

# Measurement Bias in the Canadian Consumer Price Index: An Update

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- The consumer price index (CPI) is the most commonly used measure to track changes in the overall level of prices. Although the CPI has some advantages—it is timely and it focuses on transaction prices—it is not a true cost-of-living index and is therefore subject to measurement bias.
- This article describes the four main sources of bias in the CPI and provides estimates of their size, both in absolute terms and relative to those obtained in previous studies conducted at the Bank of Canada.
- The total CPI measurement bias is estimated to be about 0.5 percentage point per year over the 2005–11 period, consistent with the Bank's earlier findings. Slightly more than half of this bias is caused by the fixed nature of the CPI basket of goods and services. More frequent updates of the weights that are used in the basket would reduce this error by more accurately reflecting changes in spending patterns following a change in relative prices and the introduction of new products.

The consumer price index (CPI) tracks changes in the overall level of the prices of consumer goods and services (i.e., inflation) by computing the cost of buying a fixed basket of goods and services over time.<sup>1</sup> This basket represents expenditures made by a representative household during a specific period and is updated periodically to reflect shifts in the spending patterns of Canadian consumers.<sup>2</sup>

The CPI serves two main purposes. First, it is widely used by consumers, corporations and government agencies to measure changes in purchasing power over time and to index expenditures and incomes. Second, it plays a central role in the Bank of Canada's monetary policy framework, particularly since the adoption of the inflation-targeting regime in 1991, which established the Bank's official inflation target as a 2 per cent rate of inflation

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<sup>1</sup> Other measures of inflation exist. For example, the implicit price deflator of gross domestic product is a production-based measure that covers the entire economy.

<sup>2</sup> The CPI assigns weights to the various items in the index. To maintain a basket that is broadly representative of current consumption patterns, Statistics Canada revises the weights for individual items approximately every four years using information from its Survey of Household Spending. The most recent weight update was introduced with the release of the May 2011 CPI and was based on the 2009 survey.

as measured by the CPI. The CPI is used extensively for these purposes because it is available on a monthly basis, it has a short publication lag, and it relies heavily on retail transaction prices rather than imputed prices.<sup>3,4</sup>

The CPI is not a cost-of-living index (COLI), since, for example, it does not adjust quickly to changing consumption patterns. The CPI measures changes in the cost of a fixed basket of goods and services over time, while a COLI measures the changes in the minimum cost to attain a fixed standard of living. Thus, since the CPI departs from a true COLI, it is subject to measurement bias and does not necessarily reflect real changes in the well-being of consumers, which could be problematic for monetary policy and when making cost-of-living adjustments to wages and salaries. For monetary policy, since this bias may vary over time and there is no systematic way to forecast it, difficulty could arise when assessing whether an increase in the measured rate of inflation is the result of a true change in prices or an increase in measurement error. In addition, errors in the measured rate of inflation could lead to important income redistribution effects among economic agents and possible distortions in the government's fiscal system (Ragan 2011).<sup>5</sup>

Biases in the measurement of CPI can occur for four main reasons: (i) the CPI methodology does not capture the ability of consumers to substitute away from more expensive goods in response to changes in relative prices (commodity-substitution bias); (ii) it does not capture the cost savings from shifting to lower-priced retail outlets (outlet-substitution bias); (iii) new products or brands may be excluded from the current basket, and welfare gains from a broader selection of goods and brands will not be captured (new-goods bias); and (iv) quality changes may not always be properly captured by statistical agencies (quality-adjustment bias). The following sections elaborate on these types of bias.

## Commodity-Substitution Bias

Commodity-substitution bias reflects the fact that, while the weights of items in the CPI basket are held constant for a period of time, a change in relative prices may cause patterns in consumer spending to change. If, for example, the price of chicken were to increase considerably following supply constraints, consumers would likely purchase less chicken and increase their consumption of beef, since the two meats may be perceived as substitutes for each other. The CPI, however, assumes that consumers would continue to purchase the same quantity of chicken following a price change. This means that the measured change in the CPI will overstate the increase in the minimum cost of reaching a given standard of living (i.e., there is a positive bias).

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<sup>3</sup> For a more comprehensive discussion of the advantages of using the CPI, see Crawford, Fillion and Lafliche (1998).

<sup>4</sup> Imputed prices are not directly observable, but can be inferred using data on average production costs or the prices of similar products. Imputed prices are used more frequently in a personal consumption expenditure (PCE) deflator than in the CPI. For example, the deflator uses implicit prices to measure the cost of owner-occupied housing (employing the approach of rental equivalence) and health care services.

<sup>5</sup> In particular, with a positive CPI bias, fiscal revenues would be lower, since the basic personal exemption would be too high relative to what it would be if based on the change in the cost of living, while government expenditures would be higher, since many transfers such as childcare benefits are indexed to the measured rate of inflation.

The size of commodity-substitution bias can be determined by comparing the official CPI series with a measure of the cost of living. Using a retrospective Fisher index for the COLI,<sup>6</sup> we estimate that the size of the commodity-substitution bias in Canada is 0.20 percentage point,<sup>7</sup> on average, per year over the 2005–09 period.<sup>8</sup> This result is similar to the bias of 0.23 percentage point per year obtained for the 2005–11 period, using the approach of Diewert (1998).<sup>9</sup> These findings (an average of about 0.22 percentage point per year) are somewhat higher than the 0.15 percentage point per year reported in a previous Bank study (Rossiter 2005) for the 1998–2004 period. The difference in our estimation relative to previous studies is mainly the result of variation in the amounts of relative price changes over the sample periods.

## Outlet-Substitution Bias

Prices for most items in the Canadian CPI are collected from a sample of retail outlets that have high-volume sales of each commodity. However, if the outlet sample is fixed, a potential bias could occur when prices for goods and services of identical quality are consistently cheaper in certain types of outlets, causing consumers to shift their patronage from one type of retail outlet to another (for example, from higher-priced traditional stores to lower-priced big-box retailers). A fixed outlet sample would not capture the decrease in average price arising from the continuous growth in market share of discount stores in some segments of the Canadian retail market, resulting in a positive outlet-substitution bias.<sup>10</sup>

Three pieces of information are required to calculate this outlet-substitution bias: (i) the components of the CPI basket that are likely to be affected, (ii) the change in market share of discount retailers for these items, and (iii) the percentage difference in quality-adjusted prices between discount retailers and traditional retailers.<sup>11</sup>

To determine the overall impact of outlet-substitution bias on the CPI, the components subject to this bias are assumed to include most items sold by retailers (excluding such goods as gasoline and automobiles),<sup>12</sup> representing about 35 per cent of the CPI basket.<sup>13</sup> Access to data on the market shares

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<sup>6</sup> The retrospective Fisher index is defined as the geometric average of the Laspeyres and Paasche indexes. The Laspeyres index is based on prior-period weights and tends to overstate increases in the cost of living, while the Paasche index is calculated with current-period weights and tends to understate increases in the cost of living. The Fisher index is calculated retrospectively once information on current-period weights becomes available. For more details on these indexes, see ILO (2004).

<sup>7</sup> While many of the statistics reported are in two-decimal-point form, our estimates do not have that level of precision. We use two decimal points to reduce rounding errors when components are added.

<sup>8</sup> The result covers the 2005–09 period, since the Paasche index was based on the latest Survey of Household Spending and could be calculated only up to 2009.

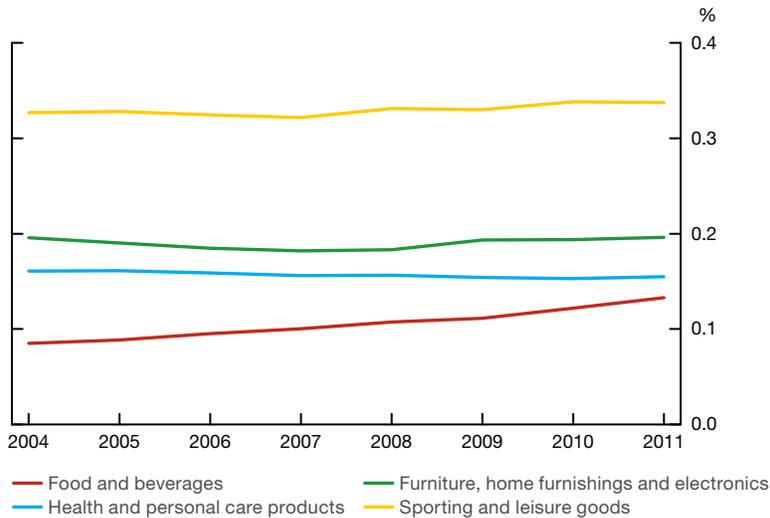
<sup>9</sup> Diewert (1998) shows that the bias can be approximated using a formula that depends only on the dispersion of relative prices.

<sup>10</sup> When rotating outlet samples, Statistics Canada assumes that quality-adjusted prices are identical at the old and new outlets (i.e., the observed price differential is fully explained by an equivalent difference in quality between the two outlets), thus outlet rotations do not lead to a decrease in the measured price. If this assumption were incorrect, outlet-substitution bias would remain, even with more-frequent outlet rotations.

<sup>11</sup> Estimates of the size of outlet-substitution bias must take into account the fact that the market price of an item depends on both the quality of the commodity and the quality of the retail outlet where it is purchased, based on such factors as the level of service and the convenience of the location.

<sup>12</sup> Items subject to outlet-substitution bias include food purchased from stores; clothing and footwear; communications products and services; household chemical products; paper, plastic and foil supplies; household furnishings; air transportation; health care goods; personal care supplies and equipment; recreational equipment and services; home entertainment equipment and services; tobacco products; and books.

<sup>13</sup> Outlet-substitution bias does not exist for those items provided by a single supplier in a given market or where there may be many outlets, but no significant changes in market share. Most of the services in the CPI are also judged not to be subject to outlet-substitution bias.

**Chart 1: Market share of general merchandise stores**

Sources: Statistics Canada and Bank of Canada calculations

Last observation: 2011

of discount stores for all categories of items would be ideal; however, these data are available only for clothing and footwear (through Trendex).<sup>14</sup> Trendex indicates that the market share of discount stores for clothing and footwear increased by 0.7 per cent per year between 2004 and 2008. For other goods, market shares of general merchandise stores are used as a proxy for the market shares of discount retailers. These data are from Statistics Canada's Quarterly Retail Commodity Survey (QRCS)<sup>15</sup> or from Rossiter (2005). Chart 1 shows the evolution since 2005 of the market shares of general merchandise stores for different types of goods. According to the QRCS, among general merchandise stores, only the market share for food and beverage purchases has grown. For most other goods included in the QRCS data, the market share has remained relatively unchanged.<sup>16</sup>

Using microdata on the retail food industry in the United States, Greenlees and McClelland (2011) estimate that the average quality-adjusted prices<sup>17</sup> for food and beverages are about 10 per cent lower in discount department stores and warehouse clubs than in traditional large grocery stores. We therefore use a discount of 10 per cent for food purchased from stores included in the CPI. For other CPI components, we use the assumptions for price discounts used in Rossiter (2005)—a 15 per cent discount for clothing and footwear and 10 per cent for the remaining components—since no new evidence has become available.

These assumptions are different from the approach taken by Statistics Canada when constructing the CPI, which does not assume a divergence in the quality-adjusted prices between retail outlets. Instead, Statistics Canada

<sup>14</sup> Trendex North America is a marketing research and consulting firm specializing in the Canadian and Mexican markets. The information used in this article is taken from its 2008 reports on the Canadian apparel market.

<sup>15</sup> The QRCS provides a breakdown of retail sales by commodity type as well as by the type of retail outlet where the commodities are sold.

<sup>16</sup> For the components of the CPI basket that were previously identified as subject to outlet-substitution bias, but for which no data are available from the QRCS or Trendex, we use the same market-share progression as in Rossiter (2005), i.e., 2.5 per cent per year.

<sup>17</sup> Greenlees and McClelland (2011) use hedonic regression to account for the differences in item characteristics.

attributes any divergence in prices between two types of outlets to differences in the quality of the product or the quality of services provided by the different outlets, which might be too restrictive when goods are highly homogeneous and outlets provide the same quality of service, or when the market has not yet reached an equilibrium state (i.e., the market shares of different types of outlets are continuing to evolve).

Table 1 shows the results for outlet-substitution bias. By combining the information on the average annual change in market share and the price discount for the different CPI components, we find that outlet-substitution bias is about 0.04 percentage point per year, which is slightly weaker than the 0.08 percentage point per year assessed previously (Rossiter 2005). The lower estimation for outlet-substitution bias relative to the previous Bank study is due to the stabilization in the market shares for some goods. The upper bound is calculated using a price discount of 15 per cent for all components subject to outlet-substitution bias, and could also be consistent with a period of more-rapid changes in market shares.

**Table 1: Contributions to outlet-substitution bias**

CPI components	Weights (%)	Change in market share (percentage points per year)	Price discount (%)	Bias (percentage points per year)	Upper bound (percentage points per year)
Food purchased from stores	11.2	0.70	10 <sup>c</sup>	0.01	0.02
Health and personal care products	3.3	-0.10	10 <sup>d</sup>	0.00	0.00
Clothing and footwear	5.0	0.70 <sup>b</sup>	15 <sup>d</sup>	0.01	0.01
Furniture, home furnishings and electronics	4.1	0.00	10 <sup>d</sup>	0.00	0.00
Sporting and leisure goods	1.3	0.20	10 <sup>d</sup>	0.00	0.00
Other goods and services that could be subject to outlet-substitution bias <sup>a</sup>	9.4	2.50	10 <sup>d</sup>	0.02	0.03
<b>Total CPI (sum)</b>	<b>34.3</b>			<b>0.04</b>	<b>0.06</b>
<b>Total CPI (Rossiter 2005)</b>				<b>0.08</b>	<b>0.10</b>

a. Communications products and services; household chemical products; paper, plastic and foil supplies; air transportation; home entertainment equipment and services; tobacco products; and books

b. Based on the database provided by Trendex

c. Based on Greenlees and McClelland (2011)

d. Based on Rossiter (2005)

## New-Goods Bias

Bias may also occur if the CPI methodology does not capture the effects on the true cost of living from the introduction of new goods. For convenience, we can decompose the total new-goods bias into a bias associated with the introduction of entirely new categories of goods (new-products bias) and a bias caused by the introduction of new brands of existing products (new-brands bias).

### New-products bias

While new products (such as high-definition televisions or electronic tablets) are regularly introduced into the retail market, there is a lag before they enter the CPI basket because the basket's product classification is updated only periodically. Since new goods and services are not immediately captured in the CPI, and the rate at which their prices change (adjusted for quality) is different from that of items already included in the basket, the CPI is subject

◀ *Since new goods and services are not immediately captured in the CPI, and the rate at which their prices change is different from that of items already included in the basket, the CPI is subject to new-products bias*

to new-products bias. For example, when the evolution of prices for new goods that have not yet been incorporated into the CPI basket is slower than the average evolution of prices for goods already included in the basket, the CPI is positively biased.<sup>18</sup> This is usually the case for many electronic products, the prices of which tend to fall immediately after their introduction to the market. In addition, failure to include new products in the CPI basket implies an underestimation of welfare gains to consumers resulting from the availability of a wider range of products.<sup>19</sup>

To calculate new-products bias, we need to know the percentage of new goods not yet introduced into the CPI basket, as well as the average percentage difference in the changes in the quality-adjusted prices for new goods relative to goods already included in the CPI.

In the latest basket update (May 2011), for example, new retail products that had already been available for some time were added to the basket, including telephone equipment and emerging multi-purpose digital devices such as smart phones and tablet computers. These goods, which carry a weight of 0.1 per cent of the CPI, would likely cause a positive bias, since they already appeared in the market but their introduction into the CPI basket was delayed between the 2007 and 2011 updates.

Several sources of information (including Hausman (1997) and the *Washington Post* (2011)) suggest that the relative prices of these products experienced an average decline of about 5.5 per cent per year for telephone equipment (from 1998 to 2008) and 8 per cent per year for smart phones and tablet computers (from 2005 to 2010).<sup>20</sup> As shown in **Table 2**, the upward bias on total CPI that is created by these new products amounts to only about 0.01 percentage point annually, given that their weight is so small.<sup>21</sup>

As suggested by Diewert (1998), new-goods bias extends beyond new inventions and could also refer to the wider selection of products that consumers can choose from, given advancements in telecommunication technologies (online shopping) or better transportation infrastructure (providing easier access to more stores). The increased product variety resulting from fewer geographical restrictions may lead to a positive bias, since the expanded access to a wider variety of products leads to welfare gains that are not captured in the CPI. Estimating the contribution of these factors to the bias is based on judgment. The increase in market share of e-commerce from slightly less than 1 per cent of total retail trade in 2004 to about 8 per cent in 2010<sup>22</sup> suggests, however, that these factors are important and have likely intensified.<sup>23</sup> An average bias of 0.09 percentage point per year is

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<sup>18</sup> Despite their exclusion from the CPI basket, there would be no new-products bias if the evolution of prices for new goods were the same as that of the overall index.

<sup>19</sup> The fixed nature of the CPI basket does not necessarily mean that it fails to capture indirect effects, since the presence of these new products in the marketplace might put downward pressure on prices for obsolete items that are still included in the CPI basket.

<sup>20</sup> These reported declines are not adjusted for quality; hence, it is likely that the real decline is larger, given the degree of technological advancement that accompanies these products. However, since their weight is low, an assumption of 10 per cent would result in the same overall impact when rounded to the second decimal point.

<sup>21</sup> In addition, other new goods (for example, satellite radio receivers, the latest video game consoles and single-serving coffee makers) may already be in the market but not yet captured by Statistics Canada, which would likely increase the amount of this bias modestly.

<sup>22</sup> According to Forrester Research, Inc. (Indvik 2011)

<sup>23</sup> The rise in online sales is the result of such factors as increased Internet connectivity (with devices such as smart phones and tablets), better-performing search engines, and an intensification of online accessibility by retail firms.

assumed to result from this increased access, with a total bias of 0.10 percentage point for new products, which is in line with the estimates provided by both Rossiter (2005) and Crawford (1998).<sup>24</sup>

## New-brands bias

Another type of new-goods bias is new-brands bias, which results from potential gains in consumer welfare owing to the availability of a greater selection of brands among goods already included in the CPI basket (cereals, clothing and so on). If new brands are not a perfect substitute for existing brands, an increase in the number of brands would lower the minimum cost of reaching a given standard of living, thereby reducing the cost of living. Since the CPI does not allow for these possible effects, the introduction of new brands may lead to a positive bias.<sup>25</sup> It is difficult to determine the value that consumers place on having access to a larger selection of brands, but it could be argued that this bias may be considerable, since there has been a significant increase in brand selection over time.

We use the same assumption as was used in Rossiter (2005) and Crawford (1998) for the potential bias arising from wider access to new brands, i.e., 0.10 percentage point per year (with an upper bound of 0.15 percentage point per year).<sup>26</sup> Therefore, the estimate of the new-goods bias arising from new products and new brands amounts to 0.20 percentage point per year, in line with previous studies (Table 2).

◀ *New-brands bias results from potential gains in consumer welfare owing to the availability of a greater selection of brands among goods already included in the CPI basket*

**Table 2: Contributions to new-goods bias**

CPI components	Weights (%)	Relative price decline of these new goods (%)	Bias (percentage points per year)	Upper bound (percentage points per year)
Telephone equipment	0.10	5.8 <sup>a</sup>	0.003	
Multi-purpose digital devices (smart phones, tablet computers)	0.04	7.5 <sup>b</sup>	0.002	
New-products bias on total CPI			0.01 <sup>c</sup>	0.01
Better access to new goods (from improved telecommunications technologies and transportation infrastructure)			0.09	0.10
New-brands bias on total CPI			0.10	0.15
New-goods bias (new-products bias and new-brands bias) on total CPI			0.20	0.26
Rossiter (2005)			0.20	0.30
Crawford (1998)			0.20	0.30

a. Based on Hausman (1997) and the *Washington Post* (2011)

b. Based on the *Washington Post* (2011) as well as judgment

c. The total impact from new-goods bias is rounded to the second decimal point.

<sup>24</sup> Rossiter (2005), however, attributes 0.05 percentage point to the introduction of new products (assuming an average price decline of 10 per cent for new goods with a weight of 1 per cent) and 0.05 percentage point to better access.

<sup>25</sup> An increase in the number of brands would, however, increase competition and possibly put downward pressure on prices for top-selling items that are included in the CPI. Such an increase in brands could therefore be partially captured in the CPI.

<sup>26</sup> With the increase in the number of choices, the consumer can achieve the same level of utility at a lower cost. Hausman (1994) estimates the effect on consumer welfare of the introduction of a new brand of cereal, and finds that the impact of new brands on consumer welfare appears to be significant.

## Quality-Adjustment Bias

Since the CPI basket is fixed, its quality should, in theory, remain constant over time. In practice, however, the quality of goods and services usually changes as their characteristics evolve (e.g., when flat-screen televisions replaced cathode-ray-tube televisions). To separate pure price movements from quality changes, statistical agencies usually adjust raw data using various quality-adjustment techniques. A bias occurs when the size of these quality adjustments is incorrect. Quality-adjustment biases can be either positive or negative for different components of the CPI: the bias is positive if quality improvements are underestimated and negative if they are overestimated. The size and direction of the quality-adjustment bias for the total CPI depend on the net effect of all positive and negative biases for individual items in the basket.

◀ A bias occurs when the size of quality adjustments to separate pure price movements from quality changes is incorrect

Our assessment of the quality-adjustment bias is based on a methodology proposed by Bils (2009), which uses the microdata underlying the CPI as well as consumer expenditure data. We report the findings of Kryvtsov (2011), who applies Bils' approach using price-survey microdata from Statistics Canada. According to this methodology, the rate of changes in prices ( $\Delta$ ) for CPI components is divided into three separate parts:

$$\Delta_{\text{unit price}} = \underbrace{\Delta_{\text{new goods}}}_{\text{during basket updates (i)}} + \underbrace{\Delta_{\text{same model}} + \Delta_{\text{new model}}}_{\text{between basket updates (ii) (iii)}}$$

- (i) the rate of price change for new types of goods (introduced during basket updates)
- (ii) the rate of price change for the same models that occurs between basket updates
- (iii) the rate of price change that occurs when new models of existing products replace older models between basket updates

When introducing new product categories to the CPI classification at the time of basket updates, a higher or lower price for these items would not translate into a potential for a positive or negative quality-adjustment bias, consistent with Bils' methodology. According to this approach, a quality-adjustment bias can therefore occur only between basket updates, when newer models of the same good are included in the CPI (the quality does not change for existing models).

We use two parameters to estimate the quality-adjustment bias: the share of the CPI components subject to quality adjustment, and the quality adjustment that should be applied to avoid this bias. We assume, as in previous Bank studies, that, on net, only durable goods are subject to this type of bias, given that such goods are the most likely to be affected by technological improvements.<sup>27</sup> Consequently, the net quality-adjustment bias arising from all of the other CPI components is assumed to be zero. The quality-adjustment bias in the total CPI would therefore equal the weight of durable goods in the Canadian CPI basket (12.8 per cent) multiplied by their annual quality-adjustment bias.

<sup>27</sup> The assumption of a net bias of zero in the services sector is compatible with the possibility that some types of services, such as dental services, might be positively biased since they benefit from improved technology. This bias is offset by negative bias in other services, such as the airline industry, resulting from perceived decreases in the quality of service.

To calculate the extent of quality-adjustment bias, Bills (2009) examines the assumption that if higher prices for new models represented only inflation (no change in quality), this would lead to a complete substitution of these more expensive models with the older but more affordable ones. Bills rejects this assumption, finding instead an increase in the market share of these new models. Accordingly, the higher prices for new models could represent a combination of higher quality-adjusted prices and an improvement in quality. However, the initial price increase for new models might also represent a temporary increase in consumer demand due to the novelty of the product, which is eventually eliminated.<sup>28</sup>

To measure the importance of these effects, Bills (2009) and Kryvtsov (2011) estimate the persistence of the increase in relative prices for newly substituted models. Kryvtsov (2011) finds that one-third of the change in prices for durable goods, excluding computers, in Canada should be allocated to quality changes and two-thirds to pure price movements.<sup>29</sup> Since the quality adjustment performed by Statistics Canada is 40 per cent, slightly exceeding Kryvtsov's rule of thumb, there appears to be a modest negative quality-adjustment bias in the CPI. For computers, including both equipment and supplies, the quality-adjustment bias is assumed to be zero, based on Bills (2009) and Lebow and Rudd (2003).<sup>30</sup>

Table 3 shows detailed results for the quality-adjustment bias. The average price increase in Canada between 1998 and 2006 for changes in models is 1.6 per cent for durable goods, excluding computers.<sup>31</sup> According to Kryvtsov (2011), 0.5 per cent of this total should be attributed to quality adjustment to avoid any bias. However, he finds that 0.6 per cent has been allocated to quality adjustment, resulting in a negative bias of about -0.10 percentage point per year for durable goods, which has an impact on total CPI of -0.01 percentage point per year. Our estimate for quality-adjustment bias is much smaller than previous Bank studies largely because of the new method for assessing quality-adjustment bias for durable goods. The estimated upper limit of the quality-adjustment bias is obtained by allowing for a small net positive bias for components other than durable goods.

◀ Our estimate for quality-adjustment bias is much smaller than previous Bank studies largely because of the new method for assessing quality-adjustment bias for durable goods

**Table 3: Quality-adjustment bias following model substitutions**

CPI components	Weights (%)	Quality-adjustment bias (percentage points per year)	Impact on total CPI (percentage points per year)	Upper bound (percentage points per year)
Durable goods, excluding computers, equipment and supplies	12.20	-0.10	-0.01	
Computers, equipment and supplies	0.57	0.00 <sup>a</sup>	0.00	
Total CPI except durable goods	87.20	0.00	0.00	
Mean estimate for total quality-adjustment bias	100.00		-0.01	0.05
Rossiter (2005)			0.15	0.20
Crawford (1998)			0.10	0.20

a. Based on a combination of Bills (2009) and Lebow and Rudd (2003)

<sup>28</sup> When a new novel comes out, for example, people may prefer to read it right away because they do not want to hear the ending from someone who has already read it. In this case, demand for new novels will be higher (than for older ones), which leads to their relatively higher prices regardless of their quality.

<sup>29</sup> Bills (2009) finds instead that, in the United States, the novelty premium accounts for about one-third of the initial price differential, while the remainder represents improved quality, suggesting that the increase in relative prices for newly substituted models is more persistent in the United States than in Canada.

<sup>30</sup> Using U.S. data, this assumption is based on approximately the middle of the range between the slightly negative quality-adjustment bias that Bills (2009) found using the hedonic approach and the small positive bias that Lebow and Rudd (2003) found using a different sample period.

<sup>31</sup> Data for the sample period were available only until 2006.

## Measuring Total Bias in the CPI

The total bias in the Canadian CPI can be estimated by aggregating the different sources of bias (Table 4). Our results indicate a total CPI bias in Canada of roughly 0.5 percentage point per year, with an upper bound of about 0.6 percentage point per year. From this total, slightly more than half seems to be a result of the CPI basket being fixed.<sup>32</sup> Our estimate of the bias is slightly lower than the estimate in Rossiter (2005), largely because of the new method for assessing quality-adjustment bias for durables. Our estimate relies on an improved methodology that uses Canadian CPI microdata instead of data from U.S. studies.

◀ From the total CPI bias, slightly more than half seems to be a result of the CPI basket being fixed

**Table 4: Total bias in the Canadian consumer price index**

Percentage points per year

Type of bias	Crawford (1998) Mean	Rossiter (2005) Mean	2005–11	
			Mean	Upper bound
Commodity substitution	0.10	0.15	0.22	0.22
Outlet substitution	0.07	0.08	0.04	0.06
New goods	0.20	0.20	0.20	0.26
Quality adjustment	0.10	0.15	-0.01	0.05
<b>Total</b>	<b>0.47</b>	<b>0.58</b>	<b>0.45</b>	<b>≈0.60</b>

## Conclusion

Given that slightly more than half of the total measurement bias in the CPI may be caused by the fixed nature of the CPI basket, the commodity-substitution bias and some of the new-goods bias could be reduced by increasing the frequency at which weights are updated.<sup>33</sup> Although this might not always be the case, empirical evidence suggests that the average size of the measurement bias in the Canadian CPI has been relatively constant over the past 15 years. As well, since some of the divergence between our estimates of quality bias and those of previous studies appears to be related to improved methodology and better access to data specific to Canada, the difference in these estimates should not be attributed to a true decline in the underlying bias. Further analysis based on Canadian-specific data would enhance our empirical evidence of the size of the CPI bias.

It is important for central banks to be aware of both the level and the volatility of measurement bias in the CPI. In an inflation-targeting regime, measurement bias in the CPI can be accounted for by setting the target at a level that equals or exceeds the estimated bias to provide flexibility in insuring against deflation. This article has shown that the bias in the Canadian CPI remains below the rate of inflation targeted by the Bank of Canada.

<sup>32</sup> More precisely, the fixed nature relates to both the commodity-substitution bias and some of the new-goods bias. Accordingly, the sum of the commodity-substitution bias and the fraction of the new-goods bias resulting from the delay in adjusting weights is 0.23 percentage point per year.

<sup>33</sup> As part of a larger CPI enhancement project, Statistics Canada is planning to update the CPI basket weights every two years, instead of every four years.

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