Chapter 5

HANDLING QUALITY CHANGES IN THE CANADIAN NATIONAL ACCOUNTS PRICE DEFLATORS

by

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Introduction

This chapter describes how quality change is treated in those price indices that are used in measurements of productivity. The measurement of productivity change depends on the measurement of change of real inputs and outputs, which in turn depend in many cases on the deflation of current values by appropriate price indices. Errors in price indices produce errors in the opposite direction in the measurement of real values. In measuring output, an over-estimate in measuring price change produces an equal under-estimate of output. Concerning capital input, an over-estimate of price change produces an equal under-estimate in gross capital formation, although its diffusion into the measure of capital use is more complicated.

As changes in productivity are a residual from comparing differences between changes in other large economic variables, and considering in how many ways the measurement of price change in those variables is deficient, it is a wonder that any reliable estimates can be made at all. That credible estimates are made is a tribute to the robustness of large quantities of data, and to the fact that methodology in measurement changes slowly, if at all. Following Baily and Gordon (1988), if we are to explain changes in productivity estimates on measurement errors we must look for one of two things: either changes in the means of measurement, or, if the methodology does not change, we must find errors whose size or direction is connected with the size of change in the economy – for example, indications that biases are larger, as the rate of price change is greater. Otherwise, a consistent error would not affect trends.

This chapter will examine the treatment of quality change, including the accommodation of new goods, in the price indices that go into the deflation of the Canadian National Accounts. It will deal only with the business sector, and mainly with goods in the business sector. The reason for this is that for most of the non-business sector, and for many services in the business sector other than consumer services, the measurement of constant dollar values is not done by deflating current dollars using price indices.

Deflation of goods

There are two quite different sets of constant price estimates in the Canadian System of National Accounts: gross domestic expenditure by final demand category, which is calculated quarterly, and gross domestic product by industry, for which annual benchmarks are calculated, forming part of the input-output tables. The data that are used in productivity studies are normally taken from the input-output tables, which at the most detailed level define 485 commodities. Of these, 356 are products of manufacturing, which are defined in much more detail than any other part of the Canadian economy. The price indices used for deflating most of these values are taken from the Industrial Product Price Indices (IPPI), covering the output of Canadian domestic manufacturing, or Machinery and Equipment Price Indices (MEPI), covering capital purchases of Canadian industry, whose domestic components are calculated from the same price survey as the IPPI.

Table 1 indicates the method of adjustment used to obtain constant price estimates in the input-output tables. It shows the sectors where price indices are used directly, and indicates that only a relatively small proportion of final demand is determined by the use of these price indices.

Table 1. Most common type of measure used to convert for price change

	Percentage share of GDP	Price indices	Unit values	Other methods[1]
Business sector				
Primary industries	7.1		x	
Manufacturing	18.4	IPPI, MEPI		
Construction	5.5	various		
Transportation[2]	4.4	CPI		x
Communications	4.0		x	x
Utilities	3.1		x	
Trade	12.2			x
Financial services	15.8			x
Personal services	7.7	CPI		x
Business services	4.4			x
Non-business sector	17.4			x

1. "Other" covers a wide variety of methods. Like unit values, which are used in deflating most outputs of primary industries, there is no quality adjustment for them.
2. The CPI is used for deflating public transport only (about 0.3) and about two-thirds of personal services.

Methodology of IPPI and MEPI

Since 1981 IPPIs have been calculated in the following way. We start with about 1 500 Principal Commodity Groups (PCGs) which cover the whole of manufacturing. (These are mapped onto the 356 for the detailed I/O tables, though there is often data available at the more detailed level.) From this array of commodities, samples are defined for about 700 separate, so-called elemental, indices. Most of these are PCGs, but in some cases a PCG is split into more detail. Between them they cover about 85 per cent of total Canadian manufacturing output. Samples are held constant from one December to the next, but the sample for any elemental index can be completely redesigned any December. In fact most samples persist for several years and when they are redesigned, there is considerable overlap between the old and new sample.

Within each elemental index individual price observations are sought from a sample of manufacturers of the products in that index, and from them, a representation of their range of products and markets. Samples average about 12 individual price quotations; generally, the more highly valued ones will have larger samples, but the limited number of producers of some products imposes a constraint. The best-selling varieties of product lines tend to be over-represented in the sample.

The domestic components of MEPIs use the same sampling method, except that for some specialised machinery and equipment separate samples are drawn for purchases by different industries.

Changes in the set of price observations can come about in one of two ways: by changes in the sample selection in December, or by the individual replacement of one price observation by another, which can occur at any time. In the first case the accuracy of the index is predicated on the linked series of samples continually representing the products being made and sold in that commodity group; in the second, it depends on being able to make a correct comparison between the value of the original and the replacement observation. This comparison is based on the assumption that the relative value of output is proportional to the relative value of inputs using the same technology.

MEPIs cover capital goods only, while IPPIs cover both intermediate and consumer goods. It is convenient to discuss these separately.

Consumer goods

Producers' price indices for consumer goods are distinguished from the rest as there is an alternative source of measurement of price change – the retail market – whose results are captured in the Consumer Price Index (CPI). In fact, in the National Accounts the deflation of producers' values for consumer goods is constrained somewhat to be consistent with the deflation of consumer expenditure at purchasers' prices using the CPI.

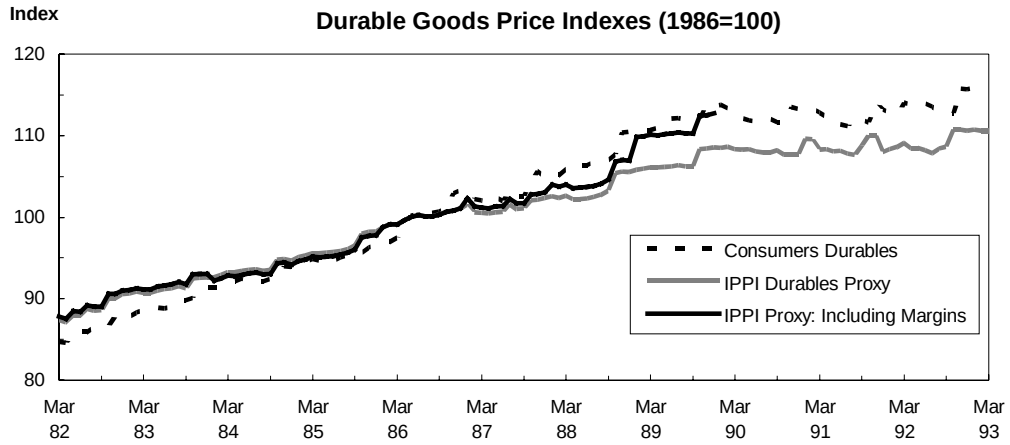
Apart from operational differences in the calculation of these two sets of indices, there can be differences arising from the different treatment of quality change. In the CPI the comparison of a price observation and its replacement should be based on the relative utilities of those items in the same market. It is difficult to see how evaluations based on comparisons of producers' costs or on relative utilities can produce continually different results unless the markets are separated – examples where approaches differ : should heating charges for poured concrete in winter be treated as price or quality change; should imported strawberries in January be treated as better than domestic strawberries in July as they include a value of transportation – depend on the separation of markets in time. But markets are separated in time when varieties of products are replaced and the old varieties are no longer available.

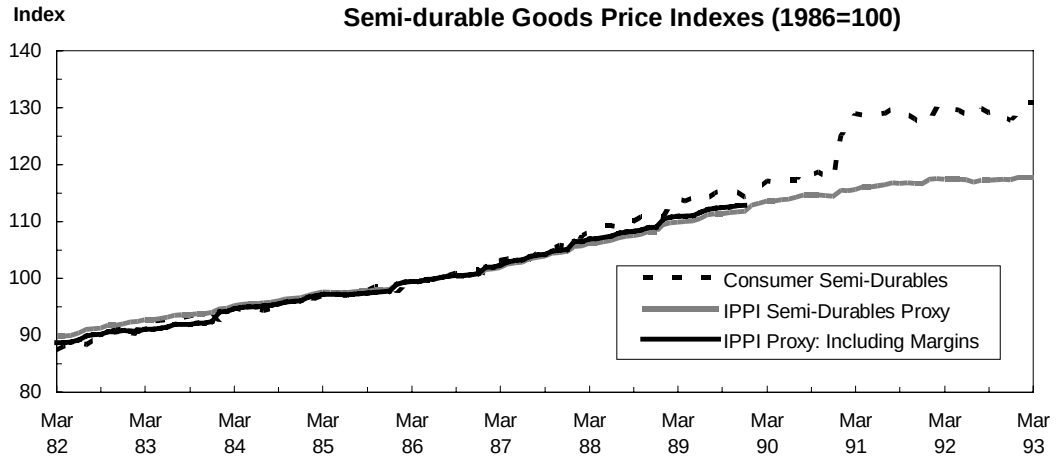
In practice, the makers of the IPPI and CPI each use approaches supposedly more appropriate to the other index. In the CPI, manufacturers' appraisals of the comparative value of different versions of their product are used in assessing quality change for some consumer durables, and in the IPPI market comparisons are widely used to assess quality differences. For evaluating the annual changes in North American automobiles there is a combined effort to make the evaluation consistent between the two indices.

Comparison between CPI and IPPI movements

There does not seem to be much difficulty in practice in deflating the producers' prices consistently with the deflation of retail purchasers' prices. In a study covering the years 1982 to 1992, Davies (1993), shows that the measures for consumer goods' prices in the IPPI compare quite closely with the measures of CPI for the same groups of commodities, once margins are taken into account. He constructed aggregates of producer price indices to match the CPI groups of non-durable goods, semi-durable and durables. Although the CPI is affected by imports, while the IPPI only covers domestic production, the indices move fairly similarly, once the IPPIs are adjusted to include

changes in transportation, trade and tax margins. Table 2 shows the percentage change in prices between 1982 and 1989, and the percentage margins were of the consumer price in those two years.





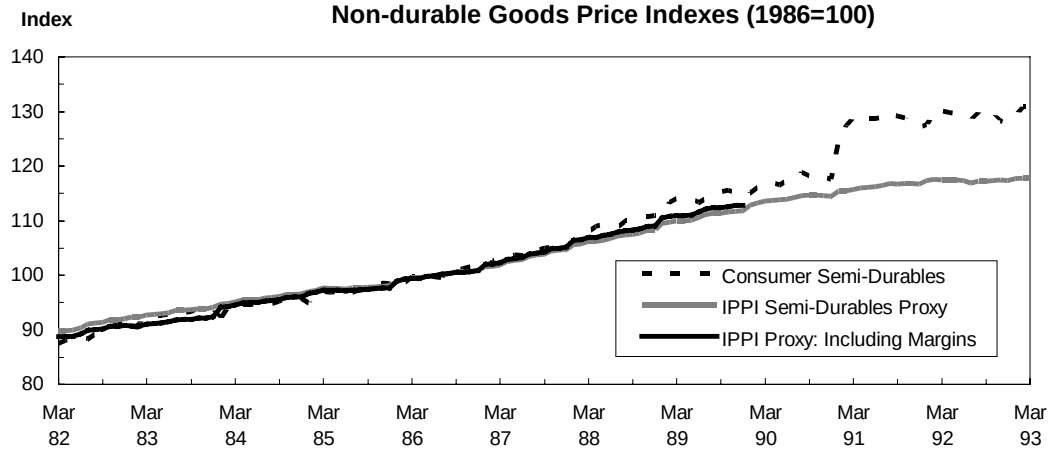


Table 2. IPPI and CPI measures for consumer goods

	Non-durables	Semi-durables	Durables
Percentage change from March 1982 to December 1989			
CPI	42.1	30.7	34.0
IPPI	27.4	24.4	24.2
IPPI, incl. margins	45.7	27.2	28.3
Trade and transportation margins as percentage of expenditure			
1982	41.8	44.7	39.8
1989	49.1	45.9	41.7

Margins and tax changes explain most of the difference in movements at the retail level. For the semi-durable and durable groups the margins stayed constant, except for indirect taxes, which rose substantially. However, for non-durable goods (electricity and other heating fuels were excluded) the movement of trade margins was quite different; growing quite sharply during the 1980s (as did taxes on non-durables). Although movements in margins account for all the difference between the IPPI and CPI for non-durable goods, the larger gap between the two indices originally means there was more scope for there to have been inconsistencies in measurement between those two price indices.

Overall, the index movements are close enough that the results obtained from the treatment of quality change in the IPPI are probably similar to those obtained from the possibly different treatment in the CPI. It is useful, therefore, to consider the observations about quality changes that have been made on the CPI, as CPIs generally have come under more scrutiny.

Quality change in the CPI

Consumer price indices have been accused of overstating price change by failing to reflect adequately improvements to products when they change and by failing to account for new products properly, if at all.

Treatment of regular quality change

When a version of a product is replaced by another in the Canadian CPI, there are three ways of handling the change. One is to drop the observation from the sample, run the estimation on the rest of the sample for a while, and introduce the replacement later. This is not done often in the CPI, although it is more common in the IPPI. The second is to "splice" the replacement item into the sample, using the ratio of quoted prices to represent the ratio of quantities (or qualities), so that the index does not change on account of the replacement. This method is widely used; in the CPI it is used almost exclusively for non-durables, as well as extensively for durables and semi-durables (Lowe, 1995). The third is to make an explicit quality adjustment (which may still be the same as the reported price change) based on the price collector's judgement, a comparison of production costs or on some other grounds. It is possible, therefore, by any of these methods, to either over- or under-estimate price change due to quality changes, once it is recognised that a quality change has occurred.

Crawford (1993) has assessed the likely upward bias in the Canadian CPI due to inaccuracies in evaluating quality change to have an upper limit of about 0.2 per cent per year. It is also possible that the bias may be negative on occasion. This is because it is likely that quality improvement on some commodities is over-estimated. While this estimate applies to the total consumer expenditure, most of the scope for this kind of error lies in the areas of consumer durables and semi-durables, which make up only about 25 per cent of total spending, so the range of potential error in these areas should probably be multiplied by four.

It is extremely difficult to decide whether quality adjustment produces bias. Quality change is not a phenomenon which is ignored. Making explicit adjustments may lead to error, but it does recognise change; splicing or changing the sample, while mechanical, are actions that acknowledge change. One possible way of assessing the accumulated effect is to look at long-term results. Schultz (1995) has shown, for some clothing commodities, that comparisons between the movement of average prices of items in the sample over the last 22 years and the movement of the price index for those items imply changes in average unit quality that appear unlikely – the implication being that the indices overstate quality improvement, or understate price change.

This is in an area where explicit price adjustments are widespread. It should be noted that the apparent increases in unit quality are greatest – about 50 per cent – for more stylish items – there are virtually none for underwear, for which reported quality changes are less common – and they were greater in the 1970s, especially, and in the 1980s, than in the last few years. This could mean that quality change evaluation has improved lately. It could also mean that it is easier to disguise price increases for clothing as quality improvements when inflation is higher.

Table 3. Implicit unit quality percentage change for some clothing items

	1981/73	1990/81	1994/90	1994/73
Women's blouse	65.0	-6.6	-8.8	40.5
Women's bra	4.8	-5.8	3.6	2.3
Men's suit	41.5	-0.8	6.2	49.1
Men's dress shirt	21.8	20.9	2.6	51.1
Men's work pants	14.5	8.1	2.4	26.8
Men's underwear	10.1	-8.4	2.0	2.9
CPI clothing price change	77.6	39.3	12.4	178.1

This comparison can be undertaken for clothing as items are priced by the unit and it is reasonable to suppose that the quality of an individual unit has not changed that much over the years. It is more difficult to test other items. Also, this comparison was between the average price movement of those items in the sample, and the price index. The difference between the two measures could have arisen because of a shift over time to sampling higher quality items in the range available as well as a result of the explicit quality evaluations. We do not know how the average price of all products sold changed over the period, only the sample.

Whether the extent of errors is related to the rate of price change is difficult to say. The methodology, while under a continual attempt to improve, has not changed essentially in at least 25 years. However, if different methods lead to different kinds of errors, the mix of methods may have changed in different periods, so the effects of these errors may have been different with different rates of inflation.

Other work being carried out in Statistics Canada has analysed the effects of explicit quality adjustments in recent years by comparing the results with indices in which all quality changes are

treated as sample changes rather than using individual judgements. This has been done for 35 commodities in clothing, appliances and recreation equipment where there have been a relatively high proportion of explicit adjustments. There is a consistent relationship between the rate of price change and the difference between the two indices. If prices are rising, then the indices in which all changes are treated as sample changes consistently run lower than when explicit adjustments are made. When prices are falling, the reverse is true. Also, the greater the rate of price change, the greater the difference tends to be. Twenty-five of the 35 commodities show this.

Table 4. Index changes and differences from matched samples

	1989 to 1993		1989 to 1994	
	Price change	Difference	Price change	Difference
Household appliances and furnishings	-1.8	-0.9	-1.4	-1.5
Clothing	12.9	5.0	16.5	3.9
Recreational equipment	-1.8	-0.4	0.3	-1.4

The difference is positive when the regular index is higher than the alternative. Prices generally fell for appliances and recreational equipment during the period. The year 1994 was the "worst" behaved of the whole six-year period.

We obtain these results because, when there is a replacement of one item by another, a higher price for the replacement item tends to be associated with an assessed quality increase, usually less than the price increase. A decline in the replacement price tends to be associated, though less strongly, with quality decreases. Thus, increases, even allowing for quality increases, tend to raise the index, and decreases to lower it. Because of the asymmetry in the strength of the connection, there seems to be no effect at about a 2 per cent rate of overall price change. This suggests, however, that splicing, which postulates no change in the price index, dampens any index movement, and the effect is the greater, as the rate of price change is greater. This implies that the greatest understatement of price change occurs when the rate of price increase is greatest; which is consistent with Schultz's results. It also suggests that, if results from the recent low-inflation period can be imputed to the much higher rates in the 1970s and early 1980, the greater source of downward error in clothing may have been splices and sample substitutions, rather than explicit adjustments.

Treatment of new goods

The argument concerning the treatment of new goods rests on three legs. First, that new goods, once they are introduced, tend to drop in price, at the same time as they are securing a larger share of the market. Index makers do not include new goods in time to reflect that price behaviour. Second, that the increased level of utility that a truly new good brings to consumers is not measured at all. Third, the proliferation of choice that new varieties of existing goods create produces a benefit to society that is not measured. In assessing these arguments for the Canadian CPI, Crawford only really deals with the first. He estimates a very small loss, 0.1 per cent at most, due to not including new goods earlier, because, naturally, when they have only a small share of the market, they have only a small impact on the overall measure of price change. To the second point, that the benefit of a truly new good is not recognised, there is no defence. On the third point, the institutionalisation of development and marketing of new products for, *e.g.* cars, clothes and cereals, suggests that the *change* in missing consumer utility may not be so great.

Quality changes in the IPPI

Treatment of regular quality change

The distribution of quality changes in the IPPI is different from that of the CPI. One kind of change, the disappearance of a product, is handled by running a reduced sample until the end of the year, and then adjusting the sample, either by bringing in one new observation to fill the gap left by the lost one, or by drawing a whole new sample. Changes in the sample are more common than in the CPI, and such changes are almost equivalent to splicing. Individual quality change adjustments run at the rate of about one-third of the rate in the CPI. However, when there are quality changes applied to individual items, explicit quality adjustments are more common than splices. A count of quality changes over the last eight years shows that, overall, 59 per cent of quality adjustments are explicitly not splices, although when automobiles and trucks are excluded (which account for almost 20 per cent of all changes), the figure drops to 50 per cent. Nevertheless, while splicing is almost always used in the CPI for foods, 40 per cent of adjustments for food at the producer level are not splices, and among other finished consumer goods, excluding cars and trucks, the figure is 53 per cent. This group has the highest incidence of quality changes.

The recommended method of making an assessment of the value of a quality change is to obtain from the manufacturer a comparison of the costs of producing the old and new varieties using the same technology. This works well when the change is relatively minor between an old and a replacement version of the same product, where the difference in costs is closely related to the cost of the materials used. It works quite well when the change is the addition of some feature which was not available earlier. It does not work at all well when the change is major – in such cases the new item is usually spliced into the index.

The system of quality change evaluation is best developed for automobiles for which there is still usually a change to the product each year. We obtain from the manufacturers a description of changes to the various models and estimates of the costs to them of the new features compared to the old. We do not necessarily accept all the valuations supplied to us. Sometimes this is because we have alternative valuations – if the change is making standard what was previously an option we look at how popular the option was at its old price and accept a fraction of the new reported value. Cosmetic, or wholly styling changes are not accepted; this seems to be on moral grounds, but even if there is a cost incurred in making the change, it is likely there was a similar cost in getting to the previous style as well. In contrast, the cost of legislated items is accepted, although some argue that such items are a tax rather than a chosen expenditure. The one occasion when this system broke down entirely was when models were downsized in the late 1970s. New versions were so much smaller, and used so much less material than the versions they were replacing, that is was judged impossible to make a comparison between the two, and the new models were spliced to the old.

If the costs were being reported correctly, and all development as well as production costs correctly assigned, under the same technological environment, all reported costs should have been accepted for use in producer-based indices. But in the case of the downsizing, with a different set of platforms being introduced, the technology was not constant, and the present method used is a practical compromise between the impossibility of obtaining truly accurate figures and the requirements of those trying to measure changes in utility.

Since, on other items, recourse to splicing is more common and sample changes are often used, it raises the question more generally as to whether splicing dampens price movements in the IPPI and whether that dampening moves the indices closer to an unbiased measure, or further away. In recent

years it has become more difficult to get cost estimates from respondents, and it is likely that there is more splicing now than 15 years ago.

New goods in the IPPI

The handling of new goods in the IPPI is similar to the CPI. The classification system does not allow for a truly new good. Since the existing classification covers all commodities, a new good has to be introduced into an existing elemental index when the sample for that index is being redesigned. New goods are introduced into the index with a lag, and even then their movement may be imputed from the movement of other items in the same index. The impact on the indices of the lag is believed to be small. Nakamura *et al.* (1994) calculated what the effect on the IPPI would have been if the proper indices for computing equipment had been introduced in 1971. Even though the share of computing equipment was 7.5 per cent of the Office and Store Machinery and Equipment index in 1971, the average annual difference from 1971 to 1981 would only have been 0.3 per cent, 1.6 per cent compared to 1.9 per cent. At higher levels of aggregation the differences became negligible. From 1971 to 1981, the accumulated difference for all machinery industries was only 0.6 points, on an increase of over 130 per cent. This was a product which had an extremely fast rate of price decline. But Nakamura *et al.* warn that the delay in getting good price observations after the good has been formally included in the index system may be more serious as its weight is more significant.

The question of whether there is an increase in consumer utility due to increased choice among consumer goods translates, in the producer context, into whether there is increased economic activity to provide this increased choice. If economic activity is required to introduce new varieties of goods, its value must be reflected in the price of the new goods themselves, or in the price of the regular goods. If there is a change in the activity put to development and marketing of new varieties, even if the good doesn't change physically, this extra activity should be reflected in a producer price index. There does not, however, appear to be extra economic activity in this area. Although the category cannot be said to capture this activity precisely, the percentage that the component in the input-output tables for Travel, Advertising and Promotion accounts for has barely changed from 1961 – holding at just under 2 per cent of total output.

Intermediate goods

For calculations of productivity for the total economy, at least in a closed economy, mis-measurement of quality changes for intermediate goods is not so serious. It affects the allocation of productivity change among industries, but nets out at the total aggregate level. However, in an open economy such as Canada, which trades in many intermediate goods, the question is more pertinent. Also there may be some improvements associated with intermediate goods which do not net out in the aggregate.

Most of what applies to consumer goods applies equally to intermediate goods. Quality changes are handled in exactly the same way. Intermediate goods experience quality change less frequently than do finished goods; there are a large number of important intermediate commodities for which the same product specification can be held unchanged for decades. The incidence of quality change for first-stage intermediate goods (principally pulp, primary metals and industrial chemicals) is only about half the average rate for all manufactured goods, but 63 per cent of those cases lead to explicit adjustments. For second-stage intermediate goods (those commodities that are sold to other manufacturers for processing into finished goods), the incidence of changes and the pattern of their treatment, about 50 per cent splices, are close to the overall averages. However, the lack of apparent changes can lead to problems.

When a product shows no physical change we make no quality adjustment for it. If the means of production have been made more efficient, that is a productivity gain; in fact it is probably one of the most important sources of measured productivity change. But what of economic activities not directed to changing the product?

In 1980 a steelmaker sent us a list of improvements to steel that he felt were not reflected as improvements in our index calculations. These included improved production techniques so that there was less waste to the user when he bought a coil of wire, better quality control on plating, installation of pollution-abatement equipment in their plants, increased environmental assessments that went on before building new plant or extensions, and greater social benefits paid to employees.

As an example of improved production techniques, consider the reduction in waste for the user of wire. Suppose the waste had gone from 5 per cent to zero. If this is not treated as a quality improvement, the user will buy 5 per cent less input and show a productivity improvement. If it is shown as a quality improvement, the steel industry will be measured to be producing 5 per cent more, but the user will be using the same amount, so will show no productivity change. There is a productivity improvement in the user's output either way. Only if we are trying to allocate the productivity improvement between the different industries by deflating inputs and outputs does the correct measurement matter – or if steel is being exported. In the specification of commodities, enough detail is given to identify the same commodity so that it can be priced in future time periods. If a characteristic of the commodity changes, it should be adjusted for, but so long as the same item can be identified, the changing characteristic is likely not to be noticed.

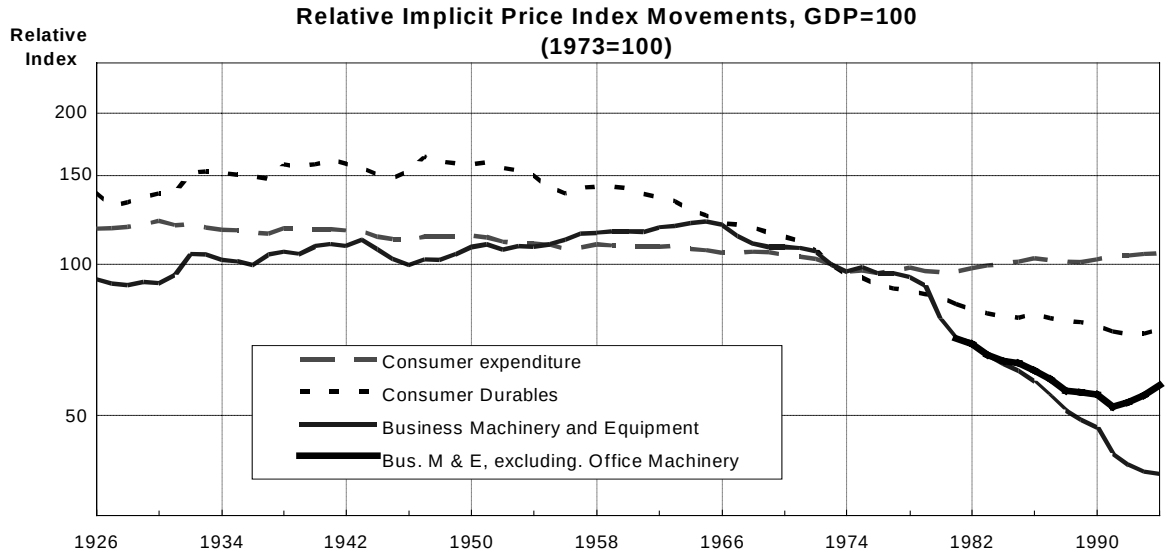
However, consider pollution-abatement equipment. The steel company reported average expenditures each year during the 1970s of about 7 per cent of value added, about 2.5 per cent of the price of sales. (During the 1970s the price of steel rose by more than 130 per cent.) Since the expenditures continued at the same rate for several years, this may be taken as a rough estimate of the annual use of capital during that period. No-one paid a market price for the improved air quality separately, but those expenditures must have found their way into the price of steel. If they had been asked for cost comparisons of producing the same steel product before and after the installation of the equipment they would have reported some differences, arguably under the same technology, if the pollution-abatement equipment did not affect production processes. All we can say is that we have consistently ignored such economic activity, except for cars where the owner carries around the equipment in the car and pays for it.

The problem is that there is no separate market for the output of some activities. One may wonder how much of the increase in business services also fits into this category. If this economic activity has provided value to the final user, it has not been reflected in adjustments to market prices. According to the input-output tables, the share of business services in total output has gone from about 1.3 per cent in 1961 to 3.3 per cent in the early 1990s. Most of this increase, about 1.5 per cent, occurred between 1971 and 1981. If all of this was unrecognised improvement it could amount to 0.15 per cent a year.

Capital goods

There are conflicting implications in this area because an over-estimate of price change reduces the output measure, but also reduces the measure of additions to capital. Thus, the result will tend to raise the total factor productivity measure, since input is reduced comparatively more. A further complication in Canada is that a high proportion of machinery and equipment is imported. The Machinery and Equipment Price Index (MEPI) covers domestic production from the IPPI survey, but

imports are covered using other measures – mainly US producer price indices, adjusted for exchange rate and custom rate movements. This area is the one in which we have most changed our ways of measurement over the years. Witness the implicit price deflators since 1926: the graph below shows the implicit price indices for various component from the income and expenditure accounts expressed as a percentage of the total GDP deflator. So, a fall in the line over time means that prices for that component are rising slower than GDP as a whole. (1973 was chosen as the base year for comparison.)



There are two obvious patterns: *i)* a tremendous relative drop of machinery and equipment prices in recent years, due largely to computers (since 1981, however, when we can show some components of Machinery and Equipment separately, the implicit index excluding office machinery has also fallen relatively quickly); and *ii)* although consumer durables prices fell relatively from 1946 to 1973, machinery and equipment prices did not fall until the mid-1960s; in fact, until that time, they rose relative to everything else.

It seems surprising that the improvements in consumer durables could not be shared by machinery and equipment but, before 1955, the only deflators for machinery and equipment were in the raw material price index, and they were a pretty basic set of products. Even from 1955 to 1970, the set of price indices was rather limited. It seems likely that the rate of capital accumulation before 1955 and the growth of output were greater than has been measured.

For most commodities indices are calculated as standard IPPIs. The incidence of quality change for capital goods was similar to that for first-stage intermediate goods, much lower than for other intermediate goods, or other finished goods, other than food. This seems surprising as there might be expected to be more changes in specifications in this area. There is also a higher percentage of splices when dealing with quality changes; only 47 per cent of adjustments were non-splices. It would be dangerous to draw conclusions without more study of the changes. This is going on, but if the patterns obtained from the consumer goods analysis turn out to apply here, then this area may be particularly subject to the biases inherent in too much splicing.

However, generally, in recent years, prices of domestic machinery and equipment, even for the same kinds of goods, have risen faster than the prices of imports from the United States. This must temper any suspicion that splicing has under-estimated price change in recent years. It is nevertheless worrying that the machinery which has shown the largest price increase, cars and trucks, is the area where we capture the most quality changes.

There are three areas where indices are calculated using different data or different methodology: *i)* telecommunications equipment; *ii)* heavy engineering; and *iii)* computers.

Telecommunications equipment

Price changes are obtained from the major purchasers of this equipment. The commodity selection is up-to-date and comprehensive. However, the pricing depends on matching similar purchases, so the replacement of one kind of equipment by another is always presumed to be at constant prices. In recent years the price index rose 3 per cent between 1986 and 1990, then has fallen, by 1994, to 10 per cent below 1986 levels. While all components have shown the same pattern of weaker prices since 1990, the indices for central office equipment and general equipment have shown the greatest decline. Since these are areas where rapid technical change is believed to occur it leaves open the question that without matched samples the indices might have fallen faster still.

Heavy engineering

The problem here is that every order is unique, so the pricing is done by identifying a representative contract with each manufacturer and obtaining an estimate of how much it would take to win the order in subsequent periods. This only covered a small area, related to electricity generation. The disadvantage of this kind of pricing is that the quotations are hypothetical; the advantage, compared to pricing inputs, is that so long as the order remains representative it will reflect productivity changes. Since 1986, prices have risen faster than for other specialised machinery, about 32 per cent by 1993, compared to about 23 per cent for the remainder. This could be because the quotations provided were really based on inputs rather than outputs, but more likely it reflects the fact that such work cannot reap the benefits of lengthy production runs. Similar work occurring in heavy engineering in ships and other transportation equipment is one of the areas that is not properly priced in the IPPI but relies on proxies. However, from 1971 to 1986, the price increase for this group of unique goods, about 260 per cent, was almost exactly the same as for all specialised machinery and equipment. It may be that the overwhelming price changes of all inputs obscured any differences between productivity changes, but this is impossible to substantiate.

Computers

Until 1984 the Canadian indices did not include computer equipment in its index of office and store machinery, although by that time it was clearly a substantial proportion of sales. After 1984 prices were collected for computers and peripheral equipment, using the conventional IPPI approach for adjusting for model changes. In 1986 the index for imports which had been based on various US producer price indices was changed to use the new indices from the US Bureau of Economic Analysis based on hedonic methods. The historic figures were reworked. Thus an index which had doubled between 1971 and 1985 was replaced by one which had fallen below 20 (1971=100). The new indices were also used to deflate Canadian production. Since 1992, effective with 1990 data, indices for Canadian production of microcomputers and printers have been based on prices from Canadian distributors, with model changes evaluated using hedonic methods. Using distributor data is not

totally appropriate for deflating production, and samples are being developed to replace this database with manufacturers' data.

This is the only area in price index making in Canada where hedonic methods are being used. Its main justification is that the other measurements were obviously worse. It was impossible to compare production costs with the technology changing so rapidly, and unjustifiable to splice models as no common stable market existed. However, hedonic methods are no better than any other in valuing a characteristic available in one period but not in a prior one.

Construction

In Canada the measurement of price change in non-residential building construction (and new apartment construction) is done differently from some other countries, and has been noted by others (Baily and Gordon; Pieper). The main features are that estimated prices are obtained from contractors for specific work put in place. The long-term advantage is that productivity changes that occur within individual trades (including general contracting) are reflected in the price; although, as the specifications for each building are held constant for many years, any productivity improvement in the design of the building itself is not captured. A disadvantage is that the prices are hypothetical, but even so they show far more sensitivity in the short term through trade cycles than do input indices. These indices have been produced since 1978, and as the input indices were continued for many years the differences between the two can be calculated. The graph shows the year-to-year movement since 1972 of the two indices, and the table shows average annual price changes over different periods.

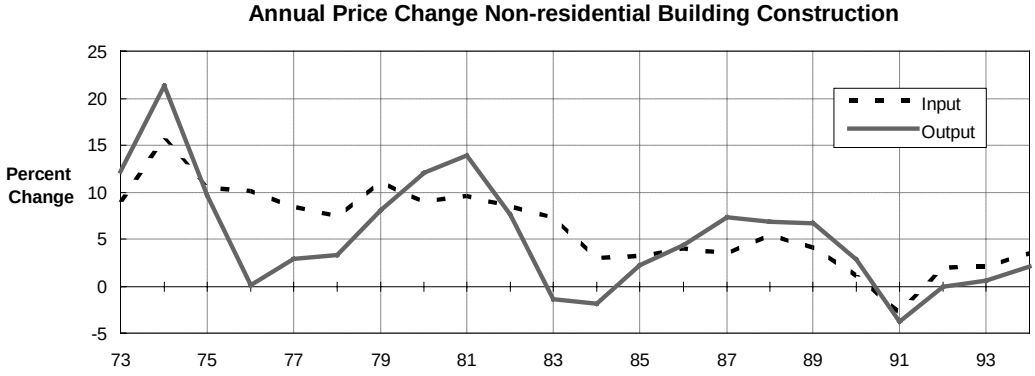


Table 5. Annual rates of price change for non-residential building construction indices, Canada

	Output index	Input index	Difference
1972 to 1994	5.2	6.1	0.9
1972 to 1980	8.6	10.2	1.6
1980 to 1987	4.5	5.6	1.1
1987 to 1994	2.1	2.2	0.1

Over the whole period 1972 to 1994 the difference is 0.9 per cent a year, though there are larger differences from year to year as the output index is far more sensitive to the trade cycle. Since 1990, as inflation has fallen, the gap between the input and output indices in the trough of the cycles has not been enough to overcome the gap that the output index had built up in the expansionary part of the cycle, unlike earlier cycles.

However, the introduction of the output price indices did not greatly affect the deflation of non-residential construction expenditures. Prior to the availability of this index, a constant estimate for productivity improvement was made to the input index in deflating this element of expenditure, which averaged about the same amount, so the introduction of this series only changed the estimate of constant price values through the trade cycle, smoothing them out somewhat.

Summary

We have considered a number of sources of error in dealing with, or not dealing with, quality change. They may be summarised in the table below:

Type of error or change in methodology	Items particularly affected	Time period particularly affected
Over-recognition of quality change.	Clothing, possibly other items where cosmetic factors apply.	The higher the price changes (1970s), the more likely the indices are to understate price increases.
Failure to recognise quality change where it occurs.	Commodities with long production runs.	--
Failure to recognise new goods.	Durables.	--
Failure to recognise increasing variation in existing goods.	Most commodities.	--
Failure to include environmental improvements and the value of business services.	Heavy industries and the users of business services.	Greatest growth in the 1970s, which would cause indices to be over-estimated.
Impact of splicing tending to dampen index movements – to under-estimate index increases for items where prices are rising, and to under-estimate decreases for those for which prices are falling.	Commodities with a higher incidence of quality change – finished goods other than consumer non-durables.	Most rapid price rises were in the 1970s; most price drops were in the 1990s.
Poor representation of commodities.	Machinery and equipment.	1947 to 1965 would have over-estimated price change; some effect continuing into the 1970s.
Use of output indices rather than inputs.	Non-residential building construction, some services.	None, except through trade cycles.
Introduction of regression techniques.	Computers, although could be applied to others.	Retroactively affected the 1980s; no reason to expect any impact otherwise.

Some of these factors oppose each other in their effect. In any case, it is difficult to estimate their impact, except that generally it seems to be small. Even if we make large alternative estimates in the rate of growth of computer spending it has surprisingly little impact at aggregate levels. And any other specific change is lost almost immediately. For the undervaluing of abatement equipment in steel prices we are looking at about 2.5 per cent on top of the price change. From 1970 to 1980 steel prices rose by about 130 per cent. The increase in the constant dollar share of business services from 1971 to 1981 was from 1.6 per cent of total inputs to 3.1 per cent. This is, indeed, the period of maximum growth in this group of industries, but it amounts to only about 0.15 per cent a year, even if all the activity went to unrecognised economic activities. The impacts of errors in splicing, or in over-correcting for changes, or failing to recognise changes, while possibly substantial for individual commodities, do not seem likely to add up to much in the total. Even if they do, the consistency that underlies most methodology over the last 30 years does not suggest that much explanation of changes in the rate of output growth will be found from these sources. This is, of course, a conclusion which has been reached before.

NOTE

1. I would like to thank Dirk Pilat and Paul Schreyer for helpful suggestions and comments, but of course they bear no responsibility for the contents of this chapter.

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