The Retail Revolution and Food-Price Mismeasurement

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In December 1995, the U.S. Senate Finance Committee's Commission to Review the Consumer Price Index issued its final report. This report stated that the U.S. Consumer Price Index (CPI) was an upwardly biased measure of the cost of living that most likely exaggerated inflation by 1.1 percentage points a year. Exaggerating inflation means that we underestimate the purchasing power of our money and thus reduce gains in output when we measure them in inflation-adjusted dollars. The report attempted primarily to estimate the current and future bias of the CPI; it did not discuss the *historical* bias nor whether the bias had increased. This article presents evidence that the upward bias in measures of U.S. inflation worsened in the late 1970s. A rising bias would support the argument that the slowdown in growth of U.S. inflation-adjusted output and labor productivity reported since the mid-1970s is an artifact of mismeasurement.[1]

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[1]Labor productivity is the average amount of inflation-adjusted output produced by an hour of work. For further discussion of productivity measures and the productivity slowdown, see "Is the U.S. Economy Really Growing Too Slowly? Maybe We're Measuring Growth Wrong," *Business Review*, March / April 1997.

Nobel laureate economist Robert Solow has said of this slowdown, "We see computers everywhere but in the statistics." This so-called Solow paradox draws its power from the observation that not only is there no apparent pickup in productivity growth from the widespread adoption of personal computers that began in the late 1970s, but, instead, our official statistics report a drastic slowdown. I argue here that one of the impacts of the new electronic technology has been a retail revolution that has made price measurement more difficult. Our failure to see faster growth from computerization is thus a side effect of the confrontation between an outmoded statistical system and a rapidly changing economy.

In particular, the implementation of new technologies—scanners, universal product codes, and electronic cash registers—that began in the late 1970s has enhanced the ability of producers and retailers to charge a variety of different prices for identical or similar products.[2] Deregulation of the U.S. economy has removed restrictions on competition, also enhancing the ability of sellers to change prices and increase their product offerings. One such act was the repeal of so-called fair trade laws—these laws, despite their name, tended to prevent retail discounting.[3] As these changes took hold, the methodology underlying the U.S. Consumer Price Index (CPI) was revised substantially. The methodological change was intended to reduce the upward bias in inflation measurement, but, in practice, it exaggerated the bias as price dispersion accelerated.

Food prices provide an illuminating case study of the measurement problems created by price dispersion.[4] Food is historically the most basic product in any economy, and its inflation rate has long been documented. The American economic historian's bible, *Historical Statistics of the United States, Colonial Times to 1970*, records wholesale and retail food prices going back to the 18th century. When the U.S. Department of Labor's Bureau of Labor Statistics (BLS) first began collecting monthly data on retail prices after World War I, it began with a set of 30 food articles and investigated monthly price changes going back to 1890. While much of the discussion of the mismeasurement of inflation has centered on the introduction of new goods (see my article, "Measuring Inflation in a High-Tech Age"), two recent studies, by Marshall Reinsdorf (1993) of the BLS and by James MacDonald (1995) of the U.S. Department of Agriculture, suggest that, since the late 1970s, the Consumer Price Index has substantially overestimated inflation in food. (See *It Isn't Just An Eating Disorder.*)

THE RETAIL REVOLUTION

Retailing in the United States has been revolutionized over the past two decades. The use of scanners, for example, began slowly but picked up rapidly in the 1980s (Table 1). Scanners read the bar codes on products for the cash registers, which translate the codes into product descriptions and prices and then tally them

[2]Levy et al. (1997) examined a sample of four large supermarket chains with the modern technology and showed that the cost of changing prices was 52 cents per product price change. At a chain located in a state in which retailers are required to place a price on each individual item, the cost averages $1.33 per product price change. They went on to show that the four chains whose cost is lower change prices far more frequently.

[3]Two laws, the 1937 Miller-Tydings Resale Price Maintenance Act and the 1952 McGuire Act, made it possible for a small retailer to sign an agreement with a manufacturer that would then prevent *all* retailers in that state from offering discounts on the manufacturer's products. Since 1976 such so-called fair trade agreements have been illegal.

[4]This article is based primarily on Nakamura (1998), which discusses empirical evidence on retail food prices and the underlying economic theory of price measurement when price dispersion occurs.

It Isn't Just An Eating Disorder

The biases for food discussed in the article are also found in the CPI for airfares, college tuition, gasoline prices, hotel rates, and prices for department store merchandise. Airfares are a particularly good example of the joint impact of deregulation and computerization. In 1978, there was only one round-trip coach fare on most routes, as fares were regulated by the Civil Aeronautics Board. At present, by contrast, dozens of different fares are available with a variety of restrictions on every route, and the fare structure changes by the minute.

Between 1978 and 1996, the average price paid per mile by passengers grew at an annual rate of 2.7 percent (Table). The CPI-U for airfares grew at an annual rate of 8.3 percent, a difference of 5.6 percentage points. If we use the CPI for airfares to deflate airline revenues from passenger travel, we find that "real" airline passenger travel fell from 1978 to 1996. But, in fact, passenger miles on airlines more than doubled.

How can such a substantial gap have been sustained for so long? The reason is the dispersion of fares. Full fares for unrestricted travel have risen at an average annual rate of 9 percent, and the CPI for airfares has basically tracked the full fare.The average restricted (discount) fare has increased only 2 percent a year. The average domestic unrestricted fare is now about three times the average restricted fare. But only 7 percent of passenger miles are flown at full fare. By contrast, in 1978, virtually all travel on scheduled airlines was at full fare.

College tuition shows a bias because colleges offer reductions in tuition to a large proportion of students—this is, of course, straightforward price discrimination on the basis of ability to pay. Tuition data collected by the National Association of College and University Business Officers show that, not counting scholarship discounts, private school tuition for their members rose 6.6 percent annually from the school year 1990-91 to 1995-96, but only 4.3 percent annually over the same period if you include the discounts.

Airfares

		1964	1978	1996	Annual growth 1964-78	Annual growth 1978-96
CPI, annual average 1982-84=100		23.7	45.5	192.5	4.8%	8.3%
yield, cents per passenger-mile	full fare	6.1¢	8.5¢	38.9¢	2.4%	8.8%
	average			13.7¢		2.7%
	restricted			12.0¢		2.0%

Sources: BLS and Air Transport Association

for the customer and the store. If the store is part of a chain, the scanners permit the store's daily sales to be cumulated for relay to the chain's centralized computer, the electronic data warehouse. The electronic data warehouse supplies detailed, item-by-item data on sales and store inventory to managers, buyers, and suppliers. These tools have made it possible for retailers to change prices rapidly; prices that previously were printed on items or stamped on by hand could instead be attached to the shelf. This system eliminated much of the work of stock clerks and substantially reduced the cost of changing prices. Changing prices of products on a weekly basis became a core practice in grocery stores. Equally important, stores became more adept at tracking inventory and measuring the profitability of individual products. Retailers' increased use of technology, in turn, gave added momentum to a move toward larger stores offering greater quality, variety, and convenience.

Conventional supermarkets accounted for 73 percent of supermarket sales in 1980. But they lost their market dominance and, by 1994, accounted for only 28 percent of sales.[5] They were replaced by two types of establishments: superstores (supermarkets that include bakeries, butchers, delicatessens, pharmacies, and other formerly separate units), whose share of sales rose from 22 percent in 1980 to a dominant 57 percent in 1994; and warehouses (large discount supermarkets), whose share rose from 5 percent to 15 percent over the same period. The total floor space of grocery stores rose nearly 40 percent between 1977 and 1992, and hours of operation increased: the average chain supermarket was open 131 hours a week in 1994—nearly 19 hours a day! The average number of different items stocked, which had increased 20 percent from 1970 to 1980, rose 75 percent from 1980 to 1990. New product introductions also accelerated dramatically (Table 2).[6] And while retailers were able to reduce the number of clerks stocking shelves, they in-

[5]Conventional supermarkets are large self-service stores that offer a complete line of grocery items but lack the full-service departments found in superstores, yet they provide more variety and service than discount warehouses.

[6]These new product introductions are predominantly brand extensions, such as new soup or cereal varieties.

TABLE 1

Supermarket Scanner Usage Grew Rapidly in the 1980s, with Chain Stores Taking the Lead

(Percent)

	1982	1983	1990	1994
Chain Stores	26%	38%	80%	95%
Independent	18%	22%	61%	80%

Source: *Progressive Grocer*, various issues.

TABLE 2

Variety at the Average Supermarket Accelerated as New Technology Was Deployed

	1970	1980	1990	1994
Items per Store	7,800	9,400	16,500	19,612
New Products	1,365	2,689	13,244	20,076

Source: *Progressive Grocer* and *New Product News*, various issues.

creased the number of checkout clerks and cash registers. In short, supermarkets offered dramatically more services to their customers—more space, more variety, longer hours, and faster checkouts.

These larger stores typically set up shop in suburban areas, where relatively low land prices made opening new stores less costly and competition stiffer. Much of this competition did not take the straightforward form of uniformly lower prices. Instead, supermarkets increasingly offered weekly specials, with fliers going out to neighborhood shoppers. Manufacturers increased their issuance of cents-off coupons, and supermarkets sweetened these coupons by doubling them. And while manufacturers promoted brand-name products with national ad campaigns, supermarkets increasingly offered in-house brands at discount prices.

On its surface, this price dispersion seems irrational or tyrannical. After all, it forces us to spend more time shopping—looking for coupons, mailing in rebate coupons, searching the shelves to compare prices, and going from store to store to "cherry pick" the bargains.

If price dispersion were merely a cost imposed on customers, it would not be a successful retail strategy. Customers would shun supermarkets that adopted the new technology and embrace stores that stayed with the old. But the reverse has happened.

Chain stores adopted the new technology more rapidly than independent stores did, and at the same time, the shift away from independent ownership of supermarkets to chain ownership accelerated. The sales share of independents declined 4 percentage points, from 42 percent to 38 percent, in the 20 years from 1954 to 1974. In the 20-year period in which scanners were adopted, 1974 to 1994, the sales share of independents slid 12 more percentage points—three times as much.

So why is price dispersion such a prevalent phenomenon? How does it benefit consumers and the retailers that adopt it?

The Efficiency of Price Dispersion. The increase in living standards that made many Americans dissatisfied with bright yellow mustard, canned peas, and gelatin desserts has led to a desire for a vast variety of food products. Different shoppers want different characteristics from their stores, and in particular, some customers value low prices more while other customers place greater importance on variety and quality.[7] Price dispersion then becomes a strategy the retailer can employ to satisfy a diverse clientele.

Mr. Retiree will drive 15 extra miles to stock up on tuna fish or toilet paper if the price is right. Ms. Superwoman is always having to change her schedule at the last minute and wants to put a gourmet meal on the table with nearly no shopping or cooking time. Price isn't the issue; time is. Mr. Xgen wants food with style but has no money to spare. Ms. Maven tries out new foods and passes the news on to her relatives and neighbors. By shrewdly juggling prices, the store manager can deliver low prices on basics to Mr. Retiree, a broad selection of fresh and frozen dishes with a high markup to Ms. Superwoman, hip new foods at low prices to Mr. Xgen, and a wide variety of new foods to Ms. Maven at relatively high prices.

Mr. Retiree would shop at the store with the lowest prices regardless of variety or service. So the superstore makes sure that at least once every two months each basic item on Mr. Retiree's shopping list goes on sale for a week, at the lowest price in the area. And the extra checkout clerks the store provides to shorten

[7]This section argues that price dispersion, under the pressure of competition, is efficient. The argument is that grocery store owners—as far as possible—use Ramsey pricing to get consumers with different price elasticities to pay different shares of the fixed costs associated with variety and convenience. A nice theoretical discussion of this is Bliss (1988); empirical support is provided by Betancourt and Malanoski (1995).

Ms. Superwoman's waiting time at the cash register gives Mr. Retiree a reason to prefer the superstore when prices are equal. Mr. Xgen trolls the gourmet aisles for discounts; he helps the store manager keep inventories of fancy foods—especially perishables—under control. This is particularly important because new and fancy foods are subject to fads—often led by Ms. Maven and joined by Ms. Superwoman.

Of course, Ms. Maven and Ms. Superwoman would prefer to pay lower prices, but they aren't willing to wait for discounts. Nevertheless, they often do benefit from discounts—but less than more patient shoppers do. Mr. Retiree and Mr. Xgen would prefer not to have to spend so much time shopping, but they demand low prices. And they are beneficiaries of the more cordial service and large variety that the wealthier customers demand.

Price dispersion enables store managers to satisfy all these types of customers—to the extent possible. And electronics makes price dispersion feasible by lowering the cost of changing prices and providing an abundance of information on the success of different pricing strategies. When markets are highly competitive, stores succeed by satisfying their customers.

The Customer Is Always Right, but the Price Inspectors May Be Wrong. Unfortunately, our official price-measurement system is not well adapted to a world in which prices change frequently. Suppose the typical store that sold Diet Pop for $3 a 12-pack last year now sells it for $2 for three days a month and $4 for 27 days a month. Has the price fallen to $2 or gone up to $4? The Bureau of Labor Statistics' price inspectors will find the price $2 one-tenth of the time and $4 nine-tenths of the time, for an average price of $3.80. But the store is likely to sell much more per day at the $2 price than at the $4 price, as shoppers learn to stock up at the lower price. If the store sells the same total number of 12-packs at the lower price in three days as it does at the higher price in 27 days, the average price, weighted by sales, is $3.00—the price consumers pay, on average, hasn't changed.

How would this price dispersion affect our measures of output and productivity? Suppose 1 billion 12-packs of Diet Pop are made and sold each year. The first year it took 10,000 workers to produce and sell that much soda, and the second year it took 9000 workers, so that productivity rose 11 percent (from 100,000 12-packs per worker to 111,000). In both years, $3 billion is spent on Diet Pop. But the price inspectors, on average, report a price increase from $3 to $3.80 a 12-pack. Using this price information, it appears as if the second year's $3 billion expenditure on Diet Pop represents only 790 million 12-packs ($3 billion divided by $3.80 per 12-pack) even though consumers are buying as much as ever.[8] In this case, measured productivity will show a *fall* of about 11 percent, that is, a decrease from 100,000 12-packs per worker to 89,000 (= 790 million divided by 9000 workers), instead of a rise of 11 percent.

To tell whether our official measures have been significantly affected in this way, we need to check what alternative methods tell us about prices being paid. One possibility is supermarket tape data. These data show how much the stores surveyed sold of each product and the prices at which each was sold. Another possibility is to compare wholesale prices, the prices supermarkets pay. These prices may be less subject to the price dispersion that occurs at the retail level.

[8]Broadly speaking, within the U.S. federal statistical system, the Bureau of Labor Statistics, part of the Department of Labor, collects price data while nominal expenditure data are collected by the Department of Commerce. The Department of Commerce's Bureau of Economic Analysis is responsible for constructing measures of real output for the national income accounts, for the most part deflating the nominal expenditure data by the Bureau of Labor Statistics' price indexes.

EVIDENCE OF FOOD-PRICE MISMEASUREMENT

Recent studies by two U.S. government economists suggest that food-price inflation in the U.S. CPI has been overstated between 1.5 and 2 percentage points a year.

Marshall Reinsdorf's 1993 study compared the CPI for food with an alternative food-price measure, the series on average food prices, also compiled by the Bureau of Labor Statistics.[9] This average price (AP) series does not differentiate as the CPI does between generics and brand names and between types of stores. In particular, if consumers switch from full-price stores to discount outlets, or from name brands to house brands or generic products, this switch will show up in the AP as a decline in average price but will not affect the comparable CPI series.

The AP series is what economists have collected historically and, except for a break from 1978 to 1980, is available going back to 1890 for nine foods. Before 1978, the CPI series and the AP series showed no systematic tendency to diverge. Reinsdorf showed that from 1980 to 1990, these series for comparable products diverge by roughly 2 percentage points a year, with the CPI series rising faster than the AP series. And the same divergence continued through 1995 (Nakamura, 1998).

The advantage of the CPI method is supposed to be that the items for which it collects prices and the outlets where they are sold are held fixed. But if consumers change where they shop or what they buy, the CPI can give a misleading impression of what is happening to the prices they pay. If quality is rising (as the apparent improvement in freshness, availability, and variety of fresh fruits and vegetables would suggest), average prices should be rising more rapidly than the CPI. After all, if quality is rising and consumers are, on average, shifting toward better goods that are costlier to produce, this should cause the average price across all goods to rise faster than the price of a typical good of fixed quality. Instead, the opposite is happening: the CPI reports that prices of fixed-quality goods are rising faster, a contradiction that suggests that the CPI is gravely overstating inflation.

In Reinsdorf's studies, 16 of the 52 food items covered by the average price series are fresh fruits and vegetables. The evidence indicates that much of the discrepancy, at least for fresh fruits and vegetables, is caused by problems associated with price variability and price dispersion. Fresh fruits and vegetables are seasonal products, and their prices rise and fall dramatically from month to month, if the item is available at all. Moreover, their perishability can cause prices to vary dramatically across stores. The formulas that the BLS introduced in 1978 were apparently very vulnerable to these fluctuations and provided upwardly biased measures because of them. But the problems are not confined to fresh fruits and vegetables.

James MacDonald, an economist with the Department of Agriculture, showed similar discrepancies for nonperishable food products in a 1995 study that compared CPI data with supermarket checkout (scanner) data for 1989-94. MacDonald used A.C. Nielsen Company data that report the quantity sold nationwide in a given month for a particular item, as well as the total dollar sales for the item. The advantage of Nielsen data is that they report the quantities sold at different prices, while the BLS's price inspectors report only the particular price they observe, not the amount sold at that price.

MacDonald did two analyses. The first used data from 1988-91 for those items for which the BLS product categories and the A.C. Nielsen product categories closely corresponded. For each of these 14 groups, the CPI inflation measures were consistently higher; the average gap

[9]The CPI for food discussed here is the index for "food-at-home," which excludes "food-away-from-home," that is, restaurants.

was 1.4 percentage points a year. The second comparison used a wider array of classes of nonperishable products, comparing annual price changes for the leading brand in each of 323 product classes between April 1988 and April 1993 with the BLS price indexes for these product classes. The CPI for these products grew at an annual rate of 3.7 percent per year, compared with 1.9 percent for the Nielsen items—the CPI showed an upward bias of 1.8 percentage points a year. This finding shows that the bias is not confined to seasonal products.

In another study, Reinsdorf (1994) noted that the CPI for food could be compared to the BLS's Producer Price Index (PPI) for the same category (called consumer foods).[10] In this comparison, it again appears that although before 1978 the CPI and the PPI for food showed no systematic tendency to diverge, after 1978 the CPI for food has grown nearly 1.5 percentage points a year faster.

OUTPUT MEASUREMENT

An important use of price data is to permit us to compare real expenditures over time: real expenditures are said to rise if the dollars spent rise faster than the prices of the items purchased. If the CPI is upwardly biased in measuring food inflation, using it to deflate nominal expenditures on food will produce underestimates of growth in real expenditures. One test of the accuracy of the CPI is to compare nominal measures deflated using the CPI with direct measures of quantity. If CPI-deflated output grows more slowly than a pure measure of quantity, we have strong evidence that the CPI is biased.[11]

The U.S. Department of Agriculture computes implicit quantities of U.S. food consumption by weight by adding up U.S. production, imports from abroad, and carryover inventory from the previous year, and subtracting exports, processing and nonfood uses, and final end-of-year inventory. These measures are called disappearance estimates. Over the period 1978 to 1988, disappearance data imply that per capita consumption of fresh fruits and vegetables measured in pounds rose 25 percent, or 2.3 percent a year (MacDonald). But deflating U.S. domestic expenditures on fresh fruits and vegetables by the CPI measures for these categories implies that consumption of fresh vegetables *declined* 1.2 percent a year and consumption of fresh fruits declined 0.2 percent a year. Thus, when compared with measures based on disappearance data, the CPI-based measures underestimate growth in consumption of fresh fruits and vegetables by over 2 percent a year. This discrepancy is a strong argument that the CPI overstated food-price inflation during this period.

Another way to measure output is to ask, what is the contribution of different actors along the distribution chain? Consumption is, after all, the result of the net contributions of farms, factories, wholesalers, truck drivers, and retailers in adding value to the product until the consumer can purchase it. To measure the net value-added of food retailers, we can measure the real output of farms, factories, and wholesalers in producing goods that food retailers buy and subtract that contribution from the real sales of the food retailers. But our official statistics, again, give a distorted view.

Deflating food-store sales for 1992 by the CPI for food gives a measure of the real value of food products and retail services delivered to

[10]The Consumer Price Index measures prices paid by urban consumers to retailers, while the Producer Price Index measures prices received by producers (such as farmers or manufacturers).

[11]This assumes that the quality of a unit of output was constant or increased over the period, which seems reasonable.

consumers. Similarly, using the PPI for consumer foods to deflate food stores'1992 purchases of goods gives a measure of the real value of products that farms and manufacturers delivered to food stores. The difference between these two measures should be real retail services added by the food stores: the economic contribution of supermarkets as implied by our official statistics (Table 3). What we see is that, since 1977, the purchased input of supermarkets in real terms has risen 1.3 percent a year faster than the supermarkets' sales.[12] In effect, the statistics argue that supermarkets are decreasing their contribution to real output, using more inputs and somehow wasting much of the increase. When we use this so-called double-deflation methodology to estimate the real contribution of supermarket output, we find that food-store output has been declining at an annual rate of 7.7 percent.[13] This seems unreasonable. As I have shown, the services provided by food stores have been increasing along a variety of dimensions. In other words, our CPI statistics overstated inflation and understated output growth in this industry.[14]

The empirical studies we have been discussing provide further evidence that the CPI mismeasured food-price inflation after 1978. Moreover, Reinsdorf (1994) showed that the average price and PPI data are consistent with the CPI data until 1978. Did the revision to the BLS's methodology for the CPI in 1978 — done to correct upward biases — actually exacerbate them? We now turn to this crucial revision.

BLS PRICE MEASURES

The statisticians at the BLS are using a sta-

[12]The CPI revision was phased in beginning at the end of 1977.

[13]The "double-deflation" method deflates the revenues of food stores by the CPI to obtain the total real output received by consumers. It then uses the PPI to deflate the total input received by the food stores from producers to obtain a measure of the total real input of the producers. The difference is the implied real value-added by the retailer. Without going into all the details of the calculations, when revenues are deflated at a faster rate than costs, as here, the difference declines at a very fast rate.

[14]Another possibility is that the PPI for consumer foods understates inflation. But the other evidence I have presented suggests the CPI is at fault. In either case, mismeasurement is occurring — and has worsened since the late 1970s.

TABLE 3

The CPI Implies Unrealistic Declines in Services Provided By Food Stores

	PPI, Consumer Foods	CPI, Food-at-Home	Real Sales of Food Stores	Real Wholesale Purchases of Goods for Resale by Food Stores	Double-Deflation Output
1977-92	3.5 %	4.9 %	0.9 %	2.2 %	-7.7 %

Source: *Economic Report of the President*, 1997; BLS, *Productivity Measures for Selected Industries and Government Services*, July 1996, Bulletin 2480; and author's calculations.

tistical framework constructed during an earlier period, when prices were far less flexible than they are now. Ironically, recommendations–made in 1960 and finally implemented in 1978—to improve the price statistics appear to have backfired.

The Pre-1978 CPI Method and the Quality Issue. Until 1978, BLS price inspectors around the country priced products specified by BLS headquarters in Washington. For example, all inspectors would be asked to price "whole milk, in glass bottles, quarts, delivered" or "bacon, hand sliced, best quality." These pricing categories were necessarily broad, as price inspectors had to be able to find the product in each of the dozens of urban markets they covered. Even so, items within the categories were often hard to find. Indeed, by 1978, home-delivered milk and hand-sliced bacon had both long ceased to be dominant retail items. As a result, price inspectors might have found themselves forced to price a commodity that had become unimportant in total sales and whose price movements had become idiosyncratic.

The breadth of the category definitions meant that improvements in quality might occur without being picked up. One obvious example is the pasteurization of milk in the early part of the 20th century. Another is the improvements in cars that took place in the 1950s. If a new model Chevrolet came standard with a more powerful engine and larger seating capacity or, less obviously, a superior braking system or smoother clutch, was the price increase associated with the introduction entirely inflation—or should some of it be counted as quality improvement?

A government-mandated review of the statistics in 1960 recommended that the quality problem be partially solved by focusing on narrower product definitions, developed locally by price inspectors, and by systematically replacing products to update the sample. This recommendation was implemented in 1978.

The 1978 CPI Revision. Under the revisions, price inspectors were empowered to determine which products they would track. The price inspectors were given broad product categories, such as flour and prepared flour mixes, and a store location based on a nationwide survey called the Consumer Point of Purchase Survey. For example, the inspector might be told to collect prices at the Price Chain supermarket at the corner of Broad and Vine in Philadelphia. Then the price inspector, with the help of store personnel, would choose several popular items within the product category and, using scientific sampling, pick one, say, Grandma Nakamura's chocolate fudge cake mix. Each month for the next five years, the price inspector would record the price of that particular item at that particular store (unless the store stopped carrying that item or closed). This procedure improved the odds that the quality of the good being priced was indeed unchanged. This solution, which was widely discussed and approved in the 1970s when it was introduced, does not appear to have worked well in practice, partly because of price dispersion.

Prices have diverged into (a) the brand name's "list" or full price at the traditional supermarket; (b) the "sale" price of the brand name; (c) the price of the generic equivalent or alternative "discount" brands; and (d) the price at the discount superstore. The highest of these prices is the first, and the gaps have widened over time, but the narrow product definitions focus on the first price. To the extent that sales have shifted away from the brand name at full price at the traditional supermarket, the CPI inflation rate is going to be biased upward relative to the average price consumers pay.

Every five years, the Consumer Point of Purchase Survey data are used to refresh the sample and new product-store combinations are substituted. This substitution assumes that the old good at the old location and the new one at the new location offer the same quality per dollar, so that any difference in price between them does not represent inflation. In fact, the new

product-store combination may have replaced the old precisely because it offered superior value, but this added value is ignored. If the old good was a particular brand and size of toothpaste sold at $3, and the new good was precisely the same brand and size but sold at $2 at the new, more efficient outlet that replaced the old outlet, none of the decline in price is recorded. The CPI treats the decline in price as a decline in quality–the lower price is taken to mean that the inconvenience of buying the toothpaste at the new store costs the consumer $1 per purchase.[15]

The Bureau of Labor Statistics Continues to Revise Its Methodology. The BLS has identified and acted on one problem caused by price dispersion, so-called formula bias. Suppose, when the sample is refreshed, the new product chosen is Diet Pop at each of two similar supermarkets. At one store, Diet Pop is on sale at a discount when the survey is taken: $2 a 12-pack. At the other, Diet Pop is offered at the regular price: $4 a 12-pack. At each store, let us say, the priced item represents a beverage category that has $200,000 in annual sales. The store with the discounted price apparently sells 100,000 12-packs, while the store with the nondiscounted price apparently sells only 50,000 12-packs; the result is that Diet Pop at the store that is temporarily discounting it is given a greater weight in calculating the Consumer Price Index. This procedure would be sensible if these were permanent price differences between the two stores, reflecting higher costs at one location.

But suppose there is no real difference between the two stores. Next month, Diet Pop at the first store reverts to the regular price while the second store discounts it. In calculating the inflation rate of Diet Pop, the store that had the lower price when the weights were determined is given more weight. So instead of the two changes canceling out, the net effect is an increase in inflation. This is formula bias, and it results from the fact that price differences need not reflect cost differences and may reflect price dispersion instead.

In January 1995, the Bureau of Labor Statistics revised its methods for introducing products into the CPI for food with a technique called seasoning. The idea behind seasoning is to construct the quantity weights for a newly introduced or substituted product using a price that is months old. This sharply reduces the chance that a good with an unusually low current price is given too high a weight. This change corrects much of the problem for fresh fruits and vegetables and has reduced the upward bias in the CPI for food by roughly one-half of a percentage point, leaving about 1 to 1.5 percentage points of upward bias.

How do we know that food-price mismeasurement continues? An important clue comes from the use of the CPI to deflate U.S. personal consumption expenditures for food. According to the Bureau of Economic Analysis, the real consumption of food (including at restaurants) remained almost unchanged between 1994, when real food consumption was $688 billion, to the third quarter of 1997, when it was $689 billion. It is extremely unlikely that, with population growing and income and employment rising, Americans were not increasing their total food consumption at all. This is strong evidence that the CPI for food is still significantly overestimating food-price inflation.

CONCLUSION

The new technology of retailing has decreased firms' cost of changing their prices. As a result, price dispersion has increasingly become the norm for products—the price paid for a product varies across stores, brands, days of

[15]Moulton (1996) argues that the bias resulting from shifts to "warehouse" stores is small, since, as pointed out above, the share of purchases at such stores has increased only 10 percentage points. But the shift to superstores has also resulted in bias, and purchases at these stores have increased 35 percentage points.

the week, and customers. One consequence of this change has been that measuring the price paid for a product has become increasingly difficult.

Alternative data sources are available for checking the validity of CPI price measures. But the chronically underfunded U.S. statistical agencies are, by and large, limited to using a single, imperfect methodology for price measurement. This methodology led to dramatic overstatement of food-price inflation during a period in which inflation was public enemy number one. Although steps have been taken to improve the accuracy of the Consumer Price Index, and more are in progress, the continuing rapid changes in retailing technology—including the Internet—suggest that U.S. statistics will continue to lag behind the marketplace.

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