New Zealand Consumers Price Index: Retrospective Superlative Index, 2002–08

Katrina Lindsay, Ricky Ho and Chris Pike

Prices, Statistics New Zealand, P O Box 2922, Wellington, New Zealand
info@stats.govt.nz, www.stats.govt.nz

Abstract

The New Zealand Consumers Price Index (CPI) Revision Advisory Committee met in June 2004 to undertake an independent review of the practices and methods used to compile the CPI. One of the committee's recommendations was that at each reweighting of the CPI basket, Statistics New Zealand should calculate a 'superlative' index on a retrospective basis to provide information on the effect of upper-level (or commodity) 'substitution' on the fixed-weight CPI.

This paper, which builds on one prepared for the tenth meeting of the Ottawa Group, presents details of a retrospective superlative index time series calculated between the June 2002, June 2006 and June 2008 quarter price reference periods. The six-year time series provides an indication of the effect of commodity substitution on the fixed-weight CPI. It also reflects changes to and improvements in the methods and data sources used to derive the expenditure weights. A tradables/non-tradables breakdown has been added for the first time.

The analytical time series described above were published in November 2008.

Contents

1. Introduction

A review of the Consumers Price Index (CPI) was implemented when the September 2008 quarter index was released in October 2008. The review encompassed reselecting and reweighting the basket of representative goods and services to ensure it continues to reflect household spending patterns.

Once each new set of CPI expenditure weights has been calculated, it is possible to make use of the existing and new weights to calculate a 'superlative' index on a retrospective basis. This paper presents results of a retrospective superlative index time series calculated between the June 2002, June 2006 and June 2008 quarter price reference periods. Expenditure weights as at the June 2002 and June 2006 quarters were used to compile the superlative index series from the June 2002 quarter to the June 2006 quarter, and expenditure weights as at the June 2006 and June 2008 quarters were used to compile the superlative index series from the June 2006 quarter to the June 2008 quarter.

The six-year time series provides an indication of the effect of commodity substitution on the fixed-weight CPI, which occurs when households react to changes in relative prices by choosing to reduce purchases of goods and services showing higher relative price change, and instead buy more of those showing lower relative price change. The resulting superlative index will also reflect changes and improvements in the methods and data sources used to derive the expenditure weights.

In 2007, Statistics New Zealand published a CPI retrospective superlative index paper following the implementation of the 2006 CPI Review. This provided information on a retrospective superlative index calculated between the June 2002 quarter and the June 2006 quarter. The 2006 review was informed by a seven-member CPI Revision Advisory Committee which completed an independent review of the practices and methods used to compile the CPI. One of the committee's recommendations was that at each reweighting of the CPI basket, Statistics NZ should calculate a superlative index on a retrospective basis to provide information on the effect of upper-level (or item) substitution on the fixed-weight CPI.

2. Summary of results

The seasonally unadjusted analytical CPI all-groups index, calculated using a fixed-weight Laspeyres formula, increased by a total of 17.0 percent from the June 2002 quarter to the June 2008 quarter. The analytical retrospective superlative index, calculated using a Fisher formula, rose by 15.8 percent over the same period. The 2002 weights used to calculate the superlative index included in this paper relate to the series compiled using alternative housing weights, which best reflect falling home-ownership rates and were compiled using methods that are consistent with the 2006 and 2008 weights.

The Laspeyres index number for the June 2008 quarter, expressed on a base of the June 2002 quarter (=1000) was 1170, whereas the Fisher index number was 12 index points lower, at 1158.

The Laspeyres index rose by an annual average rate of 3.0 percent from the June 2006 quarter to the June 2008 quarter, compared with 2.8 percent for the analytical Fisher index, a difference of 0.2 of a percentage point per year. This result is broadly consistent with international studies.

The Laspeyres index rose by an annual average rate of 2.7 percent over the six-year period, compared with 2.5 percent for the analytical Fisher index, a difference of 0.2 of a

percentage point per year. This result is again broadly consistent with international studies.

Differences in annual movements during the six-year period ranged from no difference to 0.3 of a percentage point. Differences were greatest during the period from the September 2003 quarter to the March 2004 quarter. Subsequent differences were 0.1 or 0.2 of a percentage point.

3. Retrospective superlative index

3.1 Introduction

Under normal economic conditions, price and quantity relatives are negatively correlated. Households tend to react to changes in relative prices by reducing purchases of goods and services showing higher relative price change, and instead buying more of those showing lower relative price change. Under such circumstances, a base-weighted Laspeyres index will be greater than a current-weighted Paasche index. A Laspeyres index will overstate price change, whereas a Paasche index will understate price change.

If apple prices increased a lot, but pear prices increased only a little, consumers might be expected to purchase more pears and fewer apples than before. Continuing to price the same quantities of apples and pears would overstate the actual price change faced by consumers.

For practical reasons, CPIs are generally calculated using a Laspeyres formula (or a Lowe or Young variant), where weights reflect expenditure shares in some historical period. CPIs are therefore subject to upper-level (or item) substitution bias, unlike indexes calculated using a superlative index formula such as the Fisher index formula (which is the geometric mean of the overstating Laspeyres index and understating Paasche index, where weights reflect current-period expenditure shares).

International studies have found the difference between superlative and Laspeyres CPI indexes to be between about 0.1 and 0.2 of a percentage point per year in inflation rates. In other words, annual price changes would have been around 0.1 to 0.2 of a percentage point lower if the CPIs allowed for item substitution.

Under a Laspeyres formula, reweighting the basket periodically will minimise the effect of item substitution, but not eliminate it. Substitution occurs continuously and differences accumulate over time, so the longer the period between basket reweights, the larger the potential bias.

The New Zealand index is, on average, reweighted once every three years, which is well within the ILO recommendation of at least once every five years. The 2006 reweight was implemented four years after the previous reweight in 2002, a year later than usual. The 2008 reweight was implemented two years after the 2006 reweight, bringing the CPI back to a three-yearly review cycle.

Once each new set of CPI expenditure weights has been calculated, it is possible to make use of the existing and new weights to calculate a superlative index between the two reweighting periods on a retrospective basis.

The 2004 CPI Revision Advisory Committee recommended that Statistics NZ should calculate a retrospective superlative index to provide information on the effect of upper-level substitution on the fixed-weight CPI:

> **Recommendation 10**: At each reweighting of the CPI basket, Statistics New Zealand should calculate a superlative index on a retrospective basis to provide information on the effect of item substitution on the fixed-weight CPI. Consistent with recommendation 8, Statistics New Zealand should also assess the value of providing users with real-time estimates of the effect of item substitution on the CPI.

In 2007, Statistics NZ published a paper – *Consumers Price Index: Retrospective Superlative Index and Impact of Alternative Housing Weights* – which provided results of a retrospective superlative index between the June 2002 quarter and the June 2006 quarter. This 2008 paper builds on the 2007 paper by extending the existing time series by a further two years. This involved calculating a retrospective superlative index between the June 2006 quarter and the June 2008 quarter (using the 2006 weights and the 2008 weights), and then linking it to the time series calculated for the 2007 paper.

The analytical superlative index time series provides a broad indication of the effect of item substitution on the fixed-weight CPI. However, it is important to note that it also reflects:

- changes and improvements in the methods and data sources used to derive the expenditure weights
- volume adjustments for some goods and services, to reflect trend change in quantities since the 'weight-reference' period.

Section 3.2 describes how the analytical superlative index was constructed and section 3.3 presents results.

3.2 How the superlative index was constructed

The analytical retrospective superlative index time series from the June 2002 quarter to the June 2008 quarter was based on the CPI seasonally unadjusted basket of sub-index time series and expenditure weights.

The 2002 weights were based on expenditure information from the 2000/01 Household Economic Survey (HES) and other sources, price updated to the June 2002 quarter. The effect of price updating, recommended for CPIs by the International Labour Office and common international practice, was to express the underlying 2000/01 quantities in the prices of the June 2002 quarter price-reference period.

The 2006 weights were based on expenditure information from the 2003/04 HES and other sources, price updated to the June 2006 quarter. The effect of price updating, in this case, was to express the underlying 2003/04 quantities in the prices of the June 2006 quarter price-reference period. As noted above, volume adjustments were made in 2006 for some goods and services, to reflect trend change in quantities since the 2003/04 weight-reference period. As a result, the retrospective superlative index between the June 2002 quarter and the June 2006 quarter (four years apart) is based on underlying quantities (for 2000/01 and 2003/04) that are three years apart (although in some cases adjustments were made to reflect quantity changes since the 2003/04 weight-reference period). The results of the index time series between the June 2002 quarter and the June 2006 quarter were published in the 2007 paper.

The most recent CPI reweight, implemented in the September 2008 quarter, was based on expenditure information from the 2006/07 HES and other sources, price updated to the June 2008 quarter. Volume adjustments were also made in 2008 to reflect trend change in quantities since the 2006/07 weight-reference period. As a result, the retrospective superlative index between the June 2006 quarter to the June 2008 quarter (two years apart), is based on underlying quantities (for 2003/04 and 2006/07) that are three years apart (although in some cases adjustments were made to reflect quantity changes since both weight reference periods). The resulting two-year series was then linked to the June 2002 to June 2006 quarter series at the June 2006 quarter.

There were 672 goods and services in the 2002 CPI basket, 685 in the 2006 basket and 694 in the 2008 basket. Some goods and services were removed from the basket and some new ones were added at the time of each reweight. The majority of goods and services are in all three CPI baskets. The expenditure weights of goods and services added to the basket at the 2006 and 2008 reweights were re-allocated across similar, remaining goods and services. The expenditures of those removed from the basket were re-allocated across similar, remaining goods and services.

The Laspeyres, Paasche and Fisher price index formulae used to calculate the analytical time series are given in the Appendix. Tornqvist-Theil and Walsh formulae were also used to calculate indexes for the June 2006 quarter compared with the June 2002 quarter, and for the June 2008 quarter compared with the June 2006 quarter. The Tonqvist-Theil and Walsh indexes are also superlative index formulae that make use of weights for both the earlier and later periods being compared.

The Laspeyres, Paasche and Fisher index time series have been expressed on a base of the June 2002 quarter (=1000).

Index numbers presented in this paper have been rounded to the nearest index point, which is in line with standard rounding procedures used for the CPI. Similarly, percentage changes are calculated from rounded index numbers and are presented to one decimal place. Any differences between the Laspeyres and Fisher series are based on comparisons of the index numbers rounded to the nearest index point. Differences based on unrounded index numbers may be slightly smaller or larger. Where differences between rounded and unrounded index numbers are material and may affect interpretation, unrounded results are also noted.

3.2.1 The impact of alternative housing weights

The retrospective index provides an indication of the effect of commodity substitution on the fixed-weight CPI. It also reflects changes and improvements in the methods and data sources used to derive the expenditure weights at each reweight.

The expenditure weight for the purchase of new housing was 5.51 percent in 2008, having fallen from 8.47 percent in 2002 to 4.66 percent in 2006. The fall between 2002 and 2006 was partly the result of employing a new method that better reflects a fall in the home-ownership rate. The weight of rentals for housing was 7.70 percent in 2008 and was 6.71 percent and 5.54 percent in 2006 and 2002, respectively. The 2006 expenditure weights for housing implied a stronger relative shift from owning to renting than was really the case. For the 2008 CPI reweight, the methodology used to estimate the expenditure on housing remained consistent with what was used for the 2006 reweight.

As discussed in the 2007 paper, the new method was used to re-estimate the 2002 expenditure weights for the purchase of new housing and for rentals for housing. These alternative weights for housing were used to calculate an analytical seasonally unadjusted CPI all-groups index between the June 2002 quarter and the June 2006

quarter, using a fixed-weight Laspeyres formula and using a Fisher formula. This had a downward influence on the Fisher index, as house construction prices increased during the four-year period at more than twice the rate of dwelling rentals. The analytical seasonally unadjusted CPI all-groups index with alternative 2002 housing weights, calculated using a fixed-weight Laspeyres formula, increased by a total of 10.3 percent from the June 2002 quarter to the June 2006 quarter. The analytical retrospective superlative index, calculated using a Fisher formula, rose by 9.6 percent over the same period.

In order to provide a six-year retrospective superlative index time series, the index from the June 2006 quarter to the June 2008 quarter has been linked to the existing analytical times series with alternative housing weights (which ran from the June 2002 quarter to the June 2006 quarter). Section 3.03 presents the findings.

3.3 Analytical retrospective superlative index time series results

The analytical retrospective superlative index, calculated using a Fisher formula, rose by 5.7 percent from the June 2006 quarter to the June 2008 quarter, while the seasonally unadjusted CPI all-groups index, calculated using a fixed-weight Laspeyres formula, increased by a total of 6.1 percent over the same period.

Over the six-year period from the June 2002 quarter to the June 2008 quarter, the analytical Fisher index rose 15.8 percent, compared with an increase of 17.0 percent for the Laspeyres index.

Table 1 shows the superlative index time series from the June 2002 quarter to the June 2008 quarter. At the June 2008 quarter, the analytical Fisher seasonally unadjusted all-groups series was 1158, which was 12 index points lower than the analytical Laspeyres seasonally unadjusted all-groups CPI.

Table 1

Consumers Price Index
Analytical seasonally unadjusted all-groups with alternative housing weights – index numbers
Base: June 2002 quarter (=1000)

June quarter	Laspeyres	Paasche	Fisher	Index points difference (Laspeyres minus Fisher)
2002	1000	1000	1000	0
2003	1013	1009	1011	2
2004	1034	1026	1030	4
2005	1061	1049	1055	6
2006	1103	1088	1096	7
2007	1124	1106	1115	9
2008[1]	1170	1147	1158	12

(1) Tornqvist-Theil and Walsh index numbers for the June 2008 quarter were 1160 and 1161, respectively.

It should be noted that the differences between the unrounded all-groups Laspeyres and Fisher index numbers were 7.33 index points at the June 2006 quarter, and 11.54 index points at the June 2008 quarter. Between 2006 and 2008, the difference grew by 4.21 index points on a base of the June 2002 quarter (=1000), or 3.44 index points if the series were expressed on a base of the June 2006 quarter (=1000).

Figure 1 shows that, as expected, the gap between the seasonally unadjusted all-groups Fisher and Laspeyres series grew over time.

Figure 1

Analytical Seasonally Unadjusted CPI Indexes with Alternative Housing Weights
Quarterly indexes
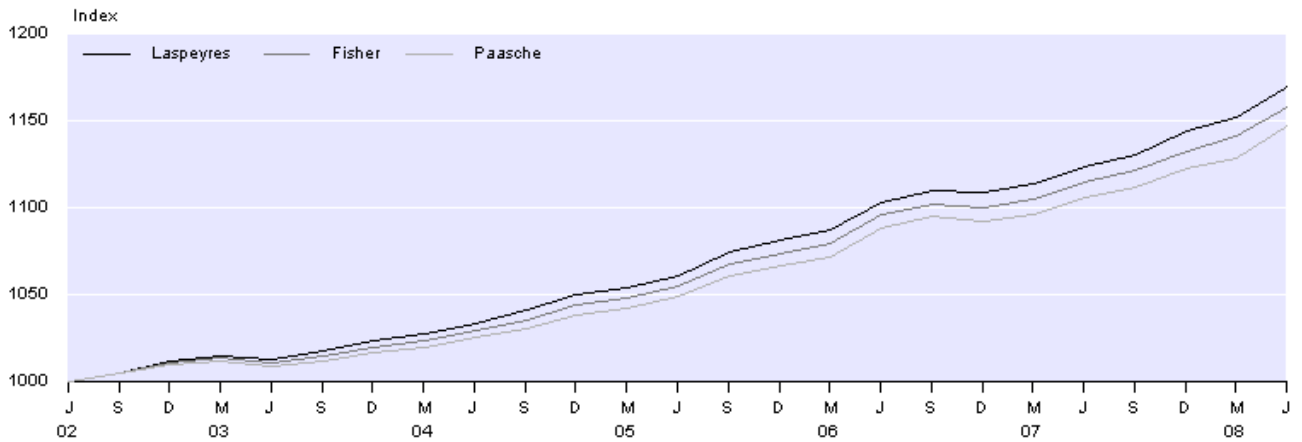Base: June 2002 quarter (=1000)

Figure 2 shows the differences in annual movements during the period between the Laspeyres and the analytical Fisher indexes. These differences ranged from no difference to 0.3 of a percentage point during the six-year period.

Figure 2

Analytical Seasonally Unadjusted CPI Indexes with Alternative Housing Weights
Percentage change from same quarter of previous year
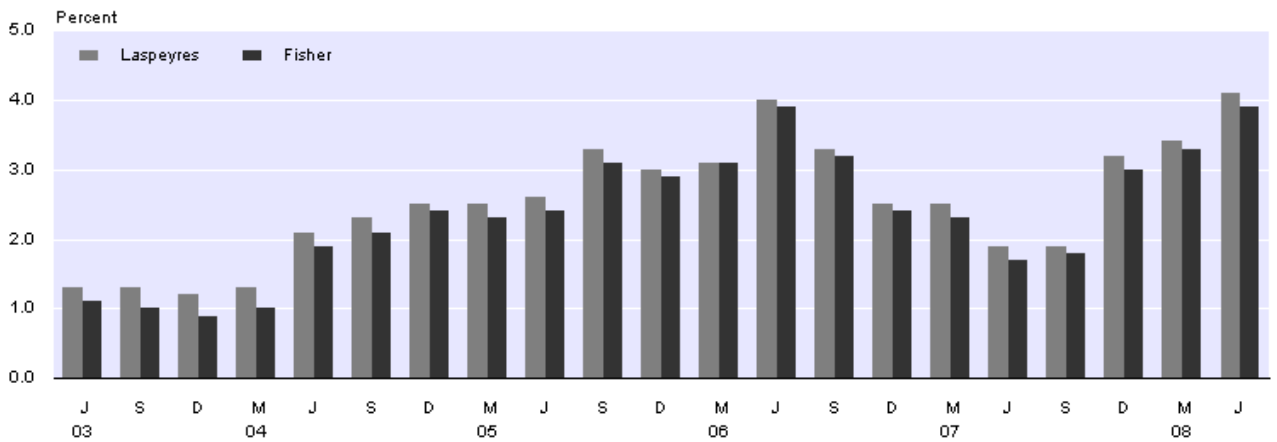
From the June 2006 quarter to the June 2008 quarter, the Laspeyres index rose by an annual average rate of 3.0 percent during the period, compared with 2.8 percent for the Fisher index, a difference of 0.2 of a percentage point per year. This result is broadly consistent with international studies.

Over the six-year period from the June 2002 quarter to the June 2008 quarter, the Laspeyres index rose by an annual average rate of 2.7 percent during the period, compared with 2.5 percent for the Fisher index, a difference of 0.2 of a percentage point per year. This result is again broadly consistent with international studies.

As noted above, the CPI is, on average, reweighted once every three years, which is well within the ILO recommendation of at least once every five years. The frequency at which

the CPI could be reweighted is currently constrained by the main source of expenditure weighting information, the HES, being conducted only once every three years.

However, expenditure weights are published and fixed until the following reweight at the class level of the New Zealand Household Expenditure Classification (NZHEC) (adopted at the 2006 reweight). This classification comprises 107 categories, providing some flexibility to keep the weights below the class level up-to-date between reweights, and to mitigate the impact of item substitution, but only to the extent that it occurs within classes of the NZHEC.

Groups showing relatively small differences between the Laspeyres and Fisher series included:

- food
- alcoholic beverages and tobacco
- clothing and footwear
- housing and household utilities
- household contents and services
- transport
- education
- recreation and culture.

The recreation and culture group had 2002, 2006 and 2008 expenditure weights of 9.73 percent, 10.21 percent and 9.54 percent, respectively. Of the 11 groups, the analytical Fisher index and Laspeyres index showed the most significant difference for this group.

From the June 2006 quarter to the June 2008 quarter, the Laspeyres series for the recreation and culture group showed a decrease of 0.5 percent, compared with a stronger decrease of 2.8 percent for the analytical Fisher series. Over the six years to the June 2008 quarter, the Laspeyres series for the recreation and culture group showed an increase of 2.6 percent, compared with a 2.9 percent decrease for the analytical Fisher series. These differences were mainly due to large price decreases and associated large volume increases within the audio-visual equipment class for goods such as television sets, DVD players and digital cameras.

The audio-visual equipment class includes goods that evolve quickly and has a relatively high incidence of new goods and products appearing. The appearance of new goods between the 2006 and 2008 reweights is partly reflected in the Fisher index through a contribution to the Paasche weights. However, the price movements of new goods prior to being added to the basket at the 2008 reweight have not contributed to price movements used in the Fisher calculations.

The communication group had 2002, 2006 and 2008 expenditure weights of 2.92 percent, 3.26 percent and 3.21 percent, respectively. Like the recreation and culture group, this group also had significant differences between the analytical Fisher index and the Laspeyres index.

From the June 2006 quarter to the June 2008 quarter, the Laspeyres series for the communication group showed a decrease of 0.2 percent, compared with a decrease of 1.6 percent for the analytical Fisher series. Over the six years to the June 2008 quarter, the Laspeyres series for the communication group showed a decrease of 0.1 percent, compared with a decrease of 3.6 percent for the analytical Fisher series. These differences can be attributed to large price decreases and associated large volume increases within the telecommunications equipment subgroup. The volume increase implied by the 2006 and 2008 expenditure weights for this subgroup was partly the result

of volume adjustments at the 2006 and 2008 reweights, which were made to reflect growth since the weight reference period in cellphone connections and improvements in the quality of handsets.

The heavily weighted housing and household utilities group had 2002, 2006 and 2008 expenditure weights of 19.04 percent, 20.02 percent and 22.75 percent, respectively. The analytical Fisher index was slightly lower than the Laspeyres index at the June 2008 quarter. The difference at the June 2006 quarter was also small (calculated using alternative 2002 housing weights which better reflect falling home-ownership rates, and consistent with the methods used in 2006 and 2008).

From the June 2006 quarter to the June 2008 quarter, the Laspeyres series for the housing and household utilities group showed an increase of 10.5 percent, which is similar to the movement shown by the analytical Fisher series (up 10.3 percent). Over the six years to the June 2008 quarter, the Laspeyres series for the housing and household utilities group increased by 35.0 percent, which again is similar to the movement shown by the analytical Fisher series (up 34.7 percent).

4. Tradables and non-tradables

The tradables and non-tradables components of the CPI divides 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 foreign competition (non-tradables). 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.

This section presents the results of superlative index time series for the tradables and non-tradables components of the CPI. These are new series which were not included in the 2007 paper.

Table 2 shows the Laspeyres and Fisher index time series for tradables and non-tradables. At the June 2008 quarter, the difference for the tradables component was 15 index points, while the difference for the non-tradables component was only 3 index points.

Table 2

Consumers Price Index
Analytical seasonally unadjusted all-groups with alternative housing weights – tradables and non-tradables index numbers
Base: June 2002 quarter (=1000)

June quarter	Tradables			Non-tradables		
	Laspeyres	Fisher	Difference	Laspeyres	Fisher	Difference
2002	1000	1000	0	1000	1000	0
2003	988	986	2	1034	1034	0
2004	982	979	3	1078	1077	1
2005	990	984	6	1122	1120	2
2006	1027	1019	8	1167	1165	2
2007	1022	1011	11	1214	1213	1
2008	1071	1056	15	1256	1253	3

From the June 2002 quarter to the June 2008 quarter, the tradables Laspeyres index rose by an annual average rate of 1.2 percent during the period, compared with 0.9 percent for the Fisher index, a difference of 0.3 of a percentage point per year. Over the same six-year period, the non-tradables Laspeyres index rose by an annual average rate of 3.9 percent during the period, compared with 3.8 percent for the Fisher index, a difference of 0.1 of a percentage point per year.

The differences between the Laspeyres and Fisher indexes for the non-tradables series are much smaller than those for the tradables series. This is partly because groupings that had large price decreases and associated large volume increases, such as the audio-visual equipment class and the telecommunication equipment subgroup, tend to fall under the tradables category. On the other hand, groupings that showed relatively small differences between the Laspeyres and Fisher indexes, such as the housing and household utilities group, tend to fall mainly under the non-tradables category.

5. Conclusion

Statistics NZ has supplied the analytical time series presented in this paper to provide users with an indication of the impact on the CPI of both item substitution and changes to the data sources and methods used to compile expenditure weights.

Statistics NZ plans to compile a retrospective superlative index following the next CPI reweight of the CPI basket, which is scheduled to take place in 2011. In the interim, Statistics NZ intends to use available information to monitor the weights below the class level of the NZHEC classification and update them where necessary, in order to minimise the effect of item substitution bias.

By holding underlying weight reference period quantities fixed, price updating assumes that households do not react to changes in relative prices by reducing purchases of goods and services showing higher relative price change, and instead buying more of those showing lower relative price change. For some types of goods and services, the approach of holding quantities fixed might best reflect household behaviour, but for other goods and services the alternative approach of not price updating (that is, holding expenditure shares fixed and letting quantity shares vary) might better reflect household behaviour. In 2007, Statistics NZ published a paper which presented analytical time series based on 2003/04 expenditure weights that were not price updated to reflect subsequent price change. Further research is being undertaken, by extending the time series based on 2006/07 expenditure weights that are not price updated to reflect subsequent price change.

Appendix – price index formulae

The **Laspeyres** price index formula, expressed in terms of expenditure weights and price relatives is:

$$P_L = \frac{\sum_{i=1}^{n} w_{i0}\left(\dfrac{p_{i1}}{p_{i0}}\right)}{\sum_{i=1}^{n} w_{i0}}$$

The **Paasche** price index formula, expressed in terms of expenditure weights and price relatives is:

$$P_P = \frac{\sum_{i=1}^{n} w_{i1}}{\sum_{i=1}^{n} w_{i1}\left(\dfrac{p_{i0}}{p_{i1}}\right)}$$

The **Fisher** price index is the geometric mean of the Laspeyres and Paasche price indexes:

$$P_F = \sqrt{P_L \times P_P}$$

The **Tornqvist-Theil** price index is a weighted geometric mean of price relatives, with the weights being the arithmetic mean of expenditure shares in periods 0 and 1:

$$P_T = \prod_{i=1}^{n}\left(\frac{p_{i1}}{p_{i0}}\right)^{\left(\frac{s_{i0}+s_{i1}}{2}\right)}$$

The **Walsh** price index formula, expressed in terms of expenditure shares and price relatives is:

$$P_W = \frac{\sum_{i=1}^{n}\left(s_{i0}s_{i1}\right)^{(1/2)}\left(\dfrac{p_{i1}}{p_{i0}}\right)^{(1/2)}}{\sum_{i=1}^{n}\left(s_{i0}s_{i1}\right)^{(1/2)}\left(\dfrac{p_{i0}}{p_{i1}}\right)^{(1/2)}}$$

Where:

P_L = Laspeyres price index
P_P = Paasche price index
P_F = Fisher price index
P_T = Tornqvist-Theil price index
P_W = Walsh price index
w_{i0} = expenditure weight of the ith good or service for the base period 0

w_{i1} = expenditure weight of the ith good or service for the current period 1

s_{i0} = expenditure share of the ith good or service for the base period 0

s_{i1} = expenditure share of the ith good or service for the current period 1

p_{i0} = price or index number of the ith good or service for the base period 0

p_{i1} = price or index number of the ith good or service for the current period 1