (1989) and subsequent Policy Targets Agreement (PTA) that provided the real impetus for the calculation of additional measures of inflation. The PTA between the Governor of the Reserve Bank and the Minister of Finance formalised price stability as a defined target in terms of 'acceptable' movements in a price index. In this regard the New Zealand was the first country in the world to adopt a price stability target and formalise this arrangement in such a way.

The first PTA, signed in March 1990 (1990a), directed the Reserve Bank to "direct monetary policy towards the stabilisation of the 'general level of prices' ", and directed the monitoring of a range of price indexes. While the all groups Consumers Price Index (CPI) was the prominent index used for practical purposes, it was not initially considered an entirely suitable measure,<sup>1</sup> and the Reserve Bank was directed to produce additional measures. In particular, one such additional measure was one that incorporated a different conceptual approach to the CPI, the housing adjusted price index (HAPI). The HAPI excluded the financing costs of housing and replaced the purchase and construction of new dwellings component with a rental equivalence approach.

Contained within each PTA was also a list of caveats, in recognition of the one-off events that could result in changes in prices outside the agreed stability band, for which a policy response would cause undue disruption to real economic activity. Notably, this list evolved from listing

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<sup>1</sup> Given that the CPI also incorporated prices and servicing costs of investment-related expenditures, notably in the housing field.

specific events to a more suggestive description of events, as monetary policy matured.<sup>2</sup> Early caveats included: natural disaster, significant changes in the terms of trade, changes in goods and services tax (GST) and indirect taxes (GST had only recently been introduced when the first PTA was signed)<sup>3</sup>, and changes to government and local body levies.

The price target was later simplified to consider price stability as being annual rises in the CPI of between 0 percent and 2 percent<sup>4</sup> (1990b), and the requirement to produce the HAPI removed (1992). Interestingly, when the HAPI was removed from the PTA and discontinued, it was replaced with the publication of a measure of 'underlying inflation'<sup>5</sup> which excluded certain components altogether and the influence of others at times, and aligned somewhat with the caveats outlined above.

Such an approach to monitoring the general price level, while 'looking through' extraordinary events, led to the development of a range of additional measures, generally referred to as core inflation. These assisted in understanding the price signals for future inflation contained within the overall all groups CPI alongside the wider range of measures utilised to understand movements in the 'general price level'. Such measures included a range of CPI less specific components series, in particular the measure of underlying inflation.

With respect to core inflation, the approach up until the mid-1990s was clearly focused on additional analytical measures that were exclusion-based. Other exclusion-based measures include the CPI less fresh fruit and vegetables, and energy (including vehicle fuels), and CPI less housing related costs (purchase of new dwellings, sections and holiday houses, professional and real estate agent services, dwelling maintenance services, and rentals).

Decomposition measures also formed part of the monitoring of the general price level, notably the central and local government charges, and tradable and non-tradable series, which are discussed below. The central and local government charges component and CPI less central and local government charges have their genesis in the range of caveats contained with the PTAs of the early-1990s (the exclusion of changes in GST and indirect taxes) and they have aided the calculation of underlying inflation.

Scott Roger, of the Reserve Bank, made a significant contribution to the research and interpretation of core inflation (1995b, 1997 and 1998), moving away from the exclusion-based and decomposition measures towards statistical measures of core inflation. Roger, in his commentary on the June 1995 quarter CPI results in the *Reserve Bank Bulletin* (1995a), presented moments in the price distribution for mean, variance, skewness, and kurtosis, alongside a range of analytical inflation measures: in particular the weighted median and the 10 percent trimmed mean. He went further to suggest that "the 57th percentile [movement] appears to be a reasonable approximation to the population mean percentile" (Roger, 1997).

However, it was not until the May 1998 Monetary Policy Statement<sup>6</sup> (MPS) that these statistical measures of core inflation were introduced into the MPS and economic projections publications. Notably, this coincided with the discontinuation of the underlying inflation

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<sup>2</sup> This is reflected in more recent PTAs requiring price stability 'on average over the medium term', hence allowing for movements outside the target band in the short term (provided that these movements are based on temporary impacts of prices).

<sup>3</sup> GST was introduced on 1 October 1986 at 10 percent and raised to 12.5 percent on 1 July 1989.

<sup>4</sup> While the target band was defined in terms of the all groups CPI, the Reserve Bank continues to monitor a wide range of price indexes, including the labour cost index, producers price index and GDP implicit price deflator, and inflation expectations, to fully understand changes in the general price level.

<sup>5</sup> Calculated as the CPI less credit services (including interest costs), government charges, and oil. Further, meat, dairy and timber were also excluded on occasion when they made a 'large' contribution.

<sup>6</sup> The May 1998 MPS introduced "three 'robust' measures of the general trend of inflation": 10 percent trimmed mean, a '1 standard deviation from the mean' trim (designed to exclude price changes of more than 1 standard deviation above or below the mean), and the weighted median.

measure at the end of 1997, when the latest PTA redefined the target price index to be the CPI less credit services (referred to as CPI-X).

The move to discontinue the Reserve Bank's measure of underlying inflation resulted from growing disquiet, mainly internally, about the credibility of a measure calculated within the Reserve Bank that was based on subjective decisions as to when to exclude the impact of additional sources of price change. Further, the principal difference between the underlying inflation measure and the CPI-X, the impact of interest costs included within credit services, was to be excluded from the all groups CPI with the publication of the September 1999 quarter CPI.<sup>7</sup>

During the early-2000s, Statistics NZ widened the measures that it produces to include the statistical measures of core inflation; essentially producing those measures previously calculated and reported by the Reserve Bank.<sup>8</sup> This has allowed greater accuracy of results<sup>9</sup> and credibility. The Reserve Bank has gone on to develop additional, and more statistically sophisticated, measures of core inflation. This has resulted in the development and addition of factor model approaches to the Reserve Bank's understanding of price developments and forecasting, and reporting these measures in its MPSs.

## **Desirable qualities and characteristics of core inflation measures**

Roger, in his work on statistical measures of core inflation in the mid-1990s, proposed a range of desirable qualities and characteristics that measures should demonstrate. These are outlined below, and discussed against each measure outlined in the following sections.

The desirable properties, as outlined in Roger (1998) are:

- robust and unbiased – measures of core inflation should be efficient in distinguishing between persistent and transitory inflation, and not be biased relative to the target measure of inflation
- timely
- credible
- verifiable.

Further, core inflation measures should be useful in policy formation (of which the robust and unbiased property is a necessary but not sufficient condition), and allow policy transparency and accountability.

Holden (2006) further expands on the desirable properties and suggests that the key characteristics of a statistical measure of core inflation are:

- simplicity
- picking up persistent changes in inflation
- leading or being coincident with measured inflation
- unbiased indication of measured inflation
- smoothness (eg, having low variance)
- low prediction error for measured inflation.

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<sup>7</sup> This also included the removal of residential section prices.

<sup>8</sup> Further, a wider range of statistical measures were produced, whereas only the 10 percent trim, 1 standard deviation trim and weighted median were published. The range of measures is discussed in section 7.

<sup>9</sup> Given that Statistics NZ calculates these from unrounded movements and weights, which not available to the Reserve Bank or general public.

These later criteria have been developed with statistical measures of core inflation in mind, and coincide with evaluation of the more recent statistical measures developed by the Reserve Bank, outlined in section 8.

## Exclusion-based measures

Exclusion-based measures represent the earlier development in measures of core inflation. Exclusion measures are calculated by excluding those components that demonstrate perverse behaviour, or are prone to exceptional or non-representative price movements (for example seasonal fruit and vegetable prices, and vehicle fuels) (Roger, 1995).

### Exclusion based on classification

A number of series are produced by Statistics NZ for the New Zealand context:

- All groups less credit services
- All groups plus interest (an approximation of the CPI under the 'payments' approach)
- All groups less each of the 11 groups
- All groups less housing and household utilities group and credit services
- All groups less purchase of housing class
- All groups less household energy subgroup and vehicle fuels
- All groups less vehicle fuels
- All groups less food and vehicle fuels
- All groups less petrol class
- All groups less food group, household energy, and vehicle fuels
- All groups less international travel.

A number of exclusion-based measures are also published by the Reserve Bank, to highlight particular inflation concepts (definitions of some components mentioned are discussed in the following section):

- All groups less housing non-tradable items
- Non-tradable less housing items
- CPI less government charges, food and petrol.

Exclusion-based measures have the strength that they are consistent in calculation, in that the same component is excluded each time, making the resulting explanation clearer and more credible. Such measures are credible as there are no subjective decisions made each quarter as to which component to exclude (unfortunately, which component to exclude in the first instance is a subjective decision, discussed below).

The exclusion-based approach essentially presents a hypothetical scenario, one that assumed that the excluded component demonstrated the overall price change, and can therefore remove the impact of price change (for the excluded component) that is well above or below the 'core' (ie remaining items) price change<sup>10</sup>. Further, the difference between the exclusion-based measure and the 'headline' measure contains valuable information to help interpret underlying price signals for future inflation contained within the core.

However, the weaknesses of the exclusion-based approach are that:

- they are not based on any general theoretical approach
- results may be biased (compared with the long-run price trend in the all groups CPI).

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<sup>10</sup> This is easily proved, as the only way that the excluded item could be reintroduced into the basket, with a positive weight, and without altering the overall result, would be if it had recorded the same price movement as the rest of the basket.

The first point is one of the major criticisms of core inflation measures. The lack of theoretical grounding is demonstrated most clearly with exclusion-based approaches – by what means did one arrive at the components to exclude? This weakness should be moderated somewhat by the calculation of 'second generation' exclusion-based measures, where the components are arrived at by measures of volatility (eg CPI less volatile items). There remains a degree of subjectivity with second generation measures with respect to the definition of volatility, and decisions as to the level of aggregation at which to exclude, and weight to exclude. However, measures based on volatility can often closely resemble those based on economic priors, such as food, energy, and vehicle fuels, suggesting this may simply be an ex-post justification.

Core inflation estimates that are constructed using exclusion-based methods are also limited in their ability to cope with shocks that do not fit neatly into identifiable CPI classifications.

Interesting, given that one of the purposes of a core inflation measure is to allow central banks to 'look through' (ie not respond to) an initial price increase as a result of a supply shock – as this may not warrant a monetary policy response<sup>11</sup> – the secondary impact of such shocks does warrant a response. Therefore, provided that core inflation measures are constructed around stated sources of supply shock that will be 'looked through', in a monetary policy sense, core inflation measures may have some theoretical grounding. Such measures as CPI less vehicle fuels are a pertinent example – supply shocks from international oil prices on vehicle fuels may be considered a first round effect, to which a monetary policy response would cause undue economic disruption, while the subsequent impact on prices throughout the supply chain and on inflation expectations would require a response.

A further weakness is that exclusion-based measures can be biased, and not predict future inflation well, compared with long-run headline inflation. This can be witnessed in a number of exclusion-based measures where the items excluded consistently demonstrate price change greater than, or less than, the average. Indeed, central banks would not want to ignore components that consistently exhibited price change that is different from the average.

As seen in figure 1, over the past 10 years, petrol and household energy<sup>12</sup> prices have risen at a faster rate than the CPI. Food on the other hand, has periods when the index is above, and periods when it is below the CPI all groups, suggesting that, while the CPI less food will be unbiased in the long run, it may not give robust estimates of future inflation at a given point in time.

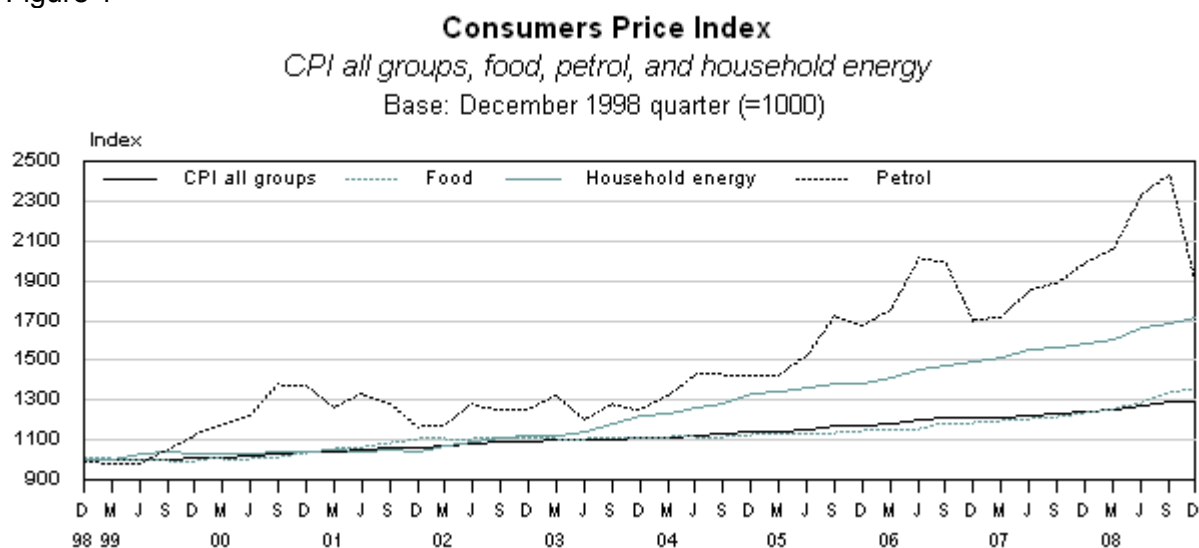
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<sup>11</sup> Given the undue disruption on economic activity that such a response may generate in the short-run.

<sup>12</sup> Household energy here is electricity, gas, and solid fuels.



Figure 1



Following from the discussion above, while it may be beneficial to exclude the petrol component, to eliminate the first round effects on the CPI all groups, it would be much harder to make the same statement about household energy.

### Exclusion of price change: calculating scenarios by holding prices constant

Given that exclusion-based measures implicitly replace the price movement of particular components with the overall price change, another approach is to remove the price movement altogether. This means that the component remains in the basket, although with a zero price movement.

This type of analysis is often contained within the regular New Zealand CPI release, for hypothetical quarterly and annual percentage changes in the all groups CPI, or tradable or non-tradable components. The scenario assumes prices for a particular class or item under consideration had remained unchanged. These scenarios are constructed by removing the index points contribution of the class or item under consideration from the CPI all groups index number. This assumes that the item remains in the basket of goods and services, but its price remained unchanged over the period of comparison.

However, such measures are not overly credible given the subjectivity in deciding which components to hold price constant for. Indeed, they would definitely be biased if price changes are excluded for more than an annual period.

### Decomposition measures

Decomposition measures of price change split the CPI into specific, or rather specified, components of the whole, to decompose CPI price change. This divides the overall CPI basket of goods and services into sub-categories. Generally speaking, the overall CPI price change is the weighted average of the sub-components, thus giving consistency of aggregation. Decomposition measures therefore allow identification of the various sources of price change to be examined, understood, and then forecast appropriately.

Interestingly, decomposition measures clearly stand alongside index series for the standard commodity (rather, commodity consumption) classifications, such as the United Nations Classification of Individual Consumption According to Purpose (COICOP). These classifications also allow for the creation of goods and services measures – a goods and services decomposition. Most statistical offices produce such measures.

While providing an interesting 'window' into the sources of price change within the CPI basket, decomposition measures can suffer from the same criticism as exclusion-based measures, although to a lesser degree, in that a theoretical underpinning is lacking. However, appropriate frameworks, such as the goods and services decomposition above, can provide a sound basis for calculation and interpretation.

Several measures that utilise such frameworks are produced by Statistics NZ. Notable is the calculation of a tradable and non-tradable decomposition of the CPI basket into one component where the goods and services are subject to international price pressures, and one in which items are much more likely to be influenced by domestic demand and supply conditions. Another is the component for central and local government charges (and the CPI less this component), which came about as a result of particular caveats contained with the PTA, and gave rise to some of the other exclusion-based measures to core inflation in the New Zealand context. Each of these indexes is detailed below, and the frameworks used to construct the respective basket of goods and services is discussed, along with the composition of the goods and services series.

### **Central and local government charges non-standard series**

The decomposition measure for central and local government charges is part of the evolution of monitoring of core inflation in the New Zealand context (as seen by the inclusion in the 'underlying inflation' measure constructed by the Reserve Bank and as a series in their own right). There is a corollary series for CPI less central and local government charges, which provides the counterpart basket that comprises all other items that are not determined as central and local government charges.

As previously discussed, the policy targets agreements throughout the 1990s highlighted that changes in central and local government charges could cause CPI inflation to move outside the price stability target without requiring the 'standard' monetary policy response. There was discussion as to whether movements in the central and local government charges should be part of the "inflationary process that monetary policy should be concerned with, or should they be viewed differently?" (McCaw, 1998). Ultimately, a more complete [inflation] picture can often be gained by looking at the data from different angles (ibid).

The framework that was used to initially decide the composition of central or local government charges, considered:

- charges placed on goods and services provided by a government-owned organisation, or a direct fee placed by government on a service
- charges for a service provided by the private sector, that attracts a government subsidy, and the maximum that can be charged to the consumer is capped by the government
- charges for a service provided by the private sector, that attracts a government subsidy, but the government places no limit on the charge to the consumer. However, the government can influence the level of fees paid by the consumer by reducing the subsidies payable to the organisation
- charges subject to excise duty.

The central and local government charges index includes Housing New Zealand and local authority rentals, land transfer registration fees, local authority rates, water supply and part of refuse disposal, electricity, prescription charges and oral contraception, general practitioner fees, vehicle relicensing fees, road user charges, driver licensing fees, postage, State and integrated schools, tertiary education, other education, cheque duty, and official passports, licences and certificates.

### **Tradable and non-tradable non-standard series**

The tradable and non-tradable component series allow users to decompose CPI goods and services into two components: one contains goods and services that are imported or in competition with foreign goods, either in domestic or foreign markets (tradables); and the other contains goods and services that face no direct foreign competition (non-tradables).

Tradable and non-tradable components illustrate the sources of price movements within an open economy. Movements in the tradables component (tradable inflation) demonstrate how international price movements and exchange rates are impacting on movements in consumer prices. The non-tradables component shows how domestic demand and supply conditions are affecting consumer prices. Tradable and non-tradable component series can be utilised in monetary policy by the Reserve Bank, as tradable inflation reflects external price shocks, whereas non-tradable inflation is more directly impacted on by domestic monetary policy.<sup>13</sup>

To determine the tradable/non-tradable split Statistics NZ furthered work undertaken by the Australian Bureau of Statistics (ABS). The methodology classified those items with significant exports or imports (relative to domestic consumption) as tradable, given that these items would very likely have significant international price pressures due to foreign competition in domestic markets, or domestically produced goods and services facing competition in international markets. Items were classified as non-tradable if there were little or no imports or exports, and little or no international competition (Statistics NZ, 2004).

### **Goods and services non-standard series**

The goods and services series allow users to decompose CPI into its goods and services components. These components allow users to analyse the sometimes differing price pressures from commodities and price pressures from services.

The goods component comprises: the food group (except restaurant meals); alcoholic beverages and tobacco group; clothing and footwear group (except clothing services); purchase of new housing, property maintenance materials, water supply, household energy, household contents and services group (except repair and hire of household appliances, hire of major tools and equipment, and other household services); medical products, appliances and equipment; dentures; purchase of vehicles, vehicle parts and accessories; petrol, other vehicle fuels and lubricants; telecommunication equipment; recreation and culture group (except recreational and cultural services, accommodation services and package holidays); and the miscellaneous goods and services group (except hairdressing and personal grooming services, jewellery and watch repair, insurance, credit services and other miscellaneous services). The services component comprises all items not in the goods component.

### **Distributional information**

The distribution of item-level index movements as presented in the regular CPI release gives information on the distribution of price movements for the current quarter's CPI movement. These analytical statistics include: the weighted average price increase and decrease; expenditure weight, and number, of items increasing and decreasing; alongside the index point and percentage point contribution of items that increased and decreased. This distributional information gives an indication of how widespread price changes are, and their relative magnitude when compared with previous quarters. Currently no annual distributional information is compiled and released.

Given the interest in discovering the underlying price changes, the distribution of price change gives an indication of how widespread price increases and decreases are, and their relative

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<sup>13</sup> It should be noted however, that the exchange rate mechanism is seen as one of the key monetary policy channels.

importance within the overall CPI price change. With information about the number of items reporting price increases or decreases, the overall weight of those items, and the magnitude of those changes, users of CPI data can make their own inferences about the underlying distribution of price change and the current quarterly movement.

Other distributional measures that have been presented include moments of the distribution of (weighted) price change – mean, variance, kurtosis and skewness (see Roger, 1995a). However, such distributional characteristics may lack credence with wider audiences given possible difficulty in understanding their interpretation.

## **Trend measures of price-level change**

Given the weaknesses of exclusion-based measures and decomposition measures, which lack theoretical grounding and where the shocks may not fit within CPI classifications, statistical approaches to the measurement of core inflation have been proposed. These measures are often referred to as trend measures.

Over the long term, the CPI captures the broad pattern of price change, but over shorter horizons the trend in price change can be masked by one-off events. In particular, the CPI:

- can be subject to temporary influences, such as adverse climatic conditions affecting the prices of fresh fruit and vegetables
- is influenced by other supply disturbances, which, while they affect the cost of living, do not directly affect the underlying inflationary pressures in the economy. For example, supply disturbances for petrol or electricity can have a large impact on the CPI in the short term
- includes some items that are subject to seasonality, such as international air fares and rental car hire, which may induce volatile short-term price behaviour.

Trend measures can be calculated to filter some of the short-term disturbances that may affect the CPI. These measures attempt to isolate the more persistent component of general price-level changes, using statistical approaches. Statistical measures such as trimmed means and weighted percentiles can provide robust measures of core inflation. These measures are constructed primarily to meet the need for robust analytical measures of core inflation, which are largely free of subjective decision making.<sup>14</sup>

As a method for estimating core inflation, trimmed means are less subjective in nature than other methods such as exclusion and specific adjustment. Because a predetermined statistical methodology is used, there are no decisions as to which index items need excluding or adjusting, and therefore trimmed means are less subjective than other measures. However, there is little economic basis to trimmed means because a statistical measure of the distribution of the price movements is used to determine the outlying price movements to be removed from the index.

The trimmed mean measure involves calculating the weighted mean of price movements in the central core of the ranked distribution, in effect cutting off the tail at each end of the distribution of price movements. For example, the 10 percent trimmed mean removes 5 percent of the weight from each tail. The weighted median measure is the movement of the item or group of items that rank in the middle of the distribution. This weighted median is also known as the 50th percentile, as half the weighted price changes are below the median and half are above.

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<sup>14</sup> There remains some subjectivity in deciding the level the trim is made at and the weight of each tail to trim.

Several series are constructed to give a good guide to the trend in price-level change (5, 10, 15, 20, 25 and 30 percent trims),<sup>15</sup> and a weighted median measure (the 50th percentile) is produced. Four other weighted percentile measures are also available (the 10th, 25th, 75th and 90th weighted percentiles), primarily to highlight the distribution of price changes within a particular time period. Where the distribution of price movements is positively skewed, the weighted median movement will tend to lie below the CPI movement. Where the distribution of price movements is negatively skewed, the weighted median movement will tend to lie above the CPI movement.

The annual measures have been derived from annual item-level percentage changes, rather than the aggregation of the four relevant quarterly percentage changes. The main reasons for this are that:

- it cancels out quarterly seasonal effects. Items such as fresh fruit and vegetables, international air travel, rental car hire and motel accommodation tend to be seasonal in price behaviour. Due to their volatile nature, they will often be 'trimmed' in a quarterly measure. However, over a 12-month period, the seasonal effects will cancel each other out, providing a better underlying measure of price change
- it eliminates potential bias from staggered price setting, such as education fees and local authority rates and payments.

However, an issue arises with trend measures derived from annual item-level percentage changes when these measures span a price reference period. When the CPI is reweighted, there is a transition period during which the percentage changes used to calculate the annual trimmed means and weighted percentile measures span the price reference period.

Traditionally, the weights used each quarter to calculate the trimmed means and weighted percentile measures are price updated from the relevant price reference period to the earlier of the two quarters in the relevant comparison. Price updating involves multiplying the price reference period expenditure weight by a ratio of the price index number for the earlier of the two quarters in the comparison to the index number for the price reference period.

An alternative approach to calculating the annual trimmed means and weighted percentile measures during the transition across a price reference period is to 'price backdate' expenditure weights that relate to the new price reference period. Price backdating involves multiplying the new expenditure weight by a ratio of the price index number for the earlier of the two quarters in the annual comparison to the index number for the new price reference period.

Both approaches was taken for annual trimmed mean and weighted percentile measures that span the June 2006 and June 2008 quarter price reference period.

When interpreting the two parallel time series for the annual trimmed means and weighted percentiles two considerations are important. Firstly, consistency with the published all groups CPI, and secondly, relevance of the expenditure weights. These two considerations are discussed with respect to the annual period that spanned the introduction of June 2006 quarter expenditure weights.

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<sup>15</sup> The Reserve Bank has a preference for the 10 percent trim (see Reserve Bank of New Zealand, 2006) while the Reserve Bank of Australia produces a 30 percent trim in conjunction with the ABS (2007). Notably, the ABS calculates the 30 percent trim at a more aggregated level of the CPI classification.

### Consistency with the all groups CPI

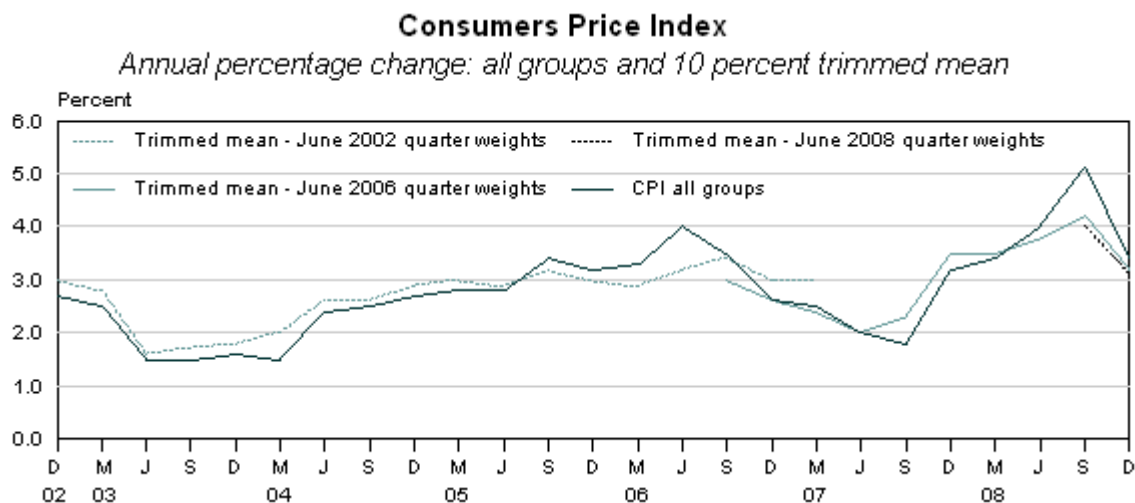
When the comparison spans a price reference period, it can be seen that, during the transition across the reweight period, the annual percentage change in the all groups index shows progressively more influence from the new set of expenditure weights.

As the two separate annual trimmed mean and weighted percentile time series each uses only one set of weights in its calculation, consistency with the all groups index can guide its interpretation. For example, for the September 2006 quarter all groups CPI annual percentage movement, the new set of expenditure weights was only used for the movement between the June and September 2006 quarters. The old set of expenditure weights was used for quarterly movements for the December 2005, March 2006, and June 2006 quarters.

Considering this, the September 2006 quarter annual trimmed means and weighted percentiles using price-updated June 2002 quarter weights have three quarterly movements in common with the all groups CPI. However, for the December 2006 and March 2007 quarters, this falls to two quarters and one quarter, respectively. This means that, during the transition period, the annual trimmed means and weighted percentiles based on price-backdated June 2006 quarter weights became progressively more consistent with the all groups CPI; the price-updated June 2002 quarter trimmed mean and weighted percentile annual movements became progressively less consistent with the all groups CPI.

Annual movements for the all groups CPI and the two 10 percent trimmed mean series (based on the June 2002 quarter and June 2006 quarter expenditure weights) are shown in figure 2.

Figure 2



### Relevance of expenditure weights

Another consideration is which of the two sets of expenditure weights for calculating annual trimmed means and weighted percentiles in 2006 and 2007 is more relevant – the June 2002 quarter weights or the June 2006 quarter weights?

The price-updating of weights accounts for any price change between the price reference period and the earlier period in each annual comparison. However, when a new set of expenditure weights is introduced, the weights reflect the underlying quantities of the new weight reference period. The weight reference periods (and main weighting source) corresponding to the June 2002 quarter and June 2006 quarter price reference periods are the 2000/01 Household Economic Survey (HES) and the 2003/04 HES, respectively.

The quantities underlying the June 2006 quarter expenditure weights are considerably more recent than those underlying the June 2002 quarter expenditure weights. Because they are more recent, the June 2006 quarter expenditure weights (based on 2003/04 quantities) could be considered more relevant for calculating annual trimmed means and weighted percentile inflation in 2006 and 2007, than the June 2002 quarter expenditure weights (based on earlier, 2000/01 quantities).

Given the interest in core inflation to distil the price signals for future inflation, annual trimmed mean and weighted percentile inflation measures based on the latest weight and price reference periods would be more likely to be coincident with future inflation than those of the earlier price reference period.

Alternative annual measures could be constructed by aggregating (ie compounding) the four relevant seasonally adjusted quarterly movements to create the annual percentage change.<sup>16</sup> However, care is still required to ensure that seasonal adjustment correctly accounts for staggered price setting. Research is currently underway by Statistics NZ into the appropriate calculation of seasonally adjusted CPI series, which would allow investigation of the possible differences between trimmed mean and weighted percentile measures calculated from annual percentage changes, and measures calculated from compounded seasonally adjusted quarterly percentage changes.

### **Recent developments in 'core inflation' in New Zealand**

There has been a general acceptance of the trimmed mean and weighted percentile statistical measures, even to the point where these measures are now reported by media organisations for the general audience (not just the business audience). This resulted from not only from the openness of the Reserve Bank in their calculation of the trimmed means and weighted percentiles, but from increased understanding of these measures and the eventual calculation and publication by Statistics NZ, which allowed greater accuracy of results and credibility.

Acceptance of these statistical measures has allowed the Reserve Bank to develop additional, and indeed even more statistically sophisticated, measures of core inflation. This has resulted in the development and addition of the factor model approach to the Reserve Bank's understanding of price developments and forecasting, and reporting of these measures in its monetary policy statements.

### **Core inflation monitoring by the Reserve Bank**

Giannone and Matheson (2006) outline some of the core inflation measures utilised by many central banks, including the Reserve Bank, that have evolved from the initial investigation into trimmed means and weighted percentile work by Bryan and Cecchetti (1993) and Roger (1995), as follows:

- trimmed mean, generally the 10 percent trim
- weighted median
- median
- CPI excluding food, administration charges and petrol
- double weighted median
- exponentially smoothed inflation.

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<sup>16</sup> Such an approach is taken by the ABS in the calculation of annual trend measures on behalf of the Reserve Bank of Australia (2007), where concurrent seasonal adjustment is made for all series prior to calculation of the trend measures. The annual trend measures are then the compounded four quarterly seasonally adjusted trend measures.

While the first four measures listed above are recognisable from the discussion above, it is worth quickly detailing the last two, which are given below (from Giannone and Matheson, 2006):

The double-weighted measure of core inflation weights each of the components of the CPI according to its relative expenditure weight and a weight  $v_i$ , which is inversely proportional to its variability (ie more volatile components are down weighted). Double-weighted inflation is calculated as:

$$\frac{\sum_{i=2}^{n+1} w_i v_i \pi_{it}}{\sum_{i=2}^{n+1} w_i v_i} \quad \text{where} \quad v_i = \frac{1/\sigma_{it}}{\sum_{i=2}^{n+1} 1/\sigma_{it}}$$

$\pi_{it}$  is the annual change in CPI item  $i$ , at period  $t$ ,  $w_i$  its expenditure share and  $\sigma_{it}$  is the standard deviation of inflation in component  $i$  relative to headline CPI inflation,  $(p_{it} - p_{1t})$ .

The exponentially smoothed inflation measure is given by:

$$\phi \sum_{i=1}^j (1 - \phi)^j \pi_{1t-i}$$

where  $\phi$ , the expectations adjustment parameter, is set to 0.125, (as in Cogley (2002), quoted in Giannone and Matheson, 2006).

### Recent developments in core inflation monitoring

While econometric approaches to estimation of the (theoretical) stochastic approach were suggested as early as 1993, by Bryan and Cecchetti, recent advances in econometric modelling have made such estimation possible. However, it has more likely been the general acceptance of statistical measures of core inflation in the wider monetary policy arena, namely the trimmed means and weighted percentile measures, that has led to the inclusion of dynamic factor modelling in the September 2006 Monetary Policy Statement. The dynamic factor measure was introduced in the September 2006 MPS as one of the two preferred measures of core inflation (the other being the 10 percent trimmed mean).

Balk (2008) describes the stochastic approach as being a model for individual price relatives, of the form:

$$p_n^1 / p_n^0 = f(\mu^{01}, \varepsilon_n^{01})(n = 1, \dots, N)$$

Balk goes on to suggest that such a model is represented by the common component  $\mu$  and an idiosyncratic component  $\varepsilon$ .

This is given in Giannone and Matheson (2006) as:

$$\pi_{jt} = \chi_{jt} + \varepsilon_{jt}$$

where inflation is represented as a common component  $\chi$  and an error term. Further, for the measurement of core inflation,  $\chi$  can be decomposed into:



$$\pi_{jt} = \chi_{jt}^L + \chi_{jt}^S + \varepsilon_{jt}$$

Where:

- the long-run component  $\chi^L$  (core inflation), and
- short-run component  $\chi^S$

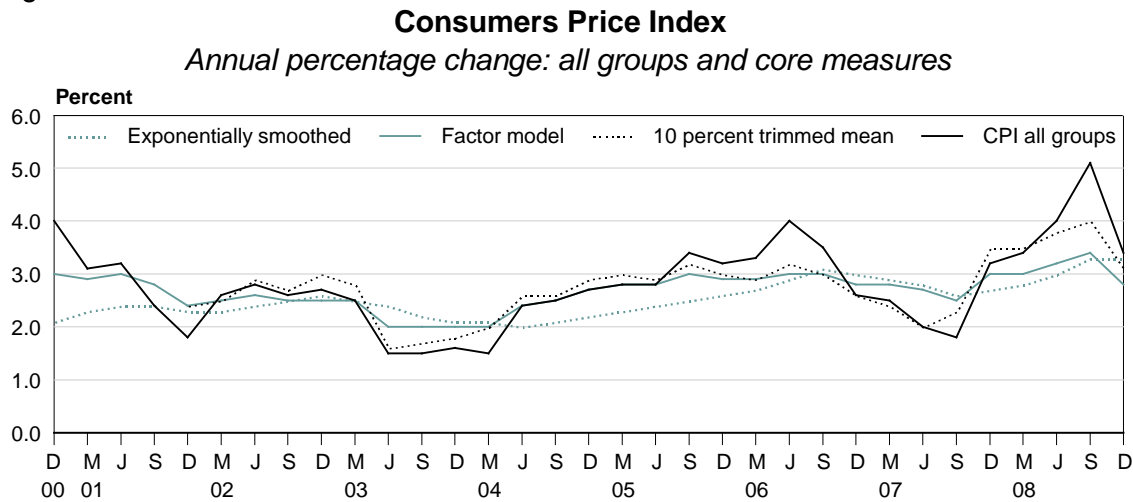
This approach smoothes out the short-term fluctuations that do not require a policy response, and removes the idiosyncratic noise specific to each CPI component. Isolating the unobserved component can be achieved by assuming that the common components are driven by shocks that are pervasive throughout the CPI components, while the shocks driving the idiosyncratic terms are local and affect only a limited number of prices (Giannone and Matheson, 2006).

Vector autoregression is then used to estimate the common factors within the model, and forecast future inflation provided that there are sufficient leading and lagging variables to project the long-run component of inflation.

In its interpretation, the factor model can be seen as being the price signal for future inflation that is contained within the current period inflation outcome. In this respect, the factor model was the best predictor of future inflation when compared with the trimmed mean and exponentially smoothed measures in Holden (2006).

The results from the factor model are presented alongside the exponentially smoothed inflation measure, the annual increase in the CPI all groups, and 10 percent trimmed mean, in figure 3.

Figure 3



Sources: Statistics New Zealand, Reserve Bank of New Zealand

## Appendix 1: Calculation of trend measures

### Calculating trimmed means and weighted percentiles

The trimmed mean measures involve calculating the weighted mean of price movements in the central core of the ranked distribution, in effect cutting off the tail at each end of the distribution of price movements. Therefore, unlike the other CPI analytical series produced by Statistics NZ (published in tables 3.01, 3.02 and 3.03 of the Hot Off The Press – Consumers Price Index), it does not automatically exclude certain items every quarter or year. Instead, the items that are excluded from the trimmed mean from period to period will depend on the distribution of price changes.

#### Calculation of a trimmed mean

The procedure for calculating an x percent (quarterly or annual) trimmed mean is as follows:

1. Calculate the percentage change for each of the item-level indexes in the CPI regimen.
2. Calculate the price-updated expenditure weight for each item.
3. Express the price-updated expenditure weights as percentages, summing to 100.
4. Sort the percentage changes in price from the smallest decrease to the largest increase, along with the price-updated expenditure weight for each item.
5. Form the cumulative sum of the weights for each ranked price change, *i*. For example, the cumulative weight associated with PC3, the third-ranked price change, equals  $W_1 + W_2 + W_3$
6. Exclude those percentage changes in price for which the cumulative weight is either less than or equal to  $(x/2)\%$  (ie unusually small decreases), or, for which the cumulative weight of the previous item is greater than  $(100 - [x/2])\%$  (ie unusually large increases).
7. For the first (smallest) percentage change in price that has a cumulative weight greater than  $(x/2)\%$ , reset its weight,  $W_i$ , to the value of its cumulative weight less  $(x/2)\%$ .
8. For the first (smallest) percentage change in price with a cumulative weight greater than  $(100 - [x/2])\%$ , reset its weight,  $W_i$ , to the value of  $(100 - [x/2])\%$  less the cumulative weight of the previous item.
9. The trimmed mean movement is calculated as:

$$\frac{\sum_{i=F}^L W_i PC_i}{\sum_{i=F}^L W_i}$$

where:

- $W_i$  = the price-updated expenditure weight for item *i*
- $PC_i$  = the percentage price change for item *i*
- $F$  = the first (ranked) price change to be included
- $L$  = the last (ranked) price change to be included.

### **Calculation of weighted median and other weighted percentiles**

The weighted median measure is the movement for the item or group of items that is in the middle of the ranked distribution (also known as the 50th percentile). That is, half the weighted price changes are below the median, and half are above.

The procedure for calculating a quarterly or annual weighted median is as follows:

1. Repeat steps 1 to 5, above.
2. The median rate is set as equal to the first percentage change in price with a cumulative price-updated expenditure weight greater than or equal to 50 percent.

The weighted percentile movements are calculated in a similar manner. The xth percentile rate is set equal to the first percentage change in price that has a cumulative price-updated expenditure weight greater than or equal to x percent.

## Appendix 2: Core Inflation measures published by selected national statistical offices and central banks

### Statistical Offices

Office	Exclusion-based measures	Decomposition measures and special measures (including statistical measures)
Bureau of Labor Statistics (United States)	All items less: <ul style="list-style-type: none"> <li>• food and energy</li> <li>• energy</li> <li>• food</li> <li>• shelter</li> <li>• medical care</li> </ul>	<ul style="list-style-type: none"> <li>• commodities and services</li> <li>• durables/non-durables</li> <li>• commodities less food and beverages</li> <li>• non-durables less food and beverages</li> <li>• non-durables less food, beverages, and apparel</li> <li>• commodities less food</li> <li>• non-durables less food</li> <li>• non-durables less food and apparel</li> <li>• services less rent of shelter</li> <li>• services less medical care services</li> <li>• energy</li> <li>• commodities less food and energy commodities</li> <li>• energy commodities</li> <li>• services less energy services</li> </ul>
Statistics Canada	All-items excluding: <ul style="list-style-type: none"> <li>• food</li> <li>• food and energy</li> <li>• gasoline</li> <li>• eight of the most volatile components (as defined by the Bank of Canada)</li> </ul>	<ul style="list-style-type: none"> <li>• goods and services</li> <li>• energy (includes electricity, natural gas, fuel oil and other fuels, gasoline, and fuel, parts and supplies for recreational vehicles)</li> <li>• core CPI</li> </ul>
Australian Bureau of Statistics	CPI less: <ul style="list-style-type: none"> <li>• each of the category groups,</li> <li>• housing and financial and insurance services</li> <li>• hospital and medical services</li> <li>• 'volatile items' (fruit and vegetables and automotive fuel)</li> </ul>	<ul style="list-style-type: none"> <li>• tradables and non-tradables</li> <li>• goods and services</li> <li>• goods less volatile items</li> <li>• services less volatile items</li> <li>•</li> </ul>
Office of National Statistics (United Kingdom)	CPI excluding: <ul style="list-style-type: none"> <li>• indirect taxes,</li> <li>• energy</li> <li>• energy, food, alcoholic beverages and tobacco</li> <li>• energy and unprocessed food</li> <li>• seasonal food</li> <li>• energy and seasonal food</li> <li>• tobacco</li> <li>• alcoholic beverages and tobacco</li> <li>• liquid fuels, vehicle fuels and lubricants</li> <li>• housing, water, electricity, gas and other fuels</li> <li>• education, health and social</li> </ul>	CPI: <ul style="list-style-type: none"> <li>• CPI at constant taxes</li> <li>• goods and services (including detailed series within each)</li> <li>• durables, semi-durables, and non-durables</li> <li>• seasonal food</li> <li>• non-seasonal food</li> <li>• energy, food, alcoholic beverages and tobacco</li> <li>• energy and unprocessed food</li> <li>• energy and seasonal food</li> <li>• tobacco</li> <li>• housing, water, electricity, gas and other fuels</li> <li>• education, health and social</li> </ul>

## Core Inflation Measures Produced in New Zealand, by Daniel Griffiths

	protection	protection
	RPI excluding: <ul style="list-style-type: none"> <li>• mortgage interest rates</li> <li>• housing</li> <li>• mortgage interest rates and indirect taxes</li> <li>• mortgage interest payments and council tax</li> <li>• mortgage interest payments and depreciation</li> <li>• energy</li> <li>• energy, food, alcoholic beverages and tobacco</li> <li>• seasonal food</li> <li>• food</li> </ul>	RPI: <ul style="list-style-type: none"> <li>• goods and services</li> <li>• consumer durables</li> <li>• seasonal food</li> <li>• food excluding seasonal</li> </ul>
Japan	General excluding: <ul style="list-style-type: none"> <li>• fresh food</li> <li>• imputed rent</li> <li>• food (excluding alcoholic beverages) and energy</li> </ul>	<ul style="list-style-type: none"> <li>• goods and services</li> </ul>

### Central banks

Agency	
Cleveland Federal Reserve	<ul style="list-style-type: none"> <li>• weighted median</li> <li>• 16 percent trimmed mean</li> <li>• CPI excluding eight components</li> <li>• Private consumption expenditure implicit price deflator excluding food and energy</li> </ul>
Bank of Canada	<ul style="list-style-type: none"> <li>• core CPI – excludes from the all-items CPI the effect of changes in indirect taxes and eight of the most volatile components identified by the Bank of Canada: fruit, fruit preparations and nuts; vegetables and vegetable preparations; mortgage interest cost; natural gas; fuel oil and other fuels; gasoline; inter-city transportation; and tobacco products and smokers' supplies</li> <li>• CPI excluding food, energy, and the effect of changes in indirect taxes</li> <li>• weighted median</li> <li>• 1.5 standard deviation trimmed mean</li> <li>• double weighted measure (adjusted to exclude changes in indirect taxes)</li> <li>• chain price index for consumption</li> <li>• chain price index for consumption excluding food and energy</li> <li>• chain price index for GDP</li> </ul>
Reserve Bank of Australia <sup>(1)</sup>	<ul style="list-style-type: none"> <li>• 30 percent trim</li> <li>• weighted median</li> </ul>
European Central Bank	<ul style="list-style-type: none"> <li>• CPI less administered goods</li> <li>• CPI less unprocessed food and energy</li> <li>• goods</li> <li>• services</li> </ul>

(1) These series are actually published by the Australian Bureau of Statistics, under the title "Reserve Bank of Australia Consumer Price Measures".

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