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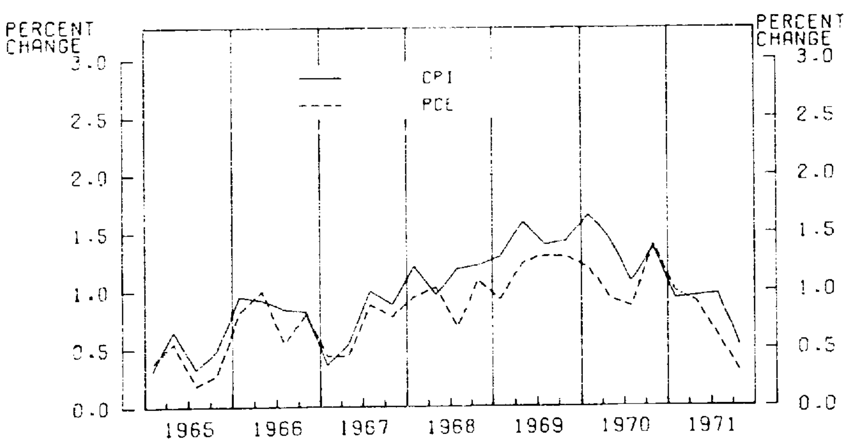
THE CPI AND THE PCE DEFLATOR: AN ECONOMETRIC ANALYSIS OF TWO PRICE MEASURES

BY JACK E. TRIPLETT AND STEPHEN M. MERCHANT*

This paper shows that differences in the movement of the CPI and the PCE deflator can largely be attributed to different price changes recorded by comparable individual components of the two indexes, rather than to differences (such as the weighting patterns) in methods for constructing the aggregate indexes out of the micro data. The results provide a basis for choosing between alternative price measures for consumption.

Two measures of aggregate price change for consumption goods and services are in general use—the Consumer Price Index (CPI), published by the Bureau of Labor Statistics, and the Implicit Price Deflator for Personal Consumption Expenditures (PCE), from the Bureau of Economic Analysis. The two indexes frequently present contradictory evidence of the magnitude—and sometimes even the direction—of price movement (see Figure 1), so that index users, faced with a choice between the CPI and the PCE, frequently ask: What is the source of the divergence between the two series? And, which is preferable for a particular use?

Figure 1 Quarterly Percentage Changes (Seasonally Adjusted). Consumer Price Index and Implicit PCE Deflator, 1965–1971.



Sources: PCE: computed from data published in *Survey of Current Business*, July 1968, p. 49, July 1969, p. 47, July 1970, p. 47, July 1971, p. 43, July, 1972, p. 47 (correction of errors in printed data provided by BEA).
CPI: computed from BLS data.

* Office of Prices and Living Conditions, U.S. Bureau of Labor Statistics. Conclusions are those of the authors, exclusively. The paper does not represent an official position of the Bureau of Labor Statistics nor is it necessarily endorsed by the staff of the Office of Prices and Living Conditions, either individually or collectively. We wish to thank the following for assistance: Robert F. Gillingham, Marian L. Hall, and Brian D. Hedges of the BLS, the reviewer for this journal, and John C. Musgrave, Bureau of Economic Analysis.

Determining answers to either of these questions is difficult. Although it is well known that the CPI and PCE deflator differ in coverage, concept, weighting patterns, and computational procedures, available published information is insufficient to determine exact details of differences between them.[1] There is even less information about the quantitative impact of differences in construction methods on index behavior. The present article compares behavior of the two indexes, using methods which permit statistical testing of relationships between them; results suggest that divergence between the PCE and the CPI stems from sources other than those previously considered.

Previous Approaches to the Problem

Descriptions of the PCE implicit price deflator indicate that wherever CPI data exist, the CPI series are used as deflating indexes.[2] Thus, in a simple example where only one value series and one CPI deflating index appear in the computation of a PCE component, the PCE should present an exact image of the CPI components used as inputs. Thus, it is tempting (though as we show, incorrect) to conclude that if the aggregate PCE and CPI do not move together, the source of the discrepancy *must* lie in the different weighting schemes employed to aggregate the individual components into an overall index, or in coverage differences in the two indexes (components which make up about one-quarter of the weight of the PCE have no counterpart in the CPI), or in differences in concept employed in the measurement of price change in certain components (housing and used cars being the best known examples). We believe, from examining fragmentary remarks sprinkled through the literature, that most index users comparing the two indexes, or trying to decide which of them to employ in a study, have regarded weights, concept and coverage to be the relevant—and, indeed, only—considerations.

However, previous investigations which have explored weighting and concept differences have failed to resolve discrepancies between the two indexes. One approach involves reweighting the PCE according to constant weights of some base period, thus converting it into a fixed-weight type of index (as is the CPI). Substantial divergences between the reweighted PCE and the CPI have remained unexplained.[3]

Another approach that has been tried is to delete, from both indexes, a few components known (or thought) to differ in concept, and then to examine the aggregate behavior of the remainder. Removing Housing from both indexes, for example, often seems to reduce the differences in the aggregates.[3a] The major problem with this approach is that there is no systematic way to assure oneself

[1] Standard documentation of the CPI is U.S. Department of Labor. Bureau of Labor Statistics, "The Consumer Price Index: History and Techniques." Bulletin No. 1517. Washington, D.C.: U.S. Government Printing Office (1964). To our knowledge, the most thorough description of the PCE deflator is Gregory Kipnis. "Implicit Price Index (IPI)." Appendix C, in U.S. Congress. Joint Economic Committee, Subcommittee on Economic Statistics. "Inflation and the Price Indexes." 89th Congress. 2nd Session (July. 1966).

[2] As indicated above, our major source of information on the PCE was Kipnis. *op. cit.*

[3] Kipnis *op cit.*, pp. 104–105. Allan H. Young and Claudia Harkins. "Alternative Measures of Price Change for GNP." *Survey of Current Business*, March 1969. vol. 49, No. 3. pp. 47–52; also. *Survey of Current Business*, August 1970, pp. 12–13; *Survey of Current Business*. August 1971. pp. 23–26.

[3a] The appendix contains an analysis of the behavior of the Housing components of both indexes.

that the few components deleted are the only ones which behave differently. Moreover, simple inspection is the only technique readily employable with either approach, and when there are large quantities of data, it is difficult to learn much from simple inspection.

A New Approach

The present investigation commenced by posing a different question, namely: Is it really true that those components of the implicit PCE deflator which incorporate CPI data as deflating indexes *behave* as if they were based on the CPI? Unless they do, exploring the impact of different weighting patterns, etc., does not strike us as particularly interesting (and interesting or not, the exploration cannot be carried out very effectively without knowledge of any behavioral differences that exist among the various components of the two indexes). There are two reasons for exploring the matter: (1) the inability to account for CPI-PCE differences with approaches used previously suggests searching for an explanation along different lines, and (2) computing the national accounts is a far more complex process than what is usually depicted in simple textbook examples, and the deflator is a by-product of that process. Accordingly, we set out to analyze the behavior of components of the two series, in order to isolate where problems arise, and to indicate which components need to be studied more closely.

Another way to describe the approach we use is the following. We want to design a test to determine where discrepancy between the two price measures originates. We compare, statistically, behavior of counterpart components from the two indexes. If we find that comparison of matched series from PCE and CPI indicates that all's well at that point, then index users and others interested in the behavior of the two indexes may confidently turn to consideration of weighting patterns, or PCE components not derived from the CPI, as the explanation of index differences, and act accordingly. If, on the other hand, we find (as we do) that even matched components of the PCE and the CPI differ in movement, then the question becomes one of determining why this should be so, and users should be alerted to a different set of factors which must be considered before choosing between the two indexes.

The Statistical Model and the Data

If a CPI component is used alone as the deflating index in constructing a component of the PCE, then the process for computing the national accounts, and the implicit price deflator, implies values for regression coefficients in the relation

$$(1) \qquad \Delta PCE = \alpha + \beta(\Delta CPI) + \varepsilon.$$

There are two hypotheses to be tested. First, we test[4] the joint hypothesis that the values of the regression parameters are $\begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$. The second hypothesis

[4] By means of the F-test outlined in: Franklin A. Graybill, *An Introduction to Linear Statistical Models*, Vol. 1, pp. 128–133.

refers to the fit of the regression. It is not enough to find that there is *some* relation between a PCE component and the CPI. Since most of the questions posed by deviations between the PCE and the CPI have to do with the variability of short-term movements (rather than trend behavior), testing the components for an excessive degree of variablity is of equal importance to testing values of the regression parameters. The Fisher z-statistic[5] may be adapted to provide an appropriate test of the R^2. The z-statistic approaches infinity as the correlation coefficient approaches unity, so it is not possible. strictly speaking, to test the hypothesis $R = 1$; we can, however, use the z-statistic to test the hypothesis that R takes on some arbitrary value close to (but not actually equal to) unity. We chose $R = 0.95$ (or $R^2 = 0.90$) as a reasonable value for testing.[6]

What we will hereafter refer to as our "general hypothesis" is: Components of the PCE deflator are reflecting the measure of price change obtained from the counterpart series in the CPI used as an input for the PCE measure. We accept the general hypothesis only if both the specific hypotheses $\begin{bmatrix}\alpha\\ \beta\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix}$ and $R^2 \rightarrow 1$ fail to be rejected.[7]

[5] $z = 1/2[\log_e(1 + R) - \log_e(1 - R)]$ with $\sigma_z = 1/\sqrt{n - 3}$. See T. W. Anderson. *An Introduction to Multivariate Statistical Analysis*, pp. 74–79.

[6] If the hypothesized value approaches unity too closely. the test would result in rejection of the hypothesis in nearly every case. It is known that the Fisher z-statistic is equivalent to the standard F-statistic when the test is for $H_0: R = 0$, because it is both necessary and sufficient. for $R = 0$, that the vector of regression coefficients. β. also be zero. However, we test the hypothesis that $R = 1$: in this case. β can take on any (non-zero) value whatever. so there is no test on β implied by the hypothesis that $R^2 \rightarrow 1$.

[7] Because the CPI is measured with error. it might be thought that errors in variables provides the appropriate statistical model. rather than the classical regression approach introduced in equation (1). However, the determination of the correct statistical model depends not on the nature of the CPI measure, but on the logic of the investigation, which in this case causes us to reject the errors in variables formulation.

The errors in variables framework. if applicable to the present case. would start with the proposition that both variables were measured with error, viz.:

$$\text{(a)} \quad \Lambda_i + \delta_i = \text{PCE}_i$$

$$\text{(b)} \quad \Pi_i + \xi_i = \text{CPI}_i$$

In addition (and this is the crucial part that determines whether the situation is an errors in variables model) it is posited that the true relationship among these variables is one between Λ and Π. or.

$$\text{(c)} \quad \Lambda_i = \theta + \psi \Pi_i .$$

and that there is no true relation between CPI and PCE. In the present case, equation (c) is interpretable as a relation between the "true" deflator and the "true" price index.

The errors in variables theorem then asserts that β, in our regression (equation 1) is a downward-biased estimator of ψ.

The reason we reject the errors in variables framework is that we are not. in the present investigation. interested in the relation between the "true" deflator and the "true" price index (if there is one). The investigation was not designed to obtain an estimate of ψ: instead. we are interested precisely in β. Of course. to obtain an estimate of β the classical regression model of equation (1) is the appropriate one. In our framework. we assume that measurement error in the CPI is passed through directly into the PCE. For this reason it is appropriate to enter the quarterly change in the CPI as if it were a fixed variate. The only cases for which the above reasoning fails to hold are instances in which a PCE component is based entirely on some independent (of the CPI) measure of price change. Another form of estimating bias (the omitted variable problem) is considered at a later point in the paper.

A priori specification of values for the parameters of relation (c) is a complex task, which may not be possible. There exist economic concepts known as the "true cost of living index" (often thought of

Data used in the analysis are quarterly percentage changes (seasonally adjusted) in twenty-one matched components of the CPI and PCE for all quarters from 1965–I through 1971–IV. All components used are listed in Tables 1 and 2. The level of aggregation is determined by the level of detail available in the PCE, so in several cases CPI components have been combined to match PCE coverage.[8] Components included in the analysis account for about three quarters of the weight of both the CPI and the PCE deflator. Where a component from either index has been excluded, it was solely because information available to us indicated there was no counterpart in the other index.[9]

Regression Results

To gain an overview, all the quarterly changes for all 21 components were combined and run in one pooled regression. The results were (standard errors in parentheses):

$$\text{(2)} \qquad \Delta PCE = \underset{(0.033)}{0.283} + \underset{(0.026)}{0.609}[\Delta CPI] \qquad R^2 = 0.48 \qquad S.e.e. = 0.58$$

Although there is a significant (at the 1 percent level) relation between the two indexes, the R^2 is surprisingly low, and the hypothesis $\begin{bmatrix}\alpha\\ \beta\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix}$ is conclusively rejected.

In the present investigation, results for individual components are of primary interest. Separate regressions were run for each of the 21 components common to both indexes. Each of these regressions takes on exactly the same form as the pooled regression, the data cover the same quarters and again we test the hypotheses that $\begin{bmatrix}\alpha\\ \beta\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix}$ and $R^2 \rightarrow 1$.

To facilitate comparison, we have grouped components, in the attached table of "Regression Results" (Table 1), according to whether or not each of the two hypotheses is rejected (i.e., by the results of the F-test on values of α and β,

as the cost of remaining on the same indifference curve) and the "true deflator for national output" (the cost of producing on the same production possibility curve). The latter concept is spelled out in Franklin M. Fisher and Karl Shell, "The Pure Theory of the National-Output Deflator," in Fisher/Shell, *The Economic Theory of Price Indices*, New York and London, Academic Press, 1972; for a comprehensive specification of the true cost of living index—to which the CPI is an approximation—see Robert A. Pollak, "The Theory of the Cost of Living Index," Research Discussion Paper No. 11, BLS, Office of Prices and Living Conditions, June, 1971. Economic meaning can be attached to relation (c) only if Π_i is taken to be a component of the true cost of living index, but then the distribution of ξ is non-normal because the CPI is an upper bound on Π. If Λ is taken to be the true output deflator (or the true deflator for the consumption part of output), then the relation between Π and Λ obviously involves the structure of the entire economic system. The argument in the preceding paragraphs of this footnote indicates that the appropriate specification of relation (c) is a will-o'-the-wisp (at least within the context of the present study). The reason for the present paragraph is to indicate why one cannot take the true value of ψ to be unity, and use such information to make inferences about the structure of the statistical model estimated in the paper.

[8] Data were taken from files of BEA and BLS, and in some components represent detail not normally published.

[9] Omitted components are listed in Tables 3 and 4.

TABLE 1

REGRESSION RESULTS, QUARTERLY PERCENT CHANGES (SIMPLE) OF THE PCE COMPONENT INDEXES ON THE CORRESPONDING CPI INDEXES (1965 I-1971 IV)

	α	β	R^2	Standard error of estimate
Group I (pass F-test, pass z-test)				
New Cars	0.002 (0.061)	0.972 (0.046)	0.944	0.32
Food Away From Home	−0.023 (0.048)	1.014 (0.035)	0.970	0.07
Shoes	0.128 (0.089)	0.934 (0.071)	0.868	0.17
Women's Clothing	0.205 (0.091)	0.838 (0.083)	0.795	0.23
Men's Clothing	0.220 (0.078)	0.846 (0.072)	0.842	0.20
Drugs	0.014 (0.019)	0.911 (0.046)	0.937	0.09
Group II (fail F-test, pass z-test)				
Furniture and Household Equipment	0.019 (0.047)	0.790 (0.071)	0.827	0.18
Food At Home	0.150 (0.059)	0.821 (0.049)	0.914	0.23
Group III (pass F-test, fail z-test)				
Tires	−0.067 (0.217)	1.084 (0.197)	0.538	0.68
Ophthalmic and Orthopedic Devices	0.196 (0.174)	0.796 (0.151)	0.517	0.35
Gasoline and Motor Oil	0.209 (0.205)	0.630 (0.168)	0.351	0.93
Tobacco	0.064 (0.188)	0.917 (0.121)	0.689	0.47
Semi-Durable House Furnishings	0.329 (0.110)	0.840 (0.108)	0.701	0.47
Group IV (fail F-test, fail z-test)				
Alcoholic Beverages On Premises	0.386 (0.149)	0.119 (0.105)	0.048	0.45
Alcoholic Beverages Off Premises	0.237 (0.123)	0.473 (0.161)	0.251	0.39
Toilet Goods	0.169 (0.074)	0.666 (0.079)	0.731	0.33
Fuel and Ice	0.520 (0.315)	0.301 (0.211)	0.073	1.37
Housing	0.483 (0.112)	0.184 (0.078)	0.177	0.30
Personal Services	0.691 (0.133)	0.347 (0.114)	0.263	0.27
Recreation	0.642 (0.147)	0.485 (0.148)	0.292	0.41
Transportation	0.728 (0.147)	0.313 (0.060)	0.511	0.60

Figures in parentheses are standard errors.

and of the z-statistic on R^2). Since the z-statistic has a standard error which depends only on the number of observations, and each of the 21 regressions contains exactly the same number of observations, significance tests on the correlation coefficients use a single critical value. For values of $R^2 > 0.74$ we cannot reject—at the 1 percent level of significance—the hypothesis that the true R^2 is 0.90. Hence, all those components for which $R^2 \leq 0.74$ are classified as exhibiting excessive variability.[10]

Group I, in the table of "Regression Results," contains components for which we can reject neither hypothesis. In other words, these are the components which behave as expected, and for which the regression confirms that the PCE components are in fact closely related to the CPI.

Groups II and III contain components which pass tests on one of the two hypotheses, but fail on the other. It might appear that the most interesting part of the general hypothesis involves the testing of the specific hypothesis on α and β. This would imply a more sanguine attitude toward those elements falling into Group III than toward those of Group II.

Notice, however, that there are cases (the most striking is the Gasoline and Motor Oil component) where the F-test results in failure to reject the specific hypothesis on α and β, even though the estimated values are not at all close to the hypothesized ones. The cause is high variability of the estimates (as the size of the standard errors suggests). For the two components of Group II (components for which we *can* reject the specific hypothesis on α and β), the estimated values for α and β are actually nearer the hypothesized values than are the estimates for several components of Group III (for which the hypothesis cannot be rejected).

There is thus a sense in which we are reluctant to accept, without qualification, the result of the statistical test on the regression coefficients. We want to avoid concluding that PCE and CPI components are closely related just because standard errors are so large that it is difficult to reject the $\begin{bmatrix}\alpha\\ \beta\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix}$ hypothesis for almost any estimated values of the coefficient vector, a pitfall which underscores the importance of combining the F-test on the regression coefficients with the z-test on R^2. This is the rationale for regarding the components of Group II as somewhat more satisfactory, from the standpoint of conformity between PCE and CPI, than those of Group III.

We have, finally, the eight components of Group IV, for which we reject *both* the specific hypotheses. For some of these components, the outcome was surprising, although others (Housing, for example) had long been singled out as a source of discrepancy between the two indexes. Housing, Recreation, Personal Services, and Transportation were subjected to special analysis, reported in the Appendix.

Index weights for components falling into Groups I–IV are presented in Table 2. Of the 21 components studied, only *six* (those of Group I) behave in

[10] It is conceded that the selection of the hypothesized value of R^2—based, as it was, on what we judged was "reasonable"—was completely arbitrary. Readers who have definitions of "reasonableness" differing from ours may prefer to base the z-test on a different value. If one tests $H_0: R^2 = 0.95$, the boundary of the critical region rises to $R^2 = 0.81$; alternatively, $H_0: R^2 = 0.85$ changes the boundary to $R^2 = 0.63$. Either of these alternatives would result in some realignment in the groupings of Table 1, which the reader may carry out for himself if so inclined.

accordance with expectations. These six account for 19 and 17 percent of the weight of the PCE and CPI, respectively, and a little under one-fourth of the total index weight accorded to the 21 components examined in this study. In contrast, the eight worst-behaved components (those of Group IV) actually account for a larger proportion of the indexes—one-quarter of the PCE and one-third of the CPI.

We conclude, from the evidence provided by regressions on individual index components, that most PCE components do not behave as if they are purely a reflection of the CPI components used as deflating indexes. With the exception of the six components of Group I, our general hypothesis is rejected, or partially rejected, by the data. If these 21 components (which ought to be the most closely related components of the two indexes) behave differently, it is, then, not too surprising that the overall PCE and CPI often give different measures of the course of inflation.

Regressions on Aggregate Indexes

Additional information on the behavior of the indexes can be obtained by analyzing the data in yet another arrangement. First, we take as observations quarterly percentage changes from the published indexes for the overall CPI and the overall, fixed-weight PCE.[11] Using these data in a regression of the same form as equation (1) gives:

$$(3) \qquad \Delta PCE = \underset{(0.120)}{0.155} + \underset{(0.155)}{0.721}\,[\Delta CPI] \qquad R^2 = 0.60 \qquad S.e.e. = 0.23$$

The estimated values of regression parameters in equation (3) depict the lack of correspondence between the two series that has so puzzled users of the indexes. For comparison, we aggregated index changes on the 21 components of Table 1. The quarterly change in each component of each index was weighted by the index weight of that component (in its own index) and the changes summed over all components, which yields an aggregate change for the 21 components.[12] When these summed quarterly changes are used in a regression, the results are:

$$(4) \qquad \Delta PCE = \underset{(0.082)}{0.128} + \underset{(0.081)}{0.660}\,[\Delta CPI] \qquad R^2 = 0.72 \qquad S.e.e. = 0.17$$

One would expect that equation (4) should yield results more in conformance with the hypotheses tested than does equation (3), since equation (3) includes components for which counterparts in both series do not exist. It is surprising, therefore, that the two sets of regression results are so similar, and that the R^2 value in equation (4) shows so little improvement over equation (3). Regressions

[11] The 1967 fixed-weight PCE was used. This is the only fixed-weight version published which covers the entire 1965–1971 period. Source: *Survey of Current Business*, August 1971, *op. cit.* After this paper was completed, revised values for the deflator for 1969–1971 became available.

[12] The weighted average of index percentage changes (which is what we have computed) is not the same as the percent change in the weighted average of index numbers. The difference between the two will be larger the larger the index changes. In the present case, the probable size of the divergence, in data on *quarterly* changes, does not justify the amount of additional (hand) computation required to derive data for equation (4) on the percent change in the twenty-one component aggregate index numbers.

on both indexes fail the z-test as we have set it up (regression 4 by a narrow margin), and for both regressions, the $\begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ hypothesis is rejected at the 1 percent level. We conclude from this that there is little basis for distinguishing between the aggregate behavior of our 21 components and that of the overall indexes.

There is considerable interest in comparing the individual regressions of Table 1 with the more aggregative regressions (equations 2, 3, and 4). Weighted means[13] of the coefficients from the 21 regressions are: $\bar{\alpha} = 0.244$ and $\bar{\beta} = 0.648$, not far from the estimated values of α and β in equation (4) and remarkably close to the results of the pooled regression (equation 2).

Measures of dispersion about the regressions, however, show a different picture. The weighted mean of the standard errors of estimate for the 21 components is 0.33. This figure is just about twice the size of the standard error of estimate from equation (4)—0.17. Regression results and plots of residuals from the regressions also confirm the fact that there is a good deal more variability in the movements of individual component indexes than in the aggregate, or overall, indexes.

The reason why the two aggregate indexes usually show smaller quarter-to-quarter deviations than do the underlying component series is simple and rather obvious. There are usually both positive and negative deviations among the individual PCE and CPI series, in any given quarter, so that a major part of the disparity in the movements of individual series is netted out in the aggregation process. Thus, it is possible for the overall PCE and CPI to change by approximately the same amount, even in quarters in which there is a substantial amount of divergence present in movements of the various component series. But this implies that convergence of the overall PCE and CPI is a probabilistic event, with a distribution depending on joint frequency distributions of deviations in the underlying series. Whether the overall PCE and CPI price measures agree or diverge may therefore depend mainly on statistical accident.

We are concerned with the question of why the overall PCE and CPI often give different measures of inflation; the answer we give (partial as it admittedly is) is that the aggregates differ because the price measures provided by individual components differ even more. The problems implied by this answer are not rendered less relevant by the fact that we can count on a variant of the law of large numbers to assure (probably) that in any given quarter there will be at least some negative deviations to set against positive ones.

Regression Coefficients and Index Relationships

As indicated above, weighted means of regression coefficients from Table 1 were very close to values estimated in equations (2) and (4). Consistency of this order promotes confidence that relationships between the overall PCE and CPI can in fact be characterized by the estimated regression coefficients.

The positive intercept term which emerges in nearly every regression suggests an upward drift of these 21 PCE components relative to their counterparts in the

[13] Weights were those of the PCE, since PCE components were dependent variables.

CPI (of a magnitude of approximately 0.15–0.25 percentage points per quarter). The regression slope coefficient, however, indicates that a one percent change in the CPI will move the PCE by only about six-tenths of one percent.[14] Hence, these parameter estimates suggest that the PCE will tend to overstate the change in the CPI for low rates of price increase, but understate the CPI change for high rates of price change (in excess of approximately 1 percent per quarter).

These results cast a new light on certain aspects of the behavior of the two indexes that have received some attention. For one, the total PCE deflator has risen less than the overall CPI in recent years, which have been years of relatively high price change. Our regressions indicate this is the normal pattern. Moreover, because price increases usually are greater during the expansion phase of the business cycle, the relationship uncovered by our analysis provides some explanation for Prell's observation that the CPI has risen relatively more rapidly than the PCE during the expansionary phases of post-war business cycles, with the PCE overstating the CPI change during contractions.[15]

We ran additional regressions to test for homogeneity over time. There was strong evidence that the two indexes moved together more closely in 1970–1971 than they did in earlier periods, and 1965–1966 were quarters of least correspondence. We have not reproduced these results. The BEA has suggested to us that data for recent years fit the general hypothesis better because the national accounts for those years are still subject to revision, and that revisions tend to make the PCE correspond less closely to the CPI.

Use of the Method to Explore Weighting Differences

Taking the 21 PCE and CPI components, we weighted the quarterly change in each component by the *PCE weight* of that component. The quarterly changes were then summed over all components, giving an aggregate quarterly change in each index *weighted according to the* (fixed-weight) *PCE*. A regression on the aggregate, 21-component indexes gave:

$$(5) \qquad \Delta PCE = \underset{(0.063)}{0.140} + \underset{(0.066)}{0.698}\,[\Delta CPI] \qquad R^2 = 0.81 \qquad S.e.e. = 0.14$$

This regression differs from regression (4) only in the weighting pattern. In regression (4), components were assigned their weight in the index to which they belonged; in regression (5), a common set of weights was used for components in both indexes. Because imposing a common set of weights on the index changes has little effect on the estimates of the regression coefficients (the hypothesis on α and β

[14] Since α and β have separate economic interpretations, it might be argued that individual t-tests could be carried out, rather than relying on the joint hypothesis test we employ. Separate tests would permit distinguishing components for which there seems to be substantial upward drift in the PCE (measured by the value of α) from those where the problem of correspondence seems to involve primarily the slope coefficient. Characterizing our "general hypothesis" in the form of three specific hypotheses (instead of two) results in an eight-way classification in Tables 1 and 2, with many of the cells of very marginal interest. Readers who believe that either ordinary Student's or Bonferroni t-tests are appropriate can readily carry them out for themselves, using the data of Table 1. The Bonferroni tests, of course, are an alternative to the F-test we employ.

[15] See Michael J. Prell, "Relative Movements of U.S. Price Indexes in the Post-War Period," unpublished Ph.D. dissertation, University of California (Berkeley), 1971, pp. 132–133.

is still rejected, in equation 5, using the F-test), weighting patterns do not appear to account for much of the difference in the behavior of the CPI and fixed-weight PCE.

BEA studies have shown that the fixed and current-weighted deflators may exhibit different quarterly changes, but that as the period of comparison lengthens, reweighting the PCE deflator in various ways makes surprisingly little change in the overall index. Regression (5) suggests that weights do not account for much, if any, of the substantial quarterly divergence between the CPI and the fixed-weight PCE. The two pieces of evidence do not permit a conclusive judgment on the impact of weighting patterns on index behavior. They do suggest that the weighting question may not be as important, empirically, as it has often been assumed to be. Index users, attributing behavioral differences to Paasche-Laspeyres weighting patterns, have often selected a measure of price change on the basis of which set of weights seemed preferable.[16] But if weights do not account for the difference in price movement shown by the two indexes, consideration of the theoretically appropriate weighting scheme is of minor consideration, if it should be considered at all, in choosing between the indexes.

INTERPRETATION OF THE RESULTS OF THE STUDY

At this point it is appropriate to acknowledge the fact that the results presented above are novel and surprising. To our knowledge, no one has previously suggested that the two indexes might differ in the ways our analysis suggests. Having analyzed the data from a variety of perspectives, we are reasonably sure that our facts are indeed facts; we are less positive about the explanation for the facts we have uncovered.

Where one or both of the specific hypotheses tested is rejected, in an individual index component, four possible explanations for the findings could be advanced.

(1) There may be differences in measurement concept which result in systematic differences in measured price changes. Housing, often referred to in this regard, is discussed in the Appendix. The present study indicates that there is so much difference in the behavior of many components which are conceptually similar that it is difficult to see how they could be less related if they were conceptually dissimilar.

(2) Where PCE components are built up from several CPI series, the *internal* weighting structure of the PCE component may differ from the relative importance of the same items in the CPI. We are inclined to dismiss the internal weighting structure of PCE components as an explanation largely because of various pieces of evidence indicating that changing the weighting structure *among* components produces slight impact on the overall index.

(3) Many PCE components are aggregations of one or more CPI indexes, plus one or more indexes from other sources (WPI, U.S. Department of Agriculture indexes, earnings indexes, and implicit indexes constructed by BEA--see the listing in Table 2); where non-CPI data have a large weight, it may exert sufficient impact on the PCE price measure to deflect it significantly from the course of its

[16] Actually, the PCE is only partially a Paasche index. Kipnis (*op. cit.*, p. 106) calls the PCE deflator "the inverse of current year weighted reciprocals of Laspeyres price indexes."

TABLE 2

INDEX WEIGHTS OF THE PCE AND CPI INDEXES USED IN THE REGRESSION ANALYSIS; AND A LIST OF OTHER INDEXES IN THE PCE

PCE Components		CPI Indexes		Other Indexes In PCE, If any
Title	Weight	Title	Weight	
Group I				
New Cars (Domestic)	5.71	New Cars	2.55	
Purchased Meals and Beverages	3.15	Food Away From Home	4.54	
Shoes	1.19	Footwear	1.51	Agric.
Women's Clothing	4.80	Women's and Girl's Apparel	4.08	Agric.
Men's Clothing	2.42	Men's and Boy's Apparel	2.86	Agric.
Drugs	1.25	Drugs and Pharmaceuticals	1.14	
Total	18.52	Total	16.68	
Group II				
Furniture and Household Equip.	7.24	Furniture (1.44) + Appliances (1.36)	2.80	Agric. WPI. Implicit
Food Off-Premises	16.35	Food at Home	17.89	Agric.
Total	23.59	Total	20.69	
Group III				
Tires	0.54	Auto Parts (Tires and Tubes)	0.72	Agric.
Ophthalmic and Orth. Devices	0.31	Optom. Exam. and Eyeglasses	0.29	
Gasoline and Motor Oil	3.66	Gasoline and Motor Oil	3.28	Agric.
Tobacco	1.71	Tobacco Products	1.89	Implicit
Semi-Durable House Furnishings	1.02	Textile House Furnishings	0.61	WPI. Agric.
Total	7.24	Total	6.79	
Group IV				
Alcoholic Bev. On Prem.	1.17	Beer (1.06) + Whiskey and Wine (0.78)	1.84	Implicit
Alcoholic Bev. Off Prem.	1.81	Beer, Cocktails Away From Home	0.80	Implicit (No CPI)
Toilet Goods	1.07	Toilet Goods	1.52	
Fuel and Ice	1.27	Fuel Oil and Coal	0.73	Agric.
Housing	14.50	Rent (5.50) + Home Ownership (14.27)	19.77	
Personal Services	1.68	Personal Care (Services)	1.23	WPI. Implicit
Recreation	1.58	Reading and Recreation	5.94	WPI. Implicit Earnings
Transportation	2.76	Public Transportation	1.24	Implicit Earnings
Total	25.84	Total	33.07	

Sources: Weights—U.S. Department of Commerce and "The Consumer Price Index: History and Techniques." Bulletin No. 1517, U.S. Department of Labor, pp. 97–8; Other Indexes in PCE—Kipnis, op. cit., pp. 95–6.

TABLE 3

PCE COMPONENTS NOT USED IN THE REGRESSION ANALYSIS

PCE Component	Weight (Percent of Total PCE)*	Deflating Indexes used in Computing the PCE Component
Foreign New Cars	0.28	CPI New Cars
Used Car Margins	0.34	Implicit
Trailers	0.37	CPI New Cars
Accessories and Parts	0.30	WPI, Agric., Others
Jewelry	0.80	WPI. Other
Books and Maps	0.44	CPI. Agric.
Wheel Goods	0.71	CPI. WPI
Inventory Change for Used Cars	0.00(+)	Implicit
Civilian Food	0.23	CPI
Military Food	0.13	Implicit
Farm Food	0.19	Agric.
Military Clothing	0.02	WPI
Stationery	0.32	WPI
Non-Durable Toys	0.82	CPI. WPI
Expenditures Abroad	0.36	Other Prices
Misc. Non-Durables	1.66	Unknown
Flowers	0.22	Ag. Prices
Remittances-In-Kind	−0.03	CPI. Agric.
Household Operations (Misc.)	5.85	WPI
Other Services	11.79	Unknown
Total	24.82†	

* 1965-IV.

† May differ from sum of items due to rounding.

Sources: Weight from U.S. Department of Commerce: information on Deflating Indexes from Kipnis, *op. cit.*, pp. 95–6.

CPI counterpart. There is no published information on the weight accorded to non-CPI data in PCE components, the way data from various sources are combined to produce deflating indexes, or the precise series employed. Information from BEA, and from other sources, indicates extensive use in the PCE of U.S.D.A. Prices Paid by Farmers indexes to augment the CPI sample of items,[17] as well as to provide price measures for the rural population. We suspect that in a number of components Prices Paid by Farmers indexes contribute significantly to the movement of the PCE, and partly account for divergence between the PCE and CPI.

Whenever non-CPI price series are used as deflating indexes in computing the PCE, it is clear that the statistical model used in the present paper (i.e. equation 1) is mis-specified. Suppose $X_i, \ldots, Z_i$ are non-CPI data used in the construction of PCE component i. Then, instead of equation (1), the appropriate statistical model is of a form something like

$$\Delta PCE_i = a + b_1(\Delta CPI_i) + b_2(\Delta X_i) + \ldots + b_z(\Delta Z_i) + e. \quad (6)$$

[17] The CPI is a probability sample of items, with the items selected for pricing intended to represent price movement of all items in the sampling frame for that component. Eight appliances, for example, are currently priced to represent price movements of 21 appliances from which the sample was drawn. In the computation of the PCE, we understand, indexes for the eight CPI appliances stand for themselves, and Prices Paid by Farmers indexes are used for appliances which are in the CPI appliance sampling frame, but not selected for the sample.

TABLE 4

CPI INDEXES NOT USED IN THE REGRESSION ANALYSIS

CPI Index	Weight (Percent of Total CPI)
Hotels and Motels	0.38
Other Utilities	1.82
Gas and Electricity	2.71
Floor Coverings	0.48
Other Housefurnishings	0.83
Housekeeping Services	1.55
Housekeeping Supplies	1.55
Other Apparel	2.18
Used Cars	2.47
Automobile Services	3.62
Professional Services (exc. optometric examination and eyeglasses)	2.30
Hospital Services	0.36
Health Insurance	1.61
Reading and Education	1.58
Personal Expenses	0.53
Miscellaneous	0.38
Total	24.35

Source: "The Consumer Price Index: History and Techniques," Bulletin No. 1517, U.S. Department of Labor, pp. 97–8.

Instead of the $\begin{bmatrix}\alpha\\ \beta\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix}$ hypothesis tested in this paper, we would test the hypothesis that the values of the vector b were equal to the weights assigned to the various price series $CPI_i, X_i, \ldots, Z_i$ in making up the component PCE_i. If $X_i, \ldots, Z_i$ are *price* series, such as Wholesale Price Index or Prices Paid by Farmers components, we would expect them to be positively correlated with the CPI, which means that β, in equation (1), is an upward-biased estimate of the true weight of the CPI in the PCE (i.e., of b_1, in equation 6).

(4) As the final possible source of divergence between PCE and CPI, PCE price measures will be subject to any discrepancy introduced by the nature of the computational process which intervenes between the point at which CPI series are introduced into the calculation of constant-dollar GNP components, and the end point of that process, which yields the implicit price measure. The GNP computational process has been almost entirely overlooked as a source of PCE–CPI discrepancy. If products were homogeneous, and proper price, quantity and value data always available for every component, then the implicit deflator should always mirror the deflating indexes which were used as inputs. Data, however, are messy, incomplete, and of varying quality, so the complexity of the process of actually computing the GNP is not fully reflected in the formulas which usually describe it. Any process of, e.g., adjusting data by benchmarks, checking against related series, "forcing" totals to maintain consistency, etc., introduces implicit

effects on the price measure, and may cause the implicit price deflator to diverge from the deflating indexes. This should not be taken to infer that there is anything wrong with the way BEA computes the National Accounts. It is, after all, charged with responsibility for output measures, not price indexes. Where requirements for output and price measures conflict, we presume that BEA acts to preserve the accuracy of the output measures, and price requirements must give way.

We believe that points (3) and (4) account for most of the discrepancy in movement between series in the PCE and their CPI conterparts, but we lack sufficient information to assess the relative importance of the two. We doubt if explanation (3) can account for all of the deviation observed between PCE and CPI components. PCE "Toilet Goods" is obtained entirely from its CPI counterpart, yet falls into our Group IV. Documentation of the composition of the PCE deflator would enable an investigator to evaluate our explanation (3), and serve as well to suggest something of the quantitative importance of explanation (4).

Summary and Conclusions

This study followed a disaggregated approach in attempting to discover why the overall CPI and PCE deflator frequently present different measures of the magnitude and rate of change of inflation. We have shown that individual components of the two indexes present pictures of the course of price change for individual commodities and groups of commodities that in many cases are even less in agreement than are the overall indexes. In 15 out of 21 components analyzed, we reject, wholly or partly, the "general hypothesis" that PCE components present the same economic picture drawn by their counterpart measures in the CPI. Because the CPI measures are inputs into the PCE, this result is both surprising and revealing.

Conclusions to be drawn must be tentative, because some of our results cannot at this time fully be explained, because further research along the lines of this study may turn up more information on index behavior, and because contemplation of our findings by economists with greater insight into PCE compilation procedures may result in explanations for some of our findings that we are not in a position to perceive.[18] Nevertheless, the results as they stand have implications for those who would use either or both indexes for economic research or analysis.

The implication we stress most strongly is that there is no single "cause" or "explanation" for differences in the behavior of the aggregate CPI and PCE. The weighting structures, for example, though they may contribute something to index divergence, cannot be considered a sole or even major cause of it. Where components in the two indexes are moving differently, as our results show they are, there is no weighting pattern that can resolve the discrepancy in the aggregates. Similarly, there is no single component, or group of components which can be said to account for differences in the overall indexes. Housing, simply because it has the largest weight of our "Group IV" components, comes closest on this

[18] We are indebted to John C. Musgrave, of BEA, for so resolving one or two puzzles reported in an earlier draft of this paper.

score, but even with Housing removed from the indexes, there are still 14 other components for which we reject part or all of our general hypothesis, and each of these is contributing its share of positive or negative divergence to the total.

And if there is no single source of differences in index behavior, the corollary is that there is no single or simple factor which can be taken as the criterion for choosing between the two indexes. If weights do not account for behavioral differences, it makes little sense to choose between the indexes on the basis of their weights. And if Housing is only the chief among many components which behave differently, it is unsound to choose among the indexes solely on the basis of their respective conceptual treatments of Housing.[19]

We believe that most of the divergence in movement between comparable index components can be attributed to the effect of non-CPI price series used in the PCE, and to the indirect effects on the implicit deflator of various exingencies required in the compilation of the national accounts. If the cause is primarily the impact of, e.g., Prices Paid by Farmers indexes, then the choice between the CPI and the PCE depends on whether the user wants the price measure provided by the CPI, or a combination of CPI and PPF price measures. If, on the other hand, a significant part of the discrepancy between the CPI and the PCE deflator is in fact introduced by the computation process for the accounts, it would appear that the PCE is defective as a price measure, unless there is some reason for believing that the various necessary adjustments and "forcings" on the quantity side somehow improve the price measures used as inputs.

U.S. Department of Labor

Appendix

Four components from Group IV of Table 1 were selected for additional analysis to see if it would be possible to provide any systematic explanation for the rejection of the specific hypotheses tested in the body of the paper. Housing was selected because of its large weight in both indexes and because it is well known that the construction of this component differs in the two indexes. We find that construction differences account nearly completely for differences in behavior of this component. For three other components—Recreation, Transportation, and Personal Services—we endeavored to obtain more detailed information on the construction of the PCE component, and used this additional information to revise our regressions. With one (marginal) exception, the additional information did not account for the rejection of specific hypotheses.

Housing

PCE and CPI Housing components differ in their treatments of owner-occupied housing. Many economists have stated that the appropriate pricing concept is the cost of housing services. There are, however, two available empirical

[19] As we show in the Appendix, one can get the CPI computed according to the PCE Housing measure simply by letting the CPI rent index replace the CPI Homeownership component, so the choice of measurement concept for Housing is irrelevant to choosing between the PCE and the CPI.

methods for obtaining information on the cost or price of housing services for owner-occupied houses.

One method is to estimate a cost function for housing services. The Homeownership segment of the CPI Housing component incorporates prices for major elements which make up the cost of providing housing services (taxes, insurance, maintenance, interest rates, and the prices of required capital goods), and thus may be regarded as an attempt to estimate a cost function for housing services. All prices which enter the index are, in principle, current market prices, so the Homeownership component is a measure of the *current* cost of providing housing services.

The PCE Housing component approximates the price of housing services for owner-occupied houses by using measured rents for housing units that are in fact rented. Although benchmark data on owner-occupied and rental single-family dwellings are used in computing the national accounts, the PCE *price* measure is driven by the CPI Rent index, which is a comprehensive rent measure, heavily weighted toward multi-family units. Thus, the measure used to impute rental prices for owner-occupied houses in the PCE is not exclusively a measure of rents for single-family dwellings, but includes rents for apartments and other types of housing.

With this summary description of measurement techniques employed in the two indexes of housing prices, we turn to their behavior in our regressions. Housing, in Table 1, fell into Group IV, as it failed both the specific hypotheses. The Housing equation from Table 1 is reproduced as equation (A.1), below. We noted (above) that the PCE Housing component is based entirely on the CPI Rent Series. Equation (A.2) shows results of a regression on quarterly changes in PCE Housing and CPI Rent.

$$\text{(A.1)} \quad \Delta\text{PCE Housing} = \underset{(0.112)}{0.483} + \underset{(0.078)}{0.181}\,(\Delta\text{CPI Housing}) \qquad R^2 = 0.18$$

$$\text{(A.2)} \quad \Delta\text{PCE Housing} = \underset{(0.030)}{0.064} + \underset{(0.040)}{0.946}\,(\Delta\text{CPI Rent}) \qquad R^2 = 0.96$$

As expected, the correlation is extremely high, and values of the regression intercept and slope coefficient closely approximate their hypothesized values. Thus, the extreme divergence in movement between the Housing series of the two indexes is exclusively related to the different approaches taken by the index compilers in seeking an approximation to the value of services from owner-occupied housing. In particular, the divergence between PCE Housing and CPI Housing is in fact nothing more than the divergence between CPI Rent and CPI Homeownership.

Much attention has been directed to the impact of mortgage interest rates (which have fluctuated markedly). Changes in interest rates enter immediately into the CPI, but presumably affect the PCE Housing component only with some lag, as the full effects work out through the rental housing market.

The contribution of the mortgage interest cost series to the PCE–CPI Housing measure discrepancy is perhaps best revealed from a plot of quarterly changes in various housing series. In the accompanying chart, the solid and dashed lines are, respectively, the CPI and PCE Housing series, and are thus the plot of the data

Chart A.I
COMPARISON OF PERCENT CHANGES IN PCE AND CPI
FOR HOUSING

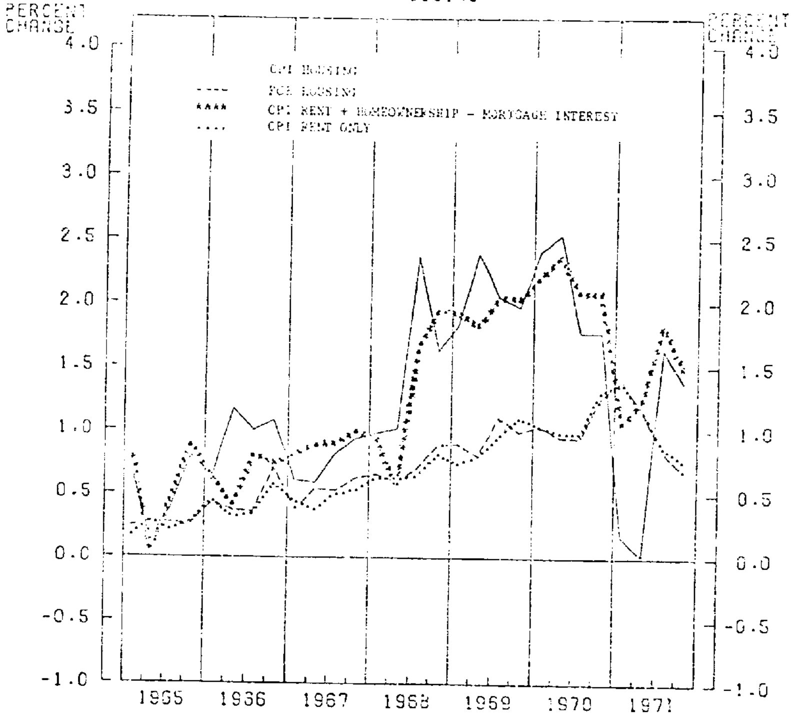
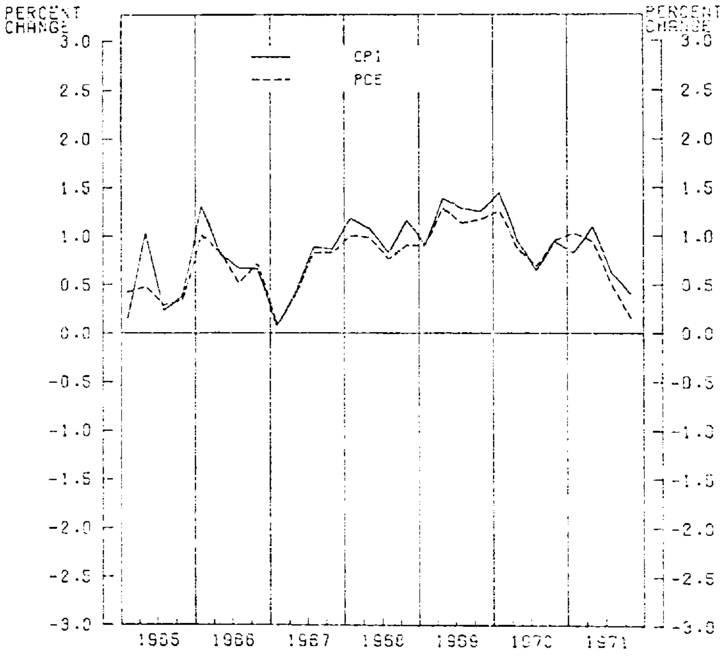


Chart A.II
COMPARISON OF PERCENT CHANGES IN PCE AND CPI
FOR AGG - HSNG



used in regression A.1; the plot indicates visually what in regression A.1 was determined through statistical measures—the two series do not coincide. Comparing the dotted line (CPI Rent) with the PCE Housing data (dashed line) shows a close correspondence between these two series—and, as noted, this is precisely the result determined by equation (A.2). Removing the mortgage interest element from the CPI (the line on the chart made up from asterisks) produces a series which remains fairly consistently near the quarterly change in the overall CPI Housing component, and does not at all approximate the PCE.

We conclude from this that (with the notable exception of the first half of 1971) mortgage interest costs are not the sole, or even major, cause of the PCE–CPI Housing discrepancy. Other housing cost elements priced for the CPI were also rising much more rapidly than rents during the period studied, so the difference in measurement must be attributed to the entirety of the difference in approach followed in the two indexes.

Because of its weight, Housing has a major impact on the behavior of the aggregate indexes. If the two Housing components are removed, either from the overall indexes or from the 21-component indexes computed for equation (4), the remainders of the two indexes move more closely together than when Housing is present (see Chart A.II). But because of this paper's findings with respect to the dissimilar movements of other index components, the Housing components are only part—though an important part—of the problem.

Recreation, Transportation, and Personal Services

Recreation. In our initial attempt to match the PCE Recreation component to a CPI index, we regressed PCE Recreation (a service in the PCE) against the CPI Reading and Recreation index. This resulted in the Recreation equation shown in Table 1 (reproduced below as equation (A.3)), which failed both the F-test on the general hypothesis and the z-test on R^2.

Additional information on the composition of the two Recreation indexes led us to conclude that the appropriate matching is the PCE Recreation index and the CPI Recreational Services index. The resulting regression is shown as A.4 below.

$$\text{(A.3)} \quad \Delta\text{PCE Recreation} = \underset{(0.147)}{0.642} + \underset{(0.148)}{0.485}\,(\Delta\text{CPI Reading and Recreation})$$

$$R^2 = 0.29$$

$$\text{(A.4)} \quad \Delta\text{PCE Recreation} = \underset{(0.155)}{0.410} + \underset{(0.116)}{0.531}\,(\Delta\text{CPI Recreational Services})$$

$$R^2 = 0.45$$

The surpising element of this "improvement" in the matching is that the regression equation is so little changed. The revised equation still fails both the F-test and the z-test, and, hence, Recreation remains in Group IV of Table 1.

The simplest explanation for the behavior of this regression seems to be the most appropriate—the PCE Recreation component prices a wider variety of services than the CPI Recreational Services component. In doing so, the PCE component employs not only CPI indexes, but also implicit indexes (for Parimatual receipts and Spectator sports, for example) plus several earnings indexes (for Commercial amusements and for Fraternal Organizations). For the CPI, on the other hand, a smaller number of recreational services are priced directly.

Transportation. Our initial choice of a CPI index to match the PCE Transportation component was the CPI's "Public Transportation" index. After further consultation with BEA, we combined the CPI "Public Transportation" index with the CPI "Auto Insurance" and "Auto repairs and maintenance" indexes (using CPI weights). The estimated regression which results from this new matching of PCE and CPI indexes is shown below as (A.6) (Equation (A.5) is our original, reproduced from Table 1).

(A.5) ΔPCE Transportation $= \underset{(0.147)}{0.728} + \underset{(0.060)}{0.313}$ (ΔCPI Public Transportation)

$R^2 = 0.511$

(A.6) ΔPCE Transportation $= \underset{(0.132)}{0.309} + \underset{(0.066)}{0.576}$ (ΔCPI [Public Transportation + Auto Insurance + Auto Repairs and Maintenance])

$R^2 = 0.745$

The new regression, while an improvement over the original, still fails (resoundingly) the F-test. It marginally passes the z-test (the critical value of R^2 being 0.74!), and thus barely squeaks into Group II. We suspect that some of the divergence between the CPI indexes and the PCE component may stem from differing means of handling automobile insurance in the two indexes.

Personal Services. The Personal Services component of the PCE was originally matched with the CPI "Personal Care Services" index to produce the regression result shown below as A.7 (reproduced from Table 1). Subsequently, additional information from BEA indicated that the PCE Personal Services component represents not only such items as haircuts (which are priced for the CPI Personal Care Services index), but also a number of other services such as dry cleaning and shoe repair, from the CPI "Apparel Services" index. We therefore have combined the CPI Personal Care Services index and the CPI Apparel Services index, using CPI weights, and used this aggregate in the regression analysis to produce equation (A.8), below (Equation A.7 is taken from Table 1).

(A.7) ΔPCE $= \underset{(0.133)}{0.691} + \underset{(0.114)}{0.347}$ (ΔCPI Personal Care Services)

$R^2 = 0.263$

(A.8) ΔPCE $= 0.543 + 0.532$ (ΔCPI [Personal Care Services + Apparel Services])

$R^2 = 0.449$

This new result is a minor improvement over the original; the new equation still fails both the F-test and the z-test, and, therefore, remains a Group IV component.

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COMMENTS ON THE TRIPLETT-MERCHANT STUDY OF THE CPI AND PCE IMPLICIT DEFLATOR

BY ALLAN H. YOUNG

The Triplett–Merchant (T–M) article is misleading in two respects. (1) Because of an improper selection of the CPI data by T–M, the regressions overstate the lack of correspondence between the CPI and PCE components and therefore T–M erroneously attribute too much importance to computational processes as a source of difference. (2) In some passages T–M appear to adopt the view that the CPI and PCE components should correspond exactly, because they have been "matched." In fact, there are good reasons for them to differ.

(1) The CPI data used by T–M are not the same as the CPI data which are incorporated in the PCE deflator, particularly for the first four years of the period included in the study. If the same data are used, the lack of correspondence noted by Triplett and Merchant tends to disappear.

There are three types of differences in the CPI data: (a) In 1965, for some components BLS obtained a price reading only once every six months. In using this information, BEA interpolated in order to obtain an estimate for each quarter. T–M entered zero change in the first of the two quarters, and the six month change in the second—a less satisfactory procedure than that followed by BEA. (b) For some other components, BLS obtained a reading only for the last month of the quarter. In using this information, BEA interpolated to obtain mid-quarter estimates. T–M did not. (c) T–M took all their data from seasonal adjustment runs through 1971. At the time the PCE estimates were prepared for the first years of the period included in the study, BLS was experimenting with seasonally adjusting a number of CPI components. Neither BLS nor BEA could at the time develop as good seasonal adjustments as are possible now. Since BEA's policy is to revise only the last three years of data each year, improved seasonal adjustments cannot be incorporated for the period 1965–1969 until the next major benchmark which will open up the books back to 1958.

Shown below for five series are comparisons of the regressions incorporating the CPI data as used by T–M, labeled A, with regressions incorporating the CPI data which were available for constructing the PCE deflators, labeled B. The regressions labeled A differ slightly from those in the T–M paper because they were recomputed to assure consistency with B. For each series the B regressions show a closer correspondence between the CPI data and the PCE implicit deflator than do the A's. On the basis of the standard errors, it appears that fuel and ice and toilet goods move from Group IV to Group I and that semidurable house furnishings move from Group III to Group II. The coefficients for food at home are much closer to 0 and 1 but the series probably remains in Group II. Closer correspondence would also be obtained for some of the other 16 series included in the study if the regressions were rerun incorporating the CPI data which were available for constructing the PCE deflators.

The results reported by T–M for sub-periods are consistent with the situation as set forth above. The lack of correspondence is greatest in the early sub-periods where the differences between the T–M data and the CPI data actually used in the PCE implicit deflator are the largest.

The lack of correspondence that would remain if the proper CPI data were used results largely from BEA's use of non-CPI data. However, the internal weights assigned CPI components within a PCE component are also a contributing factor. The computational processes which T–M refer to as intervening after the introduction of the CPI data are largely procedures used at the time of the July revision to bring in non-CPI data which were not available when a quarter is first estimated. Such computational procedures have little impact over and above the introduction of non-CPI data. (This is certainly the case in toilet goods which in the recomputed regressions shows virtually perfect correspondence.)

(2) Some passages of T–M's article carry the suggestion that the "matched" components of the CPI and implicit PCE deflator should correspond exactly. The matching appears to consist of little more than finding components with similar titles. Their approach ignores the fact that there are differences in coverage

REGRESSION RESULTS: QUARTERLY PERCENT CHANGES OF THE PCE COMPONENT INDEXES ON THE CORRESPONDING CPI INDEXES

	a	b	R^2	SEE
Food at home				
A	0.144	0.827	0.902	0.24
	(0.062)	(0.052)		
B	0.097	0.908	0.966	0.14
	(0.038)	(0.033)		
Semidurable house furnishings				
A	0.464	0.649	0.613	0.43
	(0.100)	(0.098)		
B	0.071	1.315	0.762	0.34
	(0.185)	(0.141)		
Toilet goods				
A	0.164	0.670	0.731	0.32
	(0.072)	(0.078)		
B	0.000	1.000	0.984	0.08
	(0.019)	(0.025)		
Ophthalmic and orthopedic devices				
A	0.166	0.854	0.457	0.41
	(0.201)	(0.175)		
B	−0.184	1.179	0.654	0.32
	(0.185)	(0.163)		
Fuel and ice				
A	0.624	0.271	0.040	1.21
	(0.278)	(0.186)		
B	0.007	1.003	0.994	0.10
	(0.023)	(0.016)		

Note: A—CPI as used by T–M
B—CPI as included in the PCE implicit deflator.

and concept between those CPI and PCE components which were included in the study as well as between those which were excluded. One such difference, as T–M discuss in the appendix, is the treatment of housing services. It makes no sense to ignore this fact in their regressions. Either housing services should have been excluded from the list of "matched" components or the CPI rent index used. Excluding housing services reduces T–M's Group IV to 11 percent of the weight of PCE and 13 percent of the weight of the CPI. (Excluding toilet goods and fuel and ice which the recomputed regressions place in Group I reduces Group IV another 2 percentage points.)

Another difference between the CPI and PCE implicit deflator is that the CPI is limited to families of urban wage earners while PCE also includes purchases by rural consumers. The 1960-61 Consumer Expenditure Survey conducted by BLS and USDA placed consumption by rural residents at roughtly $\frac{1}{3}$ of that of urban residents. To represent price movements of goods purchased by rural consumers, the PCE implicit deflator incorporates components of the Prices Paid by Farmers Index as compiled by the USDA. USDA indexes are incorporated in 9 of the 21 components included in the T–M study. Within particular components the USDA indexes receive weights of roughly 25 percent.

The CPI and PCE indexes also differ where the CPI coverage for urban consumers has been deficient for the purposes of deflation. While the sample design of the CPI provides an overall measure of price change for the specified universe, it does not in all cases provide suitable detail to deflate individual types of expenditures. In such cases we use various types of price indexes to supplement the CPI. For example, WPI components for luggage, window fans, pens and pencils, typewriters, tools, light bulbs, and stationery are used for deflation because no corresponding CPI components are available. The use of such additional indexes, we feel, improves the deflated expenditure components and it may also improve the overall measure of prices since it brings additional information to bear.[1] (In addition the CPI and PCE indexes differ for other reasons such as the inclusion of expenditures of nonprofit institutions in PCE. However, in general such differences are more important in the indexes excluded from the T–M study than in those included.)

It is surprising that T–M consider their results to be an important or "novel and surprising" discovery. The study by Kipnis which they cite, as well as one by Grose,[2] already had made the point that the coverage and concepts of the PCE implicit deflator are different than the CPI. Overall, Kipnis indicates that CPI components account for 67.3 percent of the weight in the PCE implicit deflator in 1958. Further, he indicates that at the detailed annual level of 119 PCE components, 87 of these incorporate non-CPI price measures in the deflator, including

[1] The weighting structure of the PCE deflation was established at the time of the last benchmark revision of GNP which was published in August 1965. Since the 1963–65 period when the benchmark was prepared, BLS has developed additional detail, and is now embarked on a new Consumer Expenditure Survey. The next benchmark revision of GNP will be an occasion to incorporate additional CPI components and to review the weights. No doubt the weight of non-CPI indexes will be reduced.

[2] Lawrence Grose, "Real Output Measurement in the United States National Income and Product Accounts," 1967, available in *Readings in Concepts and Methods of National Income Statistics*, a reprint volume published for BEA by National Technical Information Service, U.S. Department of Commerce, Accession Number PR 194900.

20 components with USDA price indexes, 32 with WPI's and 29 with earnings indexes. Grouping the annual detail into the quarterly components included in the T–M study, we find from Kipnis that of the 21 components, 15 include non-CPI information. (T–M show this in their Table 2.)

It makes little sense to judge the 21 components of the PCE implicit deflator selected by T–M on the assumption that their coverage and that of the CPI components is in common. The components of the PCE implicit deflator examined by T–M are designed with some elements in common with CPI and some which are different.

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REPLY

BY JACK E. TRIPLETT AND STEPHEN M. MERCHANT

Mr. Young makes two points. The first is that the published CPI data used in our paper "are not the same as the CPI data which are incorporated in the PCE deflator," largely, we gather, because we did not subject the published CPI data to BEA interpolation and seasonal adjustment routines before the CPI data were used in the regressions. We have reservations about any conclusions drawn from comparison of Young's regressions "A" and "B" (partly because regressions "A" do not, for unspecified reasons, always coincide with those presented in our Table 1).

WEIGHTS (IN THE COMPILATION OF THE PCE DEFLATOR) OF PRICE INDEXES DERIVED FROM VARIOUS SOURCES; COMPARED WITH PCE WEIGHT OF SERIES USED IN T-M ANALYSIS

Source	Weight (1958)	Category	Weight (1965)
Consumer Price Index (CPI)	67.3	Included in T-M analysis	75.2
Agricultural Prices (PPBF)	10.1		
Wholesale Price Index (WPI)	4.5		
Other Prices	2.4	Not included in T-M analysis	24.8
Implicit Prices	10.9		
Earnings Indexes	4.9		
Total	100.0*		100.0

* Weights do not add to total because of rounding.
Sources: Col. 1—U.S. Congress, Joint Economic Committee, "Inflation and the Price Indexes," 89th Congress, 2nd Session, July, 1966, p. 45. Col. 2—Triplett and Merchant, Tables 2 and 3.

Moreover, because we were interested in isolating the sources of discrepancy in the *published* CPI and PCE, we are unwilling to concede that the "improvement" recorded in regressions "B" supports the statement that we "attribute too much importance to computational processes as a source of difference." One could also conclude that regressions "B" prove that some PCE components are altered to a surprising degree by interpolation and seasonal adjustment.

We prefer, however, to emphasize a more important point. Young's revised regressions (run on what are presumably perfectly matched[1] components) leave our most important finding still standing: comparable components of the two indexes often do not record identical price change.

[1] Young implies that we were rather casual about determining appropriate series in the two indexes ("The matching appears to consist of little more than finding components with similar titles."). For the record, the task of matching components required lengthy conversations with BEA personnel. Moreover, previous drafts of the paper (January and May, 1972) were submitted to BEA, and we have corrected for all errors in matchings pointed out to us as the result of these earlier reviews. If any matching errors remain in the final version, surely this indicates the urgent necessity for detailed, *published* documentation of the deflator.

Young's second point is his allegation that we have shown nothing new, because Kipnis already documented the fact that many price series other than the CPI enter the deflator (see accompanying table). But we never claimed to have *discovered* the existence of non-CPI price series in the PCE. What is "novel and surprising" about our results pertains to the *significance* of these non-CPI series in the PCE price measure. We think it safe to say that prevailing professional opinion has held that the last four "sources" in the accompanying table are used primarily to provide PCE components for which there are no CPI counterparts; and most economists have presumed that PPBF series also should have only a negligible impact on the components we studied, because *farm* consumer units accounted for only 4.5 percent of total consumption in the 1960–1961 Consumer Expenditure Survey. Even in the Backman and Gainsbrugh[2] study (to which the Kipnis paper was an appendix), there is no hint that these other series were an important source of discrepancy between the two indexes, and to our knowledge it has never before been suggested in print that PPBF, WPI, Implicit Indexes, etc. significantly influence those components of the deflator *for which a CPI counterpart exists.*

Our results indicate that something other than the CPI is moving components of the PCE deflator. If it is non-CPI price series, as Young suggests, that is interesting information, and the magnitude of the impact revealed by our results is new information. If non-CPI series wholly account for our results (we are not sure this is the case), this suggests that users choosing between the two measures should ask themselves a very straightforward question: Which is more appropriate as a measure of consumption prices—the CPI, or an undocumented amalgam of CPI, WPI, and Prices Paid by Farmers indexes?

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[2] Jules Backman and Martin R. Gainsbrugh, "Inflation and the Price Indexes." U.S. Congress, Joint Economic Committee, Subcommittee on Economic Statistics, 89th Congress, 2nd Session (July, 1966).