NBER WORKING PAPER SERIES

THE BOSKIN COMMISSION REPORT:
A RETROSPECTIVE ONE DECADE LATER

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Working Paper 12311
http://www.nber.org/papers/w12311

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2006

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NBER Working Paper No. 12311
June 2006
JEL No. I1, I11

ABSTRACT

This paper provides a retrospective on the 1996 Boskin Commission Report, Toward a More Accurate Measure of the Cost of Living, and its famous estimate that the CPI in 1995-96 was upward biased by 1.1 percent per year. The paper summarizes the report's methods, findings, and recommendations, and then reviews the criticisms that appeared soon after the Report was issued. Post-Boskin changes in the CPI are summarized and assessed, as is recent research on related issues. The paper sharply distinguishes two questions. First, with what we know now, what should the Commission have concluded about CPI bias in 1995-96? Second, what is the bias now after the many improvements introduced into the CPI since the Commission's Report?

About the first question, my own recent research on apparel and rental housing indicates a substantial downward bias in the CPI over much of the twentieth century, diminishing in size after 1985. Incorporating these findings into the Boskin matrix would reduce its 0.6 percent annual upward bias due to quality change and new products to a smaller 0.4 percent bias. However, this is more than offset by the stunning discrepancy over 2000-06 in the chain-weighted C-CPI-U compared to the traditional CPI-U, indicating that the Commission greatly understated the magnitude of upper-level substitution bias. This retrospective evaluation suggests that the Boskin bias estimate for 1995-96 should have been 1.2 to 1.3 percent, not 1.1 percent.

Current upward bias in the CPI is estimated to have declined from the revised 1.2-1.3 percent in the Boskin era to about 0.8 percent today. Yet the Boskin report, like most contemporary studies of quality change, failed to place sufficient value on the value of new products and on increased longevity. Allowing for these, today's bias is at least 1.0 percent per year or perhaps even higher.

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I. Introduction

More than ten years have now elapsed since the formation of the Boskin Commission, more formally the "Advisory Commission to Study the Consumer Price Index," which was appointed by the Senate Finance Committee in June, 1995. The Commission's final report (Boskin *et al*, 1996) was issued on December 4, 1996 and concluded that the U. S. Consumer Price Index (CPI) overstated inflation by 1.1 percent per year for the time period of the Commission's deliberations, 1995-96. The report suggested that the CPI bias might have been larger before 1995 and predicted that it would be lower after 1997.

A sharp distinction must be drawn between the technical and scientific issues which led the Commission to its bias estimate of 1.1 percent, and the political and redistributional implications of that conclusion. The Commission report contained not only the technical background for its overall bias estimate but also its estimates of the vast amount by which that bias had increased the Federal budget deficit looking back into the past and would increase the deficit looking forward into the future.[1] The suggestion that the bias had caused excessive growth in Social Security and other benefits evoked a sharp and damning political reaction, as the AARP (American Association of Retired Persons) sent its lobbyists scurrying through the corridors of Congress to throw cold water on those senators and representatives who had initially been sympathetic to reducing the budget deficit by adjusting the indexation formula by some fraction of the Commission's bias estimate, the so-called "CPI minus X" approach to indexation. This paper ignores the implications of the bias estimate for fiscal policy and instead concentrates entirely on the issues of interest to the

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1. The Commission calculated that the 1.1 percentage point bias would contribute $1.07 trillion to the U. S. national debt over the period 1997-2008 as compared to an alternative scenario in which Social Security and other programs were indexed by a formula which subtracted the bias from the published CPI.

worldwide measurement community.

The Boskin Commission's Approach and Method

The Boskin Commission represented the first extensive external evaluation of the nation's price statistics in more than three decades; the previous report was the famous Stigler (1961) Commission Report. There were several important differences between the two Commissions. The Boskin report concerned only the CPI, while the Stigler report also covered the Producer Price Index (PPI) and agricultural price indexes. The Stigler report did not produce any numerical bias estimates, whereas the mandate of the Boskin Commission included the provision for a point estimate of the overall bias in the CPI. The Stigler Commission had a substantial budget to commission new research studies, whereas the Boskin Commission had no research budget at all. Thus the Boskin Commission report of necessity was a survey article based on past on ongoing research, not a producer of new research.

A novel aspect of the Commission's method was to divide up the CPI into 27 categories and develop a separate estimate of quality change bias for each. This required some extrapolation from categories for which research existed (e.g., personal computers and TV sets) to related categories where no research existed (e.g., electronic toys). While some commentators have complained of the subjective nature of the Commission's assessment of quality change bias, the Commission felt that to assume that the bias was exactly zero in categories which had not been the subject of previous research was just as subjective as to extrapolate the results of related research.

II. *Summary of the Commission's Findings*

Findings Related to Substitution

The Commission's findings are summarized in Table 1. In this section we discuss the findings related to substitution, comprising the first three lines in the table. Next we discuss the category of new products and quality change.

Table 1
Boskin Commission Estimates of Bias
in the Consumer Price Index in 1995-96
(percentage points per annum)

Source 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)*

The CPI relied on fixed weight Laspeyres indexes which did not account for consumer substitution among commodities. These Laspeyres measures of inflation were inherently an upper bound, and empirical studies led the Commission to conclude that this source of bias amounted to about 0.4 percentage points per year. Of this 0.4 percent, 0.15 came from estimates of the effect

of substitution among the upper-level "strata" (apples vs. bananas) and 0.25 from the effect of substitution among the lower-level categories (red delicious apples vs. Jonathan apples).

In addition to substitution bias among commodities, there is an outlet substitution bias, the third line in Table 1, which refers to the practice of the BLS in ignoring differences in prices for the same item across outlets. Since price data are collected *within* outlets, the shift of consumers to purchases from discounters does not show up in the CPI as a price decline even though consumers reveal their preferences for these outlets by their purchases, measured by the steady shift in market share. We estimated this adds another 0.1 percentage point of upward bias.

Findings and Recommendations related to New Products and Quality Change

The three types of substitution bias listed in Table 1 account for just a little under half (0.5 percentage points) of the 1.1 percentage point bias identified by the Boskin 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 COL index by estimating its reservation price and including the consumer surplus attributable to the introduction of the product. While accepting this framework, the Boskin Commission did not make any of its own estimates of the consumer-surplus value of new products. Instead, it took the more cautious view of primarily including estimates of explicit dimensions of quality change and the late introduction of major new products into the index. VCRs, cellular phones, and other products were included in the CPI a decade or more *after* they had penetrated the market and *after* their price had fallen by 80 percent or more.

Previous research allowed an estimate to be made of the bias in the CPI that occurred as a result of the late introduction of these new products.

The Commission attempted to identify commodity categories in which the CPI was biased for failing to take account of improvements in quality. To carry out this task, it examined separately 27 subcomponents of the CPI to determine the extent of quality bias, if any, and established an estimate for quality bias within each of the 27 categories. In eight of the categories the Commission discovered no research evidence or other factor that would indicate a bias other than zero. In the other 19 categories bias estimates were assigned which ranged as high as 3.0 percent per year for medical and hospital services and 5.6 percent for appliances and electronic goods.[2] When these 27 bias estimates were weighted by the relative importance of each category in 1995 (based on 1982-84 expenditure weights), the overall quality and new product bias was determined to be 0.6 percentage point per year.[3]

While the Commission formulated a point estimate of CPI bias related to quality change and new products, it did not attempt any quantitative estimate of changes in the quality of life. Nevertheless, it did present an informal discussion of changes in the quality of life and concluded that the "good" outweighed the "bad." It cited a reduction in air and water pollution, a decline in

2. Table 2 of the Boskin Commission report attempted to discriminate between different periods in assigning the estimates for quality change and the late introduction of new products. Thus, for instance, the bias estimate for prescription drugs was 3.0 percent for 1970-95 and 2.0 percent for 1995-96, reflecting the change in CPI methodology in 1995 which recognized the introduction of a generic version of a given drug as a price decline.

3. The only case in which alternative weights were used was in the case of consumer appliances and electronic goods, where the 1982-84 CPI weights were deemed to be too low, and weights were taken instead from the National Income and Product Accounts. See Boskin *et al.* (1996), Table 2, note a.

crime by various measures, a decline in the suicide and infant mortality rates, and an increase in

life expectancy.[4] It also cited a wide range of improvements in goods related to quality and new

products for which the Commission's estimates made no allowance, namely "the faster speed and

reduced vibration of jet planes, improved reliability of appliances and automobiles, improved

sound quality of audio equipment in homes and automobiles, improved safety devices on home

power tools and power lawn mowers, reduction in the noise, weight, and installation cost of room

air conditioners, and immeasurably better picture quality of color TV sets."[5]   As other

improvements for which no allowance was made, it cited the spread of cable and satellite TV and

the new availability of the World Wide Web to owners of personal computers (another product

which was introduced into the CPI long after it began to become common in homes).   The

Commission's section on quality-of-life issues concluded that " . . the major increase in longevity

. . perhaps swamps everything else. Accordingly, our estimate of the current bias in the CPI is, if

anything, probably understated" (p. 77).

The Commission's Recommendations

The Commission's first and overarching recommendation was that the BLS should establish

the COL index as its objective in measuring consumer prices. All of the other, more specific

recommendations were aimed at achieving this goal. The emphasis on this first recommendation

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4. The one serious negative which was cited was the increase in births to unmarried women. Other "intangible negatives" cited were "increased job insecurity, possible increased inequality, and decreased job opportunities for workers with only a high school education" (p. 76).

5. Although not identified as such in the Boskin report, this quote was copied directly from Gordon (1990, p. 560).

may seem strange to economists, but the BLS in its publications for decades had explicitly stated that the CPI is not a COL index. The Commission stated that a fundamentally sound COL index could and should be developed.[6]

As part of the short-run set of recommendations, the Commission recommended that the single current CPI, which can never be revised (due to its use in legal contracts and for indexation) be supplemented by a second "research-based" index which is published annually rather than monthly and is continuously revised to incorporate new research results. The timely monthly index would continue to be called the CPI and would move toward a COL concept by adopting a "superlative" index formula to account for changing market baskets, abandoning the Laspeyres formula at both the upper level and lower level of aggregation.

At the upper level the Commission recommended that the BLS should move away from the assumption that consumers do not respond at all to price changes in close substitutes, moving instead to a "trailing Tornqvist" index (weighted geometric mean of price relatives) or another approximation to a superlative index, and also, concurrently, to geometric means of price relatives at the elementary aggregation level. These changes would eliminate 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.

The distinction between the "timely" CPI and the new annual research-based index rests on

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6. The BLS has stated (1997) that it has embraced the Commission's overarching recommendation concerning the objective of the CPI.

the fundamental proposition that the basic monthly CPI can never be revised. The Commission recommended that as subsequent data became available, the weights were updated, and new goods were introduced and the history of their price changes was extended backward, the information incorporated in the published CPI could undergo retroactive revision of a new annual cost-of-living index using a compatible "superlative-index" formula that would no longer be affected by the lag in the availability of the required expenditure weight data. This alternative COL 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.

Continuing with recommendations that would require a somewhat longer term for implementation, the Commission felt that the BLS should revise its approach to sampling. The Commission was astonished at the number of price quotations that the BLS collected on ordinary products like bananas that were not subject to quality-change or new-product bias, relative to the effort devoted to collecting price data on new products like cellular phones, personal computers, and computer peripherals. In addition to reducing the data collection effort devoted to apples and bananas, the Commission believed that the data-collection effort should be divided up between national and local goods. In this revised scheme there would no longer be any collection of data on appliances, other consumer durables, and imported produce (like tomatoes and bananas) in each separate city — data for these national goods could be collected in a much smaller sample applied to the entire country. This would free up resources to do a better job of collecting prices for local goods with components that might vary across cities, e.g., fuel costs, rent, household services, and

non-imported produce.

III. *Criticism of the Commission's Findings and Its Reaction*

The report of the CPI Commission received much attention. Most of the findings and recommendations have generally been accepted by the economics profession, if we are to judge by various symposia in which prominent academic economists have been invited to comment on the Commission's findings. External corroboration comes from several sources, including the Federal Reserve's study of productivity (Slifman and Corrado, 1996), Nordhaus' (1998) analysis of survey data on changes in economic well-being, and Diewert's (1998) thoughtful complementary analyses of bias by type.

It is noteworthy that few if any criticisms addressed the Commission's findings related to substitution. Instead, most of the criticisms of the Commission's findings centered on its treatment of quality change and new products.

1. The Commission did not give adequate attention to quality deterioration (Abraham, 1997, BLS, 1997, Abraham *et al.* 1998);

2. The BLS already makes lots of quality adjustments, which the Commission did not adequately credit (Abraham, 1997, BLS, 1997, Moulton, 1996, Moulton and Moses, 1997);

3. The Commission made too many back-of-the-envelope calculations and was 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 (Abraham *et al.* 1998, Nordhaus 1998);

4. The Commission's estimates, whether right or wrong, are of limited use because 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, 1997b, Nordhaus, 1998).

The Commission's Response to the Critiques[7]

Because there was so little criticism of the Commission's estimates of substitution bias, it is perhaps worth noting that research by Shapiro and Wilcox (1997) suggests that the bias could have been a tenth of a percent or so higher than the estimate in our report, which was based heavily on BLS research.[8] The BLS response to our recommendations about lower-level substitution bias pointed out that, while the degree of substitution between some goods like white shirts and blue shirts may be very high, that between other goods like particular types of pharmaceuticals may be very low (Abraham *et al.*, p. 32). However, pharmaceuticals are the exception, not the rule, and within the vast majority of the 207 strata there is ample latitude for substitution, whether we are talking about types of food, shelter, apparel, cars, tires, appliances, entertainment, or personal care

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7. This section combines sections of the jointly authored paper by commission members (Boskin *et al.* 1998) with my own further observations.

8. Many of the best studies of substitution bias have been done by BLS researchers (see, e.g., 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 on both U.S. data and data from other countries. See Greenlees (1997) for further elaboration of the BLS research.

items. In fact, pharmaceuticals comprise only 1.2 percent of the upper-level weight in the CPI. If anything, the unitary elasticity of substitution embodied in the Commission's recommendation of geometric weights at the lower level probably understates the extent of substitutability within the majority of the strata.

The Debate over Quality Change and New Product Bias

Most of the criticism focused on our extensive analysis of quality change and new product bias and our willingness to extrapolate a bias estimate from one category to another, and this critique of "guesstimates" is a major theme of Triplett's (2006) paper in this volume. The notion that assuming zero bias is scientific, whereas attempting to generalize cautiously from related goods or practical reasoning is not precise enough, throws out available information. For instance, even though we will never precisely measure the value of the invention of the jet airplane, as economists we *know* that consumer surplus triangles have an area that is positive rather than zero.

Most of the Commission's estimates of quality change were based on the collection of price data from independent sources and the careful quality adjustment of those independent data. Independent sources of price data were 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 were extrapolated, sometimes partially rather than fully, to other house furnishings, nonprescription drugs, entertainment, commodities, and personal care. This left only a few remaining categories where we added a bias estimate to the CPI category in which there were 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 were food and beverages, other utilities, new and used cars, motor fuel, and personal expenses. The BLS did not object to our "down in the trenches" approach to the problem. Indeed, Moulton-Moses (1997, p. 308) 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 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.[9] However, for most categories, the extent of current BLS quality adjustments is irrelevant to an assessment of the Commission'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.[10] There is very little explicit

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9. In fact most of the Moulton-Moses paper (1997) is devoted not to a direct critique of the Commission's estimates but to an explanation of how the CPI is adjusted for quality change and to an attempt to estimate the quantitative significance of those adjustments (see pp. 322-48).

10. Some of the material in this section comes from my published discussion of Moulton-Moses (1997).

adjustment for quality change (Nordhaus, 1998). Most of the reported "quality adjustment" by the BLS, 1.65 out of the 1.76 percentage points in Moulton and Moses (1997) comes from "linking" procedures, where a missing item is replaced by another (excluding outliers, commodity pairs where the implicit price-quality differential exceeds 100 percent, the quality adjustment number shrinks to 0.3 percent). No judgment at all is made about the quality differential between the new and old item. 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 or a blue raincoat versus black. But this churning is not what we had in mind by "quality change," which rather involves the appearance of new and improved goods, greater speed, durability, variety, convenience, safety, and energy efficiency.

The area in which the Commission's bias estimates are surely likely to be too low, rather than too high, is in the area of new products. We did not make explicit allowance for the late introduction into the CPI of numerous new products. 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 elaborated and applied by Hausman (1997a, 1998) to the case of cellular telephones. We chose to deal with this by being deliberately cautious, but indicating that there was an asymmetrical bias with more potential bias on the upside than the downside. We believed that our overall estimates were conservative, both by ignoring the many intangible aspects of quality change, such as the improved safety of home power tools or the improved quality of stereo sound and TV pictures, and by omitting any explicit valuation of truly

new products.

Problems of Implementation

The BLS response to some of the Commission's recommendations has been that they are very difficult to implement in real time in a monthly CPI program using mechanical rules that are straightforward to implement. These difficulties explain 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. This second index, if it had been implemented, would have addressed many — not all — of the BLS concerns about practicality.[11]

IV. Changes in the CPI Since the Report

Despite its initial set of critical comments, the BLS moved with surprising speed to implement some of the Commission's recommendations. At the same time the BLS has introduced other changes which were planned previously to the release of the Commission report and for which the Commission can take no credit. Subsequently we will discuss the new experimental BLS index based on chain weights at the upper level; this is not included in the following list of CPI improvements because it has not been incorporated into the basic CPI-U. Here we list the most important changes changes that the CPI has introduced since the December, 1996, release

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11. The Stewart-Reed (1999) paper introduces a research-based and retrospective CPI as a one-time project, not as an ongoing annual activity of the BLS.

of the Commission report.[12]   Additional perspective on these changes is provided by Greenlees (2006).

1. **Lower-level Geometric Weighting.** Effective with data for January, 1999, the BLS introduced the geometric mean estimator for index categories that comprise approximately 61 percent of total consumer spending in the CPI. This was expected to reduce the rate of increase of the CPI by about 0.2 percent (Dalton, Greenlees, and Stewart, 1998), and this estimate was later confirmed by Greenlees (2006).

2. **More Rapid Change in Upper-Level Weights.**   In another major change that appears to be a response to the Commission's recommendations, the BLS now changes upper-level weights much more rapidly than in the past (see U. S. BLS, 1999). Eleven years elapsed between the initial use of 1982-84 weights in 1987 and the switch to 1993-95 weights in 1998. More recently the lag has dropped to a mere three years: 1999-2000 weights were introduced in January, 2002 and apply to CPI calculations for the years 2002 and 2003, implying an average three year lag between the middle of the 1999-2000 period used to calculate the weights and the 2002-2003 period over which the CPI is calculated using those weights.   With the same three-year lag structure, new weights were introduced in January, 2004, January, 2006, and so on in the future.

3. **Change from Area- to Item-Based Sample Rotation Procedures.** In a change planned before release of the Commission report, the CPI switched its sample rotation methodology in 1998

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12. The list of changes comes from background material supplied to Commission members with a 1999 General Accounting Office (GAO) survey regarding post-Boskin CPI measurement changes. This list has been checked against the list in Greenlees (2006).

(Cage, 1996). It shifted its point-of-purchase survey from time-consuming in-person visits to computer-assisted telephone surveys, which allow for an increase in sample size and focus on specific item categories where products turn over rapidly and where new products are frequently introduced.

4. **Changes in the Methods for Pricing of Hospital Services.** In another change planned before the release of the Commission's report and implemented in January, 1997, the BLS has improved its procedures for pricing hospital services (Cardenas, 1996). Instead of the old approach, which was a straightforward input cost index that did not reflect shifts in the use of inputs (e.g., shorter hospital stays for a given procedure or a shift from inpatient to outpatient treatment), the new methodology obtains prices for a sample of specified treatments for particular diseases, rather than for a day in the hospital. This approach had been introduced into the PPI in 1992.[13] Even though the PPI made no explicit allowance for improvements in medical technology of the types incorporated into the research reviewed by the Boskin Commission, during the 1992-96 period the PPI for hospital services increased at an annual rate 2.0 to 2.5 percent less than the equivalent CPI index, not far from the Commission's estimate of a 3.0 percent upward bias in the CPI for medical care services. Allowing for the value of technological advances might imply a CPI bias above 3.0 percent for the pre-1997 period.

5. **Treating Mandated Pollution Control Measures as Price Increases.** As discussed in Fixler (1998), the BLS switched in January, 1999 to treat changes in vehicle or motor fuel

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13. This shift in methodology is discussed in Triplett (1999, pp. 3-4).

characteristics arising from air pollution mandates as a change in price rather than quality. This reverses a BLS policy in effect since 1971 and follows from a recommendation in the Commission report. Since most of the changes in automobile technology introduced to reduce air pollution occurred during the 1970s and 1980s, this change will have little future effect on the CPI. This change provides another example of the need for a second, annual research-based index that can be revised into the past, and in this case the revisions would raise the growth rate of the CPI.[14]

6. Hedonic Price Indexes for Electronic Products. Again following in the footsteps of the PPI, which had used the hedonic regression technique to adjust personal computer prices as long ago as 1991, the CPI adopted the hedonic regression approch for personal computers in 1998. Similarly, the CPI introduced a hedonic regression approach to adjusting television set prices, beginning in January, 1999. This technique was introduced following the research of Moulton, LaFleur, and Moses (1998). Greenlees (2006) shows that so far this additional research on quality change has had a very small impact on the overall CPI, because the weights of the products involved are small, and that small sample sizes often preclude developing hedonic indexes from the regular CPI sample.

The Big Surprise: Upper-level Substitution Bias is More Important than We Thought

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14. Gordon (1990, p. 351, Table 8.10) exhibits a table showing the time series of BLS quality adjustments for new automobiles divided among safety, environmental mandates, and other factors. The environmental adjustments had the effect of reducing the rate of inflation of new auto prices by 1.22 percent per year over the period 1967-85. The Boskin Commission report found no net bias in the CPI for autos, taking a 0.94 percent per year downward bias due to the treatment of environmental adjustments as a quality change, and cancelling that out by a 0.95 percent upward bias due to the CPI's neglect of the increased durability of autos. The Commission's treatment of increased auto longevity is validated by White (2006), who contrasts a median auto lifetime of 10.5 years and 107,000 miles in 1977 with 13 years and 152,000 miles in 2001.

The above list of changes refers to the basic, most-often quoted version of the CPI known as the CPI-U. The list does not include the introduction of chain weights at the upper level, because the BLS decided not to take this step in the CPI-U. Instead, in a history described in detail in Cage *et. al.* (2003) and in Greenlees (2006), the CPI decided to use chain weights not in the basic CPI-U but in a new index called the C-CPI-U that is intended as an official supplemental index rather than an experimental research index.

The remarkable surprise after six years of experience with the C-CPI-U, which the BLS currently publishes from January 2000 to the most recent month, is that the bias between upper-level chain weights and Laspeyres weights is much larger than anyone would have guessed, including BLS staff and the Boskin Commission. Despite the more frequent updating of weights in the Laspeyres CPI-U now than in 1996, the difference between the C-CPI-U and the CPI-U is very large, 0.38 percent per year over the six years between January, 2000, and January, 2006.[15]   In an amazing coincidence, the difference over essentially the same period, 1999:Q4 to 2005:Q4, between the chain-weighted PCE deflator and the CPI-U is exactly the same, 0.38 percent.[16]

These facts lead to a reassessment of the quantitative importance of the Boskin evaluation

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15. The annual growth rate of the CPI-U over this six-year period was 2.68 percent and of the C-CPI-U was 2.31 percent (the 0.38 difference quoted in the text allows for rounding error).

16. The annual growth rate of the CPI-U over this period was 2.75 percent and of the PCE deflator was 2.37 percent.

and the changes in the CPI over the past decade. The Boskin Commission found substitution bias at the upper level of 0.15 percentage points and at the lower level of 0.25 points. One would have thought that more rapid updating of weights at the upper level and the movement to geometric weights at the lower level would have eliminated all but perhaps 0.1 points. But we now are faced with six years of evidence of upper-level bias of 0.38 points, suggesting that the Boskin Commission, relying primarily on previous BLS research, substantially underestimated the amount of upper-level substitution bias.[17]

V. *Implications of Research Since the Boskin Commission Report*

The final section of this paper examines the implications of research carried out since the 1996 release of the Commission Report. Our topics are recent research on outlet substitution bias, long-term historical evidence on CPI bias, and further research on quality change and new products.

Outlet Substitution Bias and the Wal-Mart Effect

The Commission had estimated outlet substitution bias to contribute 0.1 percent per year to the overall upward bias in the CPI, which ignores changes in the level of prices between full-priced and discount stores, assuming that the price differential is fully offset by a service differential. But shifts in market share contradict that assumption; when shoppers shift from full-

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17. The matter is more complicated than this, because there are numerous differences between the CPI-U and the PCE deflator other than weighting schemes, whereas the difference between the CPI-U and C-CPI-U results only from upper-level weighting differences. Thus the identical differences cited above over the past six years may be in part a coincidence.

price to discount outlets, they are "voting with their feet" that the price differential is worth more to them than any service differential. In fact, much of the shift in market share over the past two decades has been from higher priced self-service stores like Sears and K-Mart to lower-priced and more efficient self-service stores like Wal-Mart and Target. The level of service is often not an issue, as shoppers move from one type of self-service outlet to another.

Important new evidence on the Wal-Mart effect for food at home is provided by Hausman and Leibtag (2005), who study both bar-code data on prices charged by each outlet as well as household panel data that can track household shopping patterns over time. Their discount sellers of food include supercenters, warehouse clubs, and mass merchants, and they cite sources estimating that these outlets began selling food in the late 1980s and by 2003 had achieved a 25 percent market share of total food expenditures. They find an average benefit of the introduction of discount outlets to be 25 percent of food expenditures, consisting of 20.2 percent for the direct effect of lower prices at the supercenters, and an additional 4.8 percent coming from the competitive responses of lower prices at traditional outlets. They also find that the average rate of price change at the supercenters and the traditional outlets is the same; that is, the benefit of the supercenters comes from their much lower prices when each supercenter opens for business, a consumer benefit that is linked out by the CPI.

If we assume that the 4.8 percent price decline at traditional outlets is accurately measured by the CPI, then we can calculate the impact of the supercenters as a 25 percent market share, times a 20 percent price differential, or 5 percent, spread over roughly 15 years between 1988 and 2003,

or an outlet substitution bias of 0.33 percent per year for food, which has a 12 percent weight in the CPI. Thus food alone would contribute 0.04 percent to the outlet substitution bias estimated by the Boskin Commission to be 0.1 percent. Presumably other durable and nondurable goods would contribute the rest. It is doubtful that the total of outlet substitution bias could be appreciably above the Boskin estimate of 0.1 percent, because housing, medical care, and numerous other types of consumer services are not sold by discount stores.[18]

The Hulten-Brueghel Paradox and its Implications for Quality Change Bias

The Boskin Commission's CPI bias estimate of 1.1 percent per year was explicitly applied to the period 1995-96, and the Commission suggested that the bias was 0.25 points higher prior to 1995 and extending back to 1978, due to so-called "formula" bias in the arithmetic mean formula used to combine individual item prices.[19] What do we know about the bias prior to 1978? Conjectures by Nordhaus (1997) and responses by his discussant Hulten (1997) led to the recognition that an upward bias in the CPI in the order of magnitude of 1.5 percent a year cannot be extended back for a century or two without the implication that the standard of living in 1800 (Hulten) or in 1569 (Gordon, 2005) was implausibly low. By Gordon's calculations, which extended Hulten's back several more centuries, an annual price index bias of 1.5 percent implies for 1569 a median *annual income in today's prices* of only $5.60, enough to buy 0.8 ounces of potatoes per day,

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18. We note that discount chains now sell haircuts, and that big box retailers like Pet Smarte now offer both dog grooming and veternarian services.

19. The formula bias was partly eliminated by the January, 1995, introduction of a procedure called "seasoning" that is explained in Greenlees (2006).

with nothing left over for food or shelter. Gordon had chosen the year 1569 as the year of death

of Pieter Brueghel the Elder, who had painted happy burghers "often shown as overfed, content,

well-clothed, and with solid-looking houses in the background" (Gordon, 2005, p. 4).[20]

To resolve the paradox Gordon suggested that at some point in the past the CPI bias must

have been zero or even negative, and to address this possibility he carried out research on two of

the three major necessities, clothing and shelter. For apparel his major finding is based on applying

two methodologies to the same data for womens' dresses from the Sears Roebuck catalog over the

period 1914-88. Hedonic regressions are compared with a matched-model index that duplicates

the CPI pre-1988 methodology by comparing dresses from one year to the next that are absolutely

identical in every quality attribute. It had long been suggested that the matched-model

methodology would miss price increases that occur with model changes, and indeed this is what

occurred in the Sears data. The annual growth rate of the hedonic index was fully 2.9 percent faster

than the matched model index based on the same data and 1.3 percent faster than the CPI for

womens' dresses.[21] Gordon's results include a close comparison of quality in the 1914 and 1988

dresses, something that is not possible with the CPI, with the conclusion that quality in the Sears

sample deteriorated over the full period. He suggests that the CPI for apparel is roughly accurate

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20. Brueghel dropped the "h" from his name in the last ten years of his life, but his sons retained the "h".

21. These results are taken from Gordon (2005, Table 13). The fact that the Sears matched-model index grew 1.62 percent slower than the CPI could reflect differing sample sizes that causes the Sears index to miss more of the price changes, and also a kind of outlet substitution bias reflecting Sears' relatively low prices compared to other merchants in the first two-thirds of the sample period.

for 1914-47 but is downward biased by roughly 1.5-2.0 percent per year for 1947-88. He also

suggests that methodological improvements in the CPI after 1988 may have largely or completely

eliminated the downward bias, and in any case he has no evidence after that date based on hedonic

regressions.

Rental housing is the most important single component of the CPI, because the price of

rental housing is used as a proxy for owner-occupied housing. Gordon and vanGoethem (2005)

examine a wide variety of evidence, including a large biennial set of panel data on rental

apartments from the American Housing Survey, and conclude that the CPI for rental housing is

downward biased for most of the period from 1914 to 2003 at an average rate of roughly one

percent per year. They find that the period of most rapid downward bias was in the first half of

the postwar era, the same time interval that yielded the most rapid downward bias in the Gordon

apparel results, and that methodological improvements in the CPI had reduced the downward bias

to roughly one-third point per year from 1995 to 2003.

These results on apparel and rental shelter require a retrospective downward revision in

the Boskin Commission estimates of quality change bias. The Boskin bias estimate for apparel was

+1.0 percent per year, and this should be reduced to zero.[22] The Boskin bias estimate for rental

housing was +0.25 percent per year, and this should be reduced to the Gordon-van Goethem

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22. The Boskin estimate had been based on an earlier version of the Gordon paper that compared
the CPI with a matched-model index for all apparel (not just womens dresses) based on Sears catalogue
data. The hedonic study of womens' dresses had not yet been performed at the time of the Commission
deliberations.

regression-based estimate of -0.46 percent per year.[23] Taking these together and using the weights in the Boskin report reduces the Boskin estimate of quality change bias from 0.612 to 0.429 points per year for the 1995-96 period.

Post-Boskin Research on Quality Change: Medical Care and Pharmaceuticals

In looking back to the Commission's estimate of a 3.0 percent per year upward bias in the CPI for medical care services, fully 2.0 percent is accounted for by the change from input costs to a treatment basis, introduced into the PPI in 1992 and the CPI in 1997. This leaves only 1.0 percent for all remaining improvements in medical care technology, and if anything, recent studies suggest that medical care technology improvements may be reducing the true price of medical care by more than 1.0 percent per year.[24]

In a newer version of research that the Commission had reviewed, Cutler, McClellan, and Newhouse (1999) use information from hospital records to price heart attack treatments using the CPI's traditional input-cost approach and find an upward bias of 2.0 percent. Adding in the value of improved life expectancy from better treatment procedures, the bias rises to the range of 3.1-3.5 percent, and further research raises the bias estimate to 5.0 percent per year.[25] A study that implies a much larger bias was carried out by Frank, Berndt, and Busch (1999) on treatments for mental

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23. This is the average of their estimate for 1985-95 of -0.58 and for 1995-2003 of -0.33.

24. Some of this research appears in Triplett (1999), a book with a comprehensive and thoughtful introduction that provides the best available introduction into the issues, problems, techniques, and results in this area.

25. See also the other references under Cutler *et al.* in the list of references. The second 1999 paper (NBER 7089) contains larger bias estimates, with a synthetic index based on pre-1997 BLS methods rising at an annual rate of 3.3 percent for 1984-94 contrasted with a COL index measuring changes in the quality of life which declines at 1.7 percent per year, for a total difference of 5.0 percent per year.

depression. There is no component of the CPI that is directly comparable, but this research implies a possible bias of more than 10 percent per year.[26] Ellison and Hellerstein (1999) analyze a large data set on the prices of the cephalosporin class of antibiotics and find a price increase for 1988-96 of 0.76 percent per year compared to the PPI cephalosporin component which rose at 4.54 percent a year, for a bias estimate of 3.78 percent per year.[27] Newhouse (2001, Table 5) surveys available evidence at that time and considers a 3 percent upward CPI bias to be conservative.

The number of aspects of medical care subject to research has been growing, and it seems reasonable to extrapolate from areas where studies have occurred to those which may have similar characteristics. Shapiro, Shapiro, and Wilcox (1999) point to the numerous dimensions of cataract surgery. An operation that once required a week in the hospital is now a brief outpatient procedure. Subsequent recovery is much faster; complication rates have declined; intraocular lenses have replaced cumbersome cataract spectacles. As a result of improved technology and a drastic decline in prices, the rate of cataract surgery among individuals in the U. S. aged 65 years has increased by almost a factor of four. Because the operation now occurs earlier in the disease, the period of steadily obscured vision has been eliminated, with enormous benefits in welfare. The authors point to similar benefits in angioplasty, joint replacement, and laparoscopic removal of gall bladders.

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26. A follow-up study by Berndt *et. al.* (2000, p. 15) supports the earlier paper and "does not materially change findings from previous research on treatment of depression."

27. Related research available to the Commission was Griliches-Cockburn 1994 and Berndt *et al.* 1996.

Post-Boskin Research on Quality Change: Other Products

Scattered pieces of new research have emerged for other products. Moulton *et al.* (1998) concluded that there was an upward bias in the CPI for television sets of three to five percent over the period 1993-97. Ohashi (1999) developed hedonic price indexes for VCRs during the first decade of their introduction (1978-87) prior to their introduction into the CPI and found an average rate of price decline of 12 percent per year over that period. Hausman (1998) criticizes the Boskin Commission for understating the CPI bias related to cellular phones and estimates that the CPI for telephone service (taking account of the gradually increasing weight on cell phones) is biased upward for 1985-97 by between 0.8 and 1.9 percent per year.

Abel, Berndt, and White (2003) find that the prices of Microsoft software declined over 1993-2001 at an annual rate of 4.26 percent, even without taking into account any improvements in quality. A much more rapid rate of decline of 15 to 18 percent is recorded by White *et. al.* (2004) for personal computer operating systems and of 13 to 16 percent for software productivity suites. An even faster annual rate of decline of 21 to 26 percent for PDAs (Personal Digital Assistants) is found by Chwelos *et. al.* (2004).

Other than Hausman's studies of Cheerios, cellular phones, and Wal-Mart, there has been relatively little new research on the impact of new products and new outlets, and yet speculative estimates of the value of these improvements were at the core of the Boskin Commission estimates of CPI bias for quality change and new products. The traditional supermarket industry is in a state of upheaval as consumers shift market share both toward the cheaper supercenters studied by

Hausman and Leibtag (2005) and at the same time toward the greater variety offered by such upscale markets as Whole Foods. Both low-priced supercenters and high-priced markets that emphasize organic and in-house prepared foods are viewed as attractive new products, as shown by the revealed preference of consumer behavior.

VI. *Conclusion*

In evaluating the Boskin Commission report ten years later, two issues must be sharply distinguished. First, did the Commission overstate the CPI bias for the period to which it referred, 1995-96? Second, how much have improvements in the CPI reduced that bias?

On the first question, recent research on apparel and housing suggests that the Commissions's estimate of quality change and new product bias may have been roughly 0.2 percent per year too high. However, the striking 0.38 percent annual difference over 2000-2006 between the CPI-U and the chain-weighted C-CPI-U suggests that the Commission's estimate of 0.15 points greatly understated the significance of upper-level substitution bias. This is especially true, given the much more rapid updating of upper-level weights in the CPI for the 2000-06 period from which the 0.38 percent number is calculated. It is possible that, with this new information, the Commission's estimate of upper-level substitution bias for the 1995-96 interval might be 0.45 to 0.50 points, instead of 0.15 points, more than offsetting the Boskin overstatement of quality change and new product bias. Thus my own retrospective view is that the upward bias in the CPI in 1995-96 was if anything higher than the Boskin estimate of 1.1 percent and was perhaps 1.2 or

1.3 percent.

An important piece of evidence on the nature of CPI bias comes from the longstanding excess of the annual growth rate of the CPI over the PCE deflator. Any such excess is notable, because the PCE deflator uses the same underlying micro price indexes as the CPI but weights them differently. As discussed above, the CPI-U grew 0.38 percent faster than the PCE deflator during 1999:Q4 to 2005:Q4, a period when most of the improvements in the CPI were already in effect. Over the period more relevant to the Boskin Commission bias estimates, 1992-98, the CPI-U grew 0.63 percent faster than the PCE deflator. This 1992-98 difference, which can be explained only by item and category substitution effects (because the PCE has the same exact treatment of outlet substitution, quality change, and new product effects), provides *prima facie* evidence that the Boskin bias estimate may have been understated.

What about the second question, reductions in the bias due to CPI improvements since 1996? The greatest amount of progress has been made in reducing substitution bias, both at the upper level and lower level, although the thorny issue of outlet substitution bias remains untouched. However, in light of the continuing large difference in growth rates of the C-CPI-U and CPI-U, these improvements have reduced substitution bias from a higher base than the Commission recognized. Several specific improvements address part of the Commission's estimated upward bias involving quality change and new products, including new hedonic indexes for television sets and personal computers as well as an improved treatment-based methodology for measuring medical care prices.

What is my own estimate of the current CPI bias? The new C-CPI-U evidence suggests that category and item substitution bias appears to remain at about 0.4 percent per year, outlet substitution bias remains at about 0.1 percent per year, and bias attributable to quality change and new products has been reduced from the Boskin-era 0.4 percent (revised downward from 0.6 percent as explained above) to perhaps 0.3 percent primarily as a result of the switch from input prices to treatment prices for medical care. This sums to 0.8 percent per year.

Concluding as did the Boskin Commission on issues of unmeasured improvements and deterioration, I think that these point estimates substantially understate the value of inventions, new products, and increased longevity. A century ago, our forefathers had to shovel coal, carry water into their dwellings, and heat it manually before bathing or the tedious scrubbing of clothes could take place. The value of running water, water heaters, forced air heating fueled by natural gas and the cleaner air that has resulted, is enormous, even if converted to an annual growth rate over 100 years. Recent research on the value of increased life expectancy creates growth rates in welfare that swamp the Boskin debates about 10 basis points here or there. In particular, Nordhaus (2002) and related research concludes that the value of increased longevity over the past century is as large as the value of measured growth in all non-health goods and services.

Let me conclude with a small personal example. Despite global warming, it still snows occasionally in Chicago, but I don't have to touch a snow shovel. My trusty Toro snow blower is a new product from the perspective of 50 years ago. The value of its invention is not included in the CPI. But, not only does it greatly ease the job of removing the snow compared to the old-

fashioned snow shovel, but it indirectly has contributed to my life expectancy.

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