Chapter 5

THE REDESIGN OF THE CANADIAN FARM PRODUCT PRICE INDEX

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1. Background

The Farm Product Price Index (FPPI) is a monthly series that measures the changes in prices that farmers receive for the agriculture commodities they produce and sell. The price index has separate crop and livestock indexes, a variety of commodity-group indexes such as cereals, oilseeds, specialty crops, cattle and hogs, and an overall index -- all available monthly and annually for the provinces and for Canada. The index expresses current farm prices from Statistics Canada's Farm Product Prices Survey as a percentage of prices prevailing in the base period (currently1997=100). Its primary purpose is to serve as a measure of Canadian agricultural commodity price movement and as a means to deflate agricultural commodity prices.

Prices are based on either administrative data sources, or monthly surveys of agricultural producers or commodity purchasers. Commodities are priced at point of first transaction. The fees deducted before a producer is paid are excluded (e.g., storage, transportation and administrative costs), but bonuses and premiums that can be attributed to specific commodities are included. Commodity-specific program payments are not included in the price.

The FPPI is based on a five-year basket that is updated every year. This captures the continual shift in agricultural commodities produced and sold. The annual weight base is derived from the farm cash receipts series. There is a two-year lag in the years used to construct the basket because of the availability of farm cash receipts data and to reduce the revisions made to the index. Therefore, the years used to construct the basket for year y are y-6 to y-2.

The seasonal weighting pattern was derived using the monthly marketings from 1994 to 1998. This weighting pattern remains constant and will only be updated periodically such as during intercensal revisions or when the time base is revised. The methodology of the index and the price series which construct the index have been designed to control errors and to reduce the potential effects of these. However, both administrative and survey data are subject to various

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kinds of error. Survey data are mainly subject to response and data capture errors. In reporting prices each month, farm survey respondents are asked to report the average prices prevailing in their neighborhood, taking into account the various grades of each commodity marketed. Thus, average prices reported by these respondents may differ from month to month due to changes in price, quality or both. The agencies providing administrative data are considered to be the best sources available, and data received from them are judged to be of very good quality.

The FPPI is not adjusted for seasonality, but seasonal baskets are used since the marketing of virtually all farm products is seasonal. The index reflects the mix of agriculture commodities sold in each given month. The FPPI allows the comparison, in percentage terms, of prices in any given time period to prices in the base period.

2. The Main Elements of the FPPI Redesign

The Farm Product Price Index (FPPI) was discontinued with the March 1995 estimates when it was still on a 1986 time base. It was then revived in April 2001 due to the continuing demand for an index of prices received by farmers. The time base of the index was changed from 1986 to 1997, since the System of National Accounts (SNA) switched to estimates at 1997 prices. In its initial updating the FPPI was calculated up to March 2001, including all of the months from April 1995 forward for which no official estimates have been published. The indexes were also revised back to 1992, incorporating substantial changes in the way they are put together. There was no change in methodology for the indexes before 1992. Though the index levels of the 1997=100 series will be different from those of the 1986=100 series, the percent changes for the period ending in December 1991 will remain unchanged.

The methodology changes made with the revival of the FPPI are the most substantial in its history. There are five main changes:

(1) The new index is an annually reweighted chain price index, so the annual weighting pattern is updated every year. The weighting pattern for an index is also called its basket. The old index was a fixed-basket price index for the most recent period, and its basket was updated only after ten or more years had elapsed.

(2) The new index follows a seasonal-basket concept, where the volume shares of the various commodities are different in each of the twelve months of the calendar year. The old index followed a fixed-basket concept, where those shares were the same for all months of the year. Now there are 12 different baskets used in calculating the months of a calendar year in the FPPI, where before there was only one.

(3) In the new index, consistent with its seasonal basket concept, the annual index number for a given year is a weighted average of the corresponding monthly index numbers. In the old index, consistent with its fixed-basket concept, the annual index number was the mean or simple average of the corresponding monthly index numbers.

(4) In the new index, goods for which there are receipts but no marketings have their price movement proxied by a group index (e.g. maple products take their price movement from total crops). In the old index, such goods were simply omitted and had no impact on the overall index.

(5) In the new index, each annual basket will be based on marketings for an average of five years; the last annual basket for the old index was based on marketings for an average of four years from 1981 to 1984.

Probably no index redesign in the history of Statistics Canada has marked such a substantial and salutary break with the past. It is the first Statistics Canada index to be calculated with monthly baskets since 1973, when the consumer price index abandoned the monthly-basket approach it previously used for seasonal food groups. It is the first Statistics Canada index ever to implement the Rothwell formula for seasonal commodities, the monthly-basket formula most commonly used by official statistical agencies. It is the first Statistics Canada index for a goods-producing industry with annual chain linking, and the first index in North America, perhaps in the world, to combine annual chaining with a monthly-basket-formula for all aggregate and sub-aggregate indexes (the U.S. counterpart of the FPPI changes baskets every year, but is not a chain price index; there is no linking involved). It is the first annually chained index calculated by Statistics Canada that allows one to calculate a measure of pure price change for all consecutive months or quarters or years. For example, the monthly new housing price index does not allow this for all months or for any years. Finally, while the old FPPI was only linked back to 1981 on a monthly basis, the new index is linked back to 1935, making it by far the longest continuous series in Statistics Canada's industrial price index program; by contrast, the industry product price indexes only stretch back to 1956.

3. The Rothwell Formula

The seasonal basket formula used in the revised FPPI is a variant of what is usually called the Rothwell formula, after Doris Rothwell (1958), an economist with the U.S. Bureau of Labor Statistics, who proposed it for the U.S. consumer price index (CPI). However the formula was originally proposed decades previously by two economists with the U.S. Bureau of Agricultural Economics, Louis H. Bean and O.C. Stine (1924) as an index number for farm prices. Thus the formula adopted was originally designed an indicator of farm price movements.

The Rothwell formula must be used to calculate indexes of fresh fruits and vegetables in the harmonized indexes of farm product prices of the European Community.[2] Dick Carter, who now works for Statistics Canada, and E. T. Richards (1975) introduced it as the formula for the United Kingdom's agricultural price indexes in 1972. It is also used to calculate series for seasonal commodity groups in the CPIs of other countries, including Japan, France and the United Kingdom.

Restrictively defined, the Rothwell formula is the monthly-basket counterpart to the Laspeyres formula, and with a 1997 base year, is defined as:

$$(3.1) \quad P^{R(I)}_{y,m/97} = \frac{\sum p^j_{y,m} q^j_{97,m}}{\sum p^j_{97} q^j_{97,m}},$$

[2] See Eurostat (1985), chapter II, section G and Annex V.

where $P^{R}_{y,m/97}$ is the Rothwell index number for the m[th] month of year y, $p^{j}_{y,m}$ is the price of the j[th] commodity in the m[th] month of year y, $q^{j}_{97,m}$ is the quantity produced (or in the FPPI case, marketed) of the j[th] commodity in the m[th] month of base year 1997, and p^{j}_{97} is the average price of the j[th] commodity in base year 1997, defined as a unit value:

$$(3.2) \qquad p^{j}_{97} = \frac{\sum_{m=1}^{12} p^{j}_{97,m} q^{j}_{97,m}}{\sum_{m=1}^{12} q^{j}_{97,m}}.$$

The formula is shown with base year 1997 since this is the base year of the revised FPPI.

It can be seen that in the special case where $q^{j}_{97,m} = q^{j}_{97}/12; m = 1,2,...12$, the Rothwell index reduces to the corresponding Laspeyres index:

$$(3.3) \qquad P^{R(I)}_{y,m/97} = \frac{(1/12)\sum p^{j}_{y,m} q^{j}_{97}}{(1/12)\sum p^{j}_{97} q^{j}_{97}} = \frac{\sum p^{j}_{y,m} q^{j}_{97}}{\sum p^{j}_{97} q^{j}_{97}} = P^{L}_{y,m/97},$$

or in other words, the Laspeyres index is a special case of the Rothwell index.

More broadly defined, the Rothwell formula is the monthly-basket counterpart to the fixed-basket formula, and with a 1997 base year, is given by:

$$(3.4) \qquad P^{R(II)}_{y,m/97} = \frac{\sum p^{j}_{y,m} q^{j}_{c,m}}{\sum p^{j}_{97} q^{j}_{c,m}},$$

where $q^{j}_{c,m}$ is the quantity marketed of the j[th] commodity in the m[th] month of period c, which is some year or sequence of years not necessarily equal to or inclusive of base year 1997.

It can be seen that in the special case where $q^{j}_{c,m} = q^{j}_{c}/12; m = 1,2,...12$, the second variant of the Rothwell index reduces to the corresponding fixed-basket (FB) index:

$$(3.5) \qquad P^{R(II)}_{y,m/97} = \frac{(1/12)\sum p^{j}_{y,m} q^{j}_{c}}{(1/12)\sum p^{j}_{97} q^{j}_{c}} = \frac{\sum p^{j}_{y,m} q^{j}_{c}}{\sum p^{j}_{97} q^{j}_{c}} = P^{FB(I)}_{y,m/97},$$

i.e. a fixed-basket index with a basket from period c (also called a Lowe index),[3] but with 1997 base prices calculated as unit values.

Yet more broadly defined, the Rothwell formula would substitute different base prices:

[3] See T.P. Hill (2007) and Balk and Diewert (2007).

$$(3.6)\quad P^{R(III)}_{y,m/97} = \frac{\sum p^{j}_{y,m} q^{j}_{c,m}}{\sum \bar{p}^{j}_{97} q^{j}_{c,m}},$$

where $\bar{p}^{j}_{97}$, the 1997 base prices are calculated as:

$$(3.7)\quad \bar{p}^{j}_{97} = \frac{\sum_{m=1}^{12} p^{j}_{97,m} q^{j}_{c,m}}{\sum_{m=1}^{12} q^{j}_{c,m}}.$$

Note that this calculation requires an imputation for the commodity price in any month m where there are marketings in period c but not in base year 1997, and will ignore any monthly price in base year 1997 representing actual marketings if there were not also marketings of the same commodity in the same calendar month of the basket reference period, both of which are avoided using formula II. This is inevitable since any other seasonal weighting pattern will be less representative of base year 1997 than its own weighting pattern.

On the other hand, if one is going to use one seasonal weighting pattern for all other years, it is hard to justify using a different pattern for base year 1997, especially since this would lead to the absurdity that the annual index for 1997 in the second variant would be:

$$(3.8)\quad P^{R(II)}_{97/97} = \frac{\sum \bar{p}^{j}_{97} q^{j}_{c}}{\sum p^{j}_{97} q^{j}_{c}} \neq 1.$$

Of course no statistical agency would publish such an estimate; the 1997 value would be normalized to one, inducing a slight break between December 1997 and January 1998. It would be pointless to apply the rebasing factor used to normalize 1997 to all years of the series, since then the annual series for variant II would be identical with the annual series for variant III:

$$(3.9)\quad P^{R(II)}_{y/97} = (1/\frac{\sum \bar{p}^{j}_{97} q^{j}_{c}}{\sum p^{j}_{97} q^{j}_{c}}) \frac{\sum \bar{p}^{j}_{y} q^{j}_{c}}{\sum p^{j}_{97} q^{j}_{c}} = \frac{\sum p^{j}_{97} q^{j}_{c}}{\sum \bar{p}^{j}_{97} q^{j}_{c}} \times \frac{\sum \bar{p}^{j}_{y} q^{j}_{c}}{\sum p^{j}_{97} q^{j}_{c}} = \frac{\sum \bar{p}^{j}_{y} q^{j}_{c}}{\sum \bar{p}^{j}_{97} q^{j}_{c}},$$

although the monthly series would still differ somewhat:

$$(3.10)\quad P^{R(II)}_{y,m/97} = (1/\frac{\sum \bar{p}^{j}_{97} q^{j}_{c}}{\sum p^{j}_{97} q^{j}_{c}}) \times \frac{\sum p^{j}_{y,m} q^{j}_{c,m}}{\sum p^{j}_{97} q^{j}_{c,m}} = \frac{\sum p^{j}_{97} q^{j}_{c}}{\sum \bar{p}^{j}_{97} q^{j}_{c}} \times \frac{\sum p^{j}_{y,m} q^{j}_{c,m}}{\sum p^{j}_{97} q^{j}_{c,m}} \neq \frac{\sum \bar{p}^{j}_{y} q^{j}_{c}}{\sum \bar{p}^{j}_{97} q^{j}_{c}}.$$

As a practical matter, consumer price indexes not subject to revision must always use the most broadly defined Rothwell formula, as is also the case for industry price indexes if they do not allow revisions over many months (11 months, if not more). Perhaps this is why most of the literature does not really bother to distinguish between these different variants and they are all treated as representing the Rothwell formula. Szulc (1983, p.560) rightly complains about the lax terminology that would equate any fixed-basket index with a Laspeyres index, and the errors of reasoning into which this can lead one. However there do not seem to be the same dangers associated with calling variant III a Rothwell index rather than say, a monthly-basket Lowe index with basket-weighted base prices or with calling variant II a monthly-basket Lowe index with unit values as base prices, although the three different variants do have somewhat different characteristics.

In the FPPI, only variant III of the Rothwell formula is used, although with its extended revision period it would be possible to use variant II instead.

4. The Previous FPPI (1986=100)

The FPPI that was discontinued with the release of March 1996 data had the formula:

$$(4.1) \quad P^{FB}_{y,m/86} = \frac{\sum p^j_{y,m} q^j_{81-84}}{\sum p^j_{86} q^j_{81-84}}; y = 1981, 1982,$$

where $P^{FB}_{y,m/86}$ stands for the index for the mth month of year y with a 1986 base, and the FB superscript indicates that it is a fixed-basket index, and $p^j_{86} q^j_{81-84}$ is the hybrid expenditure representing expenditures for commodity j from 1981 to 1984 revalued at 1986 prices. To reduce the burden of notation, hereafter, unless required to remove ambiguity, summation over commodities will be assumed, and the commodity superscript will be omitted.

Note that, although a fixed-basket formula was used, the historical FPPI was not a Laspeyres price index. The Laspeyres equivalent of formula (1) would be:

$$(4.2) \quad P^{FB}_{y,m/86} = \frac{\sum p^j_{y,m} q^j_{86}}{\sum p^j_{86} q^j_{86}}; y = 1981, 1982, \ldots,$$

which has the obvious disadvantages, compared to (4.1), that the weighting pattern would almost certainly not be representative of some agricultural commodities that would have unusually low levels of output in 1986, and one would have to wait on 1986 receipts data before implementing (4.2); i.e., there would be smaller revisions using equation (4.1), since when the initial estimates for 1986 marketings became available the marketings for 1981-84 had already been revised several times.

5. The New FPPI (1997=100)

The new annual FPPI is defined as

$$(5.1) \quad P^{ch}_{y/97} = P^{ch}_{y-1/97} \times \frac{\sum p^j_y (\sum_{k=1}^{5} q^j_{y-1-k})}{\sum p^j_{y-1} (\sum_{k=1}^{5} q^j_{y-1-k})}.$$

The new index's basket is updated every year, whereas the old index's basket was updated every 10 years at most. A basket update no longer implies a change in the base year of the index, as it did in the old index, so it is no longer necessary to rebase the entire historical series every time a new basket is introduced. However, the observations for the new index do not have the nice properties of a fixed-basket index, as they did with the old index. For example, for the year 1999, one calculates an unlinked series with the year 1998 as base, and a basket based on marketings in 1993-97 for all of the months from January 1998 to December 1999. This is an update from the basket used to calculate 1998, when the basket was based on marketings in 1992-96. With each January updating a year is dropped and a year is added in calculating a new index basket.

The unlinked estimate for 1999 is then multiplied by the chain price index number for 1998 on a 1997 base to get the chain index number for 1999 on a 1997 base. The basket is updated but there is no change in the base year of the index, and there are no revisions to previous years of the series.

It is tempting to call the procedure for updating the basket a five-year moving average, but it is a little misleading to do so, since from one year to another the farm cash receipts are evaluated at different prices. The receipts for 1992-96 are evaluated at 1997 prices, those for 1993-97 at 1998 prices. Evaluating 1993-97 receipts at 1998 prices means that for each commodity receipts for 1993 are deflated by a price index for 1993, receipts for 1994 are deflated by a price index for 1994, and so forth, where all price indexes used as deflators are on a 1998 base. The unlinked series for 1999 is then a fixed-basket index with a 1998 base and a 1993-97 basket. It would only be correct to speak of a five-year moving average of marketings if all baskets were evaluated at the same prices, but this is not so for the calculation of the index.

In the new FPPI, baskets are updated in a far more timely way than they were in the old FPPI. The last time the old index was updated, it was to a 1981-84 basket, an updating that occurred in December 1986. The movement of the old index was revised backward to 1981 based on the new index basket, and the index was rebased to 1981. There was no linking involved to calculate the index from January 1981 forward, since it was essentially a direct fixed-basket index with a 1981-84 basket and a 1981 base period.

On the other hand, it was necessary to backward link the historical series, prior to 1981, so that it too was available on a 1981 base. Because of this linking process, the indexes for the period 1971-80 no longer had the nice properties of a fixed-basket index that they possessed on a 1971 base. For example, it was no longer necessarily true that an aggregate index would have a value somewhere between that of its smallest and largest component series. But the direct fixed-basket index, from 1981 forward, did have these properties.

Because it is a chain index, any time the new index has its time base changed (for example, from 1997 to 2002), it will be a simple arithmetic operation, not involving any change in basket. Also, because there is a two-year lag between the last year of the five-year basket and the year that the index is updated to incorporate it, there is never any need to revise the index because of basket updatings.

There are many advantages to the new basket update procedures. The most obvious advantage is operational. There is considerably less work involved in any given basket updating than there was previously, and because they occur every year, they are easier to accommodate in the production schedule. Any decision to move to a new base period can also be easily accommodated because only an arithmetic rebasing of the chain price indexes is required.

However, the more important advantage is conceptual. The FPPI is used as both a short term and a long term indicator of price changes. People interested in making price comparisons from year to year and in following the evolution of price movements over decades both make use of the FPPI. In order to make long term comparisons feasible it is necessary for the index basket to be updated from time to time. An index of farm product prices based on a 1935-39 basket would not be very useful for analyzing farm price movements in the 21st century. On the other hand, any change in basket inevitably creates a discontinuity in the monthly or annual movements of the series.

Infrequent basket changes reduce the number of discontinuities in the series, but make them more important when they occur. Moreover, infrequent basket changes create problems of their own. It may be necessary to proxy a price index for a commodity in a province where it is no longer produced. On the other hand it is not possible to introduce a new product until there is a new basket updating, which may not occur until long after a new commodity has obtained a substantial market share. With annual updating of baskets, new commodities can be added to a basket and old items deleted from it in any year.

Generally speaking, a chain price index should be constructed so that the basket used in its initial year is representative of that year, the basket used in its terminal year is representative of that year and the baskets lying between smoothly between the initial and terminal baskets, being approximately linear combinations of the two baskets. The chain price index formula used in the FPPI satisfies these criteria. A 1986-90 basket is reasonably representative of 1992 and a 1995-99 basket of 2001, while the use of a five-year basket reference period ensures that the interim baskets change smoothly from the initial to the terminal basket.

It would not be desirable to link in basket changes that were quickly reversed in later updatings. This would happen if, for example, one linked monthly, so that every twelfth update one would approximately circle back to the initial basket. It would also happen if there were only a single year determining the weighting pattern. The basket for a given year y that experienced normal weather conditions following a year in which there was a severe drought would have more in common with the baskets of earlier years than with the basket for the previous year.

Any index basket must have its expenditures expressed in terms of the constant prices of its base period in the case of a direct index, or of its link period, in the case of a chain index. The Industry Product Price Index (IPPI) basket is based on 1992 expenditures and they are not re-expressed in the prices of any other year. This is because from 1992 forward the IPPI is a direct Laspeyres index and its basket reference year and its base year are one and the same. There is no need to re-express its expenditure weights in terms of prices of another year.

The FPPI is not a direct Laspeyres index, but a chain index, and at the annual level, a chain fixed-basket index. The link year for the 1994-98 basket is 1999, so all expenditures before

1999 are re-expressed at 1999 prices. In general, any five-year basket whose initial year is y-5 has its expenditures re-expressed at prices of year y.

This ensures a measure of price change for consecutive years that involves only the prices of those years, and does not depend in any way on the prices of the five preceding years.

The FPPI practice is identical with that of the consumer price index. Its most recent basket reference year is 1996, but since the 1996 basket is only linked into the index at December 1998, 1996 expenditures are re-expressed at December 1998 prices.

A direct comparison of the baskets for two different years is an apples with oranges comparison if it is based on the weighting patterns used in the actual FPPI calculation. The 1992-96 basket is evaluated at 1997 prices, while the 1993-97 basket is evaluated at 1998 prices. If a comparison between the two weighting patterns shows a substantial increase in the basket share of a particular commodity for the more recent basket it is unclear if it due to a rise in that commodity's share of the volume of marketings from 1992-96 to 1993-97, or merely due to an increase in its price relative to other commodities from 1997 to 1998.

Any comparison of index baskets should be based on a common set of prices. In a comparison between the new index basket and the previous basket one would generally re-evaluate the basket used for the previous year at the same prices used to evaluate the current year basket. For example, for the 2002 update, a 1996-2000 basket is evaluated at 2001 prices. A comparison with the previous 1995-99 basket at 2000 prices is inappropriate; instead the previous basket should be evaluated at 2001 prices to match the current basket.

An acceptable alternative would be to evaluate both baskets at base year prices (that is, at 1997 prices), especially if three or more baskets were being compared. Just because farm prices are so volatile, there would be some merit in basing comparisons for several baskets on a multi-year base period, say 1996-99 prices rather than 1997 prices.

The FPPI contains many commodities that are unavailable in December (e.g. apricots, broccoli, cauliflower). It is not possible to link at December for these series without imputing a December price for them, and it would be better to avoid linking based on imputed prices.

One reason the CPI links at December is to ensure that the December-to-January movement is a measure of pure price change, that is, if all prices show the same rate of change from December to January, the total index will show the identical rate of change. A special case of this would be if all prices in January were the same as those in December; then the total index should show zero change. Linking at December ensures that December and January prices are both measured in terms of the new basket, whereas linking at the year would distort the comparison because of the shift from the old to the new basket. (Whether this objective is achieved, given the number of seasonally disappearing commodities in the CPI, is a moot point.)

However, in the FPPI the December to January comparison is distorted by the shift from one monthly basket to the next in any case, so this reason for linking at December does not exist. The question then becomes whether it is more important to link at December and preserve the December-to-December movement as a measure of pure price change or to link at the year, and preserve the year-to-year movement as a measure of pure price change. As was just mentioned many agricultural commodities have no marketings in December, so the year-to-year measure is much more representative of agricultural production in general than the December-to-December movement. The obvious choice for the FPPI is to link at the year.

It is not necessary to have monthly data for the earlier year to correctly calculate the chain index. This is done for analytical purposes. In a monthly-basket index the 12-month ratios of the index numbers (e.g. January over January, February over February, etc.) should be measures of pure price change, that is, if there is no change in any of the prices from one month to the next, the index change should be nil. While there is a change in the index basket from one month to the next, there is no change in the index basket between the same calendar months of consecutive years. Unfortunately, this is not the case in the FPPI because it is an annually-chained index, so the basket does change between the same calendar months of consecutive years. We calculate the chain links as 24-month spans so that we can decompose the 12-month change in the index between a pure price change component (i.e. what the change would be if the index kept its original basket) and a component for the interaction between price change and basket change. It means that every year is essentially calculated twice: The year 1999 will be calculated initially based on a 1994-98 basket, and these estimates will become part of the FPPI. It will be calculated again based on a 1995-99 basket, and these estimates will only be used to analyze price movements between 1999 and 2000.

There would be some merit in calculating each unlinked span for an extra year, so that if the basket went from year y-5 to y-1 it would be calculated over the years from y-1 to y, even though it would only be used as the basket for year y. This would mean that each year-over-year change would be comparable with a previous year-over-year change based on the same basket. Also, the pure price change component of each 12-month change would be comparable to a 12-month change for the previous year based on the identical basket.

This was not implemented because it is already a fair amount of extra work to calculate all unlinked series over a 24-month span, and it would have no influence on the quality of the index itself, only the quality of the analysis. Nevertheless, this is something that might be implemented in the future.

Prior to the revision of the FPPI, Statistics Canada calculated other industry price indexes that were chained annually. The New Housing Price Index (NHPI), for example, has its basket updated every year to reflect building completions for the last three years at base year constant prices, and these are used to weight component price indexes with the same base year for the thirteen months from December to December only, linking being at December rather than at the year. Since linking is at December, the December-to-December movement is a measure of pure price change, but the same is not true for any calendar month. There is no way to know how much of the 12-month change in the NHPI is due to pure price change because of the short span of the calculation. Consequently, analysts are forced either to ignore the 12-month changes in the index, or to treat them as if they were measures of pure price change, even though this is not so.

Likewise, the year-to-year movement of the NHPI does not represent a measure of pure price change, unlike the year-to-year movement of the FPPI. There is no way of knowing how the change from one basket to another distorts this year-to-year movement, as one would know if each consecutive unlinked NHPI series were calculated over a 24-month span, like the FPPI.

At the annual level, the FPPI is a chain fixed-basket price index, but not a chain Laspeyres price index. If it were a true chain Laspeyres index the choice of base period would impact on the series movement, since a single-year base period would imply a single-year basket.

6. The New Monthly FPPI (1997=100)

The new monthly FPPI is defined as

$$(6.1)\qquad P^{ch}_{y,m/97} = P^{ch}_{y-1/97} \times \frac{\sum p^{j}_{y,m}(\sum_{k=1}^{5} \hat{q}^{j}_{y-1-k,m})}{\sum p^{j}_{y-1}(\sum_{k=1}^{5} q^{j}_{y-1-k})}.$$

For each product, for each province, the average of marketings for the five years of 1994-98 are calculated for each month of the year. Then the 12 monthly shares for the province-product pair are calculated. To obtain the monthly revenue weight for a given province-pair, the annual revenue weight for a particular year is multiplied by the relevant monthly share. The sum of these monthly weights equals the annual weight.

Algebraically:

$$(6.2)\qquad (\sum_{k=1}^{5} \hat{q}^{j}_{y-1-k,m}) = w^{j}_{m} \times (\sum_{k=1}^{5} q^{j}_{y-1-k}),$$

where

$$(6.3)\qquad w^{j}_{m} = \sum_{y=1994}^{1998} q^{j}_{y,m} / \sum_{y=1994}^{1998} q^{j}_{y}.$$

The annual price of a commodity is defined as

$$(6.4)\qquad p^{j}_{y} = \frac{\sum p^{j}_{y,m}(\sum_{k=1}^{5} \hat{q}^{j}_{y-1-k,m})}{(\sum_{k=1}^{5} \hat{q}^{j}_{y-1-k,m})}.$$

Note that this is not a unit price (i.e. the revenues for a given year divided by same year marketings), like the annual prices to be found in a Balk index (discussed below).

One of the major strengths of the new approach is its handling of seasonally disappearing commodities. Using the old annual-basket approach, commodities, for example, sweet corn and strawberries had the same basket share in every month of the year. One had to impute prices for such commodities in months when there were no marketings. Using a monthly-basket approach, if there were no marketings for a commodity in a given month in 1994-98, then it would simply fall out of the index basket. There would be no need to impute a fictive price for it.

When prices are first established for seasonal fresh fruits and vegetables, they are based on farm income forecast work carried out by Agriculture and Agri-Food Canada (AAFC), the provinces and Statistics Canada. At the end of the season a survey is conducted to obtain the amount of the commodity harvested and the dollar value received for the crop. Based on these data, an average price for the season is established. Farmers sell their product at whatever the market offers, however, it would be prohibitively costly to collect monthly prices for the wide range of commodities to which prices must be assigned. One price for the season is established and farm cash receipts data are calculated from that price using an established marketing pattern for each of the commodities.

If there were no marketings for a seasonal commodity in a given month in 1994-98 but there were some thereafter, there would be a shift in the overall seasonal pattern of production of an agricultural commodity that is substantial enough to make the season last an additional month, though this does not happen very often. But if this did happen, the monthly weighting patterns for fresh vegetables would be updated when we move to a 2001 base, to adjust to the new seasonal profile of marketings.

Until then, we would simply ignore any prices for fresh corn in November and they would have no impact on our index. In the existing weighting pattern, even the month of October has only a 5% share of marketings of fresh corn for the province of Ontario, and November has nothing. So any marketings of corn in November would likely account for much less than 5% of the corn total. Assuming a marketings share of 0%, as is done now, is much closer to reality than assuming a share of 8⅓% (one twelfth), as under the old fixed-basket approach.

If there were marketings for fresh corn in November 2001 but not for any other year in the decade, such marketings might be reflected in an updated seasonal weighting pattern if the year 2001 were part of it. Obviously if one only has November marketings of fresh corn about once every 10 years, there would be little cause to extend the in-season months for fresh corn to include November and one would probably be well advised to edit out such expenditures from the seasonal weighting pattern.

What about the opposite problem? Suppose that, due to an early frost, there are no marketings of corn in October? This kind of scenario is more likely to occur than the one we just discussed. In this case, there would be no market price for corn but it would still have a basket share in the October index, so an imputed price would have to be assigned to it.

In such situations, the imputed price would be the weighted average price for the months through September. Though one could argue for other solutions, such an imputation is simple, does not depend on price information external to the stratum or the commodity in question, and gives the same annual price one would obtain by simply ignoring October in calculating the annual price. Also, as noted, only one annual price is calculated now for seasonally disappearing commodities, so it is logical to impute this price in a month where there are no marketings.

Only one annual price is calculated for seasonally disappearing commodities so this is the price that would be assigned. If sufficient resources ever became available to have monthly pricing for some of these commodities, then another imputation procedure would be needed.

In the official Consumer Price Index, imputation for seasonally disappearing commodities is based on the price movement of continuously priced items in the same group as the target series. This amounts to a poor man's version of seasonal weighting. If the FPPI had monthly pricing for seasonally disappearing items, it could seek to impute prices for out-of-season months more in line with the economic notion of shadow or scarcity prices.

All farm commodities without exception have seasonal marketing patterns and on this basis it makes sense to calculate the whole index as a seasonal-basket index. The European

Union (EU) approach, which requires that fresh fruit and fresh vegetables have fixed-basket shares within the overall index has the drawback of not being consistent in aggregation. If one reformulates such an index in terms of greenhouse products and field products for example, and aggregates to a total, one will not get the same result as using the primary commodity classification. This problem does not exist for the FPPI aggregation; one gets the same overall index however one chooses to reorganize groups and subgroups of commodities because they are all generated from the same underlying seasonal weighting patterns.

Even if one were to adopt a more restrictive definition of seasonal commodities it is difficult to justify limiting it to fresh fruit and vegetables as the EU does. What about Christmas trees which are far more seasonal in their marketings than virtually any item of fresh produce?

It should be remembered that in defining their standard for harmonization the EU was constrained by the fact that its standard must be implemented by a country like Luxemburg with both limited resources for calculating farm product price indexes and limited interest, given their modest agricultural bases, in doing so. Also, virtually none of the countries in the EU, with the possible exception of Finland, would have such an extreme seasonal profile of production as Canada. In many European countries field production can generate two or more crops a year, something that Canadian farmers can only dream about.

In Canada, the input counterpart of the FPPI is the farm input price index (FIPI). The FIPI is now an annual price index so for now at least a seasonal-basket price index is a moot point. The source of weights for the FIPI when it was a quarterly index was Farm Operating Expenses and Depreciation Charges for 1992. This was an annual survey and so did not provide the weighting information required to calculate a seasonal-basket index. This being said, many of the expenses associated with farming (fertilizer use, seeding) are seasonal, and this would argue for a seasonal-basket approach to the FIPI if the quarterly FIPI were restored and redesigned in the manner of the FPPI. Yet many of the expenses associated with farming (mortgage and non-mortgage interest, farm rent) are decidedly non-seasonal, so a top-to-bottom seasonal-basket approach such as has been implemented in the FPPI redesign would not appropriate for the FIPI.

7. Price Imputations for Seasonally Disappearing Commodities

It is sometimes necessary to make price imputations for seasonally disappearing commodities if one's monthly weighting pattern is based on a typical seasonal profile rather than the monthly marketings of the year in question. The Dutch economist Bert Balk (1980a and 1980b) suggested that the monthly weights for a given year be based on the given year pattern of marketings and the Balk formula actually was implemented by the Netherlands Central Bureau of Statistics for their price index numbers of output and input of goods and services of agriculture, the Dutch counterparts of our own FPPI and farm input price index (FIPI). Using the Balk formula, there is never any need for seasonal imputation, and there are never any monthly prices that go ignored in the index. If marketings for corn exceptionally occur in December then because the weighting is based on current marketings its December prices are incorporated in the December measure. If on the other hand there are no marketings in October, then corn drops out of the index in that month for that year, but not for other months where there are marketings. There is no need to impute an October price for corn if there are no marketings.

From an operational viewpoint, a Balk index is more difficult to calculate than the Rothwell index (the FPPI uses the Rothwell formula) and more subject to revision. It would not be consistent to adopt a basket reference period that does not incorporate the given year but uses a seasonal-basket formula based on the given year seasonal pattern. From a conceptual viewpoint, the greater representativeness of the Balk index is obtained at a price in comparability. Dikhanov (1999, p. 2) has noted that the idea of achieving both comparability and representativeness in a price index is not unlike the Heisenberg Uncertainty Principle in nuclear physics on determining location and speed of an elementary particle: it is impossible to determine both simultaneously. The 12-month changes of the unlinked spans of the FPPI are measures of pure price change; those of the Balk index are distorted by basket shifts. That being said, it would be of considerable interest to recalculate the FPPI according to the Balk formula.

8. Understanding the Monthly Changes

Because the index basket changes from one month to the next, the FPPI does not provide a measure of pure price change for monthly movements. Even if there is no change in prices from one month to the next there can still be a change in the index due to the basket change.

However it is possible to decompose the monthly change in the FPPI, as with the change in a Paasche price index, into a pure price change component and a residual component, for all months except January. The December-to-January change is distorted not only by the switch from one monthly basket to another but from one annual basket to another. However, the December-to-January change of the unlinked series can be decomposed in the same way as the changes for the other months of the year.

The pure price change component measures what the change in the FPPI would be if there were no change in the monthly basket. The October-to-November measure then would be based on the October basket. Because the October basket is used in both months of the year, the calculation of the pure price change component entails the calculation of imputed prices for some commodities that go out of season in November, fresh corn for example.

The monthly price movements of the FPPI do not mean very much, especially for the most seasonal commodity groups like fruits and vegetables, but neither do the monthly movements for a fixed-basket price index. What precisely would the June-to-July movement for a fixed-basket price index for fresh vegetables signify for example? If the price of corn were imputed using the last in-season price then the June-to-July movement for corn would actually reflect the October-to-June movement. If this movement were substantial enough, the measured June-to-July movement for fresh vegetables might actually exceed the June-to-July movements of any of the vegetable items for which prices existed in both June and July. Thus the fixed-basket price index would contradict one of the basic characteristics of an indicator of pure price change: that the aggregate measure should be bounded by its highest and lowest components.

It is only when one reconstructs monthly price movements using the monthly baskets that are building blocks of seasonal-basket price indexes that any meaningful analysis is possible. The mechanics of obtaining monthly measures of price change is discussed in the appendix.

9. Comparing the FPPI in Canada with the U.S. Prices Received by Farmers Index

A major inspiration was the reconstruction of the U.S. Prices Received by Farmers Index. It had a number of features that were emulated in the FPPI redesign:

- A seasonal weighting pattern for the 12 months of the year for all commodities,
- An update of the index basket every year based on marketings for the last five years,
- A considerable increase in the commodity coverage of the index.

Officials in the United States Department of Agriculture (USDA) were most helpful in responding to enquiries about their index, which was of great benefit to the FPPI redesign.

Plans to introduce a seasonal weighting pattern for the FPPI when its basket was next updated had already been made when the index was discontinued in 1995. Nevertheless, the USDA's switch to a seasonal-basket approach was a great encouragement to everyone who worked on the FPPI redesign. It confirmed that a seasonal-basket approach from top to bottom was viable, and it provided an additional incentive (compatibility with the USDA index) for adopting a seasonal-basket approach for the FPPI.

The FPPI is a chain index with a new annual basket linked into the index every year, and where the link is at the year and not at the month. The USDA index is more like a Paasche price index, with a new annual basket slipped into the index every year, without any linking. This means that the annual price change is not a measure of pure price change, as it is in the FPPI.

For each year, the USDA calculates a five-year average of farm cash receipts at current prices, so that the weighting pattern reflects the price structure of all five years. By contrast, the FPPI calculates a five-year average of farm cash receipts at link year prices, as described above. Therefore the weighting pattern of the FPPI reflects the pattern of marketings of the five different years but the price structure only of the base year, while the weighting pattern of the USDA index reflects the pattern of marketings of the five different years, and also the price structure of the five different years.

For example, for the year 2000, the FPPI basket would be based on 1994-1998 farm cash receipts at 1999 prices, which is appropriate to calculating the price change between 1999 and 2000. The USDA weighting pattern would be based on 1994-1998 farm cash receipts at current prices, so the weights reflect 1994-1998 prices. Given that their index formula is more like that of a Paasche price index than anything else, it would make more sense for the USDA to re-express the farm cash receipts at 1990-1992 prices, since the USDA index is at 1990-92=100. But it would be better still if they calculated their index as an annually reweighted chain index, and duplicated the FPPI calculation of annual baskets.

Annual FPPIs are calculated as weighted averages of monthly FPPIs, consistent with the monthly-basket concept of the index. The USDA calculates annual indexes as the means of the monthly indexes, which is inconsistent with its monthly-basket approach to calculating the monthly series, and does not ensure that each month is fairly represented in the annual index.

The FPPI includes commodities for which there are farm cash receipts but no marketings in the index basket, allowing them to influence the relative importance of the category to which they belong (crop or livestock). The USDA index simply excludes such commodities from the index. The index for prices received by farmers has a three-year base period (1990-2); the base period of the FPPI is a single year (1997).

Except for the use of a multi-year base period, all of these differences are improvements on the USDA methodology, and provide a more meaningful indicator of farm price movements.

The USDA methodology notes that "a 3-year … base period was selected since it provides … base period prices for comparison purposes that are overall closer to historical price trends than a 1-year period provides." The volatility of farm prices is such that a multi-year base period is to be preferred to any single-year base period.

A 1997 base period was chosen for the FPPI because of the rebasing of SNA expenditure estimates to 1997 constant prices, and the rebasing of most of Statistics Canada's price indexes to 1997=100. It was considered more important to have the FPPI series comparable with other published price indexes than to have a base period that better met its special needs.

This difference between the American and the Canadian index is revelatory of a difference in philosophy between the statistical programs of the two countries. In the United States there are many agencies associated with their statistical program, and there is greater emphasis on delivering products that are useful to their client groups. In Canada there is a centralized statistical agency, Statistics Canada, and there is a greater emphasis on compatibility of all economic statistics with the SNA.

Appendix: Monthly Price Change Analysis for the FPPI

This note discusses the analysis of monthly price changes for the FPPI, which is problematic because the basket changes every month for all commodities. Let the index link for the mth month of 2001 be

$$
\begin{aligned}
P_{01,m/00} &= \sum_j \left(\overline{V}^{00j}_{95-99,m} / \sum_j \overline{V}^{00j}_{95-99,m}\right) \times \left(p^j_{01,m} / p^j_{00}\right) \\
\text{(A.1)} \qquad &= \sum_j \left(p^j_{00}\overline{q}^j_{95-99,m} / \sum_j p^j_{00}\overline{q}^j_{95-99,m}\right) \times \left(p^j_{01,m} / p^j_{00}\right) \\
&= \sum_j p^j_{01,m}\overline{q}^j_{95-99,m} / \sum_j p^j_{00}\overline{q}^j_{95-99,m}
\end{aligned}
$$

where $\overline{q}^j_{95-99,m}$ represents average marketings for the jth commodity over 1995-99 for the mth month of the calendar year, $\overline{V}^{00j}_{95-99,m}$ represents the value of these marketings at year 2000 prices, and $p^j_{01,m}$ is the price of the jth commodity in the mth month of 2001.[4] The index link for the m+1st month is then equal to:

[4] For this analysis of contributions to change, the discussion is always in terms of chain links and therefore the indexes of interest are the chain links at link period prices. Since the example used in this note relates to the calculation of the April-May 2001 indexes, all of the formulas are in terms of the 2000-2001 link series, which is at

(A.2)

$$P_{01,m+1/00} = \sum_j (V^{00j}_{95-99,m+1} / \sum_j V^{00j}_{95-99,m+1}) \times (p^j_{01,m+1} / p^j_{00})$$

$$= \sum_j (p^j_{00}\bar{q}^j_{95-99,m+1} / \sum_j p^j_{00}\bar{q}^j_{95-99,m+1}) \times (p^j_{01,m+1} / p^j_{00})$$

$$= \sum_j p^j_{01,m+1}\bar{q}^j_{95-99,m} / \sum_j p^j_{00}\bar{q}^j_{95-99,m}$$

The ratio of the two indexes equals:

(A.3)

$$P_{01,m+1/00} / P_{01,m/00} = (\sum_j p^j_{01,m+1}\bar{q}^j_{95-99,m+1} / \sum_j p^j_{01,m}\bar{q}^j_{95-99,m}) / (\sum_j p^j_{00}\bar{q}^j_{95-99,m+1} / \sum_j p^j_{01}\bar{q}^j_{95-99,m}).$$

It can be seen that the expression in the first set of brackets on the right hand side of (A.3) defines a price index for the m+1st month of year y with the previous month as the base. However the prices are weighted differently in the numerator and the denominator, in each case prices are weighted by marketings for their own month of the calendar year. Therefore even if

(A.4) $$p^j_{01,m} = p^j_{01,m+1}$$

for all j, the index number would not necessarily be equal to one, that is, even if there were no price changes for any of the components of the index, it might still register a positive or negative price change due to shifts in the quantity weights. Therefore, the monthly change for the price index does not satisfy the proportionality test.

The expression in the second set of brackets on the right hand side of (A.3) defines a volume index for the m+1st month with respect to the mth month at 2000 constant prices. This index will also generally differ from one, if there is a seasonal production profile. It will be equal to one in the special case where $\bar{q}^j_{95-99,m+1} = \bar{q}^j_{95-99,m}$ for all j. In this case, (A.1) will simplify to:

(A.5) $$P_{01,m+1/00} / P_{01,m/00} = (\sum_j p^j_{01,m+1}\bar{q}^j_{95-99,m} / \sum_j p^j_{01,m}\bar{q}^j_{95-99,m})$$

which is a measure of pure price change, since if (A.4) holds for all j, then (A.5) will equal one.

Let $W^{00,j}_{95-99,m} = \bar{V}^{00,j}_{95-99,m} / \sum_j \bar{V}^{00,j}_{95-99,m}$ and $P^j_{01,m} = p^j_{01,m} / p^j_{00}$. Then, expressing the indexes as weighted averages of price relatives, one can write the difference between the indexes for two consecutive months in terms of the following decomposition:

year 2000 prices. Thus the 00 subscript does not indicate any base year 0, like the 0 subscript that one often sees in index number formulas, but rather the specific link year 2000.

$$\text{(A6)}\quad \begin{aligned} P_{01,m+1/00} - P_{01,m/00} &= \sum_j W^{00j}_{95-99m+1} P^j_{01,m+1/00} - \sum_j W^{00j}_{95-99m} P^j_{01,m/00} \\ &= \sum_j W^{00j}_{95-99m} (P^j_{01,m+1/00} - P^j_{01,m/00}) + \sum_j (W^{00j}_{95-99m+1} - W^{00j}_{95-99m}) P^j_{01,m+1/00}. \end{aligned}$$

The first term on the right hand side of the second equals sign is the pure price change component of the change. This is the difference between two index numbers for a fixed-basket index for months m and m+1, with a basket based on the mth month. The second term is the difference in the two baskets at prices of the m+1st month of 2001. It is a measure of the residual change in the index, that is, the interaction between weight change and price change.

People familiar with the literature on the Paasche price index and on implicit price indexes have probably seen a similar decomposition for those indexes. It should be obvious that the same decomposition applies if one looks at the percent change between indexes for two consecutive months rather than the simple difference:

$$\begin{aligned} &100 \times (P_{01,m+1/00} - P_{01,m/00}) / P_{01,m/00} \\ &\quad = 100 \times (\sum_j W^{00j}_{95-99m+1} P^j_{01,m+1/00} - \sum_j W^{00j}_{95-99m} P^j_{01,m/00}) / \sum_j W^{00j}_{95-99m} P^j_{01,m/00} \\ &\quad = 100 \times \sum_j W^{00j}_{95-99m} (P^j_{01,m+1/00} - P^j_{01,m/00}) / \sum_j W^{00j}_{95-99m} P^j_{01,m/00} \\ &\quad + 100 \times \sum_j (W^{00j}_{95-99m+1} - W^{00j}_{95-99m}) P^j_{01,m+1/00} / \sum_j W^{00j}_{95-99m} P^j_{01,m/00} \end{aligned}$$

Another way of decomposing the difference between the indexes for consecutive months evaluates pure price change in terms of the basket of the later month rather than the earlier one:

$$\text{(A7)}\quad \sum_j W^{00}_{95-99,m+1} (P^j_{01,m+1/00} - P^j_{01,m/00}) + \sum_j (W^{00}_{95-99,m+1} - W^{00}_{95-99,m}) P^j_{01,m/00}.$$

Again the first term represents pure price change and the second term the interaction between price changes and basket changes. However, the same thing can *not* be said of (A.7) when it is put in percent change form:

$$\begin{aligned} &100 \times \sum_j W^{00}_{95-99,m+1} (P^j_{01,m+1/00} - P^j_{01,m/00}) / \sum_j W^{00}_{95-99,m} P^j_{01,m/00} \\ &\quad + 100 \times \sum_j (W^{00}_{95-99,m+1} - W^{00}_{95-99,m}) P^j_{01,m/00} / \sum_j W^{00}_{95-99,m} P^j_{01,m/00} \end{aligned}$$

It can be seen that the numerator of the first term represents weights for month m+1, while the denominator represents weights for month m, so it does not represent a measure of pure price change, and will be distorted by shifts in the basket from month m to month m+1. Thus, while it might seem that there is no reason to favour the earlier month over the later month in choosing a common basket for price comparison, this is not in fact the case. The reason for this is the conventions governing percent changes; like one of the faces of Janus, they only look backward. For some reason, we have come to look at percent changes always using the earlier period value to scale first differences, never the later period value or some average of them. Thus in decomposing the percent change between month m and month m+1 for a seasonal-basket index, the percent change generated by a fixed-basket index based on the earlier month m is the only appropriate measure of its pure price change component.

The December to January movement, and in general, any sub-annual movement that crosses the December boundary poses special problems for the FPPI since it is a chain index as well as a seasonal-basket index. However, since December 2000 would be calculated based on a 1995-99 basket even though it is not used in calculating its official index (which is based on 1994-98) it is possible to get a measure of pure price change from December 2000 to January 2001 based on a basket for December 1995-99, that is:

$$100 \times \sum_j W^{00j}_{95-99,12}(P^j_{01,1/00} - P^j_{00,12/00}) / \sum_j W^{00j}_{95-99,12} P^j_{00,12/00}.$$

It is obvious that the contribution of any given component to the monthly percent change of the aggregate can be calculated as

$$100 \times (\sum_j W^{00j}_{95-99m+1} P^j_{01,m+1/00} - \sum_j W^{00j}_{95-99m} P^j_{01,m/00}) / P_{01,m/00}.$$

Table A1 below shows such a calculation for a particular case, the FPPI for potatoes in Alberta between April and May of 2001. Two of the three components, accounting for almost 85% of the April basket share, dropped substantially in price in the month of May; only processing potatoes showed an increase in price. Nevertheless, the FPPI for potatoes increased by 12.1% in May -- almost as large an increase as for processing potatoes themselves.

Table A1. Contributions to Percent Change for the Albertan FPPI for Table Potatoes

Commodity	Basket Share April 2001	Basket Share May 2001	$P_{t/2000}$ April 2001	$P_{t/2000}$ May 2001	%Ch	Cntrbtn to Agg %Ch
Total Potatoes	100.00%	100.00%	84.77	95.06	12.1%	12.1%
Local and Table Potatoes	12.82%	30.17%	72.54	66.25	-8.7%	12.6%
Seed Potatoes	71.80%	24.84%	81.57	77.50	-5.0%	-46.4%
Processing Potatoes	15.38%	44.99%	109.92	124.07	12.9%	45.9%

Table A1 indicates how this puzzling result was established. There are strong shifts in basket shares for components between April and May, with seed potatoes falling in importance from the dominant component to the least important, and losing more of its basket share to processing potatoes (whose price increased in May) than to local and table potatoes, whose price dropped in the same month.

As a result the contributions to aggregate percent change of all three of the components are much greater in magnitude than their own percent changes, something which can, of course, never be found in the percent changes of a fixed-basket index, where the contribution to percent change is always a fraction of its own percent change. The contribution of processing potatoes to the aggregate percent change is 45.9%, between three and four times its own percentage increase. Local and table potatoes, although it decreased by 8.7% in May, has a positive contribution to change of 12.6%, a function of its increase in basket share from 13% to 30%. Seed potatoes dropped by 5% in May, but its contribution to percent change is –46.4%, the result of its dramatic slide from a 72% to a 25% basket share. However, this negative contribution is swamped by the positive contributions of the other two components.

The more meaningful contribution is probably the contribution of the component to the pure price change portion of the monthly index change, which is

(A.8) $100 \times W^{00j}_{95-99m} \times (P^{j}_{01,m+1/00} - P^{j}_{01,m/00}) / P_{01,m/00}$.

Table A2 shows these contributions to percent changes based on an April basket for Alberta potatoes, that is, where *m*=4. Note that the contribution for local and table potatoes is now negative, matching its price decrease for May, and the contributions for the other two components continue to match their signs. None of the contributions is larger in absolute magnitude than its contribution to change, since this cannot happen for a fixed-basket index.

Table A2. Contributions to Percent Change for the Albertan FPPI for Table Potatoes Pure Price Change Component (Based on an April Basket) (May Index Number for Total Potatoes Is Not Equal to the Published FPPI Estimate)

Commodity	Basket Share	$P_{t/2000}$ April 2001	$P_{t/2000}$ May 2001	%Ch	Cntrbtn to Agg %Ch
Total Potatoes	100.00%	84.77	83.22	-1.8%	-1.8%
Local and Table Potatoes	12.82%	72.54	66.25	-8.7%	-1.0%
Seed Potatoes	71.80%	81.57	77.50	-5.0%	-3.4%
Processing Potatoes	15.38%	109.92	124.07	12.9%	2.6%

The counterpart to this price change component is the residual component, defined as

$$100 \times (W^{00j}_{95-99m+1} - W^{00j}_{95-99m}) P^{j}_{01,m+1/00} / P_{01,m/00}.$$

Table A3 shows the calculation of these components for the Alberta table potatoes example. Note that the largest basket change, by far, is for seed potatoes, whose basket share goes from almost three quarters to less than one quarter, while the next largest basket change, for processing potatoes, is substantially smaller and in the opposite direction. However, because the May 2001 index number for processing potatoes is about 60% greater than the corresponding index number for seed potatoes, the two components have contributions to residual change that largely cancel each other out so the residual change for the index largely reflects the positive impact of the local and table potatoes component.

Table A3. Contributions to Percent Change for the Albertan FPPI for Table Potatoes Residual Component (Where Pure Price Change Is Based on an April Basket)

Commodity	April Basket Share	May Basket Share	Price Index(2000=100) Apr-01	May-01	Cntrbtn to Agg Ch
TOTAL POTATOES	100.00%	100.00%	84.77	95.06	13.96%
Local and Table Potatoes	12.82%	30.17%	72.54	66.25	13.56%
Seed Potatoes	71.80%	24.84%	81.57	77.50	-42.93%
Processing Potatoes	15.38%	44.99%	109.92	124.07	43.33%

Further note that the total contribution for the residual component is 13.96%, which when added to the total pure price change component based on the April basket at -1.83% gives the 12.13% increase of the official FPPI index.

If one makes a calculation based on a May basket, one can no longer speak about a pure price change component of the FPPI monthly movement, because when the May basket is used to evaluate both April and May, the May estimate is equal to the FPPI estimate, but the April estimate is not. Since the April estimate is the denominator of the expression for percent change, and hence for any contributions to percent change from April to May, the April to May change using a May basket does not represent the pure price change part of the FPPI change, or at least not in an additive sense. The formula for percent contribution to change shown in (A8) above, should be rewritten as

$$\text{(A.9)} \quad 100 \times W^{00j}_{95-99m+1} \times (P^{j}_{01,m+1/00} - P^{j}_{01,m/00}) / P^{(m+1)}_{01,m/00},$$

where $P^{(m+1)}_{01,m/00}$ is the calculation of the aggregate for month m based on the basket for month m+1. However one should note that this measure does generate an increase for total potatoes of 3.8%, like the published FPPI, largely due to the much higher weight attached to the increase in processing potatoes, but also due to the lower weight attached to the decrease in seed potatoes.

Although using the month m basket to measure pure price change has advantages, it also has a substantial shortcoming in the case where there is a dramatic difference between the baskets in months m and m+1. This would seldom be true of livestock series in any given month, but might be, in many months, for crop series. Then neither month is truly representative of the other, and it would be better to calculate some kind of cross of the two series. In this paper, two possible crosses are considered, based on geometric and arithmetic mean formulas.

First, let us look at a geometric mean of indexes based on baskets for months m and m+1. These are Fisher-type comparisons in the sense that they are based on the square root of indexes based on the current and previous month baskets, but they are not Fisher comparisons tout court since the indexes involved do not have the Laspeyres and Paasche formulas.

As noted, if one calculates an index for both months m and m+1 based on the basket for month m+1, the index for m+1 will match the published FPPI but the index for month m will not. The opposite is true for an index based on month m. Thus the geometric mean index will match the FPPI in neither month. As for an index based on month m+1, it would be incorrect to speak of the percent change of the geometric mean index as representing the pure price change component of the FPPI change, since it does not equal the FPPI for month m.

The approximate contribution to change of a component to the geometric mean index would be just the geometric mean of the contributions of components to the indexes based on baskets for months m and m+1, that is:

$$
\begin{aligned}
&[(100 \times W^{00j}_{95-99m} \times (P^{j}_{01,m+1/00} - P^{j}_{01,m/00}) / P_{01,m/00}) \\
&\quad \times (100 \times W^{00j}_{95-99m+1} \times (P^{j}_{01,m+1/00} - P^{j}_{01,m/00}) / P^{(m+1)}_{01,m/00}]^{1/2} \\
&= 100 \times [(W^{00j}_{95-99m} \times (P^{j}_{01,m+1/00} - P^{j}_{01,m/00})) \\
&\quad \times (W^{00j}_{95-99m+1} \times (P^{j}_{01,m+1/00} - P^{j}_{01,m/00})]^{1/2} / P^{GM}_{01,m/00}
\end{aligned}
\tag{A.10}
$$

where $P^{GM}_{01,m/00} = (P_{01,m/00} \times P^{(m+1)}_{01,m/00})^{1/2}$. This would be an approximate, and not an actual contribution, since the sum of the contributions is not generally equal to the percent change of the aggregate. This is in the nature of the calculation; the square root of a sum will not generally equal the sum of the square roots of its components, though the two values should be close.

Table A4 below shows the contributions to change calculated for the previous example of Alberta potatoes. One can see that in the geometric mean calculation the index for total potatoes increases as it does in the published index, but only by 0.9%. This is entirely due to the increase in processing potatoes that would by itself have led to a 4.7% increase in the index. The smaller decrease for seed potatoes has a greater impact on the geometric mean index than the more important decrease for local and table potatoes because the average basket share of seed potatoes in April and May is considerably greater than that of local and table potatoes.

Note that while the sum of the contributions to percent change for all components does not equal the percent change for total potatoes, it very nearly does. In fact, it is only because Table A4 shows these numbers to two decimal places while all other numbers are to a single decimal place that one sees that the percent change for total potatoes (0.93%) differs from the sum of the contributions to percent change (0.94%) by only one hundredth of a percentage point.

Table A4: Approximations to Contributions to Percent Change for an Albertan Price Index for Potatoes. April-May Comparison Based on a Geometric Mean of Indexes for April and May Baskets Respectively (Fisher-Type Indexes). (Neither the April Nor the May Index Number for Total Potatoes Equals the Published FPPI Estimate.)

	$P_{t/2000}$			Cntrbtn to Agg
Commodity	April 2001	May 2001	%Ch	%Ch
Total Potatoes	88.12	88.94	0.93%	0.94%
Local and Table Potatoes	72.54	66.25	-8.7%	-1.5%
Seed Potatoes	81.57	77.50	-5.0%	-2.3%
Processing Potatoes	109.92	124.07	12.9%	4.7%

The geometric mean indexes were calculated following the discussion of the FPPI redesign by the Statistics Canada Price Measurement Advisory Committee on April 24, 2001. The Committee chair, Erwin Diewert, suggested that where there was a big shift in the index basket from one month to another it might be more appropriate to calculate monthly changes based on a Fisher cross rather than a Laspeyres-type estimate. This was good advice and confirmed the doubts that people working on the redesign project had about basing month-to-month comparisons solely on a previous month basket when estimating pure price change.

However, the geometric-mean or Fisher-type indexes have a couple of disadvantages, here listed in declining order of importance:

1. By their nature, they treat the two months being compared as essentially of equal importance, taking an unweighted geometric mean of indexes based on baskets for each month, even if one of the two months heavily dominates marketings.

2. Neither Fisher nor geometric mean indexes are consistent in aggregation, so that at each level of aggregation it is necessary to calculate Laspeyres-type and Paasche-type indexes and then take their geometric mean. Essentially one is forced to calculate three sets of analytical indexes even if one is only interested in those of the Fisher type.

The second disadvantage is an operational one rather than an analytical one but may be non-trivial in some production environments. (For the FPPI, given that it is produced on interlocking EXCEL spreadsheets, it is a fairly serious drawback.)

The first disadvantage is the more serious one in general, and is certainly quite serious in our particular example, as the two months are not even remotely of equal importance. At 2000 annual prices, the volume of marketings for Alberta potatoes in April is more than three times as great as in May. These disadvantages can be remedied by calculating a fixed-basket index based on the mean of April and May marketings, that is, an Edgeworth-Marshall-type index. Such an index will appropriately give April more influence on the determination of basket shares than May, and will allow the calculation of weighted averages of component Edgeworth-Marshall-type indexes (i.e. the formula is consistent in aggregation).

The first of these properties is the most important. An Edgeworth-Marshall-type index satisfies the property of transactions equality while the geometric-mean-type index does not.

Table A5 below shows the index generated by an index with an April-May basket, which like the index based on an April basket, shows a price decrease in May, but only a slight decline of -0.4%. It should not be a surprise that both the Laspeyres-type and Edgeworth-Marshall-type indexes show price change in the same direction, since their baskets are quite close to each other, and that the Paasche does not. It is a little more surprising that the geometric mean index also shows price change in a different direction, when both the geometric mean and arithmetic mean indexes are supposed to broker differences between the April and May baskets. However, if one takes the arithmetic mean index's measure as the true measure of monthly price change, the geometric mean index comes closer to it than the Laspeyres-type measure does, if only barely, differing from the preferred measure by 1.35 percentage points while the April-basket measure differs from it by 1.46 percentage points.

Table A5. Contributions to Percent Change for an Albertan Price Index for Potatoes. April-May Comparison Based on Arithmetic Mean of the April and May Baskets (Edgeworth-Marshall-Type Indexes). (Neither the April nor May Index Number for Total Potatoes Equals the Published FPPI Estimate.)

Commodity	Basket Share	$P_{t/2000}$ April 2001	$P_{t/2000}$ May 2001	%Ch	Cntrbtn to Agg %Ch
Total Potatoes	100.00%	86.40	86.04	-0.4%	-0.42%
Local and Table Potatoes	16.95%	72.54	66.25	-8.7%	-1.23%
Seed Potatoes	60.62%	81.57	77.50	-5.0%	-2.86%
Processing Potatoes	22.43%	109.92	124.07	12.9%	3.67%

An Edgeworth-Marshall index is an asymmetric average of Laspeyres and Paasche ones:

$$\frac{\sum p_1(q_0+q_1)}{\sum p_0(q_0+q_1)} = \frac{\sum p_0 q_0}{\sum p_0(q_0+q_1)} \times \frac{\sum p_1 q_0}{\sum p_0 q_0} + \frac{\sum p_0 q_1}{\sum p_0(q_0+q_1)} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}.$$

As the base period's share of the total volume of activity evaluated at base period prices becomes very small it will approach a Paasche price index; as the current period's share becomes very small it will approach a Laspeyres price index. It will always lie somewhere between the two measures. Surely this is far more appropriate than to take a symmetric average of the Laspeyres and Paasche indexes, however that symmetric average be defined.

Diewert (2000, p. 206-207) ignores the principle of transactions equality and suggests instead a principle of invariance to proportional changes in quantities test, which makes a virtue of the significant failure of the Fisher formula in this regard. In fact, this principle would eliminate the Edgeworth-Marshall formula from consideration. The rationale comes not from temporal but from spatial price indexes. He postulates that if one is comparing the price levels of a very large country to a small one, the basket of the large country may overwhelm the basket of the small country, and one requires an index formula that is insensitive to these scale differences. In this context this principle makes sense. If one were organizing an exchange of employees between the United States and Canada with the same number of people going in both directions one would want an index of cost-of-living differentials to give about equal importance to the two countries. An Edgeworth-Marshall index based on total consumption in the two countries would be inappropriate. But how does this pertain to measuring price change over time?

Diewert (2000, p.207) notes that "this is unlikely to be a severe problem in the time series context where the change in quantity vectors going from one period to the next is small". It would be much closer to the truth to say: "This is not at all a problem in the time series context; in fact, the opposite is true. Any index that satisfies the invariance to proportional changes in quantities test by definition does not even come close to satisfying the transactions equality principle, and so is more or less unsatisfactory in a time series context, most especially if the change in quantity vectors going from one period to the next is substantial." In the case of our specific problem, getting monthly price comparisons for farm prices that are measures of pure price change, it means that we would rule out Fisher-type measures in favour of Edgeworth-Marshall-type measures. A corollary of this observation (i.e. that a symmetric mean of Laspeyres and Paasche indexes is not generally an appropriate measure) is that it is not true that one can generally be indifferent between Laspeyres and Paasche price measures for two-period comparisons. This is only true if the relative volumes in the two periods are comparable. If the volume of activity in the earlier period is much larger than in the later period the Laspeyres measure is more appropriate; if the opposite is true, then the Paasche measure is superior. But either way, an average of the two would be more appropriate than either measure taken by itself.

For this April-May comparison, where there is such an extraordinary difference between April and May baskets, the numbers shown in Table A5 probably provide the best single analysis of monthly price change. However, for other monthly comparisons, where there is not such a dramatic shift in basket shares from one month to another, it would be easier to base the monthly analysis strictly on a measure of pure price change derived using the basket of the earlier month in the comparison (in this case, April), and the results would not be very different from those both on an April-May basket. Only such a measure of pure price change can truly be said to represent the pure price change component of the monthly change of the official FPPI. It would certainly be appropriate to have both types of monthly analysis, i.e. both Laspeyres-type and Edgeworth-Marshall-type measures. However, if this were beyond the realm of the reasonable in terms of analysis for the FPPI given current resource allocations and only one measure were to be calculated, it would be best to opt for the Edgeworth-Marshall-type indexes.

Whether the Edgeworth-Marshall-type measures are produced in tandem with the Laspeyres-type measures or by themselves, it should be recognized that they do not represent the pure price change component of the monthly change of the official FPPI (this is what the Laspeyres-type measures show). Rather they constitute the best measure of pure price change between consecutive months that can be generated from the inputs used to create the FPPI.

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