Consumer Prices, the Consumer Price Index, and the Cost of Living

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Accurately measuring prices and their rate of change, inflation, is central to almost every economic issue. There is virtually no other issue that is so endemic to every field of economics. Some examples include aggregate growth and productivity; industry prices and productivity; government taxes and spending programs that are indexed to inflation; budget deficits and debt; monetary policy; real financial returns; real wages, real median incomes and poverty rates; and the comparative performance of economies.

In mid-1995, the Senate Finance Committee, pursuant to a Senate Resolution, appointed an Advisory Committee to study the Consumer Price Index (CPI) with the five authors of this article as its members. The CPI Commission concluded that the change in the Consumer Price Index overstates the change in the cost of living by about 1.1 percentage points per year, with a range of plausible values of 0.8 to 1.6 percentage points (Boskin et al., 1996). That is, if inflation as measured by the percentage change in the CPI is running 3 percent, the true change in the cost of living is about 2 percent. This bias might seem small, but when compounded over time, the implications are enormous. Over a dozen years, the cumulative additional national debt from overindexing the budget would amount to more than $1 trillion.

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The implications of overstating inflation for understanding economic progress are equally dramatic. Over the last quarter-century, average real earnings have risen, not fallen, and real median income has grown, not stagnated. The poverty rate would be lower. Because the CPI component price indexes are inputs into the national income accounts, an overstated CPI implies that real GDP growth has been understated (Boskin and Jorgenson, 1997).

The CPI Commission represented the first extensive external evaluation of the nation's price statistics in more than a third of a century; the previous report was the famous Stigler (1961) Commission, an external commission of experts set up to report to the Budget Bureau (the predecessor of the Office of Management and Budget) on ways to improve the nation's price statistics. Some contrasts between our Commission and the Stigler Commission provide useful background for those evaluating our report, and subsequent criticisms of that report. The reports have one thing in common; Zvi Griliches was involved in both. There are several important differences. Our report concerns only the CPI, while the Stigler report covered the Producer Price Index and agricultural price indexes as well. The Stigler report did not produce any numerical estimate for biases in any of the price indexes they reviewed (although it concluded that virtually all economists would agree there was an upward bias), whereas our mandate included the provision of a point estimate of the overall bias in the CPI. The Stigler Commission had a substantial budget to commission new research studies, including Griliches's (1961) famous paper on hedonic price indexes for automobiles, whereas our Commission had no budget at all (except for travel). We did our best to assemble all the existing research by academics, BLS insiders, and others that has been done over the last 35 years. Especially seminal contributions include Diewert (1976, 1995), Pollak (1981), Griliches (1961) and Hausman (1996, 1997). In doing so, we benefitted greatly from one of the main recommendations of the Stigler Commission, which was that BLS establish a price research unit. It has produced a great deal of high quality research on price index issues (Abraham et al., and Diewert, this volume, provide references). Perhaps the most important change from the standpoint of why bias in the CPI matters to public policy was the widespread indexing of federal transfers and taxes to the CPI in the 1970s and 1980s, which has meant that the bias in the CPI will now have a direct budgetary impact.

Since the publication of our report, in a series of professional meetings, Congressional hearings, and other events, there has been much support for, and criticism of, the findings and recommendations of the CPI Commission. The purpose of this paper is to provide a readily accessible and self-contained discussion of the issues involved.

At this point in the debate, we see no reason to change our original estimate of a 1.1 percentage point per annum upward bias in the change in the Consumer Price Index. We strongly endorse the proposed improvements the Bureau of Labor Statistics (BLS) is currently planning to make, research, or explore (Abraham et al., this issue), but believe it can and should, if given the appropriate resources, do far more to improve the CPI than it currently contemplates.

The Consumer Price Index

Why are changes in the cost of living so hard to measure?[1] There are literally millions of goods and services available in modern market economies. A single supermarket may contain 30,000 differently priced items and a WalMart store over 40,000. New products are being introduced all the time and existing ones improved, while others leave the market. Relative prices of different goods and services change frequently, for example, in response to technological and other factors affecting costs and quality, which leads consumers to change their buying patterns. As we have become richer, demand has increasingly shifted to services away from goods, and to characteristics of goods and services such as enhanced quality, more variety and greater convenience. Technology and entrepreneurship provide these characteristics. But all these factors, plus others, mean a larger fraction of what is produced and consumed in an economy is harder to measure than decades ago when a larger fraction of economic activity consisted of a smaller number of easier to measure items such as hammers and potatoes.

Hence, the very first point the CPI Commission made in its report was that inflation is inherently difficult to measure in a complex dynamic market economy. The CPI program of the BLS is a large, complex and impressive undertaking. It is staffed by high quality dedicated professionals. We believe most of the problems occur because the rapidly changing nature of our economy puts immense pressure on a statistical system to keep up.

Defining what information one would need and how to use it to obtain an overall summary measure of the level and/or change in consumer prices requires various assumptions and procedures. The first question to answer is: ''What is the domain of consumer expenditures to be covered?'' The CPI program focuses on consumer expenditures on goods and services out of disposable income. Hence, it excludes non-market activity, broader quality of life issues, and the costs and benefits of most government programs. It also excludes saving, which is invested to finance future consumption. Hence, when the forward price of future consumption changes relative to current consumption; for example, when returns available to savers improve because of market forces, deregulation, tax law changes or financial

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[1] The cost-of-living index (COLI) for an individual household is defined as the ratio of the minimum expenditure necessary to achieve a base period level of utility for consumer i at the current period's prices to the base period level of expenditure, or

$$\text{COLI}_i = \frac{M_i\ (P^l,\ U^o,\ A_i)}{M_i\ (P^o,\ U^o,\ A_i)}$$

where M is the expenditure function and A represents characteristics—for example demographic—of the *ith* household. Constructing a COLI for a group (all urban consumers, or Social Security beneficiaries, and so on) or society as a whole involves several important issues of aggregation, equivalence scales and welfare comparison. See Jorgenson and Slesnick (1983), Pollak (1981; this issue), and Deaton and Muelbauer (1980).

product innovation (such as the widespread availability of low-cost mutual funds), no direct account is taken in the CPI.

Second, one has to define the commodities and services the prices of which one wants to measure, how to measure them, how to collect data on them, over what span of time and at what interval, where and when to collect the data, and how to aggregate them into one or several overall summary statistics. At each of these levels, various judgments and assumptions must be made to make practical headway. Some of the Commission's suggested improvements deal with various of these assumptions such as the use of fixed weights.

The BLS collects price quotations on 71,000 goods and services, at about 22,000 retail outlets, either monthly or bimonthly. Additional information is obtained on rent and owners' equivalent rent—that is, how much owners are paying in opportunity cost terms for housing services—from about 35,000 rental units. About once a decade the weights for different commodities are derived from the Consumer Expenditure Surveys; for the last decade, weights were from the 1982–84 period. These data are used to define categories of goods within the index (for greater detail, see BLS, 1992).

The CPI price collection goes through a hierarchical or pyramidal process. At the top is the all-item CPI—the overall summary measure of the change in consumer prices from month to month. Next comes a small number of broad commodity groups such as housing, food and beverages, apparel, transportation, medical care, entertainment and other. Each of these categories is subdivided into other categories. For example, housing is divided into shelter, fuel and other utilities, and household furnishings and operations. Each of these subcategories is divided still further; for example, household furnishings into categories such as furniture and bedding, appliances, and so on. The lowest level of aggregation for which an index is calculated by aggregating price quotes is called an item stratum. There are 207 item strata collected in 44 geographical areas, leading to 9,108 strata indexes. Below the strata are entry level items (ELI's), from which specific products are sampled. The basic price quotes, of course, are on actual commodities and services, not on this lowest level of aggregate or ELI. For example, one doesn't go into a store and buy ''apples,'' one buys a specific type and size, like large red Delicious apples. Therefore, the price data on actual commodities purchased in various places must be aggregated to get the strata indexes; for example, apples in Los Angeles.

Outlets are chosen and rotated every five years from a Point-of-Purchase Survey, asking consumers where they purchase goods and services, with probabilities of outlet selection proportional to expenditures. There is thus approximately a 20 percent refreshing per year. The prices are collected and compared *within outlets*. No account is explicitly taken of substitution across outlet types, as might be expected with the evolution of retailing; for example, the widespread use of discount stores in recent years. Within the outlet, the BLS collects prices on specific items, with probability of selection proportional to sales, and reprices the same item for five years. Often the same item is not in stock in successive months, and a judgment

must be made to price a comparable item or not; if so, differences in the substituted items are noted and, as noted below, adjustments are made.

In calculating the lowest level strata price index aggregates on the basis of price quotes, the data are aggregated (currently and historically) using a variant of arithmetic means. This was historically defended as consistent with the fixed weight formulas used at the higher level of aggregation. In short, it is assumed that there is no substitution within these categories, even when they include items among which there is likely to be immense substitution, such as types of apples, styles and colors of men's dress shirts and so on. Assuming the elasticity of substitution in consumption is zero is unrealistic for virtually every commodity group and dramatically so for most.[2] We will return to this discussion below.

Once the elementary indexes are formed in this way, higher levels of indexes are aggregated again with fixed weights up the pyramid all the way to the all-item CPI. The method used is to look at what proportion of their income consumers actually spend in each category as revealed by a past Consumer Expenditure Survey, which defines a fixed ''basket'' of goods, and then to figure what it would cost to purchase that basket in later years up to the present. This approach to measuring the changes in the cost of a fixed basket of goods is called a Laspeyres index. Notice that it assumes no consumer substitution occurs in response to changes in relative prices, an assumption that is extreme, unrealistic and unnecessary. Moreover, the expenditure weights used in the Consumer Price Index are several years out of date even on the first day a revision is introduced. For example, the 1982–84 weights were implemented in the CPI program in 1987, and the 1998 revision will use weights from 1993–1995.

There are two approaches to measuring cost-of-living indexes. The first uses estimated systems of demand equations to make exact utility comparison accounting for the substitution estimated in the demand system. This approach has been successfully implemented at a relatively high level of aggregation (Braithwait, 1980; Jorgenson and Slesnick, 1983). However, the number of parameters that must be estimated in a full system of consumer demand rises with the square of (one less than) the number of commodities and quickly becomes impossible to implement at any detailed level of disaggregation. If much of the substitution goes on at the lower levels of disaggregation, this would be missed. But in fact, the estimates of substitution bias in, for example, Jorgenson and Slesnick, are quite similar to those in numerous far more disaggregated studies by the BLS, which use the second method described below.

The second approach uses mathematical formulas to calculate index numbers, usually at a more, often extremely, detailed level of disaggregation. The most common index number formula is the Laspeyres index, which measures the changes in the cost of a fixed basket of goods from a base period—that is, it assumes no

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[2] See Diewert (1995) for a discussion of properties of alternative methods for aggregating elementary price quotes.

substitution due to relative price changes. Thus, it usually is an overestimate of a ''true'' cost-of-living index. At the other extreme is the Paasche index, which weights by current consumption pattern, and thus likely overstates substitution and understates the change in cost-of-living index relative to an earlier base period.

Superlative indexes (Diewert, 1976) approximate the true cost-of-living index, under certain assumptions, without having to estimate the demand equations and thus can handle the potential dimensionality problem inherent in disaggregation in a modern market economy with vast numbers of goods and services. The Fisher Ideal Index is the geometric mean of the Laspeyres and Paasche indexes; that is, the square root of their product (Fisher, 1922). The Tornqvist index exponentiates the sum of the weighted natural logarithms of price relatives, with the weights being the averages of the expenditure shares of the goods in the current and base periods (Tornqvist, 1936). Aizcorbe and Jackman (1993) provide the mathematical formulas for these indexes, in two-period and chained form.

When the BLS price takers confront a new product, a basic dilemma arises. If the product fits fairly reasonably into an existing category it may well be rotated in, perhaps somewhat late, as part of the sampling procedures combined with the Point-of-Purchase Survey. The use of sampling was a major recommendation of the 1961 Stigler Commission Report and was implemented in 1978.[3] However, when a new product comes along that does not fit neatly into an existing category, or is ''missed'' for other reasons, it may be an entire decade or more before the product is introduced into the CPI. This was the case with VCRs, microwave ovens, and personal computers, and is currently the case with cellular telephones and service. The problems of new products are difficult but likely to be quantitatively very important. Much of the improvement in standards of living in modern economies derives from new products, including major innovations such as in light, transportation, communications, and so on (Nordhaus, 1996).

The changes in the CPI are published monthly, and are not revised, even when subsequent information calls the previous estimate into question. Experimental indexes are used to bring new methodological and other information to bear when the BLS decides to make improvements, and are usually published alongside the traditional measure for a while before sometimes being incorporated into the CPI. This was done, for example, with the major improvement in the treatment of owner-occupied housing in the early 1980s. Similarly, the BLS will prospectively test possible changes in the index dealing with lower level substitution bias in the next few years. It is important to note that failing to adjust historically for errors such as formula bias and conceptual improvements such as in owner-occupied housing can have large budgetary consequences that persist even after corrections are made. Hundreds of billions of dollars of national debt are attributable to the larger budgetary outlays and, to a lesser extent, smaller tax revenues, due to the overstatement

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[3] Although a problem called ''formula bias'' was inadvertently introduced, leading to about a 0.2 percentage point per year upward bias in the CPI until it was corrected in 1996.

of inflation during the period these problems persisted in the CPI. Worse yet, additional budgetary impacts continue well beyond the corrections; for example, due to interest on the larger debt.

While our emphasis is on what can be done to improve the program procedures and outcomes, it is important to understand that numerous judgments and decisions had to be made all along the way as the program has developed over many decades. The dimensionality of this task is difficult to convey, and we would not wish our recommendations for improvement to detract from our admiration for, and support of, the basic program as it has evolved and improved over many years.

CPI Commission: Findings and Recommendations

How to obtain information on who is buying what, where, when, why and how in an economy, and then to aggregate it into one or a few measures of price change raises a host of complex analytical and practical problems. The mathematics of aggregating changes in the prices of different goods and services are complex and subtle (Fisher, 1922; Diewert, 1976). Despite decades of analytical and empirical research, some done by the BLS, the CPI relies on fixed weight indexes which do not account for consumer substitution among commodities. While such an index may be easier to understand (*and* misinterpret), these Laspeyres measures of inflation are inherently an upper bound, and empirical studies led the Commission to conclude that this source of substitution bias—failing to catch that consumers substitute chicken for beef when beef prices go up (upper level substitution bias), or Delicious for Macintosh apples under similar circumstances (lower level substitution bias)—leads to a *combined* substitution bias of about 0.4 percentage points per year in using changes in the CPI to measure changes in the cost of living.[4]

Likewise, there has been a fundamental change in the nature of retailing, perhaps most pronounced in the United States, but spreading virtually everywhere, with the advent of superstores and discount chains. The same VCR available for $200 in a local appliance store may be only $160 at a superstore. Since price data are collected *within* outlets, the shift of consumers to purchases from discounters does not show up as a price decline even though consumers reveal by their purchases that the price decline more than compensates for the potential loss of personal services. Thus, in addition to substitution bias among commodities there is

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[4] This estimate is based on studies comparing the CPI to geometric means at the elementary level and to a chained Tornqvist or Fisher Ideal Index, and Laspeyres to econometrically estimated cost-of-living indexes based on systems of demand equations, at the higher level. It is plausible that substitution bias increases with the level of inflation, since generally the variance of relative prices increases as the rate of inflation increases. It is also plausible that the substitution bias may tend to increase a little as we get farther away from the base period. It is curious, however, that there is no evidence to support these conjectures.

an outlet substitution bias. In the United States, we estimated this adds another 0.1 percentage point of upward bias.[5]

Another problem is that price data tend to be collected during the week. In the United States, about 1 percent of price quotes are collected on weekends and holidays, despite the secular trend of an increasing share of purchases made on weekends and holidays (probably reflecting the increasing prevalence of two-earner couples). Since some outlets emphasize weekend sales, there may be a ''when'' bias as well as a ''what'' and a ''where'' bias.

These types of problems account for just a little under half (0.5 percentage points) of the 1.1 percentage point bias identified by our Commission. Slightly over half (0.6 percentage points) results from the difficulty of adjusting fully for quality change and the introduction of new products. Economists have known since Hicks (1940) that the introduction of a new product should be dealt with in a cost-of-living index by estimating its reservation price and including the consumer surplus attributable to the introduction of the product. Noting this, our Commission took the more cautious view of primarily including estimates of explicit dimensions of quality change and the very late introduction of major new products into the index. In the U.S. CPI, VCRs, microwave ovens and personal computers were included a decade or more after they had penetrated the market and their price had fallen 80 percent or more. Cellular telephones won't be included in the U.S. CPI until 1998, despite the fact that there are 47 million U.S. cellular subscribers today and well over 100 million Americans receive calls on land line phones initiated on cellular phones.[6] Hausman (1996) estimates that the quality-adjusted price of cellular services has declined by 90 percent from its reservation price since 1989. The advent of other wireless competition and deployment of digital technology will have substantially occurred by the time cellular services begin to be priced. Correspondingly, the pace of quality change in some important areas, such as health care and consumer electronics, has been breathtaking and our statistics are not keeping up.

When economists try to define the change in the cost of living, it is to answer the question: ''How much more income will consumers need to be just as well off with the new set of prices as the old?'' In addition to the substitution issue raised above, clearly this involves measuring *quality-adjusted* prices. One would not want to count a major improvement in quality that greatly enhances well-being as inflation. Hence, the Commission examined 27 subcomponents of the CPI and, based on empirical research findings and common sense observation, estimated a 0.6 percentage points per year quality change and new product bias in the CPI (Gordon and Griliches, 1997).

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[5] Alternatively, 1 percent per decade. The BLS has argued that service levels differ between high and low price outlets. While this may be partially correct, much outlet substitution is between low or inefficient self-service outlets and more efficient low or self-service outlets.

[6] Industry sources use a rule of thumb that about one-quarter to one-third of such calls are business, not household, use and therefore would not be relevant to the CPI.

Table 1

Estimates of Biases in the CPI-Based Measure of the Cost of Living (Percentage Points per Annum)

Sources of Bias	Estimate
Upper Level Substitution	0.15
Lower Level Substitution	0.25
Outlet Substitution	0.10
New Products/Quality Change	0.60
Total	1.10
Plausible Range	(0.80–1.60)

Thus, the total bias is judged to be 1.1 percentage points per year, with a range of plausible values of 0.8 to 1.6 percentage points, as detailed in Table 1.

Recommendations

Our Commission made a variety of recommendations that form guideposts for statistical agencies to improve the quality of their statistics. Many of the world's statistical agencies, including the BLS in the United States, are planning to make progress on at least some of these fronts. These include changing from fixed-weight formulas to mathematical formulas that account for consumer substitution in the aggregation of prices of goods and services. Also important are reweighting the consumption basket more frequently, increasing the pace of sampling (the United States is ahead of most countries in its sampling procedures; some others do not yet sample) so that new products enter more quickly and the prices of new products, the commodity mix and outlet mix are adjusted more rapidly, so the prices collected are more representative of current market activity. More use should be made of hedonic statistical methods to adjust for quality change,[7] and techniques to measure the consumer surplus from new products should be incorporated explicitly as they are refined and tested.

More specifically, the Commission's first and overarching recommendation is that the BLS should establish a cost-of-living index as its objective in measuring consumer prices. All of the other specific recommendations are aimed toward achieving this goal. The BLS has explicitly recognized that the CPI is not a cost-of-living index in its publications for decades. Still, its most common and pervasive

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[7] This term refers to the technique of estimating the value of various characteristics of a good or service from regressions of price on the characteristics. When a characteristic changes, like the engine type of an automobile, the change in value can be estimated and used to make a quality adjustment.

use and interpretation is as a cost-of-living index. We believe a more fundamentally sound cost-of-living index can and should be developed.[8] Recognizing the need to manage conflicting requirements of timeliness and accuracy, the Commission recommends the publication of *two indexes*, one of which is published monthly on a timely basis and is designed to maintain the spirit of the cost-of-living index yet accommodate the inconsistent timing schedules of the required information; and a second index, which is published and updated annually and revised historically to introduce improvements arising from new information and new research results. The purpose of having two indexes is to accommodate the complex issues that must be addressed and the time delay in obtaining all of the necessary data.

We divided our recommendations into three time horizons. First are short run recommendations that can be implemented immediately with little additional resources or new data collection initiatives. These center on changing the current CPI computation, primarily to make it more current, and on computing an annually updated and subsequently revised cost-of-living index. Second are intermediate run recommendations which incorporate reforms feasible in the current state of the arts, but would require new data collection, reorganization of activities, and/or changes in the detail of the various subindexes produced by the CPI. Third are longer run recommendations, emphasizing topics in areas that need additional research and attention.

The timely monthly index should continue to be called the CPI and should abandon the Laspeyres formula and move toward a cost-of-living concept by adopting a ''superlative'' index formula[9] to account for changing market baskets. To accommodate the delay in obtaining information on quantities needed to combine the price changes of items in the lowest groupings, BLS should move away from the assumption that consumers do not respond at all to price changes in close substitutes. Thus, BLS should move to a ''trailing Tornqvist'' index or another approximation to a superlative index, at the level of item strata. Also, concurrently, it should move to geometric means of price changes at the elementary aggregation level. The familiar arithmetic mean involves summing a group of n numbers and then dividing by n, while a geometric index involves multiplying the group of n numbers and then taking the nth root of the result. In practical terms, the difference embodies a different set of economic assumptions. The arithmetic mean im-

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[8] The BLS has stated (1997) that it has embraced the Commission's overarching recommendation concerning the objective of the CPI. The Commissioner has emphasized, properly it seems to us, that goals like understandability by the public are also important.

[9] Superlative indexes—like the Fisher Ideal and Tornqvist mentioned earlier in the text—have been shown to have many desirable properties (Diewert, 1976). In particular, they are a close approximation to an exact cost-of-living index if preferences are homothetic (income elasticities are unitary). This may seem to be a strong provision, especially when making comparisons over very long periods when income effects will be confounding substitution effects if preferences are nonhomothetic. But the superlative indexes approximate the cost-of-living index for an intermediate utility level and the Tornqvist can be shown to be the geometric mean of the cost-of-living indexes with the current and base period utility levels if preferences can be represented as a (nonhomothetic) translog function.

plicitly assumes that the price elasticity of substitution between goods is zero; the geometric mean assumes that the elasticity of substitution is one. Of course, it could be well above one for many categories.

These moves would alleviate the problem of the growing irrelevancy of market baskets based on decade-old consumption patterns, reduce significantly the substitution and (any remaining) formula bias, and facilitate the speedier introduction of new goods and services into the index.

Because of the lag in collecting up-to-date information on consumer spending patterns, the weights for a superlative index will have to be based on a trailing two- or three-year average of past expenditures; for example, perhaps using 1993–4 weights for the 1996 price changes. The weights should be changed every year. This implies that the BLS should organize itself to implement ongoing rather than decadal revisions in the CPI. Both the weights and the priced commodity and services assortment need more frequent updating. Also, wherever possible, scanner data and other ''outside'' data should be used to expand the assortment of goods and services priced concurrently, to provide current item weights, to track actual transaction prices more accurately, and to introduce new items as quickly as possible after they enter the market. While scanner data can reduce the cost of data collection, whether this proposed expansion will result in a *net* reduction in the cost of data collection is an open question.

Should just the monthly CPI be produced, or should an annual revised index also be produced? We believe that as subsequent data become available, the weights are updated, and new goods are introduced and their history extended backward, the information incorporated in the published CPI should undergo retroactive revision as far back as the new information warrants, in the form of a new annual cost-of-living index, using a compatible superlative index formula. This ''revised'' cost-of-living index would be published annually, with a lag of a year or two, and would be subject to additional revisions after new information emerges and new methodology is introduced. The published versions of this index need never be ''final.''

Should the current sampling framework be retained? We believe that the BLS should study the behavior of the individual components of the index to ascertain which components provide the most information on the movements in the index and which items have fluctuations which are largely unrelated to the total. The former should be emphasized by the BLS in its data collection activities. This could result in the down-weighting or even elimination of data collection for certain cities and a revision of the commodity structure of the index. The revised index would consider some goods as having a national market, sampling a larger number of items but with less regard to geography, focusing on geographical differences only for more ''local'' commodities, such as fuel costs, rent, personal services, and fresh produce.

Currently, the BLS collects a large number of price quotes on bananas, because they are inexpensive to collect and their prices are quite variable, even though these variations are not related systematically to the underlying trend-movements in the

CPI. At the same time, less attention is paid to commodities that are less variable but more likely to change (disappear or be redesigned) and harder to measure, such as surgical treatments, consumer electronics, and communication services. The BLS should change the CPI sampling procedures to de-emphasize geography, starting first with sampling the universe of commodities to be priced and then deciding, commodity by commodity, what is the most efficient way to collect a representative sample of prices from which outlets, and only later turn to geographically clustered samples for the economy of data collection.[10]

Moving to a notion of a new ''basket'' each year will allow for a faster introduction of new items and new outlets. Moving to a national sample for most of such items would allow expansion of the number of specific items (models, varieties, types) sampled within a particular entry-level item and reduce the number of forced substitutions. Also, this would allow for the use of new sources of data, such as scanner data on prices, and industry-wide information on sales of specific items (for more detailed weights), leading to a quicker identification of new goods and their faster incorporation into the index. This is also the level at which more extensive hedonic quality adjustments, and ''comparable'' substitutions could be made, recognizing the appearance of new outlets and new versions of services which provide consumers, effectively, with cheaper sources for the same or similar items consumed previously.

Longer run considerations involve: examining the ramifications of the assumptions of the law of one price; developing, in conjunction with other statistical agencies, research programs to look beyond the current ''market basket'' framework; and developing a number of new data collection initiatives like expanding the Consumer Expenditure Surveys (also emphasized by Deaton, this issue), health status surveys to obtain more information on various quality of life issues, and detailed time use from a large sample of consumers to deal with search and related issues.

Of the 1.1 percentage point bias in the U.S. we have identified, we believe that about 0.4 percentage points, from the substitution bias, could be dealt with in relatively short order—a year or two—by the BLS. Quality change and new products are harder, but more use of hedonic statistical techniques[11] and getting more up to date information should enable the BLS to get another 0.2 percentage points or so—although exactly for which products, when, is impossible to say—over the intermediate run of several years. It is likely there will remain an irreducible minimum

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[10] The current city level price indexes are useless for geographical comparisons of levels. To do an adequate job of describing the geography of price *levels* in the U.S. will require the collection of prices for the *same* commodities and services in different cities.

[11] While the proposal to greatly expand the use of hedonic regression techniques to deal with quality change is both explicit and implicit throughout the report, we should have listed it as a numbered explicit recommendation in the last section, since at least one eminent scholar in the field interpreted its exclusion as a downweighting of its significance. We meant the opposite—it was so obvious (to us) as not to even require repetition as an explicit formal recommendation. We apologize if this led to any confusion.

of quality change and new products bias, even with the widespread use of scanner data. But the overstatement can be substantially reduced.

The Commission also made a variety of recommendations to the Congress, such as providing additional resources necessary to expand the Consumer Expenditure Survey sample and the detail collected, to make the Point-of-Purchase Survey more frequent, and to acquire additional commodity detail from alternative national sources such as industry surveys and scanner data. Congress should establish a permanent rotating independent committee or commission of experts to review progress in this area every few years, and advise it on the appropriate interpretation of the then-current statistics. Congress should enact legislation necessary for the Department of Commerce and Labor to share information in the interests of improving accuracy and timeliness of economic statistics and to reduce the resources consumed in their development and production. In particular, substantial progress can and should be made in reducing the time from survey collection to implementation in the price program.

Reactions to the CPI Commission Report

The report of the CPI Commission received much attention. Most of the findings and recommendations have generally been accepted by the profession, although disagreement remains over the likely size of the bias. Several analyses come to quite similar conclusions. Federal Reserve Chairman Greenspan (1997) comes to virtually identical estimates of the size of the bias. External corroboration comes from several sources, including a Federal Reserve study of productivity (Slifman and Corrado, 1996), Nordhaus's (1997) analysis of survey data on changes in economic well-being discussed in his comment in this issue, and Diewert's thoughtful complementary analyses of bias by type presented in his comment in this issue.

A variety of technical criticisms of our report and findings have appeared in the media, press conferences, Congressional testimony, professional meetings, discussions and technical papers. Perhaps the most extensive critique of the Commission's finding is by Moulton and Moses (1997), who are in places generous to our report, calling it "the most influential critique of the CPI in decades," while elsewhere leveling many of the criticisms listed here, each of which is discussed in our rebuttal below.

1. The Commission did not give adequate attention to quality deterioration (Abraham, 1997; BLS, 1997);

2. The BLS already makes lots of quality adjustments, which we did not either credit them for or take account of (Abraham, 1997; BLS, 1997; Moulton, 1996);

3. The Commission made far too many back-of-the-envelope calculations and was far too willing to generalize from research on one item to research on related items, both with respect to quality change and with respect to the desirability of geometric means to deal with lower level substitution bias;

4. The Commission's estimates, whether right or wrong, are of limited use be-

cause they cannot be generated from a mechanical procedure implementable in a month-to-month price program (BLS, 1997; Abraham, 1997);

5. We should have been more aggressive in our estimates of the value of new products (Hausman, 1997; Nordhaus, this issue);

6. We were elitists making judgments from ivory-tower universities; the quality change and new product biases we discussed were related to fancy luxuries only consumed by the rich (Madrick, 1996);

7. A separate price index for the elderly should be used for indexing Social Security, and it would grow more rapidly than the CPI, as would a separate price index for the poor.

The CPI Commission's Rebuttal to the Critiques

Because there is so little criticism of our estimates of substitution bias, it is perhaps worth beginning our rebuttal by saying that recent research by Shapiro and Wilcox (1996) suggests that the bias has been a tenth of a percent or so higher than the estimate in our report, which was based heavily on BLS research.[12] The potential bias because of the failure to collect price data on weekends and holidays and outlet bias combined with the discussion above, might well lead us to conclude that substitution bias among commodities at the upper and lower level, across outlets and at different times, might even be slightly larger than the 0.5 percentage points we indicated in our report. It is clear that BLS should accelerate its efforts to find alternatives to current procedures which sensibly account for consumer substitution.

The Debate over Quality Change and New Product Bias

Most of the criticism has focused on our extensive analysis of quality change and new product bias. On the question as to whether estimates of quality change bias are inevitably too ''subjective'' and ''judgmental'' to be taken seriously, it is, of course, at least as subjective to assume that every CPI category not subject to careful research has a zero bias as to extrapolate research-based estimates from one category to another. The notion that assuming zero bias is scientific, whereas attempting to generalize cautiously from related goods or practical reasoning is not precise enough, strikes us as unreasonable. Even though we will never precisely measure the value of the invention of, say, the jet airplane, as economists we *know* the consumer surplus triangles are positive, not zero. Likewise, we have known for years that PC's with Pentium processors are objectively higher quality (faster) than the 386 and 486 machines they replaced.

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[12] Many of the best studies of substitution bias have been done by BLS researchers (for example, Aizcorbe and Jackman, 1993). The studies from systems of demand equations at high levels of aggregation generally also come to an estimate of 0.2 to 0.25 percentage points on both U.S. data and data from other countries. See Greenlees (1997) for further elaboration of the BLS research.

Hence, the Commission examined 27 subcomponents of the CPI, and most of our estimates of quality change are based on the collection of price data from independent sources and the careful quality adjustment of those independent data. Independent sources of price data are employed in our bias estimates for shelter, appliances, radio-TV, personal computers, apparel, public transportation, prescription drugs, and medical care. Estimates derived from these categories are extrapolated, sometimes partially rather than fully, to other house furnishings, nonprescription drugs, entertainment, commodities, and personal care. This leaves only a few remaining categories where we added a bias estimate to the CPI category in which there are already quality adjustments, rather than computing the bias estimate indirectly by subtracting an independent estimate from the CPI estimate for the same category. These categories are food and beverages, other utilities, new and used cars, and motor fuel, and personal expenses. The BLS does not object to our ''down in the trenches'' approach to the problem. Indeed, Moulton and Moses (1997) state, ''This is the first time that a systematic analysis of quality bias has been done category by category, which we consider to be a noteworthy accomplishment of the Commission . . .[the] overall approach seems to us to be a sensible and useful way to approach the problem of coming up with an overall assessment of bias, and we expect this type of structure will prove to be useful in the future.''

Some outside critics of the Commission have argued that the BLS already does a great deal of quality adjustment, and that the Commission report is flawed for ignoring the extent of the BLS adjustments. However, for most categories, the extent of current BLS quality adjustments is irrelevant to an assessment of the Commission report's treatment of quality change. We were comparing our own evidence to the corresponding CPI indexes—however they are quality-adjusted, in a major or minor way—and thus our estimates of quality change bias are a residual that remains after the BLS has completed its efforts.

However, it is still instructive to discuss what the BLS calls quality adjustment, since it illustrates the substantive and communication difficulties in this field. There is presently very little explicit adjustment for quality change (Nordhaus, this volume). Most of the reported ''quality adjustment'' by the BLS comes from ''linking'' procedures, where a missing item is replaced by another.[13] *No* judgment at all is made about the quality differential between the new and old item. The price change during the link period is imputed, by using either the inflation rate in the overall CPI or of other commodities in the particular class. Roughly one out of three items disappear sometime during the year and have to be replaced by a different item in the same general class, such as a larger versus a smaller package of yogurt, a blue raincoat versus black, a 12-cubic-foot refrigerator with its freezer at the bottom rather than at the top. But this churning is not what we had in mind by ''quality change,'' which rather involves the appearance of new and improved goods, greater

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[13] In Moulton and Moses (1997), 1.65 out of the 1.76 percentage points in BLS quality adjustments come from linking procedures. If one excludes outliers, defined as commodity pairs where the implicit price-quality differential exceeds 100 percent, the quality adjustment number shrinks to 0.3 percentage points.

speed, durability, variety, convenience, safety, energy efficiency, and so on. Some examples include the increased variety and freshness of vegetables and fish due to improving transport facilities and the globalization of trade, the substitution of laparoscopic procedures for gallstone operations, and many more.

Yes, the BLS does lots of ''price adjustments.'' It is forced to by its sampling framework and the product turmoil in the markets. However, the BLS is not looking for the ''quality change'' that we were worried about. And it does not adjust explicitly for quality *change*, as we were defining it, except in the case of automobiles, apparel, and possibly rental apartment units and the occasional truly new goods caught by their substitution procedures.[14] While some of the Commission's estimates can be questioned—in both directions—there is very little overlap between them and the recent numbers produced by the BLS.

The helpful Moulton and Moses (1997) discussion of several categories would probably lead us to reduce our overall quality change bias estimate by perhaps 0.1 of the total 0.6 percentage points, if that were the only new information since the report, but other new research information and criticism goes in the opposite direction. Eventually, even though it may turn out that some of our estimates of quality change may be too high, others are likely to be too low.[15] Remember that except for a few cases, with low overall weight in the index, we did not explicitly estimate the additional welfare gain of the numerous new commodities in the economy. In the Commission's report, we indicate this is, in our view, a major source of the improvement in living standards. We also indicate that major problems occurred with the very late introduction of VCRs, microwave ovens, personal computers, and the soon to be introduced cellular telephone service. We indicated that the appropriate way to deal with new products is to value the consumer surplus from their introduction, as first demonstrated by Hicks (1940), and recently nicely elaborated and applied by Hausman (1996). However, we were *cautious* in this regard because, while we conjecture that the rate of introduction of new products is likely to be no different in the foreseeable future than it has been in the past (and some would even argue that the pace of introduction of new products is accelerating), it is difficult to predict which new products will become important that will not be picked up with the current BLS procedures. Perhaps many Internet-related activities are candidates. In any event, we chose to deal with this by being deliberately cautious, but indicating that there was an asymmetrical bias with more poten-

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[14] In Moulton and Moses (1997), such explicit quality adjustments account for only about 6 percent of the total ''treatment of substitutions'' effect, and amount to only 0.08 percent per year in the ''outlier-cleaned'' recomputations.

[15] Recent evidence that we may have underestimated the biases in some of the areas we did examine comes from an alternative measure of consumer prices, the PCE (personal consumption expenditures) deflator, which has been rising by about one-third percent less per year (since 1992) than the CPI. An unpublished examination of this difference by the BLS indicates that most of it arises from the use by the BEA of alternative price indexes for hospital expenditures and airfares. These indexes do not adjust for any of the quality changes mentioned by us.

tial bias on the upside than the downside because of the likely future new product introductions which were unlikely to be captured in the CPI program.

Nor did we try to quantify all of the intangible aspects of quality change, such as the improved safety of home power tools or the improved quality of stereo sound and TV pictures. But we did try to do so in some cases; for example, the increased freshness and timeliness of fruits and vegetables.

Our report considered that new goods may drive out older goods which are still valued by a subgroup of the population, or the loss of economies of scale may drive up their price. Existing goods and services may deteriorate in quality, although only a few examples can be found, as on balance, the improvement in quality is overwhelming. For example, despite the recent complaints about how health maintenance organizations have tightened up the rules of access to medical care, few would argue that unrestricted access to the technologies of yesteryear is preferable to more restricted access to the recent improvements in bypass operations, ulcer treatments, or cataract surgeries.

Practicalities of Implementation

The BLS response to many of the Commission's recommendations has been that the suggestions are very difficult to implement in real time in a monthly CPI program using mechanical rules that are straight-forward to implement. We have some sympathy for this position, which is why we proposed that the BLS calculate a second index, published annually, that would constantly be updated and continuously revised, and which need never be final, as new information and research became available both inside the BLS and externally. This second index addresses many, though not all, of the BLS concerns about practicality. For example, the BLS correctly notes that while it is undoubtedly true that much quality change in health care has gone uncorrected in the CPI, it is difficult to quantify ''what's new in surgery this month.'' But numerous studies on a wide variety of medical areas from cataracts to generic drugs to treating heart attacks (Griliches and Cockburn, 1994; Shapiro and Wilcox, 1996; Cutler and McClellan, 1996) have concluded that a quality adjusted medical CPI is increasing only at about the overall CPI rate (Cutler, McClellan, Newhouse and Remier, 1996), not the much more rapid official medical CPI rate. While it may be some time before procedures can be developed for implementing various quality adjustments and the consumer surplus from new products into a monthly CPI (with hedonics and Hausman-style econometrics,[16] for example) and perhaps never for some categories, there is no reason why the BLS cannot incorporate such information into a continually revised annual index.

Such an annual index has a number of benefits since it would be substantially more accurate than an uncorrected monthly index. Indeed, the only advantage of a monthly CPI is that it is timely, and to the extent it is desirable for contractual

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[16] Hausman also develops practical procedures for measuring the consumer surplus from the introduction of new goods which, under plausible assumptions, requires information only on current revenue and (own) price elasticity of demand—likely to be implementable in real time procedures at the BLS.

purposes, not revised. Those who are using the CPI for indexing purposes could decide if they wanted a more accurate measure that was not quite as up to date, or a far less accurate but quicker one.[17]

The BLS has been quite critical of generalizing research results from one category of goods to another, even quite similar categories. Serious issues arise as to whether quality adjustment can be done individual commodity by individual commodity, at what level of aggregation into groupings, and so on. The BLS takes the position that it will make explicit quality adjustments only for very specific commodities, when extensive research is done with a procedure that can be implemented mechanically in a monthly index. This is unfortunate. Even with substantially augmented resources, by the time the BLS does a substantial amount of new research on quality change and decides whether to do something for a particular commodity, many of the items they studied several years ago will have changed or been replaced by new products. Surely some reasonable rules of thumb can be developed for when it is permissible to generalize from closely related categories; for example, those for which many of the inputs are common (say, microprocessors). Simply assuming there is no quality change for every product for which explicit quality adjustments are not made is *certain to be wrong*. Of course, care must be taken for any selection bias in the commodities that have been studied for quality change, since the commodities under study may have been selected because there was some a priori reason to suspect they had undergone substantial quality change (Moulton, 1996). The BLS has an opportunity to lead work in this area, as it has done so well on the more traditional substitution issues.

The Bureau of Economic Analysis of the Commerce Department has moved to a Fisher ideal index for its measures of real output and prices, as have most other statistical agencies around the world. Since quantity information is not usually available contemporaneously, this immediately raises the issue of the need to have lags in the system. In our final report, we suggested that one approach would be to use a ''trailing'' Tornquist with the data continually updated. This was meant to be illustrative, not definitive, and we remain open to other possibilities. In fact, Shapiro and Wilcox (1997) have demonstrated that a very good approximation to a superlative index can be obtained with a one-parameter constant elasticity of substitution function in the same real time as the current CPI. The BLS has thus far not acted on such proposals, but whatever the merits of either of these proposals, it is clear that the BLS must accelerate its efforts to find alternatives to current procedures which sensibly account for consumer substitution.

Broader Considerations on the Quality of Life

Changes in the physical, social and economic environment may impose higher expenditures necessary to keep up with our previously achieved utility levels. How-

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[17] Commissioner Abraham has recently conveyed privately that the BLS actually thinks the second index is a good idea and may pursue it in the future.

ever, in the major areas of concern to our critics—the environment, health and crime—the traditional statistics demonstrate gains in recent years. Violent crime rates have fallen, objective measures of air and water quality show major improvement, and virtually all measures of health, most importantly life expectancy, have improved dramatically.

The same is possibly true of incorporating government services and taxes into analyses of changes in the cost of living. Nordhaus (1996b) has demonstrated how one might go about augmenting a cost-of-living index to account more appropriately for some of these issues.

We do take the point that these issues can be an important determinant of the quality of life experienced by citizens and that is why we recommended exploring the possibility of developing better supplemental information on these issues.

A Separate Price Index for the Elderly or the Poor

It has been suggested the cost of living rises more rapidly for the elderly than for the general population. While undoubtedly much of the sentiment for this point of view comes from those who seek to maintain or increase the *level* of Social Security benefits, serious substantive issues are involved. Several studies using different methods have found that there has been little difference in the cost of living for the elderly and the general population. Boskin and Hurd (1985) find this result using Laspeyres-type price indexes with different weights for the elderly and the general population for the period through the early 1980s, as do Jorgenson and Slesnick (1983), who estimate systems of demand equations for different demographic groups to calculate cost-of-living indexes directly. The BLS has begun to publish an experimental price index for the elderly which re-weights the consumption basket to reflect the purchases made by the elderly (Amble and Stewart, 1994). The primary difference in the consumption patterns of the elderly, of course, is that they spend a larger fraction of their out-of-pocket income on medical care (despite the fact that most of the medical care for the elderly is paid for by government programs). Because medical care prices went up more rapidly than the overall price level beginning in the early 1980s, this price index for the elderly increased about a quarter of a percentage point more rapidly than the corresponding price index for the general population.

However, this more rapid price increase is almost certainly misleading. First, medical care inflation is now running about the same as overall inflation, but it is not clear this will continue. Second, medical care may be the component of the CPI where quality improvement has been most endemic and systematic. Adjusting for the Commission's estimate of upward bias in the medical care component of the CPI of about 3.0 percent per year, when weighted by the out-of-pocket expenditure share on medical care for the elderly, would cause the price index for the elderly to rise slightly more slowly than that of the general population.[18]

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[18] Of course, many other differences could be noted. The elderly are less likely to own personal computers or cellular telephones. On the other hand, they surely value the ability to communicate with friends and family who do have cell phones.

These separate cost-of-living indexes for the elderly reflect different expenditure shares but utilize the same prices as the CPI. If the elderly pay different prices, for example, due to senior citizen discounts, they will have a separate, and in this case lower, price level. Only if there is a trend in the degree of such differences, however, will this affect the relative inflation rates. There are other reasons prices paid by the elderly may differ from those in the general population. For example, their geographic clustering might avail them of lower prices due to scale economies, or higher prices because it is more costly for them to get to discount outlets.[19] Certainly more research is needed on this subject. Also, the elderly own homes in much greater proportion than the general population; about 75 percent of them own their own home. When the shelter component of the CPI rises because of increases in owner equivalent rent, the owners presumably are accruing capital gains on their homes. Thus, if the purpose of having a separate price index for the elderly is to use it to adjust Social Security benefits to compensate recipients for the deterioration in their real incomes due to inflation, they (at least those that own their own homes) should not be compensated for capital gains on their housing![20]

Undoubtedly, there are some groups in the elderly for which our estimate of the bias understates, as well as other groups for which it overstates, the bias in the change in the cost of living. While further research into this area is desirable, we believe most of the complaint is with the structure and level of the benefits themselves, not with indexing per se as a vehicle for compensation for changes in the cost of living. In any event, even if one were to accept the experimental index for the elderly, the CPI bias still would amount to a little under one percentage point per year.

Tobin (1997) has made the interesting point that medical advances may lead the elderly to live longer and to the extent that medical advances are part of our quality change bias, argues it should not be included in a price index adjusting cash Social Security benefits since the elderly still must ''come home from the hospital and buy groceries.'' This raises deeper questions about the appropriate role of government social insurance programs and their financing. For example, because the benefits are paid as (inflation over-adjusted) annuities, the improved medical care lengthening life also results in substantial increases in the length of time people are receiving Social Security benefits. A true cost-of-living index measures the change in income required to maintain a given standard of living for a person or household at a given age. While expensive medical technology is among the factors increasing life expectancy, the longer lifespan is a positive, an increase in the standard of living.

An alternative argument is that indexing should expressly allow for financing

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[19] Berndt, Cockburn and Griliches (1997) show that a price index based on the drugs purchased by the ''elderly'' does not rise any faster than that based on drugs bought by the ''young.''
[20] Also, the real income and consumption of the elderly has improved substantially over the years and now is much closer to that of the general population than it was 30 years ago.

of improved quality and new products, because when people do not own the fruits of modern life, they will not feel as well off (Madrick, 1996). This confuses the relative standard of living with the absolute standard of living that a cost-of-living index attempts to measure. The CPI has always been intended to provide a single number for the average rate of inflation, not information on changes in the distribution of income. While we certainly are concerned about the economic well-being of our least well-off citizens, it is important to understand how dramatically improved the standard of living of even those poorest in the population has been. It is simply incorrect to argue that quality improvements and new products accrue only to the rich, rather than broadly throughout the population. As noted earlier, there are 47 million cellular telephone subscribers in the United States and over 100 million Americans receive a telephone call initiated on a cellular telephone. Over 98 percent of American homes have color television sets; 75 percent have some form of air conditioning; 78 percent have a VCR; and over 60 percent of homes have answering machines. Homes that used to be heated with coal and wood are now heated by natural gas. A recent study by the Employment Policy Foundation (1997) found that in the ownership of 10 of 13 categories of modern household goods, the poorest 20 percent of the population was better off in 1990 than the average household in 1970. For further discussion of a separate price index for the poor, see Garner, Johnson and Kokoski (1996).

Conclusion

While the CPI is the best measure currently available, it is not a cost-of-living index and it suffers from a variety of conceptual and practical problems. Despite important BLS updates and improvements over time, the change in the CPI has substantially overstated the actual rate of inflation, and is likely to continue to overstate the change in the cost of living for the foreseeable future. This overstatement will have important unintended consequences, including overindexing government outlays and tax brackets and increasing the federal deficit and debt. Moreover, such revisions as have occurred have not been carried out in a way that can provide an internally consistent series on the cost of living over an extended span of time.

The CPI Commission's report and findings have, in our opinion, held up to criticism and scrutiny quite well. Our overall estimate of about 1.1 percentage point of upward bias per year in the growth of the CPI still seems right to us, especially because we were so cautious in the treatment of the bias from new products. The purposes of our Commission's report included: disseminating information about the complexity of constructing a cost-of-living index; generating additional intellectual capital from academe and the private sector; and suggesting potential improvements. But these improvements must be considered, as we said in the report, with more appreciation of the efforts of our colleagues in the BLS and other government statistical agencies and an understanding of the constraints under which

they are working. The BLS and other government statistical agencies have a re-markably complex task in a dynamic flexible market economy.

The analytical and econometric research done over recent decades has dra-matically improved economists' understanding of the issues surrounding a cost-of-living index. We believe that improvements in geometric means, superlative in-dexes, more rapid introduction of new goods and new outlets, speedier updating of consumption weights, making use of hedonics and of related statistical tools, the use of scanner data, and other recommendations made here can substantially re-duce the bias in the CPI going forward. Now, the time has come for governments in the United States and elsewhere to recognize these problems and to commit the resources to dealing with them. Virtually every major private firm in the world is spending heavily on information technology, and we should not expect better sta-tistics from our government agencies without a corresponding investment.

We had hoped to provide an opportunity for the BLS (and the related statistical community) to implement an agenda for the most fundamental improvements in the nation's price statistics in many decades and to obtain financing (as necessary) for it. While we strongly support the modest improvements BLS is hoping to make (BLS, 1997; Abraham et al., this issue), we would hope that over time the size and scope of the reform agenda will expand.[21]

Ultimately, the president and Congress must decide whether they wish to con-tinue the widespread overindexing of government programs. If the purpose of the indexing is to compensate recipients of the indexed programs or taxpayers from changes in the cost of living, no more and no less, they should move to wholly or partly adjust the indexing formulas, taking due account of the partial improvements BLS will make along the way. Such changes will have profound ramifications for our fiscal futures, but these changes should be made even if the budget was in surplus and there was no long-run entitlement cost problem. They should be made first and foremost in the interest of accuracy not only for the budget and the pro-grams, but for the economic information upon which citizens depend.

[21] We have been told by leaders in government statistics agencies around the world that they were surprised that the BLS initially reacted defensively to the Commission Report, and failed to capitalize fully on the opportunity it presented.

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