

How can a Clothing Price Index be Enhanced – Statistics Canada's Recent Experience

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Abstract

The Consumer Price Index (CPI) produced by Statistics Canada is an indicator of the change in price for commercial goods and services. It is commonly used as a proxy for inflation in Canada. The CPI collects the price of the same set of products each month to produce an estimate of the pure price movement. However, the products available to consumers are constantly changing so the price collected must be adapted to accommodate for these changes. The clothing and footwear component of the CPI can be very challenging in this regard due to the rapid change of clothing products as a result of fashion trends and the evolution of consumer shopping patterns over time. This paper will give an overview of two initiatives that were recently conducted at Statistics Canada to address these issues. The first part looks at the coverage of the sample, in terms of the types of stores where products are priced, before and after a recent sample enhancement. The second part of this paper examines the use of quality adjustment measures that are used to compensate for changes in product quality over time.

Key Words: Price Index, sample coverage, quality adjustment

1. Introduction

One of the most important measure of economic change within a country is the Consumer Price Index (CPI). In Canada the CPI is the most common measure of inflation and it is used by governments and businesses for a variety of purposes such as adjusting contractual and legislative payments to keep them consistent with inflation (Statistics Canada 2014). The CPI measures the change in price for a fixed basket of goods and services that are purchased by consumers. The index then measures the pure price change in products because the items in the basket are consistent in time and they are of equivalent quantity and quality.

The Canadian CPI has a three step design (Statistics Canada 2014). The first step is the selection of geographical collection areas. The second step is the selection of representative outlets, which uses annual revenue sales as a proxy for the volume of sales to select the largest outlets to include in the sample. The last step is the selection of representative products, which meet the product specifications supplied by analysts to represent a group of similar products. The products are then chosen by the interviewer with the goal of selecting the products that are the most popular with consumers. The CPI is a longitudinal sample with the selected geographic areas, outlets and products remaining in the sample for as long as possible.

For the Clothing and Footwear index, one of the major components of the total (referred to as the “All items” CPI), the price of products is collected in person each month to calculate a price relative (price in the current month / price in the previous month). A price index is then calculated by grouping and weighting the products. Products are grouped based on a classification scheme, which successively combines groups of similar products from the lowest level of elementary aggregates (EAs), where the products all have the a similar price movement, up to the highest level of the All items CPI, which contains all goods and services. Basket weights are assigned to each elementary aggregate (and summed for subsequent levels of the classification scheme) according to the relative importance of each group in the CPI. The basket weights are derived from the Survey of Household Spending, which estimates the amount Canadians spend annually for all types of commodities.

The ability to track the “pure price movement” that is targeted by the CPI can pose many challenges due to the dynamic nature of the environment. The products available to consumers and the selection of stores where they can shop is constantly changing. For example, fashion trends and changing seasons mean that the clothing and footwear products available in stores fluctuates constantly. The shopping patterns of consumers also change over time as consumers shift the place where they shop due to product availability and price in a given store or their proximity to a store. The market share of clothing and footwear sales in general merchandise stores, including department stores, has decreased by over 4% in the last 10 years (Figure 1). Instead consumers are shopping more for clothing in specialty stores. The sample and products priced each month to calculate the CPI must be adapted to account for these changes.

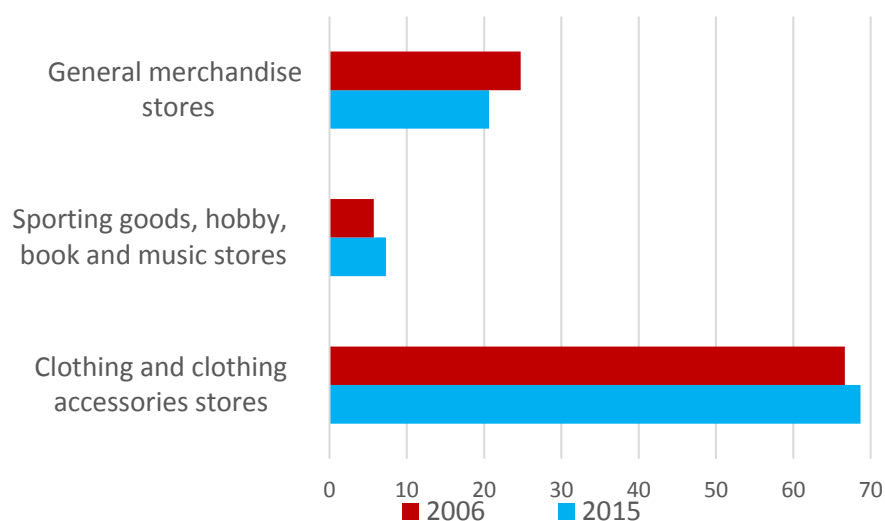


Figure 1: The change in the market share of clothing and footwear products for different types of stores (Statistics Canada 2016a)

In 2010 Statistics Canada started a large project, called the CPI enhancement initiative, to improve the overall quality of the CPI (Beaulieu, Fortier and Provençal 2015). Substantial changes were made to improve the methodology of selected indexes, increase the frequency of basket updates and increase the number of price quotes that are collected each month. The index basket is updated more frequently, every two years, and it is updated in a more timely manner with only a 13 month lag from the reference period. A new sample frame of outlets was created, which helps to ensure the sample is more representative and

allows for better coverage assessments of the sample to be made. The product classification structure for the Clothing and Footwear index was also updated and the methods used to account for changes in the product characteristics have been improved.

This paper will examine two aspects of how the clothing and footwear index was recently enhanced at Statistics Canada. Section 2 describes how the sample coverage is measured for the CPI and gives the results of the recent changes to the sample. Section 3 explores the use of quality adjustment measures to account for the constant change in clothing products that are available. The paper concludes with some overall comments and suggestions for future work.

2. Sample Coverage

One of the main objectives of the CPI enhancement initiative was to increase the number of price quotes collected each month. The number of price quotes collected for clothing and footwear was increased by approximately 30%. The main objectives of this sample increase was to improve the representation of certain major outlet brands and different types of stores where clothing can be purchased. In this section of the paper, the methods used to measure the coverage of the sample and the results of the sample increase are given.

2.1 Measuring Sample Coverage

The coverage of the CPI sample is measured in terms of the outlets or stores that are included in the sample.¹ The coverage is measured at this level since a frame of outlets exists which can be used for comparison. The sample frame is created from Statistics Canada's Business Register, which is a list of all businesses operating in Canada. The CPI frame is a list of all commercial and service outlets from the BR at the location level. The total revenue for each outlet on the frame is derived from administrative tax files. The total revenue is then split into the revenue from the sale of different types of commodities using data from the Quarterly Retail Commodity Survey. For example, the total revenue from a department store would be split into the revenue from the sales of food, clothing, house wares, auto parts, etc. The North American Industry Classification System (NAICS) is used to classify the type of outlet.

The distribution of the outlets in the sample and the frame are calculated using the revenue of all the commodity components that correspond to clothing and footwear. The revenue is used instead of the number of outlets since outlets are selected for inclusion in the sample based on the revenue and it is a better indicator of the importance in terms of market shares. The data from the frame contains the outlets where it is believed that clothing and footwear products can be purchased, as deemed by subject matter experts. The outlets in the sample were classified as either existing prior to the sample increase (i.e. they have at least one price quote for clothing or footwear before the sample increase period) or added during the sample increase (i.e. all products initiated collection during the sample increase period). Part of the overall increase in the sample was to price more representative products in existing outlets as it is more cost effective. This change in the sample coverage is not measured in this analysis; the focus is on the change in the distribution of outlets.

¹ There is no attempt made to examine the coverage of the product dimension since there is no frame listing the products available to consumers. Rather the representative product methodology is used to determine which products are priced each month (International Labour Organization 2004)

2.2 Results of Sample Increase

Overall the sample coverage has improved, with the difference between the sample and frame being reduced by 9.3 percentage points across the 14 largest store types (Table 1). One of the most important increases in the sample is for women's clothing items, since women's clothing makes up the largest portion of the index basket (2.11% for women's clothing of the total 6.08% of clothing and footwear, Statistics Canada 2016b). This was largely accomplished through the addition of women's clothing stores to the sample. The outlet types of 'other clothing stores', 'children and infant clothing stores' and 'shoe stores' were also targeted during the sample increase. The sample size for these store types is now closer to the proportion on the survey frame.

Table 1: Coverage of the CPI sample before and after the recent sample enhancement by NAICS code compared to the sample frame

NAICS	<i>Before Sample Increase</i>	<i>After Sample Increase</i>	<i>Frame</i>
Men's Clothing Stores	7.9 %	6.0 %	4.0 %
Women's Clothing Stores	4.4 %	6.6 %	13.8 %
Children and Infant Clothing Stores	1.7 %	2.3 %	2.8 %
Family Clothing Stores	26.3 %	28.9 %	23.3 %
All Other Clothing Stores	1.6 %	4.0 %	7.1 %
Shoe Stores	5.7 %	6.4 %	8.8 %
Other Sporting Goods Stores	6.4 %	8.8 %	6.3 %
Department Stores	34.4 %	27.1 %	12.9 %
Jewellery Stores	4.3 %	3.2 %	8.4 %
Other General Merchandise	0.6 %	0.6 %	2.5 %
Dry Cleaning & Laundry Services	1.0 %	0.7 %	3.1 %

There are still some further enhancements that can be made to the sample coverage. During the CPI enhancement initiative no outlets were removed from the sample as the effort was being made to increase the number of price quotes. This is one of the reasons why the proportion of department stores in the sample remains significantly higher than the proportion from the frame according the revenue shares. Department stores were only added to the sample in new geographies but since no price quotes were removed from department stores they continue to be over-represented in the sample.

However, matching the proportion of outlets from the sample frame is not the only consideration when deciding the best way to allocate the sample. The ability to price a larger range of products in family clothing stores (men's, women's and children's products for example) make them a more practical option for the interviewer. In general, it takes less time and resources to price several products in one store than to price the same products in multiple stores. This is the main reason that family clothing stores are over-represented in the sample and why that will continue to be the case.

3. Quality Adjustment

Since the goal of the CPI is to measure pure price movement, the characteristics of the products, except for the price, must remain constant over time. Ideally the exact same products are priced in the same stores each month. However, the products available are always changing. For clothing and footwear this may be due to seasonal changes; winter coats, for example, are not available to purchase all year long. Products of this nature are

termed 'seasonal products'. The price trend for most seasonal products is that they are initially sold at the 'regular' price but near the end of the season the price is reduced to a 'sale' price and the item may eventually have a 'clearance' price before the end of the season. This ensures the stock of the seasonal item is cleared out and does not have to be stored in the out of season months. When the item is back in season, the new product may be slightly different than the one that was previously available. For example, it may be a different colour, corresponding to the current fashion trend, or it may be made from a different type of fabric or with a different type of stitching. These changes in the characteristics of the product need to be assessed to determine if the quality of the product has changed. Any change in the price due to a change in quality must be accounted for so that only the pure price movement is recorded. This process is known as quality adjustment.

Quality adjustments are not only done for seasonal products, since even items such as t-shirts, which are always available to purchase, will change over time. The change may be as inconsequential as a change in the colour of the garment to a complete change in the style of the product. The number of months that a product can be continuously priced in a store before it needs to be substituted depends on the type of product. It ranges from an average of just a few months to over a year, depending on the dynamic nature of the product.

Adjusting for the quality change in the product is an important aspect of creating a price index.

3.1 Current Methods of Quality Adjustment

Currently, when a product cannot be found in a store it is substituted with a similar product by the interviewer. The interviewer also completes a quality price change report (QPCR) which collects detailed information about the characteristics of the product. The characteristics that are recorded vary by type of product but in general they include questions about the fabric or material used to make the garment, the country where it is made, the type of stitching used and the presence and quantity of embellishments like buttons or zippers.

Each QPCR form is then reviewed by a subject matter specialist at Statistics Canada's head office and expert judgement is used to determine if the change in the characteristic of the product corresponds to a change in the quality. The expert judgement follows procedural guidelines that aid the subject matter specialist in determining the most plausible quality ratio between the new and old products (Statistics Canada, 2014). The price recorded from the previous month is adjusted so that when the price relative is calculated it reflects only a pure price change. This is an example of an explicit method of quality adjustment.

In 2015 a QPCR form was completed for 10.6% of all clothing price quotes that were collected. The rate is a bit lower for non-seasonal products, 7.2% and higher for seasonal products 22.1%, which is not surprising given the large turn-over in the merchandise between seasons. Combining the rate of QPCR forms in the peak season changes of spring and fall with the 30% increase in the sample size equates to a substantial increase in the volume of forms that need to be reviewed each month. The time constraints for these adjustments remain fixed given the monthly dissemination schedule for the CPI. This amounts to an increased cost and burden on the interviewers and commodity experts, which we aim to reduce by revisiting the procedures.

Approximately one third of the quality adjustments are classified as pure price movement. In this case the products are deemed to be of a similar quality and no adjustment is made to the price. Therefore any observed change in the price corresponds to a price movement. For a little under one third of the data, the products are deemed to be sufficiently different and any difference in the price is assumed to be due to the difference in the quality. In this case a price movement of 1 is imputed for the first month the product is substituted and the price movement of the new product then begins to be tracked in subsequent months. The rest of the cases are somewhere in between these two extremes.

Overall 89% of the quality adjustment forms result in a price change of less than 0.5% (Figure 2).

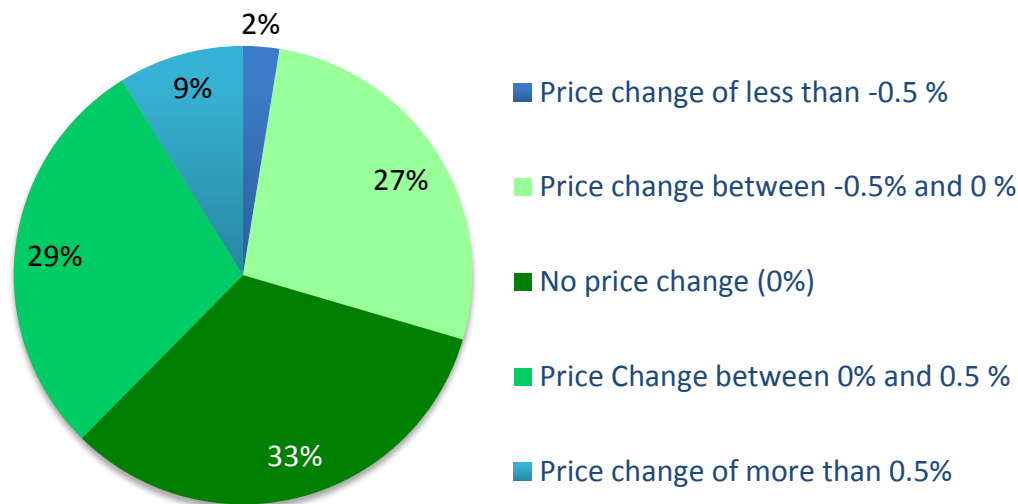


Figure 2: Percent change in the observed price of a product due to quality adjustments.

3.2 Alternate Methods of Quality Adjustment

Due to the operational burden of the quality adjustment for the clothing and footwear component of the CPI several implicit methods of adjusting the price were examined.

1. **Link to Show No Change (LNC)** – assume that products are sufficiently different in quality or it is impossible to quantify the change in the quality so no price movement is imputed for the substituted products. Price movements of the new product will be collected in future months.
2. **Direct Price Comparison (DPC)** – assume that in all cases the product substituted by the interviewer is of a similar quality to the previous product and any observed change in the price corresponds to a price movement.
3. **50% Direct Price Comparison and 50% Link to Show No Change (Hybrid)** – assume there is a variety of direct price comparisons and link to show no change in the field and impute the average value of these two extreme cases for any substituted products.

4. **Overall Mean Imputation (OMI)** – assume that the change in the price for substituted product is equivalent to the average change for other similar products. The price from the previous month of substituted products is imputed as the quotient of the current price and the average price relative of similar products. Thus the price movement for substituted products is the average price movement. In the OMI calculation adjustments are also made to ensure the regular price is compared and not a sale price.

The other common method of adjusting product quality is by using hedonic models (International Labour Organisation *et. al* 2004). A hedonic regression model assumes that the price of a product is the sum of its component parts and that this decomposition can be modelled with a linear regression model. The model can then be used to predict the price (Y) when one or more of the characteristics (X-variables) are changed. Hedonic models have been tested at Statistics Canada and are used for some products. The CPI currently uses hedonic quality adjustments for computer equipment, software and supplies and internet services (Statistics Canada 2014). The market for these products are competitive and have a rapid product turnover in which the characteristics change frequently but they are easily observed. However, for clothing and footwear, hedonic models have shown no significant advantage over the current method of expert judgement. Hedonic models are operationally burdensome to do and there are often not enough observations from a given product to create a reliable model to use for prediction.

The price index was simulated for each of the elementary aggregates in each strata that are used to create the clothing price index. The price index at the elementary aggregate level is equivalent to the geometric mean of the price movements, referred to as Jevon's index (Statistics Canada 2014). The index was also simulated with the different implicit methods to see which technique best matches the current practices (Figure 3).

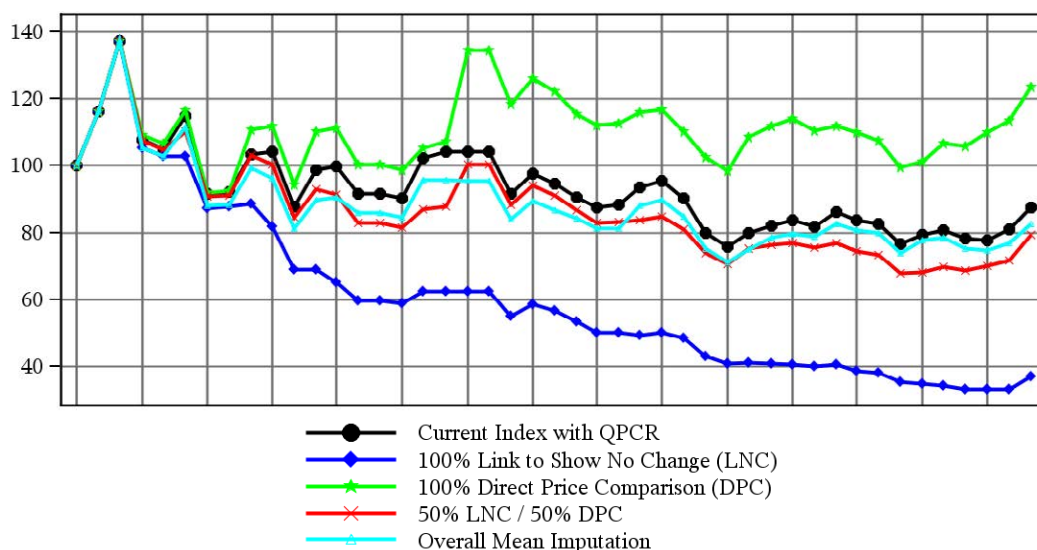


Figure 3: Simulated price index to compare different implicit methods to do quality adjustments on the price.

The example simulation of this non-seasonal product shows that overall mean imputation (cyan line) and the hybrid 50% direct price comparison and 50% link to show no change (red line) methods give similar results to the current method (black line). The trend for the

link to show no change method (blue line) exhibits a negative chain drift. This is largely because most products are sold for a sale price prior to them not being available to purchase and requiring a product substitution. If the sale price of the previous product is not adjusted back to the level of the regular price then the price relative in the index will exhibit a negative trend.

3.3 Ranking Products for Quality Adjustment Procedures

Since the implicit methods of quality adjustment were shown to produce an acceptable approximation to the judgemental adjustment method some low risk elementary aggregates were selected to test the implicit adjustment methods. This will reduce the operational burden associated with the clothing and footwear index while maintaining or improving the quality of the index.

A score function was created to determine which elementary aggregates have the lowest risk of influencing the price index due to a change in processing. The score function is composed of the following 3 criteria:

1. **Substitution Rate** – The first criterion is the proportion of quality adjustments done for the elementary aggregate over the past year. The score of criterion 1 is standardized by the proportions observed for all other products. This will assign a low score to elementary aggregates with a low proportion of quality adjustments.
2. **Price Change on Substitution** – The second criterion is the proportion of quality adjustments that resulted in a change in the price of more than 0.25%. This proportion is then standardised by the proportions observed for all other elementary aggregates. A lower score is assigned to the elementary aggregates with a smaller change in the price.
3. **Basket Weight** – The third criterion is the basket weight divided by the average number of price quotes collected each month. This value is standardised by the ratio observed for all other elementary aggregates. This criterion is used to examine the importance of price quotes on the final price index. A low score for criterion 3 is thus assigned to products with a low basket weight and a large number of collected price quotes.

The final score is the sum of the 3 individual standardized scores. A low score is assigned to products with a low rate of adjustments, a small change in the data due to quality adjustment and a small impact on the price index. These are the products that were considered as potential candidates for the use of an implicit method of quality adjustment. The explicit method of expert judgement will continue to be used for products with a high score, namely those with a high turnover rate, a large change in the price due to quality adjustment and a large contribution to the price index. Table 1 gives an example of the score function for a product with the lowest score (XXXXXX) and the highest score (YYYYYY).

Table 1: Example of the score function used to identify the elementary aggregates with the lowest risk to test the implicit quality adjustment measures

Elementary Aggregate	Description	Criteria			Score
		1- Rate of adjustment	2-Percent Revision	3-Basket Weight	
XXXXXX	Small impact of quality adjustment	-0.99	-2.06	-1.14	-4.18
YYYYYY	Large impact of quality adjustment	1.38	1.02	3.51	5.91

The score function was used to classify all of the elementary aggregates within the clothing and footwear index. 12 seasonal and 12 non-seasonal elementary aggregates were identified to test the implicit quality adjustment methods. The overall mean imputation will be used for the non-seasonal products since it produced the results most similar to the current method for the 12 non-seasonal elementary aggregates that were selected. The overall mean imputation is not applicable to seasonal products because during the first and last month a product is collected a lot of items are out-of-stock making it hard to calculate an accurate defensible value for the overall mean imputation. Instead the hybrid method of 50% direct price comparison and 50% link to show no change will be used for the seasonal products. The impact of changing the quality adjustment measure for the CPI will continue to be monitored to ensure the quality of the index is maintained if not improved.

4. Conclusion

Significant work has been done to improve the overall CPI and the clothing and footwear index. The increase to the clothing sample have improved the coverage in many areas. The sample more closely resembles the frame and it now includes the major outlet brands in Canada as of April 2015. Further enhancements to the coverage could be made by reallocating price quotes collected in department stores to specialty stores, however, matching the distribution of store types on the frame is not the only consideration since there are operational constraints to take into account.

Quality adjustments are an important aspect of price index calculation for clothing but they can be costly, time consuming and burdensome. Implicit methods of quality adjustment can be used to reduce costs while replicating the price movement observed with current methods. Statistics Canada is testing implicit quality adjustment methods for a total of 24 products and may later expand the implicit methods to more elementary aggregates.

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