An Overview of Experimental U.S. Consumer Price Indexes

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Abstract: In recent years the U.S. Bureau of Labor Statistics has produced a number of experimental consumer price indexes. In contrast to the Laspeyres formula, which holds quantities fixed over time, the experimental CPI using geometric means keeps relative expenditure shares constant within item-area categories. Experimental superlative indexes use both base and current period expenditure weights as a theoretically better approximation of a true cost-of-living index. In addition, experimental indexes have been constructed to measure price change for different target populations. An experimental CPI for Americans 62 years of age and older (CPI-E) assesses price changes faced by older Americans receiving Social Security and other pensions. Three experimental CPIs for poor consumers were calculated to analyze price change faced by consumer units typically eligible for welfare or other public assistance.

1. Introduction

The Consumer Price Index (CPI) of the U.S. Bureau of Labor Statistics (BLS) is based upon the Laspeyres framework of measuring price change over time for a fixed market basket of goods and services. The CPI currently measures price change for two official population groups. The CPI for All Urban Consumers (CPI-U) represents the spending habits of about 80 percent of the population of the United States. The CPI for Urban Wage Earners and Clerical Workers (CPI-W) is a subset of the CPI-U population, and represents about 32 percent of the total U.S. population.[2] Section 2 presents a brief overview of the construction of the official U.S. CPIs.

In addition to the two official CPIs, there are a number of experimental indexes that have been produced. Section 3 discusses two categories of experimental indexes that have been developed using *different estimation concepts* that move away from the Laspeyres fixed market basket concept. In general, the current Laspeyres fixed-weight index can be viewed as an upper bound relative to a true cost-of-living index in that it does not account for changes in consumption induced by changes in relative prices (Gillingham, 1974). While the Laspeyres framework assumes consumers purchase fixed quantities over time, the *experimental CPI using geometric means* assumes consumers keep relative expenditure shares constant within item-area categories. *Experimental superlative indexes* use both

[1] The opinions expressed in this paper are those of the authors and do not represent an official policy of the Bureau of Labor Statistics or the views of other BLS staff..

[2] The *BLS Handbook of Methods* specifically defines the CPI-U population as "consisting of the all urban households in Metropolitan Statistical Areas (MSAs) and in urban places of 2,500 inhabitants or more. Nonfarm consumers living in rural areas within MSAs are included, but the index excludes rural consumers and the military and institutional population." The CPI-W population "consists of consumer units with clerical workers, sales workers, craft workers, operatives, service workers, or laborers. More than one-half of the consumer unit's income has to be earned from the above occupations, and at least one of the members must be employed for 37 weeks or more in an eligible occupation" (Bureau of Labor Statistics, 1992, p. 176).

base and current period expenditure weights as a theoretically better approximation of a true cost-of-living index.

Section 4 details two other areas where experimental indexes have been constructed to measure price change for different target populations. An *experimental CPI for Americans 62 years of age and older (CPI-E)* was created in part to assess price changes faced by older Americans receiving Social Security and other pensions.[3] In addition, on a one-time basis, three *experimental CPIs for poor consumers* were calculated to analyze price change faced by consumer units typically eligible for welfare or other public assistance.[4]

We begin with a review of the official CPI indexes as a frame of reference for comparing and contrasting the experimental indexes produced in the U.S. CPI.

2. Brief Overview of the Official U.S. CPIs

A two-tiered weighting system is used to calculate the CPI. The universe of consumer goods and services in the U.S. CPI is stratified into 9,108 basic item-area indexes (207 strata of items times 44 strata of geographic areas). At a lower level, the 9,108 item-area indexes are estimated using a modified Laspeyres formula applied to sample data. At the higher level of aggregation, the item-area indexes are combined using a modified Laspeyres formula to calculate indexes for items, areas, and all items.

2a. Estimation

At the first or elementary aggregate level (i.e., within each basic item-area component), expenditure weights are derived from the Point-of-Purchase Survey. The price changes are measured from representative samples of specific items that are repriced at a set of sample outlets either monthly or bimonthly. The samples of specific items are updated at 5-year intervals, so that 20 percent of the areas have their samples replaced each year. The base period for each item-area sample is defined as the year in which the Point of Purchase Survey took place.

Currently the relative price change for each stratum j is measured by estimating a modified Laspeyres population index formula:

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[3] Annual cost-of-living adjustments (COLAs) for Social Security recipients, as well as COLAs for federal and military retirees, are based on changes in the CPI-W from the 3rd quarter of one year to the 3rd quarter of the succeeding year.

[4] The annual change in the CPI-U all items index is currently used to adjust the official U.S. poverty guidelines, which are often used to determine eligibility for public assistance.

(1)
$$I_{t,1j} = \frac{\sum_{i \in j} Q_{0i} P_{ti}}{\sum_{i \in j} Q_{0i} P_{1i}},$$

where $I_{t,1j}$ is the index measure of average price change between period 1 and period t for item-area j, Q_{0i} represents quantity of specific item i purchased during the base period 0, P_{1i} is the price of item i during reference period 1, and P_{ti} is the price during a current period. In the context of rotating panels, it is useful to treat period 1 as the "link" period in which the sample rotates, i.e. the new sample replaces a previous sample for the stratum.

Since the Point-of-Purchase Survey collects information on expenditures (rather than quantities), the modified Laspeyres population formula can be rewritten as a function of expenditures and base prices:

(2)
$$I_{t,1j} = \frac{\sum E_{0i}(P_{ti} / P_{0i})}{\sum E_{0i}(P_{1i} / P_{0i})},$$

where P_{0i} represents the base-period price of item i and $E_{0i} = Q_{0i} P_{0i}$ is the base-period expenditure.

The base price, P_{0i}, should, at least in theory, be the price that was charged during the same time period as the expenditures. In practice, direct information on the price during the base period is not available because the sample of specific outlets and items is selected after the Point-of-Purchase Survey, drawing from the sampling frame provided by the survey. Consequently a proxy base price must be imputed.

An important part of the context for our discussion of the alternative estimators, particularly the geometric mean, is the problem discovered by BLS researcher Reinsdorf (1994), which has become known as the "formula bias" problem. He showed that the method that BLS had used (since 1978) to impute the base prices, i.e., setting an item's proxy base price equal to its link month price deflated to the base period, led to systematic upward bias of the measured index change during the period immediately following a sample rotation. This bias arises because this base-price imputation method caused items that entered the sample on sale or at a relatively low price to receive relatively high weight, whereas items that entered the sample off sale or at a relatively high price would receive relatively low weight. The following period, the items would tend to revert to their normal prices, implying that the estimator would give too much weight to price increases and too little weight to price decreases.

Following additional research by Moulton (1993, 1996), Armknecht, Moulton, and Stewart (1995), Erickson (1996), McClelland (1996), and Reinsdorf and Moulton (1997), the BLS corrected the formula-bias problem in January 1995 for food at home (the most affected major component) and in June and July 1996 for the remaining components. The proxy base price is now imputed independently of the link month price using a method known as "seasoning"; i.e., the base price is imputed from an earlier price that was not used directly in index calculation.

2b. Aggregation

At the second or higher level of weighting, base period expenditure weights for each of the 9,108 basic item-area components of the CPI are derived from the Consumer Expenditure (CEX) Surveys and price change is measured from the elementary indexes. Here the market basket represents quantities purchased during a base period *b* which is prior to the pivot period *p* when the weights are updated. For example, the current market basket represents expenditures drawn from the Consumer Expenditure Survey during 1982-84, but that market basket was not used in index aggregation until the pivot month, December 1986. (The next market basket update is scheduled for the pivot month of December 1997 and will introduce a base period of 1993-95.) The CPI's modified Laspeyres index aggregation formula can be written as

$$I_{t,p} = \frac{\sum_j E_{bj} I_{t,bj}}{\sum_j E_{bj} I_{p,bj}}, \tag{3}$$

where $I_{t,p}$ is the aggregate index of price change from period *p* to period *t*, $I_{p,bj}$ and $I_{t,bj}$ are the elementary price indexes from base period *b* to pivot month *p* and period *t*, respectively, for the item-area stratum *j*, and E_{bj} is base period expenditures for *j*. The CPI formula (3) is called "modified" Laspeyres because price change between period *b* and period *p* was measured using an earlier set of item-area expenditure weights, which was then chained to the index using the new expenditure weights at period *p*.

3. Experimental CPIs with Different Estimation Concepts and Strategies

As relative prices change, and new items and outlets enter the marketplace, the Laspeyres approach currently used in the U.S. CPI can generally be interpreted as an upper bound to a true cost-of-living index. This substitution effect occurs at both the elementary and aggregate levels. Section 3a discusses the calculation of the *experimental CPI using geometric means* at the elementary level as one potential way of moving away from the assumption of fixed quantities by effectively keeping relative expenditure shares fixed at that level. Section 3b discusses the use, at the aggregate level, of both base and current period weights in the form of *experimental superlative indexes*, which can be viewed as a better approximation to a true cost-of-living index by accounting for substitution effects at that higher level.

3a. The Experimental CPIs using Geometric Means

Historically, analysis of substitution bias in the U.S. CPI has focused on substitution at the aggregate level (e.g., Braithwait, 1980; Manser and McDonald, 1988). The potential effects of substitutions by consumers at the lowest or elementary aggregate level of estimation in the U.S. have most recently been explored by Moulton and Smedley (1995). While the Laspeyres approach assumes Leontief preference functions in which consumers choose to purchase fixed quantities of goods and services over time (with perfectly inelastic demand), interest has recently focused on the use of the geometric mean (or "Jevons") functional form, which effectively assumes Cobb-Douglas preference functions in which consumers keep relative expenditure shares constant (with unitary demand elasticities).[5]

To assess the potential impact of using geometric means for elementary aggregate price relatives, Moulton (1993) recalculated most non-shelter basic item-area price relatives utilizing geometric means instead of arithmetic means from June 1992 through June 1993; Moulton and Smedley (1995) updated these estimates to include shelter and a longer time frame: June 1992 through December 1994.[6] Mathematically, the geometric mean price relative is:

(4) $$I^{g}_{t,1j} = \prod_{i \in j} (P_{ti}/P_{1i})^{S_{0i}},$$

where $S_{0i} = E_{0i} / \Sigma E_{0i}$ is the base-period expenditure share for specific item *i*. Since items are effectively weighted by expenditure shares, it is not necessary to estimate base period prices or quantities.

In these simulations, the CPI's item-area estimator (2) was replaced by the geometric mean formula (4), but the higher level aggregation continued to use the modified Laspeyres formula (3). For items included in the June 1992 - June 1993 simulation by Moulton (1993), the annual difference between the simulated production Laspeyres arithmetic mean and the geometric mean index was 0.47 percent; in the June 1992 - December 1994 simulation by Moulton and Smedley (1995), the annualized difference between the Laspeyres and geometric mean indexes was 0.46 percent. In these simulations, the differences between the two indexes were most striking for food, apparel, and entertainment items.

Based on the significance of these estimates, the Bureau of Labor Statistics created experimental indexes for the U.S. CPI using geometric means in calculating basic item-area price relatives of near production-grade quality.[7]

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[5] Szulc (1989) and Turvey (1989) focused the attention of price index researchers on the potential benefits of using the geometric means formula at the elementary level. See also Diewert (1995).

[6] While these initial simulations used the same formulas for calculating basic elementary aggregate price relatives, different imputation methods than the official CPI were used. The simulations by Moulton (1993) covered about 70 percent of the items, mainly excluding shelter. The simulations by Moulton and Smedley (1995) covered about 96 percent of all items, including shelter.

[7] The experimental CPI using geometric means is not considered of true production quality for several reasons. First, weights for the shelter components of the experimental index are based not on expenditures but quantities, and weights for other commodities and

We will call these near production-grade indexes the *experimental CPI using geometric means* or simply *geo-means*. The geo-means indexes have now been calculated from December 1990 through December 1996.

Unfortunately, differences between the official CPI and the experimental CPI using geometric means include more than changes associated with the Laspeyres and geometric mean estimators. These other effects can generally be characterized as "bounding" and "coding" effects. Specifically, the geometric mean estimator is not defined for zero prices (free goods), and performs poorly with near-zero prices. Therefore the experimental index using geometric means has "bounding" rules for handling extremely large percentage price changes. In general, within commodities and services, long-run price relatives for sample items that are greater than 20 and less than .05 are imputed rather than used directly in the calculation of elementary aggregate indexes. Similarly, any rents less than $20 were reset to $20 in the geo-means calculation.

In addition, there are also "coding effects" which need to be accounted for in comparing the official Laspeyres indexes with the geo-means indexes. In short, BLS began constructing the experimental CPI using geometric means in early 1996. Indexes using geometric means constructed from December 1990 through 1995, then, are based on the early 1996 production environment. Therefore, methodological changes made in the U.S. CPI between 1990 and 1995 potentially impact the geo-means index over the entire 1990-1995 period. These same changes would impact the official CPI only as they were implemented. For example, in January 1995 several methodological improvements were introduced, most of which reduced the (future) rate of growth in the official CPI. These included the elimination of "formula bias" in the setting of base period prices by seasoning of replacement samples of food-at-home items (Bureau of Labor Statistics, 1994*a*); the modification in the imputation of homeowners' implicit rent to eliminate the upward property of that estimator; and the incorporation of a six-month chain estimator used in rent to replace the composite estimator (which suffered because of an under-reporting of one-month rent changes) (Bureau of Labor Statistics, 1994*b*). The changes made in January 1995 to the shelter component, for example, are reflected in the experimental CPI using geometric means since its inception.

In order to isolate the impact of using a Laspeyres-based estimator versus a geo-means estimator for the elementary aggregates, BLS created a *Test Laspeyres* index with the same bounding and coding characteristics as the geo-means indexes. For both the Test Laspeyres and geo-means indexes, the same bounding rules described above were used. In addition, for both the Test Laspeyres and geo-means indexes, the same (i.e., early 1996 and forward) production code was used for these simulations from December 1990 forward. For these reasons, we will focus on the differences between the *Test Laspeyres index* and *the geo-means index*.

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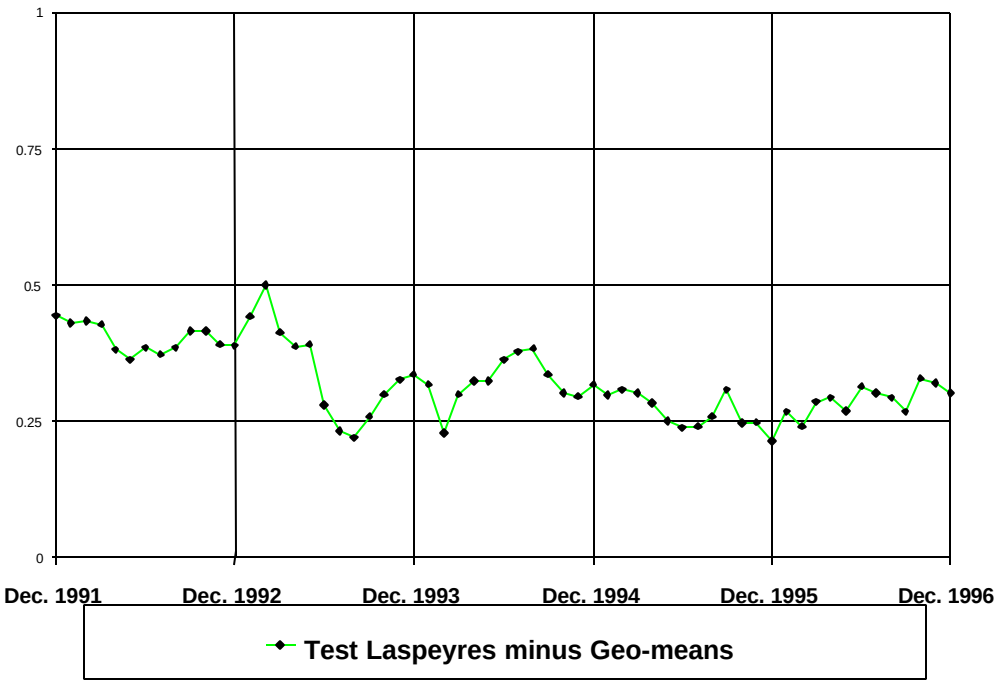
services were not estimated optimally before January 1997. In addition, issues such as the appropriate sample design and imputation of missing data have not yet been fully addressed.

Results. From December 1990 through December 1996, the Test Laspeyres rose 17.8 percent; during that same time frame, the experimental CPI using geometric means rose 15.5 percent.[8] The annualized difference between these two indexes over that time is approximately 0.33 percent. Again, in the index simulations, the differences between the two indexes were most striking for food, apparel, and entertainment items.

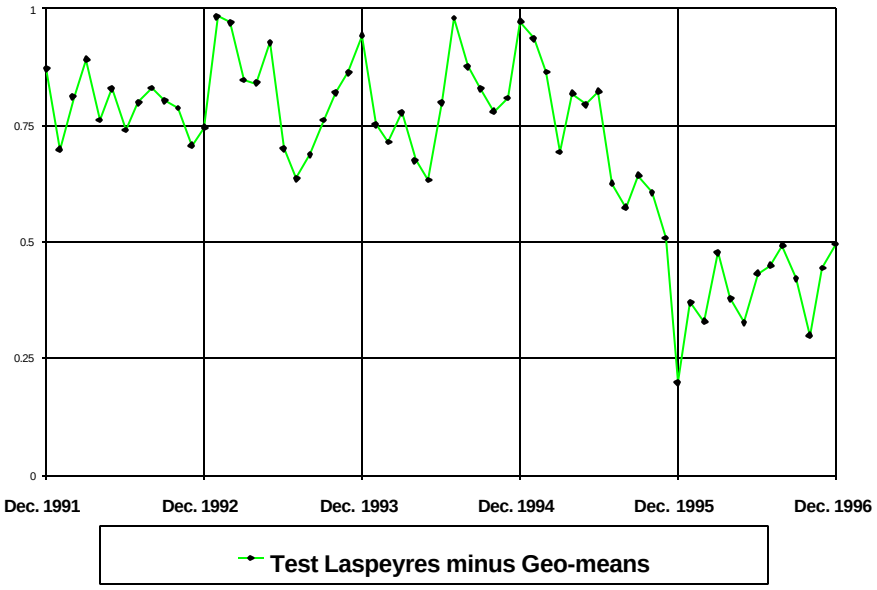
The differences between the geo-means index and the test Laspeyres index has fallen since the methodological improvements to the CPI in January 1995. From December 1990 through December 1994, the annualized difference between the Test Laspeyres and geo-means indexes was approximately 0.37 percent. At that time the functional form improvement to food-at-home items, as discussed earlier, reduced the rate of growth in the test (and official) Laspeyres indexes but had no effect on the geo-means index. From December 1994 through December 1996, the annualized difference between the two indexes had fallen to 0.26 percent (see graph 1). For food-at-home categories, the annualized difference between Test Laspeyres and geo-means has fallen from approximately 0.88 percent. from December 1990 to December 1994 to 0.34 percent from December 1994 to December 1996 (see graph 2).

Graph 1. CPI-U, All items, Differences between 12-month percent changes



[8] Baskin and Leaver (1996) have estimated variances for the geometric mean, test Laspeyres, and official Laspeyres indexes for the major shelter components of the U.S. CPI, and are in the processing of estimating variances for other commodities and services for these three measures.

Graph 2. CPI-U, Food at home, Differences between 12-month percent changes



In June 1996, BLS expanded the seasoning method to other commodities and services (Bureau of Labor Statistics, 1996*a*); in July 1996, a similar functional form bias occurring at item substitution was eliminated (Bureau of Labor Statistics, 1996*b*). The differences between the Test Laspeyres and geo-means are expected to decline further still as these methodological changes, which do not affect the geo-means indexes, reduce the rate of growth in the test (and official) Laspeyres indexes.

Tables 1 and 2 give December index levels from 1990 through 1996 for the Test Laspeyres and geo-means indexes, respectively, for all items and each of the 7 major groups.

Table 1. The Experimental CPI-U using Geometric Means, December indexes, 1990-1996, December 1990=100

CPI-U (*using geometric means*)	All items	Food and beverages	Housing	Apparel and upkeep	Transpor - tation	Medical care	Enter -tain- ment	Other goods and services
Dec. 1990	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Dec. 1991	102.3	102.0	102.4	102.1	98.2	107.5	103.4	107.8
Dec. 1992	104.8	103.1	104.5	101.9	100.8	114.2	105.8	114.5
Dec. 1993	107.2	105.3	107.1	101.1	102.8	119.8	108.4	117.1
Dec. 1994	109.6	107.5	109.2	98.7	106.5	125.1	109.8	121.7
Dec. 1995	112.2	109.6	112.4	97.3	107.7	129.3	112.9	126.9
Dec. 1996	115.5	113.8	115.6	96.2	112.1	132.6	115.1	131.3

Table 2. The CPI-U "Test Laspeyres", December indexes, 1990-1996, December 1990=100

CPI-U (*test Laspeyres*)	All items	Food and beverages	Housing	Apparel and upkeep	Transpor - tation	Medical care	Enterta in-ment	Other goods and services
Dec. 1990	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Dec. 1991	102.7	102.5	102.8	103.4	98.5	107.9	104.0	108.0
Dec. 1992	105.6	104.2	105.1	104.9	101.4	115.1	106.9	115.0
Dec. 1993	108.4	107.1	107.7	105.8	103.8	121.2	109.9	118.0
Dec. 1994	111.2	110.0	109.9	104.2	107.7	127.2	112.4	123.0
Dec. 1995	114.1	112.3	113.1	104.2	109.3	132.2	116.1	128.3
Dec. 1996	117.8	117.0	116.4	104.0	114.1	136.3	119.5	133.0

Summary. Although the U.S. Laspeyres-based CPI assumes no substitution (and a price elasticity of demand of zero), the experimental CPI using geometric means is based upon the economic assumption that consumers will substitute with unitary price elasticity within individual item categories. Simulations have shown significant differences in the estimation of basic item-area relatives using geometric versus arithmetic means, particularly before 1995. Methodological improvements made to the official CPI since January 1995 have made these differences less significant.

Future plans in this area. The BLS released the experimental CPI using geometric means in April 1997. The BLS is now evaluating the adoption of geometric mean formula into the official CPI. Assessments of price change, published estimates of demand elasticities, and analysis of scanner and other data will be used to determine the appropriateness of the geometric mean's implicit assumption that the elasticity of substitution between items within strata equals one. Issues of optimal sample design, imputation, and experiences in other countries with geometric means will also be evaluated more thoroughly. Abraham (1997) said that this evaluation should be completed by the end of 1997.

3b. The Experimental Superlative CPIs for All Urban Consumers

Consumers also shift spending patterns in response to relative price change at the aggregate level (i.e., across item categories such as beef and chicken). In the U.S., this substitution effect has most recently been measured at approximately 0.13 percent per year (Aizcorbe, Cage, and Jackman, 1997). The measurement of this substitution effect was made by comparing a fixed weight index such as (3) to superlative indexes, which account for substitution at the aggregate level by using both base and current period weights (Diewert, 1976).

To evaluate the potential impact of substitution at the aggregate level, Aizcorbe and Jackman (1993) published *experimental superlative indexes*, including Fisher Ideal and Törnqvist indexes.[9] These estimates, which have been updated (Aizcorbe, Cage, and Jackman, 1997), now include data through 1995.

The Fisher Ideal formula can be understood as a geometric average of a Laspeyres index of price change from period *s* to period *t*:

(5) $$I_{t,s}^{L} = \sum_{j} S_{sj} I_{t,sj} ,$$

where $S_{sj} = E_{sj} / \Sigma E_{sj}$ (so aggregation uses base-period expenditure weights), and a Paasche index (which uses current period expenditure weights), as in

(6) $$I_{t,s}^{P} = \left(\sum_{j} (S_{tj} / I_{t,sj}) \right)^{-1} .$$

The Fisher Ideal price index is the square root of the product of the Laspeyres and Paasche price indexes:

(7) $$I_{t,s}^{F} = (I_{t,s}^{L} I_{t,s}^{P})^{1/2} .$$

The Törnqvist price index is defined as

(8) $$I_{t,s}^{T} = \prod_{j} I_{t,sj}^{(S_{sj}+S_{tj})/2} .$$

For each of these indexes, there is a fixed-based version, where the base period, *s*, is held constant, and a chained version, where the base period, *s*, is updated annually, so that the annual change in the index is calculated using base expenditures from period $s = t - 1$, and then chained to earlier index values.

Table 3 shows the experimental superlative (Fisher Ideal and Törnqvist) indexes, 1987-95, as well as Paasche and Laspeyres indexes. While Aizcorbe, Cage, and Jackman (1997) focus on superlative indexes, their paper also includes the use of fixed-base geometric mean at the aggregate level.[10]

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[9] Superlative indexes cannot be constructed at the elementary aggregate because the detailed expenditure data for each period are generally not available.

[10] The fixed-base geometric mean index has the same form as the Törnqvist (8), except that S_{sj} replaces $(S_{sj} + S_{tj}) / 2$ in the exponent. The use of geometric means at the aggregate level is potentially advantageous in that it uses only historical expenditure data; consequently estimates of price change can be produced with no time lag. However, empirical research to date, as seen in

These are included in Table 3 as well. Comparing the fixed weight Laspeyres to the bilateral Törnqvist, the difference in the annual rates of change averages 0.18 percent per year over the 1987-95 time period; comparing the chained Laspeyres to the chained Törnqvist, the difference averages 0.12 percent per year; and - probably the most relevant as an overall measure of substitution bias- comparing fixed weight Laspeyres to chained Törnqvist, the differences averages about 0.13 percent per year.

In contrast to the findings of their earlier work (Aizcorbe and Jackman, 1993), the results reported in Table 3 do show the chained Laspeyres increasing at about the same rate as the fixed weight Laspeyres. This result agrees with the findings of Greenlees (1997) that there is not a systematic relationship between estimated price change and the age of the expenditure weights upon which the estimates are based.

Table 3. The Experimental Superlative CPIs, using fixed-base and chained indexes, 1987-95, 1987=100 (source: Aizcorbe, Cage, and Jackman, 1997).

Year	Laspeyres	Fisher Ideal	Törnqvist	Paasche	Geometric mean	Substitution effect [1]
Fixed weight:						
1987	100.0	100.0	100.0	100.0	100.0	0.00
1988	104.0	103.8	103.8	103.7	103.8	0.14
1989	108.8	108.5	108.5	108.2	108.4	0.31
1990	114.4	113.8	113.8	113.3	113.6	0.52
1991	118.9	118.1	118.1	117.3	117.9	0.79
1992	122.2	121.2	121.3	120.3	120.9	0.95
1993	125.7	124.4	124.4	123.1	123.9	1.22
1994	128.9	127.4	127.5	125.9	126.8	1.41
1995	132.4	130.5	130.6	128.5	129.9	1.83
Chained:						
1987	100.0	100.0	100.0	100.0	100.0	0.00
1988	104.0	103.8	103.8	103.7	103.8	0.14
1989	108.7	108.5	108.5	108.2	108.4	0.25
1990	114.3	113.8	113.8	113.4	113.7	0.43
1991	118.8	118.2	118.2	117.6	118.0	0.60
1992	122.2	121.4	121.4	120.6	121.2	0.78
1993	125.6	124.6	124.6	123.7	124.4	0.91
1994	128.8	127.7	127.7	126.7	127.5	1.07
1995	132.3	131.1	131.1	129.8	130.8	1.25

[1] The substitution effect was calculated as the difference in index points between Laspeyres and Törnqvist indexes.

Table 3, has shown that the geometric mean formula at the aggregate level appear to consistently understate the conceptually preferred superlative indexes.

Results and future publication schedule. The average substitution effect at the aggregate level is about 0.13 percent per year. One of the main limitations of superlative price indexes, of course, is that estimates of current expenditures are available only with a lag. Given resources, BLS has plans to expand the Consumer Expenditure Survey samples and make them available on a more timely basis, allowing the superlative indexes to be published in a more timely fashion. Unlike the current experimental superlative indexes, the new superlative indexes will be complete and of production-quality. (The experimental indexes that BLS now produces are on a research basis and are calculated at the national, all-items level only.) These indexes, which could be produced by the year 2002, may become an additional official CPI and will not replace the existing measures.

4. Experimental CPIs with Different Target Populations

In addition to the two official (CPI-U and CPI-W) populations, experimental price indexes have been constructed for Americans 62 years of age and older (see section 4a below) as well as for poor Americans (see section 4b below). These experimental indexes account for the differences in expenditure patterns across demographic groups, but use the same elementary price change as that calculated for the entire urban population.

In the U.S. CPI, for any target population, the higher level (CEX) weight of an item component represents the actual expenditure by that population on that component in the base period. For experimental indexes, then, expenditure estimates are derived from the demographic subset of the total CEX sample that was drawn to represent the urban population. In the 1982-84 CEX Survey, for example, only 19 percent of the total sample of eligible urban consumer units met the CPI definition for older Americans; for poor Americans, the proportions are even lower. Because the number of consumer units used for determining expenditure weights in experimental indexes for demographic subgroups are relatively small, the weights used in the construction of these experimental price indexes have a higher sampling error than those used for the larger, official populations.

There are other limitations of experimental price indexes for the elderly and poor populations. These experimental indexes use the same sample of urban areas, and are based on a weighted average of price changes collected from the same sample of items, used in calculating the official CPI-U and CPI-W. In addition, retail outlets are selected for pricing in the CPI to represent all urban households; the experimental indexes also use the same outlet sample used in the official CPI. The outlets thus selected may not be representative of the places older or poorer Americans shop.

Another limitation of these experimental indexes is that the categories of items to be priced are selected using expenditure weights calculated from the expenditure surveys for the urban (CPI-U) population. As a result, the specific items selected for each stratum may not be representative of the respective experimental index population.

Finally, it is important to note that the CPI-U prices are used for the construction of the indexes for the elderly and poor populations. In the official CPI, senior-citizen discount rates are used in the CPI only

in proportion to their use by the urban population as a whole. Similarly, cents-off coupons, which are rarely used in the official CPI, may be more widely used by the poor.

For these reasons, constructing experimental price indexes for different subsets of the urban population are subject to significant limitations as an estimate of the inflation rate experienced by those populations, and any conclusions drawn from the data should be used with caution.

4a. The Experimental CPI for Americans 62 Years of Age and Older (CPI-E)

Motivation and target population for the CPI-E. In the U.S., adjustments to Social Security, military and civil service retirement benefits are currently based on the percent change in the CPI-W, measured from the average of the third quarter of one year to the third quarter of the succeeding year.[11] In 1987, the U.S. Congress directed BLS to construct an experimental index for the elderly in part to help assess potential differences in the inflation experience of the elderly relative to all urban consumer units.

Mason (1988) notes that the target population for the experimental CPI for Americans 62 years of age or older was defined as all urban noninstitutionalized consumer units sampled within the Consumer Expenditure Surveys which met one of the following three conditions:

1) unattached individuals who were at least 62 years of age;

2) members of families whose reference person (as defined in the Consumer Expenditure Survey) or spouse was at least 62 years of age; or

3) members of groups of unrelated individuals living together who pool their resources to meet their living expenses, whose reference person was at least 62 years of age.

Again, only 19 percent of all urban consumer units in 1982-84 met this definition. That said, within elderly households, consumption patterns were somewhat different than urban consumers as a whole. To show this, one can define the "relative importance" of any item component as its base expenditure weight (updated for changes in relative prices) expressed as a percent of the total updated expenditures for the population. Table 4 shows the relative importance of the CPI-U, CPI-W, and CPI-E by major group for December 1996.

[11] Interestingly, since the CPI-W is limited to the spending patterns of wage-earner and clerical families, it specifically excludes the experience of families whose primary source of income is from retirement pensions.

Table 4. Relative Importance for CPI-U, CPI-W and elderly (CPI-E) populations, CPI major groups, December 1996.

Population	All items	Food and beverages	Housing	Apparel and upkeep	Transpor - tation	Medical care	Entertain -ment	Other goods and services
CPI-U	100.0	17.5	41.2	5.3	17.1	7.3	4.4	7.1
CPI-W	100.0	19.4	38.7	5.3	19.2	6.3	4.0	7.0
CPI-E	100.0	15.1	46.8	3.8	14.1	12.1	3.3	4.9

Results of the CPI-E. Table 5 shows the behavior of the CPI-E at the major group levels for the period December 1982 through December 1996. Over this period, the reweighted experimental CPI for Americans 62 years of age and older (CPI-E) rose 67.9 percent. This compares with increases of 62.5 percent for the CPI-U and 59.1 percent for the CPI-W.

As shown below, the experimental CPI for Americans 62 years of age and older indicates a higher overall inflation rate for older Americans compared to the official CPI population groups. For the reasons given in section 3 above, these results must be interpreted with caution. In addition, older Americans spend a substantially larger share of their total expenditures on medical care (see table 4). Since the medical care component of the CPI showed the largest price increase of all major groups, increases in medical care expenses account for most of the difference between the CPI-E and the official CPIs during this period. It should be noted that the U.S. price indexes for medical care have been criticized as overstating inflation by not fully accounting for improvements in quality, most recently by the Advisory Panel to Study the Consumer Price Index, also known as the "Boskin Commission" (U.S. Senate Finance Committee, 1996). A reduced rate of inflation for medical care would mitigate and perhaps eliminate the difference between the CPI-E and the official CPIs.

Future publication schedule for the CPI-E. BLS will periodically release updates of the experimental CPI for Americans 62 years of age and older in the *Consumer Price Index Detailed Report.*

Table 5. The Experimental CPI for Americans 62 Years of Age and Older (CPI-E), December indexes, 1982-1996.

CPI-E	All items	Food and beverages	Housing	Apparel and upkeep	Transpor-tation	Medical care	Entertain-ment	Other goods and services
Dec. 1982	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Dec. 1983	103.7	102.7	103.4	103.2	103.4	106.2	104.6	107.2
Dec. 1984	108.0	106.8	107.8	105.3	106.5	112.7	109.5	112.8
Dec. 1985	112.4	109.7	112.5	108.4	110.0	120.5	113.7	119.0
Dec. 1986	114.4	114.1	114.1	109.1	104.5	130.3	118.1	124.8
Dec. 1987	119.5	118.2	118.7	114.3	110.5	137.2	122.5	131.4
Dec. 1988	124.9	124.2	123.7	120.0	113.7	147.5	128.4	140.1
Dec. 1989	131.4	131.6	129.6	116.6	119.3	160.8	135.1	150.4
Dec. 1990	140.1	138.7	136.1	122.4	132.6	178.9	141.3	161.3
Dec. 1991	144.8	142.0	140.8	126.5	130.8	194.1	147.5	172.7
Dec. 1992	149.2	143.4	144.5	131.2	134.6	206.9	152.2	182.3
Dec. 1993	153.8	147.7	148.6	133.2	138.1	218.7	157.0	186.3
Dec. 1994	158.0	152.5	151.9	130.3	142.0	230.6	161.1	193.7
Dec. 1995	162.4	155.6	156.7	130.5	144.0	239.4	167.0	201.8
Dec. 1996	167.9	162.4	161.6	129.6	151.3	245.9	170.6	208.6

4b. The Experimental CPIs for Poor Americans

Motivation and target population for the experimental CPIs for poor Americans. In the U.S., adjustments to the poverty guidelines of the U.S. Department of Health and Human Services (HHS) are currently based on changes in the CPI-U all items index, measured from the annual average of one year to the annual average of the succeeding year. These guidelines are directly or indirectly used to adjust eligibility guidelines of many programs for the poor; in addition, benefit levels for these programs are often updated by changes in the CPI-U.

Policy makers may therefore be interested to know if price change for poor consumers are similar to price changes facing all urban consumers. To help assess this, Garner, Johnson and Kokoski (1996) define three populations for the poor (the income poor, the expenditure poor, and the program participant poor).[12] They define the *income poor* as those consumer units participating in the 1982-84 CEX survey that were "complete income reporters and whose income is below the Census Bureau's poverty threshold" for those three years. The *expenditure poor* are defined as "those consumer units whose annualized expenditures are below the annual poverty thresholds". Finally, the *program participant poor* are defined as "those consumer units which received supplemental security income (SSI) or general welfare" in the last interview, or received other specified types of assistance "in at least half of the quarters covered by the interview".

[12] This research follows methods similar to those developed by Kokoski (1987).

Estimates of expenditure weights. Using internal BLS data from the Interview portion of the Consumer Expenditure Surveys, Garner, Johnson and Kokoski derived national expenditure weights for 1982-84 and 1992-94 for 136 categories of goods and services.[13] These expenditure estimates were updated over time using relative price changes for all urban consumers at the national level.

Table 6 shows the expenditure weights for these 136 categories when combined into the seven major groups of the U.S. CPI. As expected, the poor spend more of their relative expenditures on food and shelter than the urban population as a whole.

Table 6. Relative Importance for CPI-U and poor populations, by major group, 1982-84.

Population	All items	Food and beverages	Housing	Apparel and upkeep	Transpor-tation	Medical care	Entertai n-ment	Other goods and services
CPI-U-official	100.0	18.0	42.4	6.6	18.9	4.7	4.5	5.1
CPI-U-interview survey	100.0	18.3	41.7	5.7	20.6	4.7	4.1	4.8
CPI-income poor	100.0	21.1	44.5	5.3	15.7	4.7	3.3	5.6
CPI- expenditure poor	100.0	26.1	50.9	4.5	8.8	4.0	1.6	4.0
CPI- program participant poor	100.0	24.4	42.9	5.5	15.2	4.7	2.6	4.7

Results. Table 7 shows the experimental CPIs for the three target poor populations versus the comparable version of the all-urban CPI. Garner, Johnson and Kokoski found "very little difference between the experimental consumer price indexes produced for the poor and the corresponding CPI for the whole sample". Garner, Johnson and Kokoski also calculated Paasche and Fisher-Ideal indexes for these three populations.

[13] The Consumer Expenditure Survey consist of both a diary survey (for small items difficult for respondents to recall) as well as an interview survey (for larger-ticket items). In constructing expenditure weights for experimental indexes for poor consumers, the CEX interview survey alone was used because the authors needed data on income and expenditures as well as demographic data.

Table 7. The Experimental Laspeyres CPIs for Poor Americans, Annual Average, 1984 through 1994, 1984=100.

Population Annual Avg.	All consumer units	Income poor	Expenditure poor	Program participant poor
1984	100.0	100.0	100.0	100.0
1985	103.6	103.6	103.6	103.4
1986	105.6	106.1	106.1	105.4
1987	109.6	109.9	109.9	109.2
1988	113.9	114.1	114.1	113.4
1989	119.3	119.8	119.8	119.0
1990	125.4	126.2	126.2	125.2
1991	130.1	130.7	130.6	129.6
1992	133.7	134.0	133.9	133.0
1993	137.6	137.5	137.4	136.6
1994	141.1	140.7	140.6	139.8

Future data in this area. There are no plans at this time to update the experimental CPIs for the poor.

5. Summary

The BLS has created a number of experimental indexes to assess potential differences between the Laspeyres concept of the official CPI and how it is used for various purposes. While the official U.S. CPI is often used as a cost-of-living index, it should more appropriately be viewed as an upper bound to that ideal. The construction of elementary aggregates using geometric means, and the calculation of superlative indexes at the higher level, allow researchers to gauge the impact of moving away from the Laspeyres concept.

Through federal and other legislation, the CPI directly affects populations other than those officially published by the CPI. The experimental CPI-E can help assess whether or not escalating pensions of older Americans by price change faced by urban wage earners and clerical workers is reasonable. Similarly, poverty guidelines and benefit levels for many poor Americans are adjusted not directly by price changes facing those populations, but rather by the CPI-U. The results of the experimental indexes for the poor show this does not significantly impact benefit eligibility or levels.

Finally, it is important to note there are significant uses of the CPI for which parallel experimental measures cannot or have not been calculated by BLS. For example, in the U.S., the CPI-U is used in the annual escalation of federal income tax brackets and personal standard tax exemption amounts. While a CPI for *all* consumers (i.e., urban and rural), might theoretically be better for this purpose, such a measure cannot be constructed because prices are not collected in rural areas.[14] Alternatively,

[14] The CPI-U now represents 80 percent of the total U.S. population. Population noncoverage in the U.S. CPI will be somewhat reduced in the CPI in 1998, as the CPI-U will then represent 84 percent of the total population. That said, an analysis of urban versus rural expenditures can be found in Rogers (1988).

identifying consumer units that represent taxpayer households may be a preferred measure to use. One might imagine that this would effectively be the complement to the indexes for the poor constructed by Garner, Johnson and Kokoski (1996).

One can also envision an experimental CPI constructed using *both* geometric means at the elementary aggregate as well as a superlative formulation at the aggregate level (or using geometric means at both levels). Aizcorbe, Cage and Jackman are currently scheduled to report on initial simulations of this type in the summer of 1997 at the Western Economic Association International conference.

Some define a (income-based) cost-of-living index as including direct taxes, such as federal income taxes, which are excluded from the U.S. CPI. While the BLS has no current experimental price indexes that include such taxes, estimates of this type have been created by Gillingham and Greenlees (1987).

Finally, critics of the CPI, such as the Boskin Commission, claim the U.S. CPI overstates inflation because it underestimates improvements in the quality of goods and services available. While there are no experimental measures of the effect on the U.S. CPI of alternative quality-estimation strategies, Moulton and Moses (1997) show broadly the impact of our current adjustment procedures on the U.S. CPI.

References

Abraham, Katharine G., "The CPI commission: Discussion," forthcoming in *American Economic Review, Papers and Proceedings,* 1997.

Aizcorbe, Ana M., and Jackman, Patrick, "The commodity substitution effect in CPI data, 1982-1991," *Monthly Labor Review,* vol. 116, December 1993, pp. 25-33.

Aizcorbe, Ana M., Cage, Robert A. and Jackman, Patrick C., "Estimates of substitution bias in the CPI incorporating both elementary aggregate and expenditure level data," to be presented at the Western Economic Association International conference in Seattle, July 1997.

Armknecht, Paul A., Moulton, Brent R., Stewart, Kenneth J., "Improvements to the food-at-home, shelter and prescription drug indexes in the U.S. Consumer Price Index," Bureau of Labor Statistics working paper 263, February 1995.

Baskin, R.M., and Leaver, S. G., "Estimating the sampling variance for alternative forms of the U.S. Consumer Price Index," forthcoming in *American Statistical Association, Proceedings of the Survey Research Methods Section, 1996*.

Braithwait, Steven D., "The substitution bias of the Laspeyres price index: An analysis using estimated cost-of-living indexes." *American Economic Review,* vol. 70, March 1980, pp. 64-77.

Diewert, W. Erwin, "Exact and superlative index numbers," *Journal of Econometrics,* vol. 4, 1976, pp. 114-145.

Diewert, W. Erwin, "Axiomatic and economic approaches to elementary price indexes," National Bureau of Economic Research working paper 5103, 1995.

Erickson, Timothy, "Effects of mismeasuring base-period prices when estimating the Laspeyres index: Some idealized cases," Bureau of Labor Statistics working paper 284, 1996.

Garner, Thesia I., Johnson, David S., and Kokoski, Mary F., "An experimental consumer price index for the poor," *Monthly Labor Review,* vol. 119, September 1996, pp. 32-42.

Gillingham, Robert, and Greenlees, John S., "The impact of direct taxes on the cost of living," *Journal of Political Economy,* Volume 95, Number 4, August 1987, pp. 775-796.

Gillingham, Robert, "A conceptual framework for the Consumer Price Index," *Proceedings of the Business and Economics Section, American Statistical Association,* 1974, pp. 246-252.

Greenlees, John S., "Expenditure weight updates and measured inflation," unpublished room document prepared for Third Meeting of the International Working Group on Price Indices, Voorburg, Netherlands, April 16-18, 1997.

Kokoski, Mary F., "Consumer price indexes by demographic group," Bureau of Labor Statistics working paper 167, 1987.

Mason, Charles C., "An analysis of the rates of inflation affecting older Americans based on an experimental reweighted Consumer Price Index," unpublished ms., Bureau of Labor Statistics, June 1988.

Manser, Marilyn E. and McDonald, Richard J., "An analysis of the substitution bias in measuring inflation, 1959-85," *Econometrica*, vol. 56, July 1988, pp. 909-930.

McClelland, Robert, "Evaluating functional form bias in various indexes using simulations," Bureau of Labor Statistics working paper 289, 1996.

Moulton, Brent R., "Basic components of the CPI: Estimation of price changes," *Monthly Labor Review*, vol. 116, December 1993, pp. 13-24.

Moulton, Brent R., "Estimation of elementary indexes of the Consumer Price Index," forthcoming in *American Statistical Association, Proceedings of the Section on Business and Economic Statistics, 1996*.

Moulton, Brent R., and Moses, Karin E., "Addressing the quality change issue in the Consumer Price Index," forthcoming in *Brookings Papers on Economic Activity 1997:1*.

Moulton, Brent R., and Smedley, Karin E., "A comparison of estimators for elementary aggregates of the CPI," unpublished paper presented at conference of Western Economic Association International, San Diego, July 7, 1995.

Reinsdorf, Marshall, "Price dispersion, seller substitution, and the U.S. CPI," Bureau of Labor Statistics working paper 252, March 1994.

Reinsdorf, Marshall and Moulton, Brent R., "The construction of basic components of cost of living indexes," in *The Economics of New Products,* eds. Timothy F. Bresnahan and Robert J. Gordon, University of Chicago Press, Chicago, 1997, pp. 397-423.

Rogers, John M., "Expenditures of urban and rural consumers, 1972-73 to 1985," *Monthly Labor Review*, vol. 111, March 1988, pp. 41-45.

Szulc, Bohdan J., "Linking price index numbers," in *Price level measurement: Proceedings from a conference sponsored by Statistics Canada*, eds. W. Erwin Diewert and Claude Montmarquette, Ottawa, Ministry of Supply and Services, 1983, pp. 537-566.

Szulc, Bohdan J., "Price indices below the basic aggregation level," in *Consumer price indices: An ILO manual*, ed. Ralph Turvey, International Labour Office, Geneva, 1989, pp. 167-177.

Turvey, Ralph, *Consumer price indices: An ILO manual*, International Labour Office, Geneva, 1989.

U.S. Bureau of Labor Statistics, Experimental Cost-of-Living Index Measures, Report 751, June 1988.

U.S. Bureau of Labor Statistics, *BLS Handbook of Methods*, bulletin 2414, U.S. Government Printing Office, Washington, 1992.

U.S. Bureau of Labor Statistics, "Improving CPI sample rotation procedures," in *CPI Detailed Report*, October 1994a, pp.7-8.

U.S. Bureau of Labor Statistics, "Improvements in estimating the shelter indexes in the CPI," in *CPI Detailed Report*, October 1994b, pp.5-6.

U.S. Bureau of Labor Statistics, "Extending the improvement in CPI sample rotation procedures," *CPI Detailed Report*, June 1996a, pp.9-10.

U.S. Bureau of Labor Statistics, "Improving CPI item substitution procedures," *CPI Detailed Report*, July 1996b, pp.8-9.

Stewart, Kenneth, and Pavalone, Joseph, "Experimental CPI for Americans 62 years of age and older," *CPI Detailed Report*, April 1996, pp. 4-7.

U.S. Senate Finance Committee, *Toward a More Accurate Measure of the Cost of Living*, final report to the Senate Finance Committee from the Advisory Commission to Study the Consumer Price Index, December 4, 1996.