Reconciling the CPI and the PCE Deflator

*New analysis compares the CPI and the
PCE Deflator and quantifies the
effect on the inflation measures
of the treatment of owner-occupied housing,
the weights assigned products and services,
and other factors in index number construction*

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The Federal Government produces two major inflation measures for consumption goods and services. The Consumer Price Index (CPI), published by the Bureau of Labor Statistics, is the most widely used aggregate price index, as well as the major source of information on price trends for individual consumption goods and services. An alternative aggregate consumption inflation measure, the Implicit Price Deflator for Personal Consumption Expenditures (PCE Deflator), published by the Bureau of Economic Analysis, is a by-product of the construction of the National Income and Product Accounts.

For at least a decade, users have noted that the CPI and the PCE Deflator often give different measures of the rate of inflation. "How," these users ask, "can we reconcile the difference between the CPI and the PCE Deflator?" This article provides an answer to that question.

Alternative price measures

The price information used by the Bureau of Economic Analysis (BEA) in constructing its price measures is largely based on detailed CPI price indexes: 85 of the Deflator's 115 components are taken directly from the

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CPI. Accordingly, the basic measures of price trend for most specific consumption commodities are common to both aggregate price measures. Differences in the movement of aggregate indexes can reflect how the basic price data are used—in other words, how the aggregate indexes are constructed.

Both the Bureau of Labor Statistics and the Bureau of Economic Analysis publish alternative aggregate indexes, in which many of the basic price data are handled differently, to suit different purposes. The BLS now publishes two official CPI's—the CPI for all Urban Consumers (CPI-U) and the CPI for Urban Wage Earners and Clerical Workers (CPI-W). It also publishes five "experimental" CPI indexes that contain alternative treatments of owner-occupied housing: these are designated CPI-U-X1 through CPI-U-X5 in the monthly CPI press release and in the periodical, CPI Detailed Report.

The BEA arranges the basic price information used in the personal consumption expenditures sector of the National Accounts into three alternative aggregate price measures—in addition to the Implicit Deflator for Personal Consumption Expenditures are two alternatively weighted price measures for personal consumption expenditures. These are described more fully later in the article.

Accordingly, 10 different aggregate consumption expenditure price measures are regularly published by the

Federal Government. Because several price measures are published, the analyst can use them to determine the effect of particular differences in index number construction on the measured inflation rate.

Sources of difference in inflation rates

The difference in the inflation rates indicated by any two of the BLS and the BEA price measures can be attributed to three factors, described in the following sections.

Owner-occupied housing. The treatment of owner-occupied housing (and a few other products) varies. The two official CPI's price houses and the costs of acquiring and operating a house. All BEA price indexes (as well as the CPI-U-X1 index) use the CPI rent index as a measure of the monthly cost of living in a house.

Different index weights. Weighting differences among BLS and BEA price measures can be broken down into two sources: (1) weighting differences stemming from differences in index definition and (2) weighting differences associated with different periods selected for determining the weights.

CPI weights refer to expenditures by a population of either urban wage and clerical workers (CPI-W) or of all urban consumers (CPI-U and all five of the experimental CPI indexes), and all are derived from an expenditure survey. The PCE consumption definition is broader than either CPI definition, adding to the expenditures of CPI-U's urban consumer, expenditures of rural household and expenditures by nonprofit organizations. In addition, its weights are drawn from the National Accounts.

With respect to differences in periods, all versions of the CPI currently use 1972–73 as the weighting period. (Before January 1978, they employed weights based on a 1960–61 survey.) BEA price indexes are available with weights for a variety of periods, including 1972 weights, current period weights, and an index in which weights are always drawn from the period just prior to the one for which the index is published.

Other factors. The price information incorporated into the indexes differs somewhat because the BEA price indexes do not use a few CPI price index components and include some non-CPI price data (mainly from the BLS' Producer Price Index and some price imputations carried out by the BEA). In any price index computation various technical factors may be handled differently by the compilers (for example, seasonal adjustment). In some cases, the net effect of these "compilation decision" differences may cause divergence in aggregate measures though it is often hard to make a comprehensive listing, and even harder to determine the effect of each factor separately. In the past, divergences in the

CPI and the BEA price measures have been associated with such factors.[1] But recent revisions and improvements in the Personal Consumption Expenditures sector of the accounts have undoubtedly greatly diminished their importance.

In order to reconcile the various inflation measures obtained from BLS and BEA, the present article presents a method for decomposing the difference between the CPI-U and the BEA's PCE price measures into the factors just discussed. The methodology is somewhat different from the well-known "reconciliation" tables published quarterly by the BEA.[2] Its objective is to derive simple and straightforward measures of the empirical importance of those factors—such as housing and index weights—that recently have become issues in the measurement of inflation.

In summary, in recent years the treatment of housing costs is the largest quantitative contributor to divergence in the price measures. The difficulty of measuring costs of owner-occupied housing has been discussed at length in recent articles.[3] Five alternative treatments of owner-occupied housing are contained in experimental CPI indexes published monthly in the CPI press release and the *CPI Detailed Report.*

In addition, the article discusses the effect of "updating" index weights from the early 1970's period to a more nearly current one. Alternative weighting schemes show that weighting effects do make perceptible differences in the measurement of inflation, but not nearly so much as is sometimes assumed—around four-tenths of a percentage point (0.4) for the double-digit inflation year of 1980. The seemingly widespread impression, reported in the press and elsewhere, of a significantly larger weighting effect arises from making a common misinterpretation of the information in the PCE Deflator. For this reason, the article includes material on interpreting price indexes which use alternative formulas and weighting schemes.

CPI and PCE deflator formulas

All versions of the CPI are computed according to what is known as a "Laspeyres formula."[4] In its purest form, a Laspeyres price index takes its weights from the earlier of any two years being compared, but in practice a particular weighting period is chosen and held constant for several years. Currently, the CPI weights are drawn from the Consumer Expenditure Survey of 1972–73.

The Implicit PCE Deflator is a "Paasche formula" price index.[5] The Paasche index takes its weights from the current period (that is, the period for which the index is computed), and for this reason, the PCE Deflator is often referred to as a "current weighted" index. At the present time, the PCE Deflator contains 115 components to which current weights are applied, an improvement over the earlier computational system described

by Gregory Kipnis[6], and the reference point for price comparisons is always 1972.[7] The accompanying tables are based on the most recent revised PCE price data, released in April 1981.

Alternative aggregate price measures compiled by the BEA use the Laspeyres price index formula. These indexes are described more fully in later sections of this article.

Step-by-step comparison of the measures

Alternative versions of the CPI and the BEA's price measures can be used to quantify the separate effects of the three factors mentioned in the introduction: (1) treatment of owner-occupied housing, (2) weighting differences associated with different weighting periods, and (3) an "all other" factor (which includes weighting differences associated with different index definitions). Table 1 is arranged to facilitate a step-by-step identification of the effect of each of these factors on the inflation measurement, over the 1972–80 period.

The 1972–80 period is used in table 1 because the current-weight PCE Deflator is properly interpreted only as a measure of price change from 1972 to some later quarter or year (for example, the price change from 1972 to 1979, or from 1972 to 1980). It does not measure the 1978–79 or the 1979–80 rate of price change, nor does it measure the price change from one quarter or month to the next, contrary to mistaken impressions of many price index users. (This point is more fully developed in the Appendix.) The 1972–80 period chosen for table 1 is determined by the nature of the computational methods for the PCE Deflator; however, a comparison of period-to-period price changes is presented in a subsequent section.

An estimate of the effect of the treatment of housing

on inflation measures can be obtained by comparing movements in indexes which differ *only* in the way owner-occupied housing costs are measured. The all-urban CPI (CPI-U) and the five BLS experimental indexes differ only in their owner-occupied housing components, and of the five, the relevant one for our purposes is CPI-U-X1 (for convenience, this designation is shortened to "CPI-X1" for the remainder of the article). In the CPI-X1 index both the weight and the price measure for owner-occupied housing are determined, in principle, by assuming that the monthly cost of owner-occupied housing can be approximated by the rent that would be paid if the house were in fact rented. This is often known as the "rental equivalence" method for measuring the cost of owner-occupied housing and is the concept also employed in all the BEA consumption price measures.

In practice, all existing "rental equivalence" housing measures (BLS or BEA) use the CPI rent index, which, because it is designed as a price measure representative of the types of units that are in fact rented is heavily weighted toward apartments; it contains a far smaller proportion of houses (for example) than would a rent sample that was designed as a rental equivalence measure. Whatever deficiencies the present CPI rent index may have as a measure of rental equivalence for owner-occupied housing, these deficiencies are shared equally by the CPI-X1 and all BEA price measures; the use of the CPI rent index in lieu of a true rental equivalence measure does not in any way distort the comparison of the CPI and the PCE Deflator, which is the question under study in this article.

The housing comparison for the 1972–80 period is contained in lines (1) through (3) of table 1. Because the indexes are based on 1972 (that is, 1972 = 100), line (3) of table 1 shows the cumulative effect created by dif-

Table 1. Comparison of cumulative changes in CPI indexes and Personal Consumption Expenditures price measures, 1972 to the date shown (1975–80)

[1972 100]

Measure	1975	1976	1977	1978	1979	1980	1979				1980			
							I	II	III	IV	I	II	III	IV
(1) CPI-U[1]	128.7	136.1	144.9	156.0	173.6	197.0	165.7	170.8	176.2	181.9	189.2	195.4	198.8	204.6
(2) CPI-X1[1]	126.5	133.8	142.3	152.0	166.6	185.3	160.2	164.4	168.8	173.2	178.7	183.1	187.2	192.0
(3) Difference, CPI-U minus CPI-X1 (housing effect)	2.2	2.3	2.6	4.0	7.0	11.7	5.5	6.4	7.4	8.7	10.5	12.3	11.6	12.6
(4) CPI-X1[1]	126.5	133.8	142.3	152.0	166.6	185.3	160.2	164.4	168.8	173.2	178.7	183.1	187.2	192.0
(5) PCE: 1972-Weight[2]	126.2	132.9	141.3	151.5	166.0	184.3	160.2	163.7	167.8	172.4	177.8	182.1	186.3	190.8
(6) Difference, CPI-X1 minus PCE:1972-Weight (other effect)	0.3	0.9	1.0	0.5	0.6	1.0	0.0	0.7	1.0	0.8	0.9	1.0	0.9	1.2
(7) PCE: 1972-Weight[2]	126.2	132.9	141.3	151.5	166.0	184.3	160.2	163.7	167.8	172.4	177.8	182.1	186.3	190.8
(8) PCE: Current-Weight[2]	125.2	131.6	139.5	149.1	162.3	178.9	157.1	160.2	163.8	168.0	172.9	177.0	180.7	184.9
(9) Difference, PCE:1972-Weight minus PCE: Current-Weight[2] (weighting effect)	1.0	1.3	1.8	2.4	3.7	5.4	3.1	3.5	4.0	4.4	4.9	5.1	5.6	5.9

[1] Annual data for the CPI-U and CPI-X1 were computed by the Office of Research and Evaluation (BLS) from unadjusted monthly data provided by the Office of Prices and Living Conditions (BLS). The quarterly data for 1979 and 1980 were computed by the Office of Research and Evaluation employing seasonally adjusted monthly data provided by the Office of Prices and Living Conditions.

[2] Data for the "PCE: 1972-weight" and "PCE: current-weight" indexes were provided by the Bureau of Economic Analysis, U.S. Department of Commerce. The data incorporate revisions released by BEA in April 1981.

ferences in owner-occupied housing treatments from 1972 to each of the years tabulated. For example, between 1972 and 1980, the alternative treatment of owner-occupied housing that is embodied in the CPI-X1 resulted in a total difference of 11.7 index points (roughly 13 percent of the measured 1972–80 price increase), in comparison with the official CPI-U.[8]

Of course, the CPI and PCE price measures differ in other respects as well. To determine the importance of those other factors on the inflation measure, we use the same technique already used to isolate the effect of housing: we look for alternative versions of the price measures that will differ only in one or a small number of respects, and use the difference between closely related indexes to show the effect of one factor or group of factors, holding all other factors constant.

The BEA publishes a price index which is quite close to the CPI-X1 index in many respects. This index is commonly known as the "Personal Consumption Expenditures: Fixed-Weighted Price Index." It is a Laspeyres-formula price index, using the same price measures that are found in the Implicit PCE Deflator, but in which major components are weighted by consumption patterns of 1972. To facilitate discussion of the effect of different weighting periods, we will refer to this index as the "PCE 1972-weight" price index.[9]

The CPI-X1 index and the PCE-1972 index both measure owner-occupied housing by a rental equivalence method using the CPI rent index, and both are base-weighted Laspeyres-formula indexes, drawing their weights from roughly the same 1972–73 period. As lines (4) through (6) of table 1 show, these two most comparable versions of the CPI and the PCE Deflator give measures of inflation that usually agree fairly closely. Over the 1972–80 interval, they differed by only 1.0 index point.

One way to interpret the 1.0 index point difference between the CPI-X1 and PCE 1972 weight indexes is that the difference captures the net effect of all the differences between the CPI and the PCE Deflator *other than* choice of weighting period and treatment of owner-occupied housing.[10] Line (6) shows that those "other factors" made a relatively small net difference in the inflation measures for most recent years.

In drawing inferences about movements of the CPI-X1 and PCE 1972-weight indexes (or comparing any versions of the CPI and PCE price measures) users should bear in mind that the PCE price measures are subject to revision well after they are published. The 1980 GNP revisions, for example, changed the PCE-1972 index (and also gave it, for the first time, a consistent Laspeyres weighting system for all its 115 components). GNP revisions can sometimes change the PCE price measures substantially; in some cases revisions reduce the discrepancy between the CPI (which is not revised) and the

PCE 1972-weight index, but in other cases the revised figures show a greater discrepancy than was apparent from earlier data.[11] For analytical purposes, data which are revised to show the latest available information or to reflect improved methodology are generally preferred, but escalation users normally prefer series which are not subject to revision.

Effect of "updating" the weights

The present CPI weights refer to consumption patterns of 1972 and 1973, but many changes have occurred since then. For example, the price of energy has risen greatly since 1972–73, and consumers have made many adjustments (such as switching to more fuel-efficient cars to reduce purchases of gasoline, and buying more insulation, storm windows and so forth to save on heating fuel). If the index weights were updated to reflect more recent expenditure patterns, how much difference would it make on the price index measure? This important question has sparked much recent speculation.

Though one cannot at present recompute the CPI using weights for a more recent period,[12] the effect of weighting pattern differences on price index measurements can be estimated from comparing alternative weighting patterns in PCE price measures. The Implicit PCE Deflator (which for simplicity we will call the "PCE current-weight" index) differs from the PCE 1972-weight index *only* in having different weights. The PCE current-weight index for any quarter or year uses weights for that quarter or year; the PCE 1972-weight index always uses 1972 weights. Because all 115 component price indexes included in each aggregate PCE index are the same, comparing these two aggregate indexes provides an estimate of the effect of weighting differences over the entire 1972–80 period. Such a comparison is shown in lines (7) to (9) of table 1.

Comparison of the two PCE indexes should be interpreted with care. Each of the "differences" tabulated in table 1 represents the cumulative effect from 1972 to the date entered in the column heading, and not the influence of the factor for a single year alone. For example, the figures entered for the year "1980" show that prices have risen by a little over 80 percent since 1972 using 1972 weights (actually, 84.3 percent); use of 1980 weights yields an inflation measure a little under 80 percent, over the same period (actually, 78.9 percent). Thus, weighting effects are estimated to account for 5.4 percentage points (184.3 less 178.9) in the inflation measure over the entire 8-year period. To put it another way, the effect of "updating" the weights in the personal consumption expenditures price measure is to reduce the measure of inflation by around 5 to 5½ percentage points. One should bear in mind, however, that under

either measure inflation has totaled around 80 percent between 1972 and 1980, so that the "weighting effect" is roughly 6 percent of the measured inflation over the entire period.

The figure for 1979 has a similar interpretation. Because the weights for the PCE current-weight index change each year, the 1979 PCE current-weight index has 1979 weights. Thus, line (9) shows that "updating" the weights from 1972 to 1979 causes a difference of around 3½ to 4 percentage points over that 7-year interval, during which the total measured inflation was somewhat above 60 percent (66.0 percent and 62.3 percent, by the two alternative measures). The "weighting effect" accordingly amounts to roughly 5½ percent of the 1972–79 inflation.

The weighting effect becomes smaller when the periods from which weights are drawn are closer together. At 2.4 percentage points in 1978, it was only about 4 to 5 percent of the 1972–78 inflation, and around 4 percent of the inflation experienced between 1972 and 1975 (1.0 percent, compared with a total of roughly 25-percent inflation between those years).

The evidence, then, is consistent with what is usually expected: as the period between weights lengthens, the effect of reweighting the index becomes greater. However, even over an 8-year period which has seen major changes in energy and other prices, the maximum measurement effect of weight updating comes to only around 6 percent of the total of inflation that occurred.

It should be emphasized that comparisons of reweighted versions of the PCE price measures can only give an impressionistic sense of what would happen to the CPI if its weights were updated. Reweighting the CPI might produce larger or smaller effects than those shown in table 1. Unfortunately, we cannot perform the same experiment on the CPI, because that would require current expenditure data to update the weights, and such data are not currently available.

In summary, weighting effects occur in price index measurements, and they have been relatively large in the past two years by historical standards. But perspective on the importance of the weighting effect requires considering the following facts:

• If the difference between PCE indexes using different weights is high in the past two years, the rate of inflation was also at a postwar high; the weighting effect, relative to the measure of inflation, may therefore be little more than it has been in the past, and our confidence in the statistical reliability of any index measurement is couched in relative terms.

• The weighting effect shows the difference between two price indexes which have different weights. It does not imply that one index is "right" and the other "wrong," for they are both valid price measures that are designed for slightly different objectives. (This is discussed in greater detail in the section on "Reconciliation.") Furthermore, these weighting effects are the gross effects of reweighting and do not provide a measure of the "substitution" effect in fixed weight price indexes (the error introduced because these indexes make no allowance for consumer substitution toward goods whose prices have risen less rapidly). The "substitution effect" is undoubtedly considerably smaller than the gross weighting effect between two alternatively weighted price indexes. (See the Appendix for additional discussion of this point.)

• The weighting effect shown on line (9) is smaller than the sum of the other two "effects" shown in table 1. The effect of housing treatment plus the "all other" CPI-PCE structural differences (lines 3 and 6) exceeds the weighting effect for every single period tabulated in table 1.

An alternative step-by-step comparison

Of course, price indexes are not used solely to make long-term comparisons, such as the 1972–80 comparisons considered so far. One also needs price indexes to answer questions such as, "How much inflation occurred between 1979 and 1980?" Or, "What was the inflation rate for the first quarter of 1981?"

Annual, quarterly, or monthly inflation rates are normally computed by taking percentage changes in the published index numbers. This practice has become so commonplace that one hardly thinks about the justification for doing it. However, of the two index number formulas in widespread use—Paasche and Laspeyres—only the Laspeyres formula will give measures of price change covering intervals other than the index number reference year or "base." As explained in detail in the Appendix, a Paasche formula price index using current-period weights and published for a reference year of 1972 (as is the Implicit PCE Deflator) cannot be used to compute inflation measures for some other period. That is, if one has the value of the PCE current-weight index for (say) 1980 and the value of the same index for 1979—both of which are index numbers expressed in relation to the 1972 price level—one cannot take the change in those two index numbers to be the price change between 1979 and 1980. Similarly, changes in quarterly values of the Implicit PCE Deflator (as, for example, fourth quarter, 1980 to first quarter, 1981) cannot be interpreted as measures solely of price change between those quarters. Many economists have used the quarterly or annual change in the Implicit PCE Deflator as if it were a measure of price change comparable to other price index numbers, but this can sometimes give a very misleading impression. This issue, a technical one, is

explained in greater detail in the Appendix.

Fortunately, for those who wish to make year-to-year (or quarter-to-quarter) comparisons, the BEA publishes two alternative price indexes which are intended to provide measures of period-to-period price change. Each one uses the same price data as the PCE Deflator. We make use of these two alternative PCE price indexes in the present section, which carries out a step-by-step comparison between CPI and PCE measures of period-to-period price change.

The information in lines (1) to (3) and (4) to (6) of table 2 is comparable to the data shown on the same lines of table 1. Table 1 showed the effects of housing treatment, weight updating, and "all other" factors on the discrepancy between the PCE's and the CPI's measurement of inflation over the entire interval 1972–80; table 2 shows the effects of these three factors on *period-to-period* changes (annual and quarterly).

As was the case in table 1, comparing the changes in the CPI-U and in the CPI-X1 isolates the effect of alternative housing treatment on the price measurement, for the CPI-X1 measure treats housing in exactly the same way as do the PCE price measures.

Line 3 of table 2 shows that the alternative treatment of housing in CPI-U and CPI-X1 indexes makes a difference of 1.7 and 2.3 percentage points in the 1979 and 1980 measures of inflation. Differences were somewhat greater in the quarterly figures than in the annual ones. Of course, under other conditions the CPI-X1 may not differ from CPI-U by the same amount, and indeed, one should not expect that the CPI-X1 will always show a lower rate of inflation than the official CPI-U.[13]

As noted earlier, the CPI-X1 index shares many common points with the form of the PCE price measure that uses 1972 weights: both are indexes computed using the Laspeyres formula, both take their weights from roughly the same period, and both treat housing in identical ways. As Laspeyres formula indexes, both can therefore

be used to compute period-to-period changes (see the Appendix). A comparison of changes in these two indexes provides a measure of the effect of "all other" factors—other than housing treatment and choice of weighting period—in index number construction.

As was true for the 1972–80 comparison shown in table 1, the "other factors" have not usually made a big impact on inflation measurement. For example, the 1979 annual chãnges do not differ at all, and the 1980 changes differ by only 0.2 percentage points—see line (6) of table 2. However, the 1975–76 annual figures (affected by the GNP revisions) and some of the 1979 quarterly changes are larger than others: the 1979 second quarter, for example, reached 1.6 percentage points.

Once assured that the CPI-X1 and PCE 1972-weight indexes usually give similar inflation measures, we can use a reweighted PCE price measure to determine the effect of weighting updates on price index measurement. This time, however, we chose a PCE price measure that can be used for period-to-period comparisons. The index chosen is usually referred to as the "Personal Consumption Expenditure: Chain Price Index." For convenience, we refer to it as the "PCE chain-weight index."

The PCE chain-weight index also uses the Laspeyres formula (as does the PCE 1972-weight index). However, the PCE chain-weight index always has weights taken from the first of any two periods being compared. For example, the PCE chain-weight index which measures price change between 1979 and 1980 uses 1979 weights, the measure of price change between 1978 and 1979 uses 1978 weights, and so on. The PCE 1972-weight index and the PCE chain-weight index are alike in every way (same Laspeyres formula, same 115 price index components, and so on) except for the period from which their weights were drawn. Their close similarity means that comparing the two provides an estimate of how updating Laspeyres weights would affect period-to-period price index measurements.[14]

Table 2. Comparison of percent changes in CPI indexes and Personal Consumption Expenditures price measures, 1975–80

Measure	1975	1976	1977	1978	1979	1980	1979[1]				1980[1]			
							I	II	III	IV	I	II	III	IV
(1) CPI-U[2]	9.1	5.8	6.5	7.7	11.3	13.5	11.1	12.9	13.3	13.7	16.9	13.6	7.2	12.2
(2) CPI-X1[2]	8.3	5.7	6.4	6.8	9.6	11.2	9.7	10.8	11.2	10.9	13.3	10.1	9.4	10.5
(3) Difference, CPI-U minus CPI-X1[2] (housing effect)	0.8	0.1	0.1	0.9	1.7	2.3	1.4	2.1	2.1	2.8	3.6	3.5	-2.2	1.7
(4) CPI-X1[2]	8.3	5.7	6.4	6.8	9.6	11.2	9.7	10.8	11.2	10.9	13.3	10.1	9.4	10.5
(5) PCE: 1972-Weight[3]	7.8	5.3	6.3	7.2	9.6	11.0	10.3	9.2	10.4	11.4	13.2	9.9	9.5	10.1
(6) Difference, CPI-X1 minus PCE: 1972-Weight (other effect)	0.5	0.4	0.1	-0.4	0.0	0.2	-0.6	1.6	0.8	-0.5	0.1	0.2	-0.1	0.4
(7) PCE: 1972-Weight[3]	7.8	5.3	6.3	7.2	9.6	11.0	10.3	9.2	10.4	11.4	13.2	9.9	9.5	10.1
(8) PCE: Chain-Weight[3]	7.7	5.3	6.3	7.1	9.3	10.6	9.8	8.8	9.9	10.9	12.5	9.7	9.5	10.1
(9) Difference, PCE: 1972-Weight minus PCE: Chain-Weight (weighting effect)	0.1	0.0	0.0	0.1	0.3	0.4	0.5	0.4	0.5	0.5	0.7	0.2	0.0	0.0

[1] Seasonally adjusted annual rates.
[2] Annual and quarterly changes in the CPI-U and CPI-X1 are taken from tables provided by the Office of Prices and Living Conditions, Bureau of Labor Statistics. The changes are compiled from 1967-based indexes.

[3] Data for the "PCE: 1972-weight" and "PCE: chain-weight" indexes were obtained from the Bureau of Economic Analysis, U.S. Department of Commerce. The data incorporate revisions released by BEA in April 1981.

Table 3. "Reconciliation" of annual and quarterly percent changes in the CPI-U and the Personal Consumption Expenditure price measures, 1975–80

Difference	1975	1976	1977	1978	1979	1980	1979				1980			
							I	II	III	IV	I	II	III	IV
Total difference[1]	1.4	0.5	0.2	0.6	2.0	2.9	1.3	4.1	3.4	2.8	4.4	3.9	2.3	2.1
Housing treatment[2]	0.8	0.1	0.1	0.9	1.7	2.3	1.4	2.1	2.1	2.8	3.6	3.5	2.2	1.7
Weighting effect[3]	0.1	0.0	0.0	0.1	0.3	0.4	0.5	0.4	0.5	0.5	0.7	0.2	0.0	0.0
"All other" effect[4]	0.5	0.4	0.1	0.4	0.0	0.2	0.6	1.6	0.8	0.5	0.1	0.2	0.1	0.4

[1] For each year, the change in CPI-U minus the change in PCE: Chain-Weight index (from table 2, line (1) minus line (8)).

[2] For each year, the change in CPI-U minus the change in CPI-X1, (from table 2, line (3)).

[3] For each year, the change in PCE: 1972-Weight index minus the change in PCE: Chain-Weight index (from table 2, line (9)).

[4] For each year, the change in CPI-X1, minus the change in PCE: 1972-Weight index (from table 2, line (6)).

Lines (7) to (9) of table 2 provide this information. The entry for 1980 on line (9) shows the difference (0.4 percentage points) between 1980's inflation rate using 1972 weights (11.0 percent) and the rate for the same year, measured with 1979 weights (10.6 percent). The rest of line (9) requires careful interpretation because the PCE chain-weight index weights change every year. The 0.3-percentage point figure on line (9) in the 1979 column refers to the difference between the inflation rates for 1979 when calculated using 1972 and 1978 weights (9.6 and 9.3 percent, respectively). Similarly, the 1976 figure shows there was no difference between the inflation rate for that year using alternative 1972 and 1975 weights (both 5.3 percent).

Reading line (9) from left to right shows how the weighting effect grows as weighting periods move further apart. As the table shows, the two PCE price indexes were once very close together, but as the period between weights lengthens, the weighting effect becomes larger. For the entire year 1980, when both PCE indexes were indicating an inflation rate in excess of 10 percent, weighting differences created a divergence of 0.4 percentage points. The quarterly data show an interesting pattern: in the peak inflation quarters in the last half of 1979 and first half of 1980 the weighting impact was averaging about 0.5 percentage points, at annual rates, but fell back to zero in the final two quarters of 1980.

Historically, differences in weighting patterns have not usually created differences in price index measures as high as half a percentage point, even for fairly short periods. On the other hand, this "weighting effect" must be related to the degree of inflation in the economy. Even in the first quarter of 1980 (when the divergence between the two PCE indexes was running 0.7 percentage points) the difference between the PCE 1972-weight index (13.2 percent) and the PCE chain-weight index (12.5 percent) was not large enough to influence significantly one's perception of the degree of inflation. That is, both indexes showed inflation in the neighborhood of 13 percent, annually, during that quarter.

Looking at all of the sources of differences in CPI and PCE price measures, table 2 supplies a picture of period-to-period comparisons that is quite similar to the long-term results shown in table 1. Most of the difference between the CPI-U and BEA inflation measures is accounted for by differing treatments of owner-occupied housing. Differences in weights and in "all other" factors have not usually made a substantial impact on the measurement of inflation.

"Reconciliation": CPI and PCE price measures

The relationships among the several versions of the PCE price measures and the CPI permit "reconciliation" of the differences in price measurements obtained by BLS and BEA. It should be clear, however, that there are two reconciliations—one for longer-term inflation measurements and one for period-to-period inflation rates.

The data from table 2 can be used to reconcile period-to-period changes in the indexes, in order to answer the question: "What are the reasons the CPI and PCE price measures show different rates of price change from one period to the next?" This reconciliation is provided in table 3.

Except for 1976 and 1977 (when the difference between the two aggregate indexes was small) housing looms as the largest factor in accounting for the difference between the CPI-U and PCE chain-weight indexes— at least half or more of the total. One would expect weighting differences to become more important as the period between weights lengthens, and the table shows that to be the case. But even the largest weighting effects (0.3 percentage point in 1979 and 0.4 percentage point in 1980) are within the range shown in the table for the "all other" factors (which varied from −0.6 to 1.6 percentage points over the period studied).

Table 4 presents a cumulative reconciliation, which is derived from the data in table 1. It answers the question: "What accounts for the cumulative divergence in the CPI and PCE price measures since 1972?" Over the entire 1972–80 period, the CPI-U rose by 97.0 percent, the Implicit PCE Deflator (PCE-current weights) by 78.9 percent. This 18.1-percentage point difference between the two indexes is distributed as follows:

Factor	Percentage points	Percent of total difference
Total	18.1	100.0
Treatment of owner-occupied housing	11.7	65.0
Weighting effects	5.4	30.0
All other factors	1.0	5.0

Again, the treatment of owner-occupied housing clearly accounts for most of the difference in the inflation messages that the two indexes send over the period. Weighting effects grow larger (as expected) as the period between weighting points increases, but weighting effects are never as great as the housing factor.

Analysis of weighting effects

Some commentators in the press and elsewhere during the past year or so have suggested that the CPI would present a far different picture of inflation if its weights were updated from 1972–73 to some more recent period. To back up their assertion, most of them have merely pointed to factors such as the great runup in energy prices that has taken place since 1972–73 and the energy-saving responses that consumers have made in recent years, leaving the reader with the impression that such changes must introduce massive measurement effects into the indexes. As the preceding sections of this article show, when one turns to the actual numbers, weighting effects on the inflation measure are relatively small.

It is worth considering whether large consumption shifts (which have undeniably occurred) and relatively small weighting effects in the price indexes can plausibly coexist. If consumers have shifted away from products (like energy) whose prices have risen most, why do these consumption shifts produce such small weighting effects on the measurement of consumption costs (for example, less than half a percentage point in 1980's year of double-digit inflation)?

For one thing, it is important to consider how the energy savings have been spent. It has widely been reported, for example, that homeowners have increased expenditures for insulation, storm windows, and so forth in order to reduce consumption of natural gas, heating oil, and other fuels. Thus, if the 1972–73 quantity weight for fuel is too high for current conditions, the weight for insulation expenditures is too low. To some extent, these weighting effects have offset each other in the measurement of overall home operation costs. In this case, the homeowner had to spend money in order to save money, so the total cost of maintaining a home has not fallen by as much as the full savings on fuel. Looking at the fuel savings without fully considering how those fuel savings were achieved overstates the effect of energy conservation on consumption costs.

Another analytical point should also be noted: any consumption price index is intended to measure the cost of a fixed standard of living (a fixed level of consumption)—or alternatively, a fixed level of consumption goods output. Some consumer responses to energy price increases involve reductions in living standards. Turning down thermostat settings, for example, would probably be regarded as a reduction in living standards by most people. In the popular view, cutting back on heating and doing without things is said to be "holding down the cost of living." Many of the articles in the press which alleged that the CPI was "overstating" the rise in the cost of living made just this mistake—they thought that a reduction in living standards ought to be reflected as a reduced rate of increase in the CPI. And this misconception got translated, somehow, into the notion that updating the CPI weights would show a greatly reduced inflation rate. But a consumption price index should not fall when the consumption or living standard falls, just as the price index does not rise with increasing living standards. The index is intended to measure the cost of a *constant* living standard.

There are, however, weighting effects in price index measurements. For some purposes, even a half point in a double-digit inflation year will be important. Isn't the current-weighted index better, the user might wonder, than one which has weights drawn from 6–8 years ago?

The answer is that neither index is better than the other for all purposes. They simply answer different questions, so one is better for some purposes, the other is superior for some alternative use. To take an exam-

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Table 4. "Reconciliation" of the CPI-U and the Personal Consumption Expenditures price measures: cumulative percent change from 1972 to the date shown (1975–80)

Difference	1975	1976	1977	1978	1979	1980	1979				1980			
							I	II	III	IV	I	II	III	IV
Total difference (1972 to date shown)[1]	3.5	4.5	5.4	6.9	11.3	18.1	8.6	10.6	12.4	13.9	16.3	18.4	18.1	19.7
Housing treatment[2]	2.2	2.3	2.6	4.0	7.0	11.7	5.5	6.4	7.4	8.7	10.5	12.3	11.6	12.6
Weighting effect[3]	1.0	1.3	1.8	2.4	3.7	5.4	3.1	3.5	4.0	4.4	4.9	5.1	5.6	5.9
"All other" effect[4]	0.3	0.9	1.0	0.5	0.6	1.0	0.0	0.7	1.0	0.8	0.9	1.0	0.9	1.2

[1] For each year, the CPI-U index minus the PCE: Current-Weight index (from table 1, line (1) minus line (8)).

[2] For each year, the CPI-U index minus the CPI-X1 index (from table 1, line (3)).

[3] For each year, the PCE: 1972-Weight index minus the PCE: Current-Weight index (from table 1, line (9)).

[4] For each year, the CPI-X1 index minus the PCE: 1972-Weight index (from table 1, line (6)).

ple, suppose someone retired in 1972 with a pension plan that calls for maintaining the real consumption value of retirement benefits constant at the 1972 level. For this purpose, the 1972-weighted price index is superior to the current-weighted one, because a 1972-weighted price index is designed to provide the answer to the question, "How much would it cost in the current period to buy the average living standard of 1972?"

On the other hand, suppose one wants to obtain a measure of price change between (say) 1979 and 1980. The 1972-weighted index measures the change in cost of 1972's consumption level between 1979 and 1980; a 1979-weighted index (such as the PCE chain-weighted price index) would measure the cost change in 1979's consumption level between the same two years. For many users, the cost change of the more recent consumption bundle is the more relevant one. Note, however, that no government price index computes the current rate of inflation with truly current weights. For example, no price index now exists which computes the 1979–80 price change with 1980 weights, or the change between the first and second quarters of 1981 using the second quarter's weights.

THIS ARTICLE HAS PRESENTED a simple method, involving nothing more than comparing alternative index numbers, for determining the effect of certain differences in index number construction on the measurement of inflation. The method can be employed by any price index user, as it does not depend on complex computations that can be carried out only within the index-compiling agency nor does it depend on special assumptions. The only requirement is that the user keep in mind what the available alternative aggregate price indexes measure, and use each of them only for comparisons for which it is appropriate.

The nature of Paasche and Laspeyres price index formulas requires two reconciliations—one for longer-term comparisons, and one for period-to-period price index changes. Results, however, are similar in both reconciliations. In recent years, housing has accounted for the greatest part of the difference between alternative price measures. The period chosen for the index weights has a smaller, though perceptible, effect on the aggregate inflation measures. All other factors, taken together, make a quite small difference, even though some of the indexes compared in this article are constructed very differently indeed.

Finally, the article emphasizes that alternative weighting systems for price indexes correspond to alternative questions for which price measurement is required. Indexes with different weights give different measurements because they were designed for slightly different purposes. No single index is best for all purposes. □

———— FOOTNOTES ————

[1] Jack E. Triplett and Stephen M. Merchant, "The CPI and the PCE Deflator: An Econometric Analysis of Two Price Measures," *Annuals of Economic and Social Measurement*, 2/3, 1973, pp. 263–82.

[2] See "Reconciliation of Quarterly Changes in Measures of Prices Paid by Consumers," *Survey of Current Business*, July 1978, pp. 6–9, 24.

[3] See Janet L. Norwood, *CPI Issues* (BLS Report 593, 1980); Robert Gillingham, "Estimating the user cost of owner-occupied housing," *Monthly Labor Review*, February 1980, pp. 31–35; Alan S. Blinder, "The Consumer Price Index and the Measurement of Inflation," *Brookings Papers on Economic Activity 2*, 1980, pp. 539–73; and Council of Economic Advisers and Office of Management and Budget, *Report on Indexing Federal Programs*, excerpted as "Indexing Federal programs: the CPI and other indexes," *Monthly Labor Review*, March 1981, pp. 60–65.

[4] The Laspeyres index for any month is symbolized by:

$$I_{ot} = \frac{\Sigma p_t q_0}{\Sigma p_0 q_0} = \Sigma \left[\frac{p_t}{p_0} \right] \left[\frac{p_0 q_0}{\Sigma p_0 q_0} \right]$$

where p_t is the current month's price for each item included in the index, p_0 is the base or reference-period price, and q_0 is the quantity of the item purchased in the base or reference period. The quantity ($p_0 q_0$ /$\Sigma p_0 q_0$) in the right-hand side is the share of total expenditure accounted for by each item in the base or reference period. As noted elsewhere in the article, the formula is modified for actual computations; it is frequently used to make statements about price change beginning from some period other than the one chosen for the weights.

[5] The Paasche price index is computed by the formula (the symbol definitions are the same as in footnote 4).

$$I_{ot} = \frac{\Sigma p_t q_t}{\Sigma p_0 q_t}$$

[6] Gregory Kipnis, "Implicit Price Index (IPI)," Appendix C in Jules Backman and Martin R. Gainsbrugh, *Inflation and the Price Indexes* (Washington, D.C., U.S. Congress, Joint Economic Committee, July 1966).

[7] That is, p_0 in footnote 5 is always taken to be prices in 1972, with p_t and q_t measured at the current-period levels.

[8] This total of 11.7 index points represents the combined contribution of two effects: (1) the owner-occupied housing cost measure is different (and the one in CPI-XI has risen more slowly than the one in CPI-U), and (2) the weight for owner-occupied housing is lower in CPI-XI than in CPI-U. See Norwood, *op. cit.* for more information.

[9] In the price index literature the term "fixed-weight index" is most commonly used to distinguish price index formulas that hold the weights fixed in both numerator and denominator of the price index calculation. In this sense, all the indexes discussed in the present article are "fixed-weight indexes" for Paasche as well as Laspeyres formulas have fixed weights. The "true cost of living index" is an example of a price index which does not necessarily have fixed weights in its formula. (See Steven D. Braithwait, "The Substitution Bias of the Laspeyres Price Index: An Analysis Using Estimated Cost-of-Living Indexes," *American Economic Review*, March 1980, pp. 64–77.)

The term "fixed-weight index" can also have a different meaning. Index number formulas, by their very nature, refer to only two periods. When constructing a time series for prices over a number of years some decisions have to be made on how to use the two-period index number formulas for multi-year comparisons. One method is to use the same set of weights for all the periods in the time series. Another is to calculate a fixed-weight index number formula for each

pair of periods in the time series and combine them in some manner. In the time series sense, a "fixed-weight index" is sometimes said to be one that adopts the strategy of holding weights fixed over the whole series, rather than changing (or "shifting") the weights for each pair of periods in the series.

Obviously, when the term "fixed-weight index" can mean two very different things, the potential for confusion exists. The CPI and the PCE-1972 weights index are fixed-weight indexes in both senses noted above. The other PCE indexes (the PCE Deflator and the chain PCE price index) use fixed-weight index number formulas, but they are not fixed in the time-series sense.

[9] As noted earlier, the weights, though taken for nearly the same time period, are not exactly the same because consumption as measured in the National Accounts (weights for the PCE) was not exactly the same as measured in the Consumer Expenditure Survey. In addition, until January 1978, the CPI was computed on the "old" weights drawn from 1960–61, so this factor contributes something to the difference, though probably a small amount. The difference also incorporates the net effect of the exclusion of some CPI series from, and the inclusion of non-CPI price data in, the PCE and a host of other factors in which the two indexes differ.

[10] The following table shows the effect of the 1980 revisions on the comparison of the PCE 1972-weight index and the CPI-XI for 1975 through 1980:

	Annual percent change					
	1975	*1976*	*1977*	*1978*	*1979*	*1980*
CPI-XI	8.3	5.7	6.4	6.8	9.6	11.2
PCE-1972 (before revision)	8.2	5.1	5.9	7.1	9.4	10.9
PCE-1972 (after revision)	7.8	5.3	6.3	7.2	9.6	11.0

[11] The current CPI weights come from the 1972–73 Consumer Expenditure survey and no comparable expenditure data for a later period exist. The new Continuous Consumer Expenditure program of the Bureau of Labor Statistics may permit CPI reweighting exercises to be carried out in the future. See Eva Jacobs, "Family expenditure data to be available on a continuing basis," *Monthly Labor Review*, April 1979, pp. 53–54.

[12] For example, if rents begin to rise more rapidly than components of the housing index in CPI-U (house prices, mortgage interest costs, taxes, insurance, and repairs), it is possible for the CPI-XI index to be the faster-rising index. For additional discussion, see Gillingham, *op. cit.*

[13] As we have already noted several times, one cannot give this interpretation to comparisons involving changes in the PCE 1972-weight and PCE current-weight indexes. See the Appendix.

APPENDIX: Interpreting changes in index numbers

This Appendix provides the technical demonstration supporting the text's statement that annual or quarterly *changes* in Paasche-formula price indexes cannot be interpreted as measures of price change between adjacent periods. First, we show that it is legitimate to use changes in Laspeyres indexes as inflation measures.

Changes in Laspeyres-formula index numbers

The Laspeyres price index formula is:

$$(1) \quad L_{ot} = \frac{\Sigma_i \, p_{ti} q_{bi}}{\Sigma_i \, p_{oi} q_{bi}} = \Sigma_i \left[\frac{p_{ti}}{p_{oi}}\right]\left[\frac{p_{oi} q_{bi}}{\Sigma \, p_{oi} q_{bi}}\right] = \Sigma_i \left[\frac{p_{ti}}{p_{oi}}\right] w_i$$

In the formula, "L" stands for the Laspeyres index. Period 0 is often referred to as the "reference" period, t is the current or "comparison" period, and b is the period from which the weights were taken (often taken to be identical with the reference period in the pure Laspeyres formulation, but in practice usually some other period); p and q are consumer prices and consumption quantities in the appropriate periods, and the subscript "i" designates the range of commodities included in the index. For simplicity in notation, the subscript "i" will be dropped in the rest of this appendix wherever the context makes it possible to do so.

Equation (1) has been written in three alternative formulations. The middle form of equation (1) is sometimes referred to as the "computational form," for it expresses the price index in terms of changes in each of the prices (p_t/p_o)—often called a "price relative"—weighted by the share of each commodity in total expenditures in the base period (the second bracketed term). On the far right-hand side, the computational

form of the Laspeyres index is rewritten, with the bracketed expression for the expenditures share designated simply as "w_i."

Textbook presentations on index numbers usually deal with only two periods, but because present purposes call for constructing a time series, we must consider at least three periods. For convenience, let us take the reference and weighting periods to be 1972 (that is, periods 0 and b are both 1972), and consider indexes which use 1979 and 1980 as comparison periods. Then we have two Laspeyres indexes:

$$(2a) \quad L_{79} = \Sigma p_{79} q_{72} / \Sigma p_{72} q_{72}$$
$$(2b) \quad L_{80} = \Sigma p_{80} q_{72} / \Sigma p_{72} q_{72}$$

We want to show that the ratio of these two indexes, from which the percentage change in the Laspeyres index can be determined, is itself a price index.

The change in the Laspeyres index can be determined from the ratio of (2b) to (2a), which is:

$$(3) \quad \Delta L = \frac{L_{80}}{L_{79}} = \frac{\Sigma p_{80} q_{72}}{\Sigma p_{72} q_{72}} \div \frac{\Sigma p_{79} q_{72}}{\Sigma p_{72} q_{72}} = \frac{\Sigma p_{80} q_{72}}{\Sigma p_{79} q_{72}}$$

Equation (3) is a Laspeyres index, though one where the period used for deriving the weights is neither the reference nor the comparison period providing the prices—that is, referring to equation (1), b = 1972, 0 = 1979, t = 1980. This Laspeyres index shows the change in cost, between 1979 and 1980, of a basket of goods and services typifying average 1972 consumption levels.

Thus, the ratio of two Laspeyres price indexes with common weights is itself a Laspeyres price index. This is a very useful property, and accounts in part for the widespread use of the Laspeyres formula: many purposes require a price index formula that can be used to

compute inflation rates for a variety of periods, and the Laspeyres index fills this need. Indeed, using the change in a Laspeyres formula price index as a price measure has become so commonplace that some economists have apparently overlooked the fact that the Paasche index, as normally computed, lacks the Laspeyres index's ability to account for inflation rates for various periods.

Interpreting Paasche-formula index numbers

The formula for the Paasche price index (which we denote by "R") is:

$$(4) \qquad R_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}$$

All the symbols have the same interpretation as in equation (1), and, as already noted, we have dropped the commodity subscript "i" because interpretation is unambiguous without it.

As before, we consider three time periods, and Paasche price indexes for two periods:

$$(5a) \qquad R_{79} = \frac{\Sigma p_{79} q_{79}}{\Sigma p_{72} q_{79}}$$

$$(5b) \qquad R_{80} = \frac{\Sigma p_{80} q_{80}}{\Sigma p_{72} q_{80}}$$

The ratio of these two indexes gives the change, which is, algebraically:

$$(6) \qquad \Delta R = \frac{R_{80}}{R_{79}} = \frac{\Sigma p_{80} q_{80}}{\Sigma p_{72} q_{80}} \div \frac{\Sigma p_{79} q_{79}}{\Sigma p_{72} q_{79}}$$

Unlike the Laspeyres case (equation 3) equation (6) does not reduce to any index number formula, because the two Paasche index numbers (1979 and 1980) have *different* weights. The change in any index number (such as the Implicit PCE Deflator) which is calculated using the Paasche formula remains the ratio of two Paasche price indexes with different weights; it can be given no standard interpretation from the theory of index numbers.

However, Richard J. McDonald, of the BLS Office of Research and Evaluation, has pointed out a relation between equation (6) and the PCE "chain-weight" price index formula, discussed in the text. Each link in the "chain-weight" index uses the Laspeyres price index formula. In the case illustrated (1979–80 annual data), the Laspeyres chain-weight index (LC) is:

$$(7) \qquad LC_{79, 80} = \Sigma p_{80} q_{79} / \Sigma p_{79} q_{79}$$

The LC index has an unambiguous interpretation as a price measure: it is the change in cost (between 1979 and 1980) of 1979's consumption level.

The equation for the LC index can be rearranged, giving:

$$(7a) \qquad \Sigma p_{79} q_{79} = \Sigma p_{80} q_{79} / LC_{79, 80}$$

When this is substituted for the numerator of the term on the right-hand side of equation (6), we have:

$$(8) \qquad \Delta R = \frac{\Sigma p_{80} q_{80}}{\Sigma p_{72} q_{80}} \div \frac{\Sigma p_{80} q_{79} / LC_{79, 80}}{p_{72} q_{79}}$$

Equation (8), in turn, can be rearranged (intermediate steps are available on request) with the final result being:

$$(8a) \qquad \Delta R = \left[\frac{\Sigma p_{80} q_{80}}{\Sigma p_{80} q_{79}} \div \frac{\Sigma p_{72} q_{80}}{\Sigma p_{72} q_{79}} \right] \times LC_{79, 80}$$

This shows that the period-to-period change in the Paasche price index (R) is equal to the Laspeyres-chain-weight index (LC) multiplied by the ratio of two *quantity* indexes (the terms in the bracket in equation (8a)). Each of these quantity indexes gives the change in consumption quantities between 1979 and 1980, but they use different prices as weights (1980 in the numerator, 1972 in the denominator).

Equation (8a) shows that the change in the Paasche price index can be greater or less than the price measure of the chain-weighted index, depending on whether the 1979–80 consumption quantity change is greater or lesser when evaluated in 1972's prices or in 1980's prices. This is, indeed, a complex relation which is not easy to analyze and has been the subject of considerable confusion. Consumption quantities may change between 1979 and 1980 for a number of reasons: (1) changing living standards (for example, reductions in consumption levels that accompany declines in real income during recessions), (2) changing consumer tastes, household formation, or other factors that may alter aggregate consumption levels, (3) shifts in consumption patterns because of consumer response to relative price changes (the substitution of fried chicken for hamburgers, for example, when the price of beef rises more rapidly than the price of poultry), and (4) all other changes in the economy that affect the consumption sector. But equation (8a) shows that it is not *just* the 1979–80 consumption quantity changes that affect the 1979–80 change in the Paasche price measure: the 1979–80 change in the Paasche price index is also influenced by price change over the whole interval back to 1972.

Quantity ratio effect in Paasche index changes

In the following, we refer to the bracketed term in equation (8a) as the "quantity ratio term" present in calculated changes in Paasche-formula price indexes (ΔR). One frequently sees ΔR used as if it were a period-to-period inflation measure, and nearly as frequently analysts have mistakenly compared ΔR with the change in the PCE 1972-weight index in order to estimate the effect of different weighting patterns on the price measurement. Such a comparison mixes the effect of the quantity ratio term with the weighting effect, properly estimated, and can be very misleading, as the following table shows:

Period	PCE: 1972 weight	PCE: current weight	Difference (False weighting effect)	True weighting effect
1979 . . .	9.6	8.2	1.4	0.3
I . .	10.3	10.0	0.3	0.5
II .	9.2	8.0	1.2	0.4
III .	10.4	99.4	1.0	0.5
IV .	11.4	10.7	0.7	0.5
1980 . . .	11.0	10.2	0.8	0.4
I . .	13.2	12.0	1.2	0.7
II .	9.9	9.8	0.1	0.2
III .	9.5	8.8	0.7	0.0
IV .	10.1	9.7	0.4	0.0

(All numbers are seasonally adjusted annual rates and the "true weighting effect" is taken from line 9 of table 2 in the main text.) In 1979 and 1980, the quantity ratio term in R was unusually large, leading many analysts[1] mistakenly to conclude that weighting effects were creating a far larger effect on the price measures than was in fact the case.

Substitution and fixed-weight price indexes

What economic interpretation should be put on the quantity ratio or "shifting weights" term? The "substitution" factor — shifts in consumption in response to relative price changes in goods and services — has a special role in price index theory. Because of this, some economists have apparently assumed that "shifting weights" in the Implicit PCE Deflator are composed entirely or primarily of substitution effects. Equation (8a) shows there is no basis for this belief, but the misperception is so widespread that it is well to say a few words on the matter.

It is well known from price index theory[2] that fixed-weight price index formulas (including both Laspeyres and Paasche indexes) contain a bias because they do not allow for consumer substitution in response to changes in relative prices. If a price index can be constructed which will adjust for consumer substitution while still holding the standard of living constant, it would be a better measure of inflation than fixed-weight alternatives, such as Laspeyres, Paasche, or Laspeyres-Chain indexes, all of which use fixed-weight formulas. The reason is the former would correct for substitution, whereas the three fixed-weight indexes do not. That is a tall order, of course, for the index that corrects for substitution would have to distinguish a reduction in (say) energy usage that was associated with reduced living standards from one that represented only substitution in response to relative price changes, with living standards constant.

Price index theory has devised alternative forms for indexes that do take account of substitution in consumption. One of the first of these was developed by

Nobel prize winner Lawrence R. Klein in a famous article published in 1948.[3]

Empirical comparisons of fixed-weight Laspeyres or Paasche price indexes with indexes that do allow for consumer substitution (usually referred to as "true cost-of-living indexes") have invariably shown that the "substitution" bias in the fixed-weight index is extremely small.[4] Studies by a number of researchers all agree in producing estimates of the substitution bias on the order of one-tenth of an index point (0.1) per year or less. (See the author's summary of these studies published in 1976.)[5]

Moreover, when the effect of weighting differences on index measurement is estimated (as in the body of this paper), the results suggest that the econometric estimates produced for earlier periods are still approximately valid for more recent years, even though no estimates of cost of living indexes have been produced for years subsequent to 1973. In the main text of this article, we estimated the effect of shifting weights from 1972 to 1979 at roughly 0.4 percentage points difference in the index during a year of double-digit inflation (1980). That gross weighting effect is clearly a major overestimate of the substitution effect. The gross weighting effect contains two different substitution effects, which relate to two different formulations of the cost-of-living index, *in addition to* the difference between those two cost-of-living indexes.[6] An educated guess would put the substitution bias in (say) the Laspeyres formula index at no more than 0.2 points of that 0.4 point total — and 0.2 percentage points in a year of double-digit inflation is, in relative terms, close to the 0.1-index point estimates contained in earlier studies for the United States.

THUS, BOTH PRICE index theory and empirical estimates indicate that the change in a Paasche-formula price index incorporates an undesirable measure of quantity change along with the price change measure. The difference between an index such as the PCE "chain index" and the Implicit PCE Deflator itself is often referred to as the "effect of shifting weights"[7] This "shifting weight" term is therefore interpreted as a factor to be removed from the change in the deflator to obtain a valid price measure (which, in this case, is the PCE chain index measure), and not as some sort of correction for the substitution bias that price index number theory predicts for fixed-weight index numbers.

To obtain a measure of aggregate period-to-period price change using the PCE price data system, the user would be well advised to use either the "fixed-weight" or the "chain-weighted" PCE price indexes (those designated in the text as "PCE 1972-weights" and "PCE chain-weights), rather than to compute the change in the Implicit PCE Deflator. It should be emphasized, however, that the Paasche price index formula employed for the

Implicit PCE Deflator does provide a valid current-weighted price measure for the whole interval from 1972 to the date of computation, and nothing in this article suggests that there are any interpretive difficulties in employing the Paasche price index formula for this use. □

— — FOOTNOTES — —

¹ See Blinder, *op. cit.* (particularly at p. 545), as well as numerous articles in the press.

² See Robert A. Pollak, "The Theory of the Cost of Living Index," BLS Working Paper 11, 1971.

³ Lawrence R. Klein and H. Rubin, "A Constant-Utility Index of the Cost of Living," *Review of Economic Studies,* Vol. 15, 1947-48, pp. 84-87.

⁴ See Arthur S. Goldberger and Theodore Gamaletsos, "A Cross-Country Comparison of Consumer Expenditure Patterns," *European Economic Review* 1, 1970, pp. 357-400; Laurits R. Christensen and Marilyn E. Manser, "Cost of Living Indexes and Price Indexes for U.S. Meat and Produce, 1947-71," in Nestor E. Terleckyj, ed., *Household Production and Consumption,* Studies in Income and Wealth, Vol. 40, National Bureau of Economic Research, 1975; Marilyn E. Manser, "A Note on Cost of Living Indexes and Price Indexes for U.S. Food Consumption, 1948-1973," BLS Working Paper 57, January 1976; and Steven D. Braithwait, "The Substitution Bias of the Laspeyres Price Index: An Analysis Using Estimated Cost-of-Living Indexes," *American Economic Review,* March 1980, pp. 64-77.

⁵ Jack E. Triplett, "The Measurement of Inflation: A Survey of Research on the Accuracy of Price Indexes," in Paul H. Earl, ed., *Analysis of Inflation* (Lexington, Mass., Lexington Books, 1975), pp. 19-82.

⁶ See Jack E. Triplett, "Comment," *Brookings Papers on Economic Activity 2,* 1980, pp. 567-72.

⁷ See the *Survey of Current Business,* March 1981.

Cost-of-living escalation

During the past decade of increasing concern about inflation, the influence on wages that has drawn most attention is consumer prices. "Indexing," or cost-of-living escalation, is an important and growing phenomenon. . . . The striking fact is how small—rather than how large—a role the cost of living plays as a wage determinant in the United States. Cost-of-living escalators are essentially absent in the nonunion sector and in nearly half of union contracts, and rarely, if ever, offer increases that are fully proportionate to rises in the Consumer Price Index. Of course, indirectly and informally, consumer prices have somewhat greater effect, partly through the emulation of wages that are escalated. Still, econometric findings on aggregate wage behavior accord a less important role to consumer prices than to past wages or product prices. I believe that this limited role of consumer prices is understandable (and . . . that it is socially desirable).

It is axiomatic that rational workers care, not about the number of dollars in their pay envelopes, but about the bundle of goods and services that it enables them to buy. Clearly, the risk-averse worker will prefer certainty about real wages to a certain path of nominal wages whose real worth has the same expected value but is subject to uncertainty. But the fact that workers care about the predictability of real wages is not sufficient to make the cost of living a major wage influence or a tractable wage norm. That will be the case only if their quit rates are raised by increases in consumer prices for a given distribution of nominal wages in the labor market; or if their concern about the cost of living enables the employer to sell them "real wage insurance" profitably. Consumer prices must be linked to wages by either quit-rate sensitivity or efficient insurance contracts.

—Arthur M. Okun,
*Prices and Quantities: A Macroeconomic
Analysis* (Washington, The Brookings
Institution, 1981), pp. 99-100.