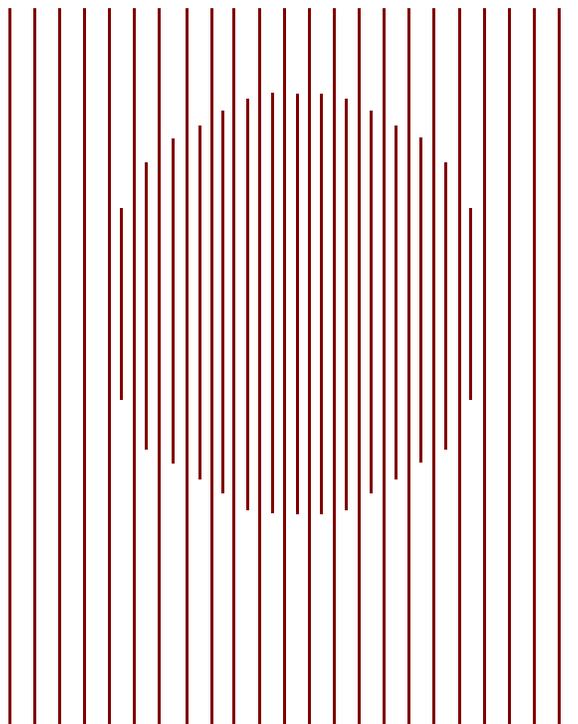


CBO PAPERS

**IS THE GROWTH OF THE CPI
A BIASED MEASURE OF CHANGES
IN THE COST OF LIVING?**

October 1994



CONGRESSIONAL BUDGET OFFICE

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**CONGRESSIONAL BUDGET OFFICE
SECOND AND D STREETS, S.W.
WASHINGTON, D.C. 20515**

PREFACE

The growth of the consumer price index published by the Bureau of Labor Statistics is widely used as a measure of the increase in the cost of living. Numerous researchers have argued, however, that changes in the consumer price index do not truly reflect changes in the cost of living, and the results of recent studies have intensified the debate. This Congressional Budget Office (CBO) paper--prepared at the request of the House Committee on the Budget--analyzes the arguments about the degree to which changes in the consumer price index may, on average, overstate the increase in the cost of living--that is, the degree to which the measure may be upwardly biased.

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Sherry Snyder edited the paper, with the assistance of Chris Spoor, and L. Rae Roy and Dorothy Kornegay prepared it for publication.

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Director

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SUMMARY

As a measure of the cost of living for the overall population, the consumer price index (CPI) is probably upwardly biased--that is, it tends to overstate the increase in the cost of living. Although the amount of bias is not known, the existing empirical evidence, which addresses many but not all of the potential areas of mismeasurement, indicates that the CPI has probably grown faster than the cost of living by between one-fifth and four-fifths of a percentage point in recent years. Other potential areas of mismeasurement that have not been subjected to empirical examination may offset or add to the bias that the empirical studies have found. Because the CPI is widely used as an indicator of both the cost of living and inflation, a bias in that index could distort economic decisions, government spending programs, and tax policies. Because of the importance of this issue, further study is warranted.

Users of cost-of-living indexes should be aware at the outset that numerous theoretical and practical difficulties are associated with measuring the cost of living and that all estimates are subject to a great deal of uncertainty. Even if all of the necessary data were readily available, fundamental problems would arise in deciding what should be included in a cost-of-living index and how best to measure the cost of living. For example, rapid changes in medical care and the potentially huge valuations that could be placed on new treatments or cures make medical care one of the thorniest problems in developing a cost-of-living index. Numerous practical problems also arise: not all of the data are readily available; and an immense effort is needed to ensure that consumers' shopping patterns are reflected in the data samples and that the value to the consumer of new and substitute goods and services is properly estimated.

The use of a price index that is based on the spending habits of one group of people to approximate the changes in the cost of living for another group introduces another potential for mismeasurement. For example, the spending patterns of the elderly are, on average, quite different from those that are used to construct the CPI. Medical care constitutes a greater percentage of the expenditures of the elderly than of the population as a whole; and the medical care component of the CPI, as currently measured, has been increasing more rapidly than the overall CPI. For that reason, an experimental index for the elderly increases more rapidly than the regularly published CPI. The current measure of medical care, however, may be biased upward. In addition, other nonmedical categories of the CPI may suffer from

a similar upward bias. If so, the growth of the CPI may, in fact, be similar to or even overstate the true increase in the cost of living for the elderly.

An overestimate of the increase in the cost of living of even half a percentage point, if not generally recognized, may seriously distort private and public economic decisions. Overstatement would obviously mislead decisions about cost-of-living adjustments to wages and other contracts, entitlement programs, and income tax brackets. But overstating the growth in prices could also affect a number of other decisions because, for example, measures of trends in the growth of real gross domestic product, real wages, and productivity would be lower than they should be. In addition, mismeasurement may lead to unintended real transfers of wealth among various groups.

The Bureau of Labor Statistics, the agency that produces the CPI, is well aware of these issues and is examining ways to address them. In fact, the bureau will institute some changes in January 1995 that are likely to reduce the degree of bias.

CHAPTER I

INTRODUCTION

The consumer price index prepared by the Bureau of Labor Statistics (BLS) is widely used as a measure of inflation and changes in the cost of living. The concept of inflation differs slightly from that of changes in the cost of living. Inflation is a general, persistent change in prices of both consumer goods and goods not directly bought by consumers, such as industrial machinery. By contrast, measures of the change in the cost of living show how changes in prices affect consumers' well-being. Therefore they should include only consumer goods and should take account of how consumers can change the composition of the goods they buy to maintain their level of well-being.

The compilation of the consumer price index is a massive undertaking requiring extensive surveys and periodic revisions. Currently, the BLS publishes two versions of the national index every month. One is based on the 1982-1984 average spending patterns of all urban consumers (the CPI-U), thereby reflecting the prices faced by about 80 percent of the population. The other is based on the 1982-1984 spending patterns of urban wage earners and clerical workers (the CPI-W, defined by the BLS to include only workers paid by the hour); about 32 percent of the total population. The BLS surveys about 25,000 outlets each month and collects prices for about 95,000 goods and services. One-fifth of the sample of items selected for price quotes is updated every year in a process called sample rotation. And in recent decades, the basic expenditure shares, or weights, used to compile the indexes have been updated every 10 years. In 1998, the two indexes will begin to reflect the expenditure patterns for the 1993-1995 period instead of the current 1982-1984 weights.

The consumer price index is an important statistic. Because it is used as an indicator of inflation as well as a measure of the growth in the cost of living, it affects both economic policy and private-sector decisions. Perceptions of real economic growth, trends in productivity, and real wages are influenced by the reported changes in the CPI. As a measure of the cost of living, the CPI is used to adjust payments from federal transfer programs such as Social Security. It is also widely used by state and local governments and the private sector to make cost-of-living adjustments.

The degree to which the CPI accurately indicates changes in the cost of living has been debated for many years. That debate has intensified recently, however, because of new evidence of an upward bias--that is, evidence that

the CPI grows faster on average than the cost of living for the overall population.

Measuring the cost of living is subject to a number of possible sources of bias. One reason the CPI may grow faster than the cost of living is that its calculation assumes that consumers do not change their buying patterns. The measurement of changes in the cost of living should reflect how changes in prices affect consumers' well-being. If consumers can change their buying patterns in response to rising prices in a way that helps to preserve their level of well-being, then some of the increase in prices does not raise their cost of living. Because the CPI does not account for how consumers can substitute one good for another, however, it tends to overstate the increase in the cost of living.

Bias can occur in numerous other ways as well. The choice of items or the weighting of the items that are sampled for price quotes may be biased toward items whose prices increase more rapidly, or the price quotes may fail to incorporate discounts. Changes in quality are another potential source of bias, one that is difficult to compensate for. In some cases, such as an increase in the durability of tires, adjustments in quality are relatively easy to make. Adjusting for changes in the quality of most of the goods and services sampled, however, is extremely difficult. Should the price of audio equipment be adjusted for changes in the quality of the sound? How should prices be adjusted for such changes in quality as an increase in banks' hours of operation, an airline's on-time record, or a physician's ability to make the correct diagnosis?

Although many analysts maintain that the CPI grows more rapidly than the cost of living, the size of the upward bias is subject to much debate. Some analysts feel the bias is relatively trivial, about 0.2 percentage points a year, whereas others feel the bias may be as much as 1.5 percentage points a year. This paper discusses the various arguments about the size of the bias. It first reviews quantitative studies of bias, then discusses other potential sources of bias in more general terms.

CHAPTER II

EMPIRICAL ESTIMATES OF MEASUREMENT BIAS

The empirical studies reviewed in this chapter attempt to determine the extent to which a number of possible types of bias may be affecting the consumer price index. The first two sections of this chapter focus on specific types of bias--commodity substitution bias and sample rotation bias. The remaining sections focus on specific commodities, such as pharmaceuticals and food, and may encompass a number of types of bias.

The difference in the focus of these studies raises the possibility of double-counting biases. For example, a study that finds a bias in the measurement of food prices may be detecting the same bias that the study of sample rotation detects. Therefore, in summing up the bias estimates, analysts must try to avoid such double-counting. To clarify how the studies add up to an estimation of overall bias, Table 1 summarizes the results discussed in this chapter.

COMMODITY SUBSTITUTION BIAS

A cost-of-living index should account for the way in which consumers may substitute one good for another to try to maintain their level of well-being when relative prices change. If, to use a common example, the price of beef rises faster than the price of chicken, consumers will buy less beef relative to chicken than they did before. The substitution of items whose prices have grown relatively slowly for items whose prices have increased relatively rapidly is called the commodity substitution effect.

By contrast, many price indexes, including the CPI, are essentially fixed-weighted price indexes in which the weights are determined by consumption patterns (the mix of goods and services people purchase--commonly referred to as the market basket) in an earlier base period (currently 1982-1984). These weights form the basis of the calculation used to aggregate the month-to-month changes in prices for the 207 basic categories (called "strata" by the Bureau of Labor Statistics) of goods and services into an overall index of price change. Fixed-weighted price indexes do not reflect changes in the mix of goods purchased over time, and therefore a fixed-weighted index that uses weights from a previous period tends to overstate increases in the cost of living.

TABLE 1. ESTIMATES OF THE RANGE OF UPWARD BIAS IN THE EMPIRICAL STUDIES

| | Minimum | Maximum |
|-----------------------------|-------------|----------|
| Commodity Substitution Bias | 0.1 | 0.3 |
| Sample Rotation Bias | 0.2 | 0.3 |
| Prescription Drugs | 0 | 0.1 |
| Major Appliances | 0 | 0.1 |
| Auto Pollution Adjustment | <u>-0.1</u> | <u>0</u> |
| Net Upward Bias | 0.2 | 0.8 |

SOURCE: Congressional Budget Office.

NOTE: Estimates of bias discussed in the text for food and apparel are included in those for sample rotation bias because those studies are probably measuring the same bias.

Analysts can also construct price indexes, called superlative indexes, that are better measures of price change for cost-of-living calculations than the fixed-weighted formula used for the CPI.¹ Updating such formulas is expensive and difficult. To do so, analysts must collect and have new information on both prices and spending patterns on a monthly basis. Superlative indexes can be used in retrospective studies, however, to estimate substitution bias in the official measure.

Two recent studies that used superlative indexes to estimate substitution bias found a bias of about 0.2 percentage points per year. One study, which used personal consumption data for 101 commodities for the 1959-1985 period, estimated the bias to be 0.19 percentage points per year.² A more recent study, using more detailed data for the 1982-1991 period, also found the commodity substitution effect to be about 0.2 percentage points per year.³

1. See W.E. Diewert, "Index Numbers," in John Eatwell, Murry Milgate, and Peter Newman, eds., *The New Palgrave Dictionary of Economics* (London: MacMillian Press, 1987), p. 77.
2. Marilyn E. Manser and Richard J. McDonald, "An Analysis of Substitution Bias in Measuring Inflation, 1959-1985," *Econometrica*, vol. 56 (July 1988), pp. 909-930.
3. Ana M. Aizcorbe and Patrick C. Jackman, "The Commodity Substitution Effect in CPI Data, 1982-91," *Monthly Labor Review* (December 1993), pp. 25-33.

A third study, which calculated the effect of more frequent updating of the market basket on the CPI, had similar findings.⁴ Although this study did not attempt to measure substitution bias directly, it provides indirect evidence of how the failure to account for changes in spending patterns can affect the size of the bias. The study indicated that using the 1982-1984 market basket boosted the measured change in prices for the 1989-1992 period by an average of about 0.2 percentage points a year from what it would have been if the market basket was updated every year.

SAMPLE ROTATION BIAS

Research by the BLS indicates that upward bias in the CPI may also result from the method used to combine price data on detailed items *within* the major categories of commodities when the sample of outlets (that is, stores, physicians' offices, restaurants, and the like) and items is changed.⁵ In particular, the price indexes for those categories in which the prices of items vary widely within subcategories of the major category (or stratum) are likely to overstate price increases significantly in the months following a change in the outlets and items sampled.

Ironically, this problem was an unintended side effect of an effort to improve the CPI in 1978. Before that time, the CPI was calculated as a fixed-weighted index between major revisions, which were usually conducted every 10 years or so. The sampled items and outlets were specified in great detail, and neither the outlets nor the items were changed except during major revisions to the survey.⁶ Therefore, new goods and services were brought into the sample infrequently.

In 1978, to better represent between major revisions the change in the mix of items and outlets that consumers actually use, the BLS instituted a procedure to rotate the sample within each stratum. Since then, about 20 percent of the outlets surveyed have been changed every year, opening up the

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4. Mary Lynn Schmidt, "Effects of Updating the CPI Market Basket," *Monthly Labor Review* (December 1993), pp. 59-62. The study only indicated how the price change measure would differ because of changes that occur for the 207 categories, and it only reweighted the categories at the national level.
 5. Brent R. Moulton, "Basic Components of the CPI: Estimation of Price Changes," *Monthly Labor Review* (December 1993), pp. 13-24.
 6. Obviously, some items or outlets would have to be dropped, or substitutions made, if the item was discontinued or the outlet closed, but the affected items and outlets did not constitute a major part of the surveyed items.

possibility of a total change of sampled goods and services every five years. Although the weights on the categories remain fixed, the specific items within the categories and their weights can change as the sample is rotated.

The 1978 innovation resulted in better selection of the items consumers actually purchase, but one aspect of the new procedure appears to have caused an upward bias in the CPI. The BLS study indicates that the CPI gives too much weight to goods whose prices are relatively low when first introduced and are therefore likely to increase more rapidly in the months following the rotation (see Box 1). This systematic overweighting of items that tend to have temporarily higher rates of price change probably overstates the annual rate of growth of the overall CPI by about 0.3 percentage points. This estimate is based on the difference, for the period from mid-1992 to mid-1993, between the growth rate as currently calculated and a growth rate that uses a weighting procedure that would not be subject to the weighting bias.

These conclusions are supported by other findings in the BLS study. The growth of the CPI for those parts of the survey that have recently undergone rotation is greater than the growth of the CPI for all other areas. In addition, the categories with the most volatile prices show the largest differences when the index is recalculated using a formula that minimizes the overweighting problem. The conclusions about the effect of sample rotation must be tempered, however, because the BLS study has not been subject to much academic review, and the estimate of the magnitude of the bias relies heavily on data for one year only. The conclusion of a bias of 0.3 percentage points should be considered tentative until more work can be done.

EMPIRICAL STUDIES OF THE CPI FOR PRESCRIPTION DRUGS

Studies of price indexes of prescription drugs suggest the CPI for drugs may be biased upward, though the effect on the overall CPI may be small. The two major reasons for possible bias are that the CPI may not adequately capture changes in quality and that the sample may not represent the actual patterns of drug expenditures. The problems with changes in quality occur because attributes of new drugs such as efficacy, side effects, and convenience of use are not tracked and because generic drugs are usually not treated as replacements for brand-name drugs. The sample may not adequately represent drug prices because current CPI methods do not reflect the high rate at which new drugs enter the market and the rapid increase in the market share of generic drugs after a patent for a brand-name drug expires.

BOX 1.**CAUSE OF UPWARD BIAS ASSOCIATED WITH SAMPLE ROTATION**

Sample rotation, the updating of 20 percent of the stores and items that are sampled for the collection of price data in the consumer price index (CPI), results in a more representative and up-to-date sample of household purchases, but it may also cause an upward bias in the CPI.

Approximately two years before a sample is changed, the Bureau of Labor Statistics (BLS) conducts a point-of-purchase survey to analyze the shopping patterns of consumers in the area. That survey is used to select the stores the BLS field representatives will examine. Then, a few months before the sample will be rotated, the representative determines the specific item to be priced within a quite narrow category--for example, the representative is told to price apples, but he or she must determine the specific type of apple. The representative usually uses the outlet's sales records to select the specific item to be sampled.

The next step is to link the new items or stores to the old ones, and that process has two parts. First, the field representative collects price data for the new items for a short period before the data are actually used in the CPI. Then, when the item is included, the growth in the item's price can be compared with its own price history during that period, not with the price history of an item that could be quite different.

The second part of the linking process--and the one that is more important in addressing the issue of bias--is to determine the weight of the new item within its own category. That is done by first deflating the surveyed price back to the time of the point-of-purchase survey and then dividing that price into the total expenditure on the item at the time of the survey. That calculation yields an expenditure weight in constant dollars.

The BLS indicates that this procedure probably systematically gives a greater weight to items or stores that happen to have relatively low prices when they are included in the sample. If, for example, Baldwin apples were on sale at a particular outlet when new items or stores were rotated into the survey, the level of the deflated price of the apples at that outlet would be lower than the average price of all apples of that type, and the weight for that sample item would be correspondingly larger. (Dividing the expenditures on apples determined at the time of the survey by an artificially low price would result in a greater weight.) In addition, the price of an item on sale during the month in which it is brought into the sample is likely to rise more rapidly in the ensuing months to get back to the normal level of prices than items that were not on sale. Therefore, items or stores that will tend to have higher inflation rates after the sample has been rotated are systematically overweighted within each category.

Improvements in the quality of drugs are extremely difficult to measure and may be virtually impossible to embed in a monthly survey of prices. Even so, improvements are hard to ignore. A study that attempted to account for the changes in the quality of brand-name antiulcer drugs found that a price index that did not adjust for qualities that patients and doctors considered important increased by an average rate of 13 percent a year between 1977 and 1989, compared with a 6 percent increase for a quality-adjusted price series.⁷

The measurement of change in quality was also investigated in a study of antihypertensive drugs.⁸ The study found that the prices of 20 of those drugs were related to measures of quality such as the magnitude of the drop in blood pressure, intolerable side effects, and the percentage of patients who responded to the drug. The analysts who conducted the study stress its preliminary nature and note that they had to make numerous judgmental decisions in collecting the data, but they found that a price index that accounts for changes in quality increased about half as fast as an index that did not incorporate such changes.

Another possible source of bias stems from the treatment of generic drugs. The CPI may fail to track true quality-adjusted prices both because generic drugs are underweighted in the sample and because they are not treated as substitutes of brand-name drugs. Generic drugs are brought into the sample late, and once in the sample, the weight is unlikely to increase as fast as it should. Generic drugs account for more than half of all drug prescriptions that are filled, and they are likely to capture an increasing share in the future.

A study of the price behavior of two generic drugs indicates that the failure to treat them as substitutes for brand-name drugs causes a large upward bias in the measurement of drug prices.⁹ The study focused on the producer price index (PPI), but the results would probably also apply to the consumer price index. By directly linking the price of a generic drug to the price of the brand-name drug, the measured rate of price change for the two drugs studied is much slower. The price of one type of drug showed no

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7. Valerie Y. Suslow, *Are There Better Ways to Spell Relief? A Hedonic Pricing Analysis of Ulcer Drugs*, Conference Paper (Washington, D.C.: American Enterprise Institute, October 1993), p. 24.
 8. Ernest R. Berndt and Stan N. Finkelstein, *Price Indexes for Anti-Hypertensive Drugs That Incorporate Quality Change: A Progress Report on a Feasibility Study*, Working Paper No. 6-92, Program on the Pharmaceutical Industry, Sloan School of Management (Cambridge, Mass.: Massachusetts Institute of Technology, 1992).
 9. Zvi Griliches and Iain Cockburn, *Generic and New Goods in Pharmaceutical Price Indexes*, Discussion Paper No. 1664, Harvard Institute of Economic Research (Cambridge, Mass.: Harvard University, December 1993).

change over four years when only the price of the brand-name drug was used, but the price decreased about 30 percent when the generic was assumed to be a perfect substitute for the brand-name drug. In the other case, the brand-name price increased by 14 percent, whereas the price index that assumed perfect substitutability fell by 53 percent. The difference between the measured rates of price change is attributable to the lateness of the inclusion of the generics with too small a weight in the official calculation and to the failure of the official measure to capture the extent to which generics increase their market share in the years after their introduction.

The behavior of prices in the pharmaceutical industry emphasizes the need for basing the CPI on a representative sample of drugs. The price of many patented drugs increases rapidly when generic drugs become available, because the companies target consumers who are almost totally unresponsive to changes in price. Some manufacturers may feel that they can maximize their profits by raising prices when their patent expires, since generic drugs are going to capture a large part of the market even if the manufacturers of patented drugs lower their prices. Consumers (individuals or medical care providers) who are unaware of price increases, or who are indifferent because of arrangements with third-party payers, will continue to buy the patented drug even at the higher price. But other, more price-aware consumers have the option to buy the lower-price generic drug.

The pricing policies that drug firms follow when they introduce new drugs, whether patented or generic, are also a factor. The prices of many new drugs fall significantly in the first few years on the market. If the current price measures are slow to include new drugs with their proper weight, they will miss much of the initial price decline.

Another study that focused on the PPI indicates the possibility of upward bias in that measure because the sample of drugs is too limited.¹⁰ The pharmaceutical industry introduces new products at a high rate. For example, the Department of Health and Human Services added 3,048 new products to its list of drug products between 1982 and 1987, almost a 50 percent increase. In the study, a price index based on a larger, more representative sample of prescription drugs rose more slowly than the published PPI drug index. Using the same basic formula as the official PPI, the study concluded that prices increased an average of 6.9 percent a year over the 1988-1991 period in the broad sample, compared with 8.4 percent in the published data. Note that this index ignores new drugs introduced between 1988 and 1991; it tracks only

10. E.R. Berndt and P.E. Greenberg, *Price Growth of Prescription Pharmaceutical Preparations: An Update and Extension*, Discussion Paper No. 94-1 (Cambridge, Mass.: The Analysis Group, Inc., January 1994).

the prices of drugs that existed at the beginning of the period. When analysts calculated another price index that incorporated drugs introduced during that period, the average annual price change was 6.0 percent.

Even large overstatements of changes in drug prices would not have a large impact on the overall CPI, however, given the small weight (about 1 percent) that drugs have in that index. Therefore, an overstatement of drug prices of even 4 percentage points per year implies an overall CPI bias of only 0.04 percentage points. Some of the evidence indicates a greater overstatement of the changes in drug prices, so the effect on the overall CPI may be greater, but it is still unlikely to be large. Drug prices, however, play a larger role in the purchases of Social Security recipients, so any overstatement of drug prices would have to be taken into account if a specific price index was to be developed for that group.

OTHER EMPIRICAL STUDIES OF BIAS

A number of studies that focused on specific categories of the CPI have been published during the past 15 years. As mentioned earlier, many of these studies may be detecting a bias caused by sample rotation, so their estimates of bias cannot simply be added to those for sample rotation to arrive at an estimate of overall bias. Therefore, the possibility of double-counting the biases is discussed below.

Food and Gasoline

One study used two different approaches to examine the price changes for food and fuel in the CPI during the 1980s and found some upward bias.¹¹ But those empirical estimates are probably detecting sample rotation bias.

In the first approach, prices for items that were being dropped from the sample at the time of rotation were compared with prices of essentially identical items that were being brought into the sample. This method led to an estimate of an upward bias in the CPI for food of at most 0.25 percentage points per year for the period from January 1987 to June 1989. Similar results were obtained for gasoline, although the results were less conclusive.

11. Marshall Reinsdorf, "The Effect of Outlet Price Differentials on the CPI," in Murray F. Foss, Marilyn E. Manser, and Allan H. Young, eds., *Price Measurements and Their Uses* (Chicago: University of Chicago Press, 1993).

The second method compared the CPI data with the average-price data for the 1980s published by the BLS. Those data track the average price paid for a specific, representative type of good. The BLS uses dollar values for those data rather than index numbers, and the change in quality is minimal since a specific type of good is tracked continuously. One drawback of the data is the implicit assumption that quality does not change when new outlets enter the sample. For example, when the price of gasoline is tracked, the increasing importance of self-service outlets implies a lower quality of service, but the price of gasoline is not adjusted for that change.

The study found that prices in the average-price data grew more slowly than the prices in the CPI for all but 4 of the 52 food items studied, and the overall annual growth in food prices was 2 percentage points slower over the 1980s. For gasoline, the average-price data also indicated that price growth was 2 percentage points slower than reported in the CPI, but the study attributed over half of the difference to the change in the quality of service.

Growth in food prices is likely to be overstated in the CPI. The study of sample rotation bias indicated an upward bias for food prices, as did both methods discussed above. These studies are probably detecting the same bias, however, so the estimate of bias that was based on average-price data should not be added to the sample rotation bias.

The evidence does not imply that the measurement of gasoline prices is biased. This study found little bias when it corrected for change in quality, and the study of sample rotation also found little bias for gasoline prices.

Apparel

Apparel prices may currently be subject to an upward bias because of sample rotation bias discussed above. Before 1991, the BLS was concerned that measured changes in apparel prices may have been biased *downward* because the CPI treated some price changes as quality changes. The causes of the downward bias now appear to have been corrected, but the rotation bias may still be present.

Large increases in apparel prices tend to occur at the time the product is first offered for sale--that is, at the beginning of a season--and prices are then discounted toward the end of a season. The procedure the BLS used before 1991 to incorporate new apparel items into the CPI did not adjust for changes in quality in the month the good was introduced. Failure to make that adjustment resulted in an understatement of the increases in apparel

prices because it included the discounting but excluded the initial price increases.

A study estimated the amount of understatement by comparing the CPI with so-called hedonic indexes for two categories of apparel--women's coats and jackets, and women's suits. (A hedonic index tries to account for changes in quality by estimating the value of various characteristics of a good. See Box 2.)¹² The hedonic indexes were constructed using the checklist of characteristics with which the BLS field representatives identified the items to be sampled on a monthly basis. Although the results were not conclusive, this study indicated that the CPI significantly understated changes in apparel prices.

In 1991, the BLS began to use hedonic techniques to supplement its evaluation of price quotes in apparel. Commodity analysts use the information from the hedonic techniques to decide how to adjust apparel prices for quality over the season and as outlets and items in the sample change. Although problems probably remain in the quality adjustment of apparel prices, most of the downward bias has been eliminated.

Although the development of hedonic indexes has adjusted the source data on apparel prices for changes in quality, the source data was itself biased because of the sample rotation effect. The sample rotation study tentatively indicates an upward bias for apparel of almost 2 percentage points during the period from mid-1992 to mid-1993.

Household Appliances

A study that tracked changes in the quality of household appliances such as refrigerators, air conditioners, washers, and dryers found that the CPI overstated quality-adjusted price increases for these items between 1972 and 1983.¹³ Using issues of *Consumer Reports* and Sears catalogs, a researcher calculated alternative price indexes for appliances that took changes in quality into account. The study used both hedonic techniques and a method in which closely similar models were tracked over time.

12. Paul R. Liegey, Jr., "Adjusting Apparel Indexes in the Consumer Price Index for Quality Differences," in Murray F. Foss, Marilyn E. Manser, and Allan H. Young, eds., *Price Measurements and Their Uses* (Chicago: University of Chicago Press, 1993).

13. Robert J. Gordon, *The Measurement of Durable Goods Prices* (Chicago: University of Chicago Press, 1990).

For the 1972-1983 period, the price increases in the CPI data were similar to the quality-adjusted indexes for some of the appliances but vastly overstated price increases for others. The maximum estimate of the overstatement of price change for appliances was about 4 percentage points a year. Given that those goods account for about 1 percent of the items in the CPI, these figures imply that the maximum effect on the overall CPI of understating changes in quality would be less than one-tenth of a percentage point. The results of this study may not be applicable to the period since 1983, however, and therefore even this estimate is extremely tentative.

Motor Vehicles

In contrast to the prices of most durable goods, prices of motor vehicles in the CPI may be biased downward. Because the BLS considers the mandatory safety and pollution control devices as improvements in quality, it adjusts list prices downward to account for the cost of those devices when they are introduced. For a cost-of-living index, however, at least some of those changes should be treated as price increases.

Since the 1960s, the BLS has adjusted the list prices of new models for changes in quality. The bureau first looks at the list of potential changes in quality at the outset of each model year and decides which should be considered actual quality changes (as opposed to styling changes or minor alterations). It then uses cost information from producers to determine how much each change in quality contributed to the price of the new model. In some cases, the BLS has adopted the full cost claimed by the manufacturer. In other cases, it has used the lowest cost claimed by the various manufacturers instituting a similar improvement. In still other cases, when changes in quality have been radical, the quality-adjusted change in a model's price might also reflect information from the change in prices of models that experienced less radical changes.

The safety mandates might properly be included in the quality adjustment, largely because the benefits accrue directly to the consumer, because consumers appear to have demanded some of the safety changes ahead of the mandates, and because the consumer may be able to weigh the costs and benefits. Pollution control, however, benefits society at large, and there is no indication that consumers would have valued it at the full cost of the improvement. Although the data are not complete, the BLS's adjustments for

BOX 2.
ACCOUNTING FOR CHANGE IN QUALITY

Whenever new items are brought into the consumer price index (CPI) sample, potential changes in quality have to be addressed. New items can enter the sample in two ways. If an item that a field representative from the Bureau of Labor Statistics (BLS) has been tracking at a particular outlet is no longer carried by the outlet, the representative will try to find a substitute item at the same outlet that best matches the characteristics of the item that was being tracked. Substitutions are found for roughly 3 percent of the nonshelter price quotes each month. New items can also enter the sample as part of the sample rotation process discussed in the text.

When substitute items are introduced, commodity analysts decide how much of the change in the price of the new item may be attributable to a change in quality. The analysts use four basic methods. They may decide the item is of the same quality, in which case the prices are directly compared--that is, the change in price from the old to the new item is used in the CPI. They may decide the prices cannot be directly compared and instead use "overall mean imputation" pricing. In imputation pricing, the price series of the old item is dropped, the price series of the new item enters the survey, and the quality-adjusted change in the price in the month the item was brought into the sample is assumed to be the same as the average price change for other goods in its category and geographic area. In a minority of cases--primarily autos--the analysts use a third method in which their decisions are guided by detailed analysis of the cost of modifications.

The fourth method uses hedonic indexes. The creation of hedonic indexes assumes that goods can be viewed as bundles of characteristics that consumers desire. With such indexes, analysts try to match qualities of the new item with those of the old to estimate the change in the quality-adjusted price. An example of a hedonic index that has been used in the national income and product accounts for many years is the price index for residential construction. Analysts track the specific characteristics of the residential units under construction--such as the number of rooms, the square feet of interior space, the number of fireplaces, and whether or not the unit has central air conditioning or a garage--and then estimate a regression equation in which they attribute variations in sales price among units to the various characteristics. Using this method, they can impute prices for the characteristics. Therefore, the price of a new set of housing units that has different characteristics from the old set can be compared characteristic by characteristic to determine how much of the change is true price change and how much stems from a change in quality.

BOX 2. CONTINUED

Hedonic techniques can provide additional information on how to adjust prices for changes in quality, but they also have a number of weaknesses. They hold constant only the characteristics that researchers have identified as the most important and that can be measured. If the researchers have failed to identify a characteristic that is important to consumers, the hedonic index will be biased. Hedonic indexes are also somewhat judgmental, both in the selection of characteristics and in the interpretation of the statistical estimation of the indexes. In addition, the qualities of a good that consumers value change over time, so hedonic specifications often have to be updated. For example, heavier automobiles were more desirable before the sharp increase in oil prices in the 1970s, so hedonic indexes calculated in the 1960s that used a car's weight as a positive characteristic were less valid during the next decade.

None of the four methods discussed above, however, is used when items enter the sample through sample rotation. The prices of the new items that are rotated into the sample are brought into the index by a fifth method called overlap pricing. The prices of the new items are sampled in the month before actually being brought into the sample, and then the rate of change in price of the new item is used to calculate the CPI in the month the new item is introduced to the sample.

The BLS's procedures can sometimes over- or understate changes in prices. If prices are assumed to be directly comparable and the replacement good is of higher quality than the discontinued item, the CPI will overestimate the true, quality-adjusted price change. Similarly, if the replacement good is of lower quality, the CPI will underestimate the price change. The same problem could occur when mean imputation pricing is used. If the replacement good is of such higher quality that the increase in its price over the old good when adjusted for differences in quality is less than the price increase of other goods in its category, the CPI will overstate the price change. Conversely, if sellers use the minor modification as an opportunity to raise the quality-adjusted price more than the mean imputation procedure assumes, the price increase will be understated. Similar problems can occur for overlap pricing techniques.

improvements in federally mandated pollution control devices deducted less than 0.05 percentage points per year from the growth of the CPI during the 1980s. Therefore, the pollution adjustments have probably had little effect on the overall growth of the CPI.

Housing

The treatment of housing costs in the CPI has been a subject of controversy for many years. That controversy led to two significant revisions to the housing component during the 1980s, and the current housing measure is unlikely to have a significant bias.

During the 1970s and the early 1980s, the CPI measure of imputed rent for homeowners—that is, what homeowners would have had to pay to rent the homes they own—tracked the cost of buying rather than renting a house. The measure would rise during periods in which mortgage rates were increasing and would fall when rates were dropping. The housing costs of the vast majority of homeowners would not be affected by rising interest rates, however, since few people would buy a home in any given year. Therefore, the CPI was clearly not tracking those costs adequately. Note that this problem did not cause a long-term bias in the measure of housing costs, only excessive volatility. In 1983, the BLS corrected this problem by basing the imputed rent on a survey of actual rents paid for houses similar to those that households own.

Another revision of the housing component of the CPI was spurred by the failure to account properly for depreciation of rented housing units. By underestimating the physical depreciation of housing units, the CPI understated the quality-adjusted increases in housing prices. Indexes of shelter costs were estimated to be biased downward by as much as 0.3 percent to 0.4 percent annually.¹⁴ In 1988, however, based on a series of studies, the BLS corrected this problem.

14. William C. Randolph, "Housing Depreciation and Aging Bias in the Consumer Price Index," *Journal of Business and Economic Statistics* (July 1988).