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CONSUMER PRICE INDEX OVERSTATES FOOD PRICE INFLATION

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The Consumer Price Index (CPI) has long been criticized by academic and government analysts on the grounds that inherent biases in the index lead to substantial overestimates of changes in the cost of living, and corresponding underestimates of growth in real incomes and productivity. The matter began to receive close media and political scrutiny in January of 1995, when Federal Reserve Board chairman Alan Greenspan informed the Budget Committees of Congress that "the official CPI may be overstating the increase in the true cost of living by perhaps 1/2 to 1 and 1/2 percent per year..." and that that overstatement led to large increases in government expenditures in indexed entitlement programs. He suggested that reductions in CPI bias could eliminate the federal deficit.

The Senate Finance Committee assembled an Advisory Commission to study the Consumer Price Index, commonly referred to as the "Boskin Commission" after its chair, Professor Michael Boskin from Stanford University (other members were Ellen Dulberger from IBM, Zvi Griliches from Harvard, Robert Gordon from Northwestern, and Dale Jorgenson from Harvard). The Commission issued a final report ("Toward a More Accurate Measure of the Cost of Living") on December 4, 1996. That report contains the Commission's best estimate of CPI overstatement (1.1 percentage points per year), an assessment of the several sources of bias, and a summary of the likely implications of CPI overstatement.

The Commission's report, and much of the surrounding discussion, emphasizes the difficulty of accounting for new products and changes in product quality in the CPI. The focus of that discussion has been on sectors, such as consumer electronics, automobiles, and medical care, that have a lot of innovation and technological change. That emphasis misses an important point: the likely CPI bias in the food at home sector is high (about 1.9 percentage points per year), and can be fixed more readily than problems stemming from innovation in rapidly growing sectors.

Table 1 summarizes the best estimates of CPI overstatement for the overall CPI as well as the components for food at home and food away from home. It breaks the overall bias down into the four sources used by the Boskin Commission. The estimates for the overall CPI are taken from the Boskin Commission's final report, and the estimates for new product/quality change bias in food sectors are also the Commission's estimates. Estimates for the other three bias categories in food at home and food away from home are ERS estimates based on review of considerable research performed by academic and government economists.

The Commission's best estimate of bias in the overall CPI is 1.1% per year, and more than half of that is due to problems in handling new product and quality change. The ERS estimate of overstatement in the Food at Home CPI is substantially higher, 1.9% per year, and more than half of that is due to another source of bias--Lower Level Substitution Bias. Estimates of bias in the Food Away from Home CPI are substantially lower.

The underlying research, most of it done by economists at the agency that produces the CPI (The Bureau of Labor Statistics), suggests that lower level substitution bias has been a serious problem for the food at home CPI since 1978, leading to substantial overstatement of food price inflation for nearly two decades. The BLS recently introduced some procedural changes that will reduce the effect of this bias, and further feasible procedural changes could eliminate it.

One source of bias (Upper Level Substitution Bias) is a well known staple of economics textbooks, and another (New Product/Quality Bias) has been an important and longstanding focus in economic research. But two others (Lower Level Substitution Bias, and Outlet Substitution Bias) are less well known. The latter two are particularly important in the food sector, and in fact the evidence on them is almost entirely based on analyses of the food sector. In order to clearly understand each of the four it's important to first understand how the CPI is constructed.

CPI Construction

The CPI is constructed in two stages, and the key to understanding CPI biases is to understand how items are selected for pricing and how their price changes are aggregated at the two stages into an index.

At the upper stage of index aggregation, a monthly CPI is built up from 44 geographic categories (such as the Atlanta metropolitan area) and 207 product categories (such as Apples, or White Bread), which are combined to form 9,108 price indexes, one for each "strata" of an item and geographic category. In order to aggregate these strata indexes into the overall CPI and its components (such as Food at Home), the BLS uses information on household expenditure patterns from the Consumer Expenditure Survey to develop weights applied to the strata indexes and components. The current weights were introduced to the CPI in 1987 and are based on expenditures over 1982-84 (a three year time span is used to expand sample size and thereby reduce sampling errors in the estimated weights). New weights from 1993-95 Surveys will be introduced in 1998.

At the disaggregated stage, separate strata indexes are calculated for each product category in each geographic category using representative samples of outlets and item prices. Outlets are selected using a Point of Purchase Survey (POPS), in which households are asked about the outlets at which they purchased goods and services. The results are used to select outlets for pricing, with the probability of selection proportional to expenditure shares as revealed in a

POPS. Data collectors then go to the selected outlets and select specific items for pricing (such as Red Delicious apples, or a 5 lb. bag of Gold Medal All-Purpose flour). Specific items are selected randomly, with the probability of selection driven by the item's share of a product category's (Apples, Flour) sales in an outlet. Since this procedure means that different items (Red Delicious vs. Rome apples) could be priced in different outlets, the samples become less useful for comparing levels of prices. Rather, the index aims to aggregate relative price changes.

Because buying patterns are infrequently surveyed at upper levels of the CPI, the weights assigned to upper level components, such as Apples, Fresh Fruit, Fruits and Vegetables, and Food at Home, are kept fixed for extended periods of time. But because Point of Purchase Surveys are done in 20% of the CPI sample each year, the CPI keeps up with changes in buying patterns at lower levels, among outlets and within product categories.

How do we go from price collectors to the CPI? First, BLS personnel construct price relatives (the ratio of this month's price to last) for each priced item. Lower level aggregation is done by calculating the simple arithmetic mean of the price relatives for specific item varieties. That is, each strata index is simply the average of price relatives across sample outlets and items in that strata. Since outlets and items are selected with probability proportional to sales, this is equivalent to weighting price changes at outlets by sales. Upper level indexes are formed by weighting component item strata indexes by the fixed weights derived from the relevant Consumer Expenditure Survey. Each substitution bias is based on specific problems that arise at these aggregation stages.

Upper Level Substitution Bias

"Upper Level" bias is the traditional textbook substitution bias of a Laspeyres index, and arises because the CPI maintains fixed weights calculated at the beginning of the comparison period. Using fixed weights that are dated create two problems. First, as consumer expenditure patterns change, the old set of weights become less relevant as measures of the price changes faced by representative consumers; the current CPI assumes that food at home occupies the same share of household budgets that it did in 1982-84, when we know that food's budget share has clearly declined. But Upper Level Substitution Bias actually refers to a related and more systematic problem. Some product categories have had relatively high price increases since 1982-84; for example, prices for fresh and frozen fish rose by about 99% between 1982-84 and 1996, while prices for beef rose by 38%, according to the CPI indexes for each. Consequently, some people will shift away from fish and toward beef because beef became relatively less expensive; but the CPI is constructed on an assumption that purchase patterns are unchanged. In brief, the index will systematically overstate the weights that consumers place on products that are rising quite rapidly in price, while understating the weights that consumers place on products whose prices are not rising as rapidly.

The BLS has done a lot of research on this sort of bias; it can be evaluated retrospectively by reweighting the index with later Consumer Expenditure Survey data. Estimates of the effect

cluster in a range of .10 to .30, depending on the products evaluated. Table 1 cites the Commission's estimate for the overall measure, while the number for food at home is taken from published research. Food at Home is larger because consumers are more likely to substitute among food at home categories in response to price changes. The term "Upper Level" means that this bias refers to substitution among product categories (Apples or Bananas) and not to substitution among items and outlets within those strata.

Lower Level Substitution Bias

Recall how recorded price changes at outlets are aggregated to the strata level: simple averages of price relatives. This formulation can create a serious bias, an "inflationary drift" that is not necessarily about substitution. Suppose iceberg lettuce is priced at two outlets: price rises from \$1.00 to \$1.50 in one, and falls from \$1.50 to \$1.00 in the other. The two price relatives are 1.5 and .67, and the mean price relative is 1.085, an 8.5% "average" price increase. Suppose prices reverse again in the following month. The index will record another 8.5% average price increase, even though average prices have been unchanged for two months. The problem is particularly important for products with substantial month to month or outlet to outlet variation in price changes, and is particularly important for fresh fruits and vegetables (where CPI bias is on the order of 3.0 to 5.0% annually) and also for fresh meats.

BLS procedures also introduced a subtle spurious correlation between price changes of outlets newly introduced into the sample and their (implicit) weights. The nature of the POPS means that outlets about to raise prices were more likely to be introduced into the CPI sample, and outlets about to cut prices were less likely to be introduced. The BLS recognized this problem in 1994, and changed procedures in January of 1995 in order to deal with this problem. The agency estimates that the changes, which it calls "seasoning", will remove 0.4% from lower level substitution bias in the CPI for food at home; looking forward, then, Lower Level Substitution Bias in the food at home CPI should be 0.7% per year and the all sources bias for food at home is estimated to be 1.5% per year.

A simple adjustment can remove the rest of the Lower Level Substitution Bias. If, rather than average the price relatives (1.5 and .67 in the example above), BLS instead averaged the natural logs of the price relatives (+.4005 and -.4005), the drift would be eliminated. BLS has generated experimental indexes based on this approach of calculating geometric rather than arithmetic means, and has found that the Food at Home CPI would be reduced by a further 0.7%, if seasoning was also retained. Because the problems seem to arise in the formulas used to aggregate price changes at lower levels of the index, the BLS refers to this source of bias as "Formula Bias".

Lower Level Substitution, or Formula, Bias can be quite large for products whose price changes fluctuate widely over time or across outlets. In particular, the CPI for fresh fruits and vegetables has probably been dramatically overstated; BLS research suggests that the simple formula adjustment outlined above would reduce the growth in the CPI for fresh fruits and vegetables by

4.50% per year. Other research finds estimates of overstatement in the range of 3.0-5.0% per year for that category. Nonfood prices are more stable, so the overall effect is estimated to be less. Because Away from Home prices are also more stable, and therefore the adjustment would have a smaller effect on Away from Home.

Outlet Substitution Bias

Ongoing POPs surveys lead to sample "refreshment", with about 1/5th of the index's outlets being newly drawn each year. BLS research has shown that newly entering food outlets have prices that average about 1.25% below the prices of exiting outlets. At present, this price difference is not included in CPI calculations. If replacement is occurring in January, for example, then the CPI will include a November to December price relative for the old outlet in the December CPI, and a December to January price relative for the new outlet in the January CPI. In other words, the CPI only includes price changes within outlets, and excludes price differences across outlets.

Current BLS procedure assumes that any outlet price differences reflect corresponding unobserved quality differences that are "paid for" by the price difference (estimated price differences can be based on the December overlap in the above example). Commission, BLS, and popular commentary on the Boskin Report seems to accept the BLS assumption at face value, by assuming that the source of this price difference is warehouse stores and Walmart (what the *Economist* calls "Americans' predilection for shopping at discount stores").

The BLS procedure is actually the correct one to follow, and there is therefore no bias, if new outlets do offer lower quality and fewer services, and if the price difference between outlets reflects that. The index shouldn't record poorer service as if it were a price decline for comparable services. But much of the shift in patronage in the last decade is toward larger food stores that offer lower prices and greater quality, in the sense of greater breadth of product line and more services, achieved through realization of scale economies offered by high sales volumes. If that's true, then outlet price differences should be included in the CPI.

If outlet price differences were included in the index, the Food at Home CPI would likely have grown about 0.25% less per year over the last decade (see table 1). Because all of the research refers to grocery outlets, the Boskin Commission reduced that estimate for the overall CPI. Table 1 keeps their reduction for Food Away from Home, but I think that truth is likely to be closer to zero, because we haven't seen the same sort of structural change in outlet sizes that we've seen in food retailing. Moreover, this estimate is actually backward-looking; that is, it is based on the dramatic changes in retailing of the last decade and a half. It will not hold for the future if structural change toward larger and lower priced food stores does not continue.

New Product/Quality Change Bias

This is conceptually similar to outlet substitution bias. Suppose a new, higher quality television is introduced to the market, and further suppose that it is introduced into the CPI in January. The December CPI will include the November-December price relative of the old models that are

rotating out of the sample. The January CPI will include the December-January price relative of the new model. In short, the index will only measure price changes within models, and will ignore any quality gains. Of course, many new consumer electronic models offer lower prices and higher quality than old models, and the index will generally ignore cross model price reductions.

In some cases, the quality improvement will occur for an existing model (this year's version of the existing television model is better). In that case, BLS may continue pricing the model, and if higher quality comes at a higher price, the increased price will be entered into the index, but not the value of increased quality.

A related problem concerns the timing of new product introduction to the CPI. Many new product prices fall sharply early in the product's life cycle, and later stabilize and begin to rise relative to other products. The BLS's well known lags in introducing new product categories to the index (the current example being cellular phones) means that products early in their life cycle (with falling prices) are underrepresented in the index.

A considerable amount of research, much of it by Commission members, has gone into this topic, with most of it focussed on electronics, appliances, automobiles, pharmaceuticals, and medical care. The research finds that these effects can be very large, and the Commission's report assigns more than half of the overall CPI bias to this source. The Commission also asserts that the effect of the CPI for Food is overstated by 0.3% annually because of this bias, but their evidence is entirely speculative. There is at present virtually no reliable evidence on the existence or extent of this bias for food products.

What is Likely to Happen?

The Boskin Commission Report makes a variety of recommendations to the BLS, to Congress, and to professional economists. The BLS has provided a detailed set of responses to the report, available at the agency's website. Some are feasible immediately, and some may become feasible. Some of the feasible recommendations are likely to be implemented, but some are not because they are expensive or because they are conceptually controversial.

The BLS could reduce or eliminate Lower Level Substitution Bias at little cost by replacing the lowest level price arithmetic mean price relatives with geometric means. The existing method violates some basic standards for an adequate price index and the new way would not fundamentally alter the CPI at upper levels. Moreover, the BLS is already producing an experimental index based on geometric means. For those reasons, this is the most likely change. If carried out it will have an important impact on the Food At Home CPI, reducing it by 0.70% annually and reducing growth in the fresh fruits and vegetables component by considerably more. These changes are in addition to the effects of the "seasoning" changes introduced in January of 1995, which appears to reduce the growth in the food at home CPI by 0.40% per year. Taken together, those two changes would have a major impact on estimates of food price inflation, and the bias should have a major impact on how we view measured food price inflation since the late 1970's.

The BLS could also easily adjust the index at little cost to take account of outlet substitution bias, as defined above. The change would have a modest (0.25%) effect on the CPI for Food at Home, but we don't know if it is really appropriate to introduce outlet price differences, and the introduction would open up a wide range of related issues on product quality. Because this step is so conceptually controversial, I don't expect it to happen, and I'm not convinced that it should.

The BLS could retrospectively adjust the CPI for Upper Level Substitution Bias with expanded Consumer Expenditure Surveys. That would require some new substantial funding, and the new index would appear late, 18-24 months after the corresponding CPI. This step is feasible and extra expense is not exorbitant. Nevertheless, it is far from certain because it would require additional funding, it would require an important conceptual shift in what the index aims to measure, and it would be reported with a fairly long lag.

Quality biases are often very difficult to handle. The BLS does frequently make procedural adjustments to handle quality change issues, and these changes have had a large aggregate effect on the index. But in many cases, analysts don't have a strong theoretical framework to guide them and don't have the reliable data needed to apply the theory that is there. As a result, major and far-reaching changes are not likely to happen, and any change that would affect food is both infeasible and unlikely to be implemented.

In conclusion, likely future changes in CPI construction could reduce the CPI for Food at Home by 0.70%, in addition to the 0.40% reduction caused by shifts in BLS procedures in early 1995. I should also caution you that most of the evidence for these estimates is based on BLS experiments over short time periods; the estimates may therefore have a wide margin of error for economic environments different from the recent past.

**Changes in Food Price Indicators
1995 through 1997**

Items	Relative importance ^{1/}	1995	Final 1996	Forecast 1997
	--Percent--		---Percent Change---	
All Food	100.0	2.8	3.3	2 to 4
Food Away From Home	37.3	2.3	2.5	2 to 4
Food at Home	62.7	3.3	3.7	2 to 4
Meats	12.2	0.1	3.5	1 to 3
Beef and Veal	6.2	-0.8	-0.3	1 to 3
Pork	3.4	0.7	9.9	3 to 5
Other Meats	2.5	1.5	3.6	1 to 3
Poultry	2.7	1.4	6.2	0 to 2
Fish and Seafood	2.4	4.8	0.9	2 to 4
Eggs	1.0	5.4	18.0	-4 to 0
Dairy products	7.4	0.8	7.0	2 to 4
Fats and Oils	1.6	2.8	2.4	2 to 4
Fruits and Vegetables	12.7	7.7	3.5	3 to 5
Fresh Fruits and Vegetables	8.9	10.3	2.8	3 to 5
Fresh Fruits	4.5	8.8	7.1	3 to 5
Fresh Vegetables	4.5	12.1	-2.0	3 to 5
Processed Fruits and Vegetables	3.8	2.2	5.0	2 to 4
Processed Fruits	2.1	3.1	5.8	2 to 4
Processed Vegetables	1.6	1.2	4.0	2 to 4
Sugar and Sweets	2.1	1.7	4.5	2 to 4
Cereals and Bakery Products	9.2	2.8	3.9	3 to 5
Nonalcoholic Beverages	5.0	6.9	-2.4	2 to 4
Other Prepared Foods	6.5	2.4	3.4	2 to 4

^{1/} BLS estimated expenditure shares.

Table 1: Estimates of Annual Average Biases in Consumer Price Index.

Type of Bias	CPI Component		
	Overall	Food at Home	Food Away from Home
Upper Level Substitution	0.15	0.25	0.10
Lower Level Substitution	0.25	1.10	0.10
Outlet Substitution	0.10	0.25	0.10
New Product/Quality Change	0.60	0.30	0.30
All Types	1.10%	1.90%	0.60%

Sources: All estimates for the Overall CPI, and the New Product/Quality Change estimates for other components: Advisory Commission to Study the Consumer Price Index (The "Boskin Commission"), "Toward a More Accurate Measure of the Cost Of Living", Final Report to the U.S. Senate Finance Committee, December, 1996. All other estimates are ERS estimates based on review of existing research.