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7 The Effect of Outlet Price Differentials on the U.S. Consumer Price Index

Marshall Reinsdorf

A major trend in the twentieth-century marketplace has been the replacement of small independent "mom-and-pop"-style retailers with large retail establishments owned by chains. Since prices at the large cash-and-carry self-service stores were often much lower than prices at the small independent stores that they supplanted, Denison (1962, 162) suggested that, over the long term, the "revolutionary changes in establishment type that have taken place in retail trade" may have caused a substantial upward bias in the U.S. consumer price index (CPI). Key in Denison's argument was an analysis of the effect of the Bureau of Labor Statistics (BLS) linking procedure for incorporating new stores into CPI outlet samples.

The present paper examines whether there exists a systematic tendency that is not reflected in the CPI for consumers to shift their retailer patronage patterns in ways that reduce the average prices they pay and hence their cost of living. Oi (1990, 15) documents the postwar trends away from higher-priced small independent food retailers, calculating, for example, that, between 1940 and 1980, the number of households per food store rose from 78 to 481 while the chains' share of food sales grew from 35.2 to 46.7 percent. Moreover, the effect of retail industry evolution on the CPI is not a matter of solely historical interest: trends of market share gains by lower-priced retail industry segments are continuing. The April 1989 *Progressive Grocer* annual report on the industry shows that the trends identified by Oi persisted up to 1988, as

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food stores went on declining in numbers and growing in average size while the chains increased their market share to almost 50 percent. Furthermore, both low-priced economy format food stores and very large "extended format" food stores experienced such rapid growth between 1979 and 1988 that their combined market share grew from about 31 percent to about 50 percent of the industry. Equally noteworthy is the rise in off-price food sales by wholesale clubs, general merchandise discounters, and drug stores. When in February of 1988 *Grocery Marketing* decided to begin including wholesale clubs in its annual industry profile "Who's Who in the Grocery Marketplace," the Price Club, founded in 1976, had a 1987 national food market share rank of eighteenth, and Sam's Wholesale Clubs had a rank of twenty-sixth despite having existed for fewer than five years.[1] Finally, even within the class of traditional, full-service supermarkets, the phenomenal gains of the low-priced chain Food Lion, whose market share rank climbed from forty-second in 1980 to thirteenth in 1987 (see *Grocery Marketing*, February 1988; and Business Guides 1980), suggest that stores pursuing low-price strategies may collectively be capturing an increased market share.

Gains by lower-priced retailers at the expense of traditional vendors are not limited to food retailing. In general merchandise retailing, Wal-Mart, which generally offers much lower prices than the small town independent retailers it has often replaced, has now supplanted Sears as America's largest retailer. Off-price "mill outlet" retail centers such as Potomac Mills near Washington, D.C., and budget-priced home furnishings sellers such as Ikea are also capturing business from higher-priced competitors. In some cases, the ascendance of price-oriented discounters at the retail level has purportedly even led to pressure on manufacturers' prices. For example, in a 30 July 1990 article on Briggs and Stratton entitled "Discount Trend's Ripple Effect," the *New York Times* reports, "Because of a fundamental change in American retailing—the move by consumers away from full-line, full-price department stores and neighborhood merchants to discount specialty stores and discount mass merchants—lawn mower prices have been falling steadily in recent years. Those price declines have greatly benefited shoppers around the country but have dragged [Briggs and Stratton's] profits down with them."

The empirical results reported in the present paper suggest that the bias in the food and gasoline components of the CPI arising from changes in consumers' patronage patterns could potentially have been large during the 1980s. For food at home, one method of determining an upper bound for outlet substitution bias yields an astoundingly large estimate of 2 percent per year. For unleaded gasoline, that method gives an upper bound estimate of nearly 1

1. About 35 percent of the sales of the wholesale clubs are to consumers (*Wall Street Journal*, 7 November 1990). Therefore, even though their overall market share overstates their importance for the consumer population whose costs are tracked by the CPI, the wholesale clubs are still important enough to influence the average prices that consumers pay for food and other merchandise significantly.

percent per year, although, if the reduction in the average price paid attributable to the shift to self-service is not counted, the estimate falls to about 0.5 percent per year. A second estimator gives more moderate values of 0.25 percent per year for both food and gasoline.

7.1 Consumers' Seller Substitution Behavior

A prerequisite for consumer benefits from cost-reducing seller substitution to exist and yet not be reflected in the CPI is the presence of persistent price dispersion in retail markets. If on the entry of a low-priced competitor into a retail marketplace the other sellers' prices decline sufficiently to match the entrant's prices after a "quality" adjustment for any differences in the value of the retailer's services, convenience, or ambience,[2] then an index that tracks only incumbents' price changes will remain unbiased. Such complete price matching may occur rarely, however. As Denison observes, similar products may simultaneously be sold by high-priced and low-priced retailers because time lags are required for market disequilibria to resolve themselves rather than because their quality-adjusted prices are identical. Indeed, the pattern of consistent gains in market share by retailers with lower-priced formats is evidence that they offer consumers superior value. In addition, the academic literature on the role of costly information in consumer markets indicates that price dispersion in a market need not be a very short-term phenomenon. Stigler (1961), who reports sizable price variation in samples of Chevrolet and coal dealers, argues that price dispersion is generally present in retail markets because information is not costless for consumers. Pratt, Wise, and Zeckhauser (1979) and Carlson and Pescatrice (1980) find substantial price dispersion for larger samples of consumer products. Successful tests of costly information models of retail price dispersion by Marvel (1976), Dahlby and West (1986), and Van Hoomissen (1988) furnish empirical evidence that outlet price differentials are at least partly real rather than merely reflective of differences in quality.

The entry of lower-priced outlets is not the only possible source of shifts in consumers' patronage toward outlets whose prices are lower. Consumer search theory implies that consumers may substitute outlets in response to changes in the distribution of the prices offered by incumbents or even—as Anglin and Baye (1987) observe—in response to changes in their own search costs.[3] Nevertheless, change in the composition of retailing industries is the

2. In the price index literature, any attribute of an item that affects its value to consumers is regarded as a component of the item's "quality." Outlets may offer a number of services and features in conjunction with the goods they sell that are valued by consumers. Erlich and Fisher (1982) emphasize the provision of information, while Betancourt and Gautschi (1988) also discuss convenience of location, depth and breadth of product assortment, guarantee of product delivery, and appealing ambience.

3. In the case of an increase in search costs, outlet substitution will, of course, increase the average price paid. However, in equilibrium, sellers' responses to changes in consumers' search

most important reason for concern about the effects of outlet substitution by consumers because such change may be associated with substantive long-run bias in the CPI.

Closely related to outlet substitution are brand and variety substitution by searching consumers. Variety substitution occurs because even a given brand of a given good may come in more than one size, style of packaging, or potency. In addition, changes between different variations of a product, such as switching from an XT-type personal computer to an AT or from a conventional tape player to one with digital technology, may be considered variety substitutions. Because the brands or varieties of a good are near-perfect substitutes, only one of them will generally be purchased by a consumer on a given occasion. Thus, brand or variety substitution may be treated as a result of a search process just as outlet choice is. Furthermore, many of the results of outlet substitution are equally applicable to brand substitution. Consumers may realize cost savings through the substitution of brands or manufacturers just as they may from outlet substitution, and manufacturers may gain market share through offering a lower quality-adjusted price than competitors just as outlets may; consider, for example, the gains of generic products in ethical drug markets. Moreover, in the U.S. CPI, the rotation of outlets and of brands and varieties is generally simultaneous because, when a new sample of outlets is drawn, a new sample of brands and varieties is drawn as well.

Since the focus of the present paper is outlet substitution, in the discussion that follows it will be convenient to refer only to outlet substitution even though often the comments could also apply to brand and variety substitution. It should be noted, however, that, despite the many analogies that exist between outlet and brand/variety substitution, two important differences exist between these phenomena in the CPI. First, in certain cases, there is more scope for very large gains in quality in the case of new varieties; examples are important product innovations from the fields of electronics and medicine. Second, when a product variety is dropped by a retailer or modified by its manufacturer, it is sometimes possible to adjust the price of the variety substituted for it in the CPI sample for quality differences using data on its characteristics. In contrast, when one outlet replaces another in the CPI sample, overlap price linking is always employed.

7.2 BLS Outlet Sampling and Linking Procedures

In order to see how the systematic displacement of high-priced outlets (and brands) by low-priced ones of equal quality would bias the CPI upward, it is

costs will largely neutralize any effect of such changes on market shares. For example, simulations of the effect of search cost changes in a modified version of the Carlson and McAffee (1983) equilibrium price dispersion model in Reinsdorf (1988) show that outlets adjust their prices so that their market shares are approximately preserved.

necessary to understand BLS outlet sampling and linking procedures. Pricing the same varieties at the same outlets over time would be most consistent with the Laspeyres fixed-weight philosophy of the CPI, but it is not feasible. As outlets and varieties disappear, the sample size would become inadequate, while the evolution of consumer patronage patterns would make such a sample increasingly unrepresentative for tracking changes in consumers' cost of living. Consequently, BLS continuously refreshes its CPI outlets samples, with about one-fifth of U.S. cities undergoing sample rotation in any year. The outlet sampling frame comes from the Continuing Point of Purchase Survey (CPOPS), with an outlet's probability of selection usually proportional to its share of consumers' expenditures for the good in question. Once an outlet has been selected to furnish prices for a good, each brand and variety sold by the outlet has a probability of selection proportional to its sales.[4] This procedure yields current, representative outlet and variety samples that provide unbiased estimates of the average price that consumers pay for an item at the time they are drawn. Nevertheless, just as when varieties are substituted, incorrect treatment of outlet quality differentials when the outlet sample changes could bias the CPI.

When an outlet disappears from a CPI sample in month t, the average price of the item in month $t - 1$ is recalculated without that outlet's price quote. Then, when the item's average price in month t is compared to its average price in month $t - 1$ in calculating the CPI, identical sets of outlets and unique items will be represented in both months. Similarly, when CPI outlet samples are rotated, collection of prices from both the new and the old sample of outlets in the month before the new outlet sample prices are first used in the index allows a comparison over time of identical sets of outlets and items. In the overlap pricing month, the average price change in the old sample of outlets is used to move the index, while, in the following month, only comparisons of prices from the new outlet sample to their former values enter the index. Thus, when one outlet replaces another in the CPI sample, an implicit adjustment for a change in quality occurs based on the percentage difference between prices at the two outlets in the overlap pricing month. For example, if in that month the newly sampled outlet charges $0.80 for at item sold for $1.00 at the outlet that it is to replace, dividing the prices from the new outlet by 0.8 and then comparing them to prices from the old outlet will give the same values for the CPI that linking with overlap prices does. If the "law of one price" held so that all contemporaneous differences in prices in fact represent quality differentials, this would, of course, be correct. Even entry by lower-priced, more efficient competitors would not bias the CPI because prices at the incumbent outlets in the CPI sample would quickly fall to match those competitors' quality-adjusted prices.

4. Occasionally, merchants are unable to furnish sales data, and fall-back methods, which are discussed in the *BLS Handbook of Methods* (U.S. Department of Labor 1988, 162–66), are used.

Persistent price dispersion arising from costly information appears to be quite common in retail markets, however. Moreover, those outlets offering genuinely lower prices can be expected to increase their market shares over time, resulting in gains for consumers but the removal of interoutlet price differentials from the CPI means that these gains will not be counted.

Current BLS procedures may, of course, be the best feasible. Even if comparing only prices in successive months of identical brands and varieties from the same outlets leads to bias, this practice probably reduces the mean square error of the index by removing the variance caused by stochastic changes in quality. Moreover, when the average price level paid by consumers changes as a result of systematic outlet substitution, the average quality level of retailer services is also likely to change. Absent a method to control for such quality changes, simply letting the CPI reflect the outlet price differential when consumers substitute outlets could also result in bias.

7.3 The Theory of Outlet Substitution Bias in the CPI

Bias in a cost-of-living (COL) index from consumers' substitution of sellers is in many ways analogous to the textbook problem of bias arising in fixed-weighted COL indexes from consumers' commodity substitution. (Theoretical studies of commodity substitution bias date from Konus [1939]; for a textbook treatment, see Layard and Walters [1978].) Commodity substitution by utility-maximizing consumers responding to changing relative prices of goods leads to upward bias in a Laspeyres price index, such as the CPI, and to downward bias in a Paasche price index.[5] These biases arise because consumers decrease their relative consumption of those goods whose prices have risen fastest and increase their relative consumption of the goods whose relative prices have fallen. Commodity substitution bias in COL indexes has long attracted economists' attention, and careful empirical estimates of its magnitude exist for the United States.[6]

In order to develop a simple theory of outlet substitution bias in the CPI, assume that consumers search for low prices but do not engage in commodity substitution. Under this condition, the true COL index is a weighted average of price indexes for individual commodities, so we can focus on the bias in a price index for a single representative product. An additional simplification is to focus on a single representative consumer.[7] Under these assumptions, a

5. In a Laspeyres price index, reference or "base" period commodity quantities are used for evaluating both reference and comparison period prices, while, in a Paasche price index, comparison period quantities furnish the price weights.

6. Examples of such studies are Manser and McDonald (1988), Braithwait (1980), and Christensen and Manser (1976).

7. It is usual to discuss a single homogeneous group of consumers in deriving results in COL indexes from economic theory because difficult problems arise in aggregating across diverse consumers. In the present paper, this "representative consumer" approach is exemplified in the assumption that all consumers face the same price of search. Although the identical consumers

COL index that incorporates fixed reference period outlet weights and search costs will be greater than or equal to the true search-based COL index. This result corresponds to the familiar upward bias property of Laspeyres price indexes resulting from commodity substitution when relative prices of goods change.

Let the marginal cost of search at time t be c_t, and let the vector of prices offered by the n outlets in the market for the quantity of the good that consumers purchase be $\mathbf{p}_t$.[8] Denote the consumers' expected cost of acquiring the good under the optimal search strategy by $M(\mathbf{p}_t\, c_t)$, and denote the associated vector of probabilities of buying from each outlet by $\mathbf{w}_t = w^*(\mathbf{p}_t\, c_t)$. Finally, define a total cost of search function $C(\mathbf{w}_t^T\mathbf{p}_t, c_t)$ as c_t times the minimum expected number of searches necessary to achieve an expected price at least as low as $\mathbf{w}_t^T\mathbf{p}_t$. For example, if $\mathbf{w}_t^T\mathbf{p}_t$ is greater than or equal to the unconditional expected price $E(\mathbf{p}_t)$, then $C(\cdot)$ will equal c_t. If $\mathbf{w}_t^T\mathbf{p}_t$ equals the mean of the ν lowest prices—as it might if $\mathbf{w}_t$ reflects a reservation price strategy—then $C(\cdot)$ would equal $c_t n/\nu$.

The next step is to note that, since $\mathbf{w}_t$ emerges from an economically optimal search of the distribution of offered prices $\mathbf{p}_t$, for any different set of outlet selection probabilities $\hat{\mathbf{w}}$, $\hat{\mathbf{w}}^T\mathbf{p}_t + C(\hat{\mathbf{w}}^T\mathbf{p}_t, c_t) \geq M(\mathbf{p}_t c_t)$. But the reference period weighted index is

$$
\begin{aligned}
L(\mathbf{p}_t, \mathbf{w}_t\, c_t, \mathbf{p}_0, \mathbf{w}_0, c_0) &= \frac{\mathbf{w}_0^T\mathbf{p}_t + C(\mathbf{w}_0^T\mathbf{p}_t, c_t)}{M(\mathbf{p}_0, c_0)} \\
&\geq \frac{\mathbf{w}_t^T\mathbf{p}_t + C(\mathbf{w}_t^T\mathbf{p}_t, c_t)}{M(\mathbf{p}_0, c_0)} \qquad (1)\\
&= \frac{M(\mathbf{p}_t, c_t)}{M(\mathbf{p}_0, c_0)},
\end{aligned}
$$

where the last expression in (1) is the "true" COL index.

In the more general case of search for many substitutable goods, two sources of complication arise. First, as Anglin and Baye (1987) observe, substitution possibilities make the optimal reservation price in each market dependent on the outcome of search in other markets. Second, comparisons of "true" indexes of the expected cost of living with fixed commodity and outlet weight COL indexes will necessarily reflect both commodity substitution bias

assumption appears innocuous in the present context, for some problems this approach is not suitable. In particular, Reinganum (1979) finds that, if all consumers are identical, including having the same marginal search costs, sequential search strategies with no learning are consistent only with dispersed price equilibria in which no one chooses to search.

8. In one of the cases examined below, food markets, it is more realistic to think of consumers as searching for the store offering the lowest price for an entire market basket rather than the lowest price for a single good. In this case, the elements of $\mathbf{p}_t$ can be interpreted as the purchase price of the desired market basket at each of the n food outlets because, in the present analysis, every good is assumed to be purchased in a predetermined quantity.

and outlet substitution bias. The difference between a fixed-commodity-weight index and an index in which both commodity and outlet weights are fixed may be regarded as a pure measure of outlet substitution bias, however, and this approach has the advantage of avoiding the problem of reservation prices that are ex ante stochastic. Since a fixed-commodity-weight COL index can be expressed as a weighted average of individual commodities' relative prices (or, in the case of searching consumers, commodities' relative acquisition costs), it is straightforward to generalize equation (1) to show that, in the multiple good case, outlet substitution bias is also nonnegative.

It is worth noting that equation (1) implies that upward bias may occur in a fixed-outlet-weight price index even if the amount of price dispersion in the market is unchanged. The present inquiry into whether consumers reduce their cost of living in a way not measured by the CPI by substituting one outlet for another when outlets' comparative prices change thus concerns the indirect implication of price dispersion for the CPI. The direct effect of changes in the amount of price dispersion on consumers' cost of living is explored in Reinsdorf (1990), which finds that increases in price dispersion may cause a short-term upward bias in COL indexes employing fixed outlet weights.

7.3.1 Indexes That Exclude Costs of Search

Because measuring the costs of search itself is generally impossible, properties of a feasible search-based COL index covering only prices paid are of as much interest as those of a complete searcher's COL index. Generally, an index of searchers' prices paid will also be upwardly biased when fixed reference period outlet share weights are used, although, for certain changes in the distribution of offered prices, this need not be so. Manipulating equation (1) shows that

$$(2) \qquad \mathbf{w}_0^T\mathbf{p}_t - \mathbf{w}_t^T\mathbf{p}_t \geq C(\mathbf{w}_t, \mathbf{p}_t, c_t) - C(\mathbf{w}_0, \mathbf{p}_t, c_t).$$

As long as the effort devoted to search is nondecreasing over time, the fixed-outlet-weight index will rise faster than the average price paid by consumers. A decrease in the benefits and hence the quantity of search due to a drop in price dispersion in period t could, however, cause $\mathbf{w}_0^T\mathbf{p}_t/\mathbf{w}_0^T\mathbf{p}_0$ to be less than $\mathbf{w}_t^T\mathbf{p}_t/\mathbf{w}_0^T\mathbf{p}_0$. For example, if the highest-priced outlet lowers its price, reducing any fixed-weighted average of offered prices, its market share may increase by enough to cause the average price paid to *rise*. (This rise will, of course, be less than the decrease in average search expenses.) Yet a faster increase in the average price paid than in the average price that searching consumers would have paid had they not altered their outlet purchasing patterns is likely to occur rarely. When the offered price distribution changes enough to reduce consumers' desired amount of search significantly, outlets' price rankings will generally be altered. Such rearrangements of outlets' price rankings will almost certainly have a greater effect on searchers' outlet selection probabilities than any reductions in the amount of search. Consumer search will thus normally result in outlet substitutions that reduce consumers' average price paid along with their cost of living.

7.3.2 Effects of Outlet Entry and Exit

Consumer search theory implies that, among a set of continuously existing outlets, those whose comparative prices decline will capture increased proportions of consumers' purchases. Nevertheless, shifts of consumer patronage caused by searchers' responses to the evolution of price relations among a set of continuously existing outlets can cause relatively little long-term bias in the CPI because gaps between competitors' prices cannot grow indefinitely. Substantial long-term bias could, however, arise from a process of gradual but steady replacement of higher-priced retail establishments by lower-priced entrants. As was noted in the introduction, the revolutionary changes in the retailing industries created in part by declines in the real price of transportation, housing, refrigeration, and mass communication (see Oi [1990] and, for the effect of mass advertising, Steiner [(1973) 1976]) have evidently involved such a process. Moreover, the structure of many retail industries still seems to be evolving in favor of lower-priced outlets. Finally, consideration of economic theory implies that firms whose expected costs are lower than incumbents' are most likely to enter, while exit is most likely for the firms with higher than average costs. Given an association between high costs and high prices, this implies a tendency for low-priced retailers (as well as manufacturers) to replace high-priced ones in the marketplace.

7.4 Price Level Differences between Old and New POPS-Based Outlet Samples

The empirical evidence on price differentials between the outlets entering and those leaving CPI samples is discussed in this section and in section 7.5 below. The analysis is limited to two classes of goods, food and energy, because of data availability and price comparability considerations. If migration of consumer patronage to lower-priced outlets indeed occurs, it should be reflected in prices that are on average lower in newly sampled outlets. Moreover, a finding of such a pattern would be evidence that outlet substitution bias exists in the CPI: even though lower prices may often be associated with lower quality, systematic gains by lower-priced outlets should occur only if their price savings exceed the value of any retailer services or ambience that their customers must forgo.

Two approaches are possible for testing for the existence of outlet substitution bias in the CPI. The first is to compare price levels in outgoing and incoming CPI outlet samples, and the second—discussed in section 7.5 below—is to compare the evolution over time of unlinked sample average prices and their linked CPI component index counterparts.

Since outlets' probabilities of sample selection are proportional to the expenditures reported for them in the CPOPS, the new outlet samples will reflect the evolution of consumer outlet choices over the preceding five years. In particular, obsolescence of the CPOPS share estimates is probably negligible in the few months that elapse before BLS first collects prices from the outlet samples reflecting those estimates, so that mean prices in new samples of outlets provide unbiased estimates of the average prices paid by consumers. Consumer search behavior and entry by lower-priced outlets should thus result in lower prices on average in newly sampled outlets than in the ones they replace.

The qualification "on average" is important for three reasons. First, changes in the quality of the outlets or the brands and varieties priced will undoubtedly occur. In some cities, increases in average outlet or brand quality will be reflected in a higher price in the newly drawn sample. Second, even if outlets whose current prices are high have low market shares and low probabilities of sample selection, they will sometimes be selected instead of the high-probability, low-priced outlets. Although sampling according to size provides an unbiased estimate of the average price paid by consumers, the estimate for any particular city will have a high variance. Pooling across cities is probably necessary to get a reliable estimate of the bias in the CPI due to consumer outlet substitution behavior.

Third, for goods usually purchased close to home, a potential source of noise in the estimation of outlet substitution effects may be differences between the neighborhoods in a city selected for sampling in successive CPOPS waves. Since 1984, clustered sampling has been used for the CPOPS (U.S. Department of Labor 1988, 164). Furthermore, in some cases, definitions of sampling areas have changed to reflect their growth. In particular, in 1987, Norwalk was included in the New York/Connecticut suburbs sample area, while, in 1988, San Jose was added to the San Francisco area, and San Bernardino was added to the Los Angeles suburbs area.

Unfortunately, comparisons of old and new CPI outlets samples are not purely tests for the effects of consumer outlet substitution. New samples of item brands and varieties are necessarily drawn at the same time that new outlet samples are drawn, so, for many goods, effects of brand and variety substitution will also be reflected in sample comparisons. A simultaneous test for outlet and brand/variety substitution is itself of interest since consumer search among brands of an item is in many ways analogous to search among outlets selling an item. Rising incomes and the introduction of improved products could, however, lead to unmeasured growth in average brand or variety quality and an underestimate of the magnitude of outlet and brand substitution bias in the CPI.

7.4.1 Testing for Sample Differences in the Location of the Price Distribution

The form of an efficient estimator of the mean price level change between the old and the new CPI outlet samples is largely determined by the way the data are collected. When rotating CPI outlet samples, BLS field representatives visit each outlet in the new sample twice before the old sample is dropped. The first visit, which is primarily to choose the brands and varieties to be priced, occurs three to six months prior to the link month for the area in which the newly selected outlet is located. The first set of observations from a new sample of outlets is thus spread out over a period of three or four months.

These scattered observations can be utilized by deflating each new sample price quote by the mean price in the old sample for the corresponding good, size, and month. A geometric rather than an arithmetic mean of the old sample prices is used so that rates of change can be calculated by taking logarithms: logarithms of new sample prices that were deflated by arithmetic means would have a negative expected value even under the null hypothesis that prices come from the same distribution in both samples.[9] Separate means are utilized for deflating different sizes or size classes to control for this important dimension of variety quality because, even after expressing all prices on a par ounce basis, for most items size appeared to affect price.

Collection of data in two months while the old outlet sample is still being priced and collection of prices for more than one item in many outlets mean that the data sets contain multiple price quotes from each new sample outlet. For food, 3,106 quotes from 584 newly sampled outlets imply an average of 5.3 quotes per outlet, while, in the fuel data set, 516 quotes from 131 newly sampled outlets imply an average of 3.9 quotes per outlet. Since observations coming from the same outlet are unlikely to be independent, a simple mean of all the price changes in the data is not the minimum variance estimator of the mean price change between samples. Moreover, nonindependent data lead to a downward bias in the ordinary formula for the standard error of the mean.

The efficient estimator of the mean price change and a consistent estimator of its standard error are easily derived in an error components framework. Let the logarithm of the jth deflated price quote from the ith outlet in the new sample be $p_{ij} = \mu + u_i + v_{ij}$, where u_i and v_{ij} are independent outlet and quote-specific error components having constant variances, and where μ represents the mean logarithmic price change between outlet samples. Also, denote the number of observations from the ith outlet by N_i, and let there be I outlets. The variance of p_{ij} is $E(u_i^2) + E(v_{ij}^2) \equiv \sigma_u^2 + \sigma_v^2$, but the variance of $\bar{p}_i \equiv \Sigma_{j=1}^{N_i} p_{ij}/N_i$ equals $\sigma_u^2 + \sigma_v^2/N_i$. If σ_u^2 is positive because outlet effects are present, then the ordinary mean of the deflated new sample prices is an inefficient estimator of μ because it equals a weighted mean of the $\bar{p}_i$ in which the weights are N_i/N, where $N \equiv \Sigma_{i=1}^{I} N_i$. The efficient weight for any $\bar{p}_i$ is inversely proportional to its variance. Define w_i as $1/\text{var}(\bar{p}_i)$. Then

9. Taking logarithms of the relative prices has two benefits. First, the logarithmic variable has a convenient interpretation as the percentage change in price levels between old and new samples. Second, price distributions tend to be right skewed, and, indeed, in the present study, the skewedness of the price logarithms was much closer to zero than was that of the prices themselves. The transformed data were thus less likely to suffer from heteroskedasticity and were more suitable for hypothesis testing using Student's t-distribution.

(3) $$w_i = N_i/(N_i\sigma_u^2 + \sigma_v^2).$$

The minimum variance estimator of μ is

(4) $$\hat{\mu} = \frac{\sum_{i=1}^{I} w_i \bar{p}_i}{\sum_{i=1}^{I} w_i}.$$

The variance of this estimator is simply

(5) $$\text{var}(\hat{\mu}) = \frac{1}{\sum_{i=1}^{I} w_i}.$$

It is, of course, necessary to have values for σ_v^2 and σ_u^2 in order to utilize these estimators. Values of σ_v^2 and σ_u^2 can be estimated on the basis of the separate means for each outlet. The variance of p_{ij} remaining after outlet effects are removed provides an estimate for σ_v^2, an approach known as Henderson's (1953) Method 3 in the statistics literature. That is,

(6) $$\hat{\sigma}_v^2 = \sum_{i=1}^{I} \sum_{j=1}^{N_i} (p_{ij} - \bar{p}_i)^2/(N - I).$$

The "total sum of squares" (TSS) is $\Sigma_i \Sigma_j (p_{ij} - \bar{p})^2$. Its expected value is

(7) $$\begin{aligned} E\,(\text{TSS}) &\equiv E\left[\sum_{i=1}^{I} \sum_{j=1}^{N_i} (p_{ij} - \bar{p}^2\right] \\ &= \sigma_u^2[N - (\Sigma_i N_i^2/N)] + \sigma_v^2(N - 1). \end{aligned}$$

Therefore, σ_u^2 can be estimated as

(8) $$\hat{\sigma}_u^2 = [\text{TSS} - \hat{\sigma}_v^2(N - 1)]/[N - (\Sigma_i N_i^2/N)].$$

Note that (8) can be interpreted as dividing the portion of the total variance of p_{ij} attributable to u_i by the appropriate degrees of freedom. Substituting $\hat{\sigma}_u^2$ and $\hat{\sigma}_v^2$ for σ_u^2 and σ_v^2 in equations (4) and (5) results in the "feasible generalized least squares" estimator of the mean effect on collected prices of rotating outlet samples and its standard error.

7.4.2 Empirical Results on the Effect of Sample Rotation on Price Levels

Estimates of the price level differences in old and new outlet samples in cities undergoing CPOPS outlet rotation are presented in tables 7.1 and 7.2. The food and gasoline items used are described in the appendix. The time periods included in the analysis are all twelve months of 1987 and July 1988–June 1989. Clearly, much longer periods would have been desirable in order to study the long-run effects of structural change in the retailing industry. Unfortunately, because CPI data are not collected for research purposes, archival files are accessible only with great difficulty, and data collected before 1987 are inaccessible.

The new food outlets' mean rates of change from old outlet sample price levels appear in table 7.1. Pooling all food products in all cities results in an estimate of −1.23 percent for μ, the mean price level change when outlet

Table 7.1 Effect of CPI Outlet Sample Rotation on Food Price Levels, 1987–89[a]

Area	Mean % Change[b]	t-Statistic[c]	Median % Change[d]	No. of Outlets	No. of Quotes
All areas pooled	−1.23	−1.89**	−.99	584	3,106
Boston	−4.83	−1.72**	−4.47	48	265
Buffalo	4.56	2.29***	2.09	22	129
Cleveland	−0.15	0.01	−1.95	42	133
Denver	1.60	0.48	0.02	24	132
Ft. Dodge	−0.34	−0.10	−0.93	7	191
Honolulu	−4.41	−1.35*	−4.22	21	137
Los Angeles suburbs	−1.50	−0.69	−0.76	62	213
Miami	−4.99	−1.96**	1.44	31	109
Milwaukee	2.03	0.51	3.04	20	70
Minneapolis	−2.14	−0.55	−0.09	21	141
New York and Conn. suburbs	−3.71	−2.53***	−3.81	79	519
Philadelphia	−0.77	−0.51	−0.87	84	505
Raleigh	−2.63	−0.89	−4.02	23	98
San Francisco	3.96	2.06***	0.65	61	204
Seattle	−2.47	−0.70	0.96	16	127
Tampa	3.30	1.29	2.62	23	133

[a]Effect variable is log $(P_i^N/\bar{P}^O)$, where P_i^N is the ith new sample price quote for a particular size of a particular item, and $\bar{P}^O$ is calculated as a geometric mean of the obsolete outlet sample price quotes for the item and size that it is to deflate.

[b]Each outlet mean observation is weighted by its inverse variance.

[c]One asterisk denotes significance at the 10 percent level in a one-tailed test, two asterisks denote significance at the 5 percent level in a one-tailed test, and three asterisks denote significance at the 1 percent level in a one-tailed test.

[d]Computed using SAS default definition (see *SAS User's Guide: Basics*, Version 5 ed., p. 1187).

samples are rotated. If the average quality of the outlets and varieties is comparable in the new and five-year-old samples, this estimate implies an upward bias due to outlet substitution in the food at home component of the CPI of 0.25 percent per year. This figure is slightly larger than Manser and McDonald's (1988) point estimate of 0.18 percent per year for the average commodity substitution bias in a Laspeyres price index for U.S. consumers, but it may possibly overstate the true outlet substitution bias because average quality in the new samples may have declined along with average prices. After correcting as described above for the effects of nonindependence of repeated observations from the same outlet, the t-statistic for the pooled mean is -1.9. The null hypothesis that price levels at newly sampled outlets are no lower than in outlets chosen five years before is thus rejected at the 5 percent level in a one-tailed test.

Use of the efficient estimator given by (4) instead of the ordinary unweighted mean has only a small effect on the point estimate of the effect of

Table 7.2 Effect of CPI Outlet Sample Rotation on Motor Fuel Price Levels, 1987–89[a]

Area	Mean % Change[b]	t-Statistic[c]	Median % Change[d]	No. of Outlets	No. of Quotes
All areas pooled	−1.29	−1.59*	−3.19	131	516
Boston	0.78	0.44	0.02	19	93
Buffalo	10.23	4.77**	12.24	3	18
Cleveland	−3.88	−1.24	−6.96	18	54
Denver	−0.79	−2.08*	−0.44	4	16
Ft. Dodge	−1.89	−0.94	−0.26	4	20
Honolulu	3.50	0.89	6.71	4	18
Los Angeles suburbs	−7.91	−3.43***	−9.51	10	33
Miami	−3.71	−2.28***	−4.10	21	47
Milwaukee	1.84	0.31	−3.52	3	8
Minneapolis	−7.84	−2.95**	−6.15	3	14
New York and Conn. suburbs	4.53	1.05	4.90	8	44
Philadelphia	−0.92	−0.45	−3.19	15	80
Raleigh	−2.65	−1.29	−0.98	5	15
San Francisco	2.41	0.37	−5.01	7	20
Seattle	−1.92	−4.45*	−0.44	3	18
Tampa	0.06	0.02	0.86	4	18

[a]See table 7.1, n. a.
[b]See table 7.1, n. b.
[c]See table 7.1, n. c.
[d]See table 7.1, n. d.

outlet rotation on price levels. In particular, for the pooled cities, the unweighted mean price change is −1.32 percent. In contrast, correcting for the correlation of observations from the same outlet does have a major effect on the estimated t-statistics: the ordinary formula would have implied a t-statistic of −3.0 for the pooled mean.

The median difference between food outlet price averages is −1 percent. The median is, of course, a less efficient statistic than the mean, both because it does not take magnitudes of observations into account and because it treats all outlet observations identically regardless of how many quotes they average.

Table 7.2 reports mean percentage differences between price levels in new and old samples of outlets for motor fuel. The items included are various grades of gasoline and diesel fuel. The pooled estimate for the mean outlet price difference between samples is −1.29 percent, which also implies an upper-bound estimate for CPI outlet substitution bias of about 0.25 percent per year. Yet, despite the similarity of this estimate to the food result, its t-statistic of −1.6 does not quite attain the −1.645 cutoff for significance at the 5 percent level in a one-tailed test. The lower t-statistic for motor fuel is evidently a result of a much smaller sample size: the standard deviation of fuel outlet price differences was actually lower than the standard deviation of food outlet differences. Yet, even for fuel, sizable variation in deflated new outlet price levels is indicated by the dispersion of the individual city means. This is not surprising given that outlets with a small market share are nevertheless likely to be selected for the CPI samples in at least a few cases. In addition, there may be noise due to variations in outlet, brand, and neighborhood quality, as discussed above. Large samples of outlets are evidently necessary to achieve highly significant results because of the modest magnitude of the outlet substitution bias effect and the large variation in prices between outlets and brands and varieties that cannot be explained or is due to unmeasured random changes in quality.

7.5 Inflation Rate Differences between BLS Average Price Series and CPI Components

The second way of testing whether a potential exists for outlet substitution bias in the CPI is to compare the growth of the average price (AP) series published by BLS with that of corresponding components of the CPI. The AP series for an item tracks the price paid on average for a representative variety by the all-Urban CPI population of U.S. consumers. There should be little quality variation due to changing varieties in the AP series because a single variety is typically chosen to represent an item in that series. Narrow variety specifications are adopted by the AP program in order to minimize variation in quote quality: the "link with overlap price" procedure for controlling for quality changes is not appropriate because dollar values rather than index numbers are published. Instead, when new outlets enter the sample, any prices that they furnish for a variety eligible for the AP program are simply utilized without quality adjustment. This approach can be viewed as polar to the overlap price linking of the CPI: whereas the CPI linking procedure implicitly assumes that there is no price dispersion between outlets, an index based on the AP series implicitly assumes the absence of outlet quality dispersion. If the average outlet quality chosen by consumers has declined, the difference in growth rates between AP series and comparable CPI component indexes would thus exaggerate the gains realized by consumers via the substitution of outlets. Nevertheless, slower growth of average prices would indicate that outlet substitution is present in the CPI since endogenous market share gains by the lower-quality outlets would be caused by greater-than-compensating price differentials.

Utilizing published AP series offers the major advantage of allowing examination of the effects of outlet substitution over a nine-year period rather than the short two-year period for which the price quote data themselves were available. Another advantage of the AP comparisons is that they include the effects of outlet disappearances: if the outlets that exit are disproportionately ones whose costs and prices are uncompetitively high, the estimates of outlet substitution bias based on outlet rotation effects will ceteris paribus be biased downward. Both food and gasoline retailing experienced notable declines in number of establishments during the 1980s, so it is likely that outlet disappearance effects are important. In the case of gasoline, the *National Petroleum News Factbook Issue* figures for numbers of retail establishments in 1980 and 1990 reveal that *net* gas station closures during the 1980s amounted to 30 percent of the industry!

Nevertheless, three limitations of the AP series comparisons are worthy of note. First, since the AP series are based on quotes for a single variety of each good, differences in the long-run evolution of the prices of different varieties of the same good could cause CPI component indexes to behave differently from indexes based on AP series. Second, there could be variation over time in the average outlet or brand quality of the individual items furnishing price quotes for the AP program. Third, comparisons between the AP series and the CPI component series may reflect price differences from geographic movements of population as well as from outlet substitution. For some purposes, price declines due to the migration of population to lower-priced areas should be considered; for example, migration in the past decade to cities with lower prices and wages may have led to overly pessimistic conclusions regarding the progress of workers' real earnings or incomes in studies that use the U.S. CPI for deflation. In estimating the effect of outlet substitution on average prices paid, however, any effects of the shifting geographic composition of the samples on their average prices would distort comparisons of changes in AP and CPI time series: because of linking, the CPI does not reflect price level changes due to geographic changes in sampling or weighting.

7.5.1 Empirical Results on Differences between AP and CPI Inflation Measures for Food

Table 7.3 compares changes in AP series for food items with changes in the most closely corresponding CPI expenditure class index. The changes are measured by the ratios of the January 1989 value in each series to the January 1980 value. The results are again consistent with the existence of significant outlet substitution bias in the CPI. Of fifty-two food items, all but four show greater inflation in their CPI indexes, and, in three of those instances (T-bone steak vs. sirloin steak, rib roast vs. chuck roast, and chicken breast vs. chicken parts), the lack of comparability of the CPI index seems likely to have been important. Moreover, means of the relative CPI food indexes weighted according to importances of the items in the CPI show an average annual increase of 4.2 percent, while the weighted mean of the average prices grows at a rate of only 2.1 percent per year. This implies an outlet substitution bias for food in the CPI of about 2 percent per year during the 1980s.

Such an extraordinarily large estimate raises the question of whether the differences in table 7.3 could themselves suffer from a large upward bias due

Table 7.3 Comparison of Changes in Average Prices and the CPI for Foods

Average Price Series Item	Jan. 1989 Avg. Price Relative[a]	CPI Expenditure Class	Jan. 1989 CPI Relative Value[a]	CPI Change Minus Avg. Price Change
Flour, white, all purpose	1.123	Flour and prepared flour mixes	1.302	0.179
Rice, white, long grain, uncooked	1.010	Rice, pasta, and cornmeal	1.391	0.381
Bread, white, pan	1.303	White bread	1.506[b]	0.203
Bread, french	1.493			
Cookies, chocolate chip	1.478	Cookies, fresh cakes, cupcakes	1.663	0.185
Ground chuck, 100% beef	0.992	Ground beef, excluding canned	1.011	0.019
Chuck roast, U.S. choice, bone-in	1.017	Chuck roast	1.138	0.121
Round roast, U.S. choice, boneless	1.054	Round roast	1.082	0.028
Round steak, U.S. choice, boneless	1.127	Round steak	1.173	0.046
Sirloin steak, U.S. choice, bone-in	1.190	Sirloin steak	1.330	0.140
Steak, T-bone, U.S. choice, bone-in	1.431	Sirloin steak	1.330	−0.101
Rib roast, U.S. choice, boneless	1.406	Chuck roast	1.138	−0.268
Frankfurters, all meat or all beef	1.239	Other beef and veal	1.396	0.157
Bologna, all beef or mixed	1.124	Other beef and veal	1.396	0.272
Bacon, sliced	1.242	Bacon	1.376	0.134
Pork chops, center cut, bone-in	1.417	Pork chops	1.496	0.079
Ham, canned, 3 or 5 lbs.	1.191	Ham	1.374	0.183
Pork shoulder picnic, bone-in, smkd.	1.114	Other pork, including sausage	1.376	0.262
Pork sausage, fresh, loose	1.357	Other pork, including sausage	1.376	0.019
Chicken, fresh, whole	1.295	Fresh whole chicken	1.494	0.199
Chicken breast, bone-in	1.568	Fresh and frozen chicken parts	1.528	−0.040
Chicken legs, bone-in	1.109	Fresh and frozen chicken parts	1.528	0.419
Turkey, frozen, whole	1.026	Other poultry	1.224	0.198
Tuna, light, chunk	1.034	Canned fish and seafood	1.421	0.387
Eggs, grade A, large	1.071	Eggs	1.366	0.295
Milk, fresh, whole, fortified	1.208	Fresh whole milk	1.227	0.019
Milk, fresh, low fat	1.187	Other fresh milk and cream	1.239	0.052

(continued)

Table 7.3 (continued)

Average Price Series Item	Jan. 1989 Avg. Price Relative[a]	CPI Expenditure Class	Jan. 1989 CPI Relative Value[a]	CPI Change Minus Avg. Price Change
Butter, salted, grade AA, stick	1.187	Other dairy prod, incl. butter	1.332	0.145
Ice cream, prepackaged, regular	1.451	Ice cream and related products	1.422	−0.029
Apples, red delicious	1.316	Apples	1.668	0.352
Bananas	1.235	Bananas	1.321	0.086
Oranges, navel	1.537	Oranges, including tangerines	2.115	0.578
Orange juice, frozen concentrated,	1.503	Fruit juices, incl. frozen	1.606	0.103
Grapefruit	1.355	Other fresh fruits	2.129	0.774
Lemons	1.308	Other fresh fruits	2.129	0.821
Pears, anjou	1.251	Other fresh fruits	2.129	0.878
Lettuce, iceberg	2.243	Lettuce	2.769	0.526
Tomatoes, field grown	1.134	Tomatoes	1.695	0.561
Cabbage	1.439	Other fresh vegetables	1.985	0.546
Celery	1.235	Other fresh vegetables	1.985	0.750
Carrots, short trimmed and topped	1.241	Other fresh vegetables	1.985	0.744
Onions, dry yellow	1.667	Other fresh vegetables	1.985	0.318
Peppers, sweet	0.898	Other fresh vegetables	1.985	1.087
Radishes	1.527	Other fresh vegetables	1.985	0.458
Cucumbers	1.558	Other fresh vegetables	1.985	0.427
Beans, green, snap	1.429	Other fresh vegetables	1.985	0.556
Potatoes, frozen, french fried	1.423	Frozen vegetables	1.573	0.150
Sugar, white, 33–80 oz. pkg.	1.405	Sugar and artificial sweeteners	1.416	0.011
Shortening, vegetable oil blends	1.240	Fats and oils	1.370	0.130
Cola, nondiet, can, 72 oz. 6 pk.	1.056	Carbonated drinks	1.297	0.241
Coffee, 100% ground roast	0.924	Coffee	1.032	0.108
Potato chips	1.369	Snacks	1.582	0.213
Weighted mean	1.202		1.450	0.248

Source: LABSTAT.

[a]January 1980 = 1.000.

[b]Fresh other breads CPI relative value is 1.519.

to the declines in average prices from shifting geographic representation. This does not appear to be the case. Primont and Kokoski (1990) find that overall food price levels differ relatively little between cities in the continental United States; furthermore, they report relatively low food prices for some of the Rust Belt cities losing population in the 1980s and high prices for some Sun Belt cities that grew. In fact, their lowest multilateral food price index for a specific urban area was 93.3 for Pittsburgh/Beaver Valley, and their highest (excluding Anchorage and Honolulu) was 106.8 for fast-growing Atlanta. Even under an implausible "worst-imaginable-case" scenario, the average food price comparisons would not suffer much upward bias from geographic effects. Supposing that the entire gain of about 3 percentage points in the weight of the Sun Belt during the 1980s occurred because population shifted from New York City, whose index of 106.7 was the second highest, to Miami–Fort Lauderdale, whose index was a very low 95.25, implies a cumulative bias over the nine-year period studied of only 0.34 percent. Additional evidence that geographic effects play at most a small role in the table 7.3 results comes from figure 7.1. The major jump in the Sun Belt's weight occurred in 1986, but figure 7.1 shows a consistent upward trend of the difference between the CPI food indexes and indexes based on AP series.

It thus appears that a considerable portion of the discrepancy between the

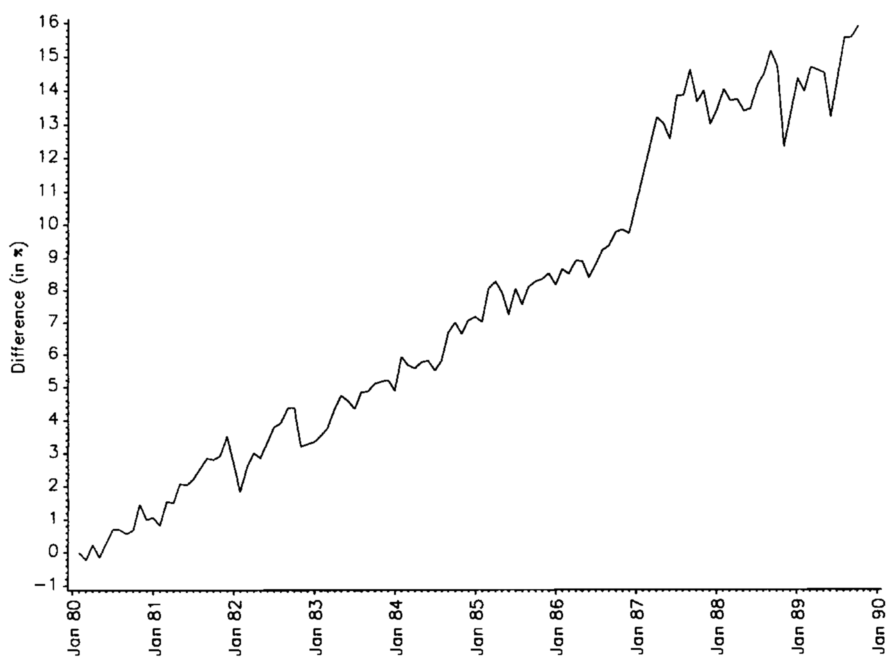

Fig. 7.1 Difference in growth of CPI and average prices for food

CPI measure of food price inflation and inflation in average food prices is due to changes in the food retailing industry's structure and systematic market share gains by lower-priced competitors. Structural changes in the industry include the continued trend of disappearances of small and independent stores, the replacement of traditional format supermarkets by warehouse and other economy format food stores (*Progressive Grocer*'s April 1988 annual report shows that their market share rose from 3.8 percent in 1979 to 15.2 percent in 1988), gains by off-price but traditional format supermarkets such as Food Lion, the emergence of the wholesale club format as a national market force, and increasing off-price food sales by retailers in other lines of business such as general merchandise discounters and drugstores. These trends that lowered the prices that consumers paid were evidently not offset by a continued trend of gains by convenience stores.

In indicating that structural changes in the food retailing industry and systematic patronage gains by lower-priced stores had a significant effect on the prices that consumers paid, table 7.3 shows that outlet substitution does reduce consumers' cost of living in a way that the CPI cannot reflect. Yet, because many of the cheaper store formats offer consumers fewer services, less selection, or less ambience than the formats they have tended to replace, quality adjusting the average food price indexes might well reduce their discrepancy with the CPI food price changes. The adjustment for changing outlet quality would not eliminate the discrepancy because consumers' willingness to alter their patronage patterns indicates that they value the outlet services that they forgo less than the price difference between the store types.

Unfortunately, data with which to attempt a direct outlet quality adjustment to the BLS average price series are lacking. It is possible that little adjustment for declining outlet quality is necessary: the negative effect on average outlet quality from gains by the off-price formats may be offset by several quality-augmenting trends in the food retailing industry. Selections of items and varieties available in a single store have grown dramatically as supermarkets have become larger and added features such as in-store bakeries, delicatessens, salad bars, and fresh fish markets. Convenience stores, which may be regarded as higher quality due to their extended hours and accessible locations, also grew in importance: their proportion of food sales rose from 5.6 percent to 7.8 percent between 1980 and 1988. Moreover, even within the economy format class, there was a trend toward greater breadth and depth of assortment. Finally, some of the shifts in consumer patronage patterns during the 1980s—such as the rapid climb of Food Lion noted above—do not appear to present quality-adjustment issues even though they probably did reduce average prices paid by consumers.

Changing brand quality is a potential source of bias in the outlet sample price comparisons of tables 7.1 and 7.2 despite the attempt to hold variety constant in the average price program. Since the end of the 1982 recession, however, the shares of cheaper generic and private label brands have steadily declined. Food brand quality is thus unlikely to have fallen in recent CPI samples, and it may even have increased.

7.5.2 Empirical Results on Differences between AP and CPI Inflation Measures for Fuel

Table 7.4 reports comparisons between price changes in CPI and AP time series for energy. It also shows faster growth of the CPI than of corresponding average prices, but the discrepancies are about half the size of the mean discrepancy in table 7.3. Unleaded regular gas fell at a 2.3 percent average annual rate in the AP series but at only a 1.4 percent rate in the CPI, while leaded regular gasoline fell at a 2.35 percent rate in the AP series but at a 1.2 percent rate in the CPI series. Since large numbers of gas stations closed during the 1980s, these dramatic discrepancies probably result in part from a tendency for the stations that went out of business to have had higher prices than the stations that remained or that opened. One change in outlet format that contributed to this was the growing importance of low-cost "pumper" stations with multiple self-service pumps and no repair services available.

Another trend that depressed the average gasoline price in the CPI samples is the increasing penetration of self-service, which grew from about a 50 percent market share to about an 80 percent market share between 1980 and 1989 (according to the 1990 *National Petroleum News Factbook Issue*). The average differential between full-service and self-service prices for regular unleaded gasoline in the 1984 *National Petroleum News Factbook Issue* is about 15 percent. Had self-service maintained a constant 50 percent market share, the January 1989 average price relative for regular unleaded gasoline would thus have been higher by a factor of about 1.075/1.03, and its average annual rate of change would have been − 1.82 percent. Approximately half the total discrepancy between the average price percentage change and the CPI percentage change can therefore be attributed to the growth of self-service. Yet whether a significant adjustment is therefore necessary in the discrepancies in table 7.4

Table 7.4 Comparison of Changes in Average Prices and CPI Components

Average Prices item	Jan. 1989 Avg. Price Relative[a]	CPI Expenditure Class	Jan. 1989 CPI Relative Value[a]	CPI Change Minus Avg. Price Change
Fuel oil #2	.950	Fuel oil	.978	0.28
Utility gas (therm.)	1.541	Utility (piped) gas	1.608	.067
Electricity	1.491	Electricity	1.634	.143
Gasoline, all types	.850	Gasoline	.898	.048
Gasoline, leaded regular	.807	Gasoline, leaded regular	.898	.091
Gasoline, unleaded regular	.812	Gasoline, unleaded regular	.881	.069

Source: LABSTAT.
[a]January 1980 = 1.000.

to arrive at the value of consumers' gains from outlet and variety substitution is not clear. Little net quality decline may be associated with forgoing the services of the station attendant because self-service reduces consumers' time cost for refueling.

For fuel oil, the discrepancy in average annual growth rates is a more modest 0.3 percent per year, which is close to the overall outlet substitution bias estimates of tables 7.1 and 7.2. It is also evident from table 7.4 that, when products differ greatly in price across regions, shifting geographic weights can seriously distort the AP series comparisons. Both piped natural gas and electricity exhibit lower inflation in their average prices than in their CPI indexes even though outlet and variety substitution possibilities are minimal for these utilities. In the case of electricity, virtually all the discrepancy is the result of shifting geographic composition of the sample giving more importance to lower-priced Sun Belt cities in 1985 and 1986. Nevertheless, the potential for geographic shifts to cause a significant upward bias in the discrepancies between AP and CPI changes appears to be just as small for gasoline as for food. Neither the amount of geographic reweighting nor the amount of interarea variation in gasoline prices in the continental United States is large. Eleven of fifteen urban areas for which BLS calculated average gasoline prices in 1989 had prices that differed by no more than 11 percent from one another, and the highest price level was found in an urban area that grew rapidly in the 1980s—Washington, D.C., and its suburbs.

Figure 7.2 depicts the evolution of the difference between CPI and average price inflation for unleaded gasoline. For the most part, it displays a persistent upward trend rather than the trendless pattern interrupted by large vertical jumps that might be expected from geographic reweighting. Geographic effects may, however, be evident in figure 7.2: near the end of 1984, there is an upward vertical jump in the AP-CPI discrepancy of 1.4 percent, and, in early 1986, there is a downward drop of 2 percent. A seasonal effect also seems to have occurred in the early years, with much of the CPI-AP discrepancy accumulating during the summer climbs in gasoline prices.

7.5.3 The Performance of Retail Industry Productivity Measures

The question of outlet substitution bias in the CPI was first raised by Denison in a discussion of the downward bias it would cause in retail productivity indexes. In fact, the BLS productivity index for food retailing exhibits such a poor performance—declining, for example, by 7 percent between 1977 and 1986—that Baily and Gordon (1988) characterize the industry as an apparent "basket case" and seek a reason for mismeasurement. The large disparities between average food price inflation and CPI measures of inflation for foods in table 7.3 indicate that the outlet substitution bias identified by Denison could account for much of the implausibly poor performance of the food retailing indexes. However, certain increases in quality also play a role: Baily and Gordon suggest that, in addition to long-term quality-improving trends

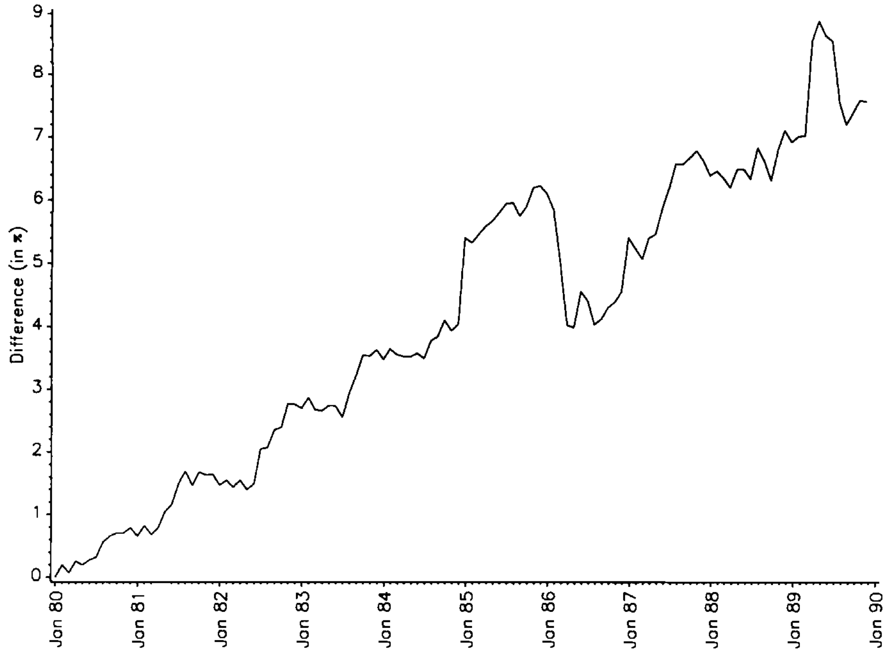

Fig. 7.2 Difference in growth of CPI and average price for unleaded gasoline

such as the expansion of item assortments and the extension of opening hours, in the 1980s food stores added "labor-intensive services valued by consumers, including full-service deli and seafood counters [and] salad bars" (1988, 411). Although quality improvements embodied in newly opened stores could be expected to raise the AP indexes in table 7.3, in the case of quality improvements from the provision of new goods the AP indexes will only reflect any increased margin on other goods that the stores offering the new goods are able to charge because of the additional store traffic that the new goods generate. Table 7.3 is not, therefore, inconsistent with this kind of quality improvement playing a role in the poor performance of the food retailing productivity index; both outlet substitution bias and a bias due to a changing mix of goods sold may simultaneously be present in the food retailing productivity index. Yet offering store-baked bread and delicatessen and salad bar meals is not primarily a case of outlet quality improvement but rather a case of adding high-quality goods for which labor contributes a high proportion of total costs. Apparent declines in labor productivity in the retail food industry are, in effect, partly a result of the substitution of labor for materials costs.

The productivity story for gasoline retailing is very different from that for food retailing. Because of the large decline in the number of gas stations per car, the changing format of the stations, and the growth of self-service, gains in service station productivity averaged nearly 4.2 percent per year from 1980 to 1987, according to the productivity index figures in LABSTAT, the BLS on-line data base. Thus, no "declining productivity" puzzle exists for gasoline retailing. Nevertheless, even if one wishes to remove the effect of the growth of self-service, table 7.4 suggests that enough productivity gains from the disappearance or replacement of less efficient outlets may have occurred to make the true productivity growth figure perhaps 0.4 percent per year higher.

7.6 Conclusion

Comparisons of new and obsolete outlet sample prices and comparisons of changes in published average prices with changes in CPI components both indicate that outlet substitution bias affects the food and fuel components of the CPI. Moreover, the magnitude of the outlet substitution bias may be large. For foods, the linked indexes from the CPI program rise a full 2 percent per year faster than the corresponding AP time series, and for unleaded gasoline the AP series grow about 0.9 percent per year faster. Nevertheless, it is important to interpret these estimates with caution. In particular, the differences between the growth of sample average prices and corresponding CPI series ought to be regarded as upper bounds for outlet substitution bias since there is no attempt to control for the possibility that average outlet quality may have declined. Furthermore, another method of estimating a bound for outlet substitution bias—comparing prices from newly selected outlets with prices from their predecessors—implies only a 0.25 percent per year outlet substitution bias for food and gasoline.

Eliminating outlet substitution bias may be possible by directly comparing the prices from new and old samples of outlets after quality adjustment, just as the downward bias in the women's apparel index created by linking of seasonal fashions was mitigated by increasing the number of direct price comparisons (see Armknecht and Weyback 1989). This would require collecting detailed data on characteristics of outlets and items priced so that hedonic regressions could be used to control for changes in item characteristics and in the types of outlets represented in CPI samples. Note, however, that hedonic adjustments to allow comparisons of prices from different types of outlets are more complicated than hedonic adjustments for changes in variety characteristics because they must allow for the existence of temporary market disequilibria and a distribution of preferences across consumers. In particular, large shifts in market share in favor of discounters indicate that the inframarginal consumers making such outlet substitutions experience increased consumer surplus. The average value of this increased consumer surplus depends on the distribution of preferences across consumers, which could be estimated if data providing equilibrium market shares at various price differentials between outlet types were available.

Collecting the necessary data to control for outlet substitution bias may, of course, be very expensive. Nevertheless, the evidence of outlet substitution bias in the CPI is sufficiently strong to warrant further study of the effects of overlap price linking when new samples of outlets are introduced into the CPI on the basis of a CPOPS or in order to replace outlets no longer in business.

Appendix

Table 7A.1 Food and Fuel Items Used in Tables 7.1 and 7.2

BLS Item Code	Description	BLS Item Code	Description
Foods		12011	Potatoes
01011	Flour	12021	Lettuce
01031	Rice	12031	Tomatoes
02011	White bread	13011	Frozen orange juice
02021	Bread other than white		
02061	Crackers	14021	Canned beans other than lima beans
03011	Ground beef	14022	Canned cut corn
03021	Chuck roast		
03031	Round roast	15021	Sugar and artificial sweeteners
03051	Round steak		
03061	Sirloin steak	16011	Margarine
		16014	Peanut butter
04011	Bacon		
04021	Pork chops	17011	Cola drinks
04031	Ham (excluding canned)	17012	Carbonated drinks other than cola
04042	Pork sausage		
		17031	Roasted coffee
05011	Frankfurters	17302	Instant and freeze-dried coffee
06011	Fresh whole chicken	*Fuels*	
		47012	Regular leaded gasoline
08011	Eggs	47013	Premium leaded gasoline
		47014	Regular unleaded gasoline
09011	Fresh whole milk	47016	Premium unleaded gasoline
		47017	Diesel
10011	Butter		
11011	Apples		
11021	Bananas		
11031	Oranges		

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Comment Joel Popkin

By analogy with Alfred Marshall's low-key definition of economics as the study of mankind in the ordinary business of life, price measurement economics is the study of price statisticians going about their ordinary work of deciding when and how to link.[1] To link or not to link is the most frequent decision a price index compiler makes and comprises the class of decisions that can potentially have the most significant ongoing effect on the behavior of price indexes.[2] Thus, the jumping-off point for this conference is the issue of linking. That is what is addressed in both the papers I have been asked to discuss. And it is a sensible place to begin.

The papers differ in subject matter—Liegey's deals with linking prices of seasonal women's clothing, while Reinsdorf's focuses on linking new outlets into the CPI to replace older ones. In one, the analysis proceeds with the use of the regression tool; in the other, alternative statistical approaches are used. Each paper has strengths and weaknesses of its own, but the intersection of these two pieces of research provides direction for future improvements in the procedure used to link price data in compiling indexes. I hope to make that intersection apparent in the course of my discussion.

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1. In its simplest form, linking is a process of introducing a substitute item or the same item priced in a substitute outlet into a price index. It is accomplished by collecting the price of both the outgoing and the incoming item for the same period and moving the price of the outgoing item by the relative of change in the new one. By implication, the two items or outlets are treated as though they were of equivalent quality.

2. Issues of index concept, such as how housing should be measured in the CPI, can have a large effect as well, but they tend to emerge as discrete rather than continuous issues.

Liegey's paper on the quality adjustment of two (entry-level) items of women's clothing—uses regression analysis to detect biases that can result whenever there is a high turnover of individual items priced within an entry-level-item category. Clothing presents an egregious case of such turnover because of the change in seasons and in fashions, particularly for women's suits and coats and jackets, which are the two items investigated. The regression for each item is estimated from monthly data covering a full calendar year in which there are two distinct clothing seasons, fall/winter and spring/summer. To the individual observations actually used in the official published indexes for each item are added two kinds of observations that were collected but not used. One (COMPARE) consists of data that did not differ in specification but for which the reported price was discarded as an outlier. The second (ADJUST) consists of prices that were not used in the official index because they had noncomparable quality characteristics. Three indexes are constructed from regressions using the published index observations plus COMPARE (1), plus ADJUST (2), and with both COMPARE and ADJUST (3). Each is compared with the published index. There are some anomalies among the three regression results that need to be explored further.[3]

Of more interest to me, however, is the picture that the results yield of possible longer-run bias due to quality adjustment. For women's suits, the published index ends the year at the same level as the index that combines directly compared and regression adjusted items. But, for coats and jackets, the latter ends the year 3.7 percent higher than the former. That is a large difference to cumulate in such a short period of time, especially since Liegey indicates that the quality-adjustment uncertainties are greater for suits.[4]

Despite these and other imperfections that arise when regressions are used for quality adjustments, two of Liegey's conclusions are justified and important. The first is that regression analysis can be valuable not merely for ex post adjustment to make price data comparable but also for selecting, ex ante, the characteristics of items that are to be priced and of substitutes for these items. Thus, regression techniques can be used to define the specification to be used in price collection. The second is that the more robust of the regression coefficients can be used on an ongoing, timely basis to adjust prices used in the compilation of the monthly indexes, without delaying their publication.

Liegey's paper provides a nice bridge to Reinsdorf's paper on linking out-

3. For example, while the author notes that interactive effects can be present, I find disquieting the results in table 6.6 for coats and jackets in which the index based on the combination of COMPARE and ADJUST ends the year about 3 percent higher than each of the two indexes that treat COMPARE and ADJUST price sets separately.

4. Not all possible quality characteristics are used in the regressions. Those selected are based on correlations between price and characteristics that the Bureau of Labor Statistics (BLS) collects. Such likely quality determinants as fabric weight and stitches per inch are not among the information that the BLS can collect.

lets. Both apparel regressions contained dummy variables for outlet types. For coats and jackets, there was a 60 percentage point differential between prices charged for the same item by the outlet categories "full-service family" and "discount department."[5] Small wonder the outlet linking issue needs attention.

In Reinsdorf's paper, two kinds of calculations show that the outlet substitution bias for food and gasoline items appears to be large. It is at least 0.25 percent per year, and by some measures even higher. Clearly, some structural effect on price movements is afoot. But, before policymakers seize on these results (as they are trying to do in some areas of service-sector pricing) to claim that their policies to control inflation are more effective than they appear, the weaknesses of this research need to be cited. The author mentions these weaknesses as well. My comments are designed merely to alter the weights accorded them.

The first is that outlet substitution and item substitution occur simultaneously. That is, when a new outlet is initiated about six months before an old one is abandoned, a somewhat different item may be selected for pricing in the new outlet than in the old. That is permitted in the so-called entry-level-item (ELI) approach, one with which I do not disagree. But it would permit the pricing of a store label cereal in a new outlet as a substitute for a brand name cereal in an old one. Clearly, that kind of substitution could explain some of the author's findings that price indexes of directly compared outlets drift down vis-à-vis published indexes.

The second issue that needs more prominence in this paper is that of defining and measuring the "quality" associated with the services provided by different outlets.

We cannot examine the issues of substitution and quality, whether they refer to items or to outlets, without reference to the CPI concept. While the unifying framework for dealing with practical questions that arise in compiling the CPI is the cost-of-living index, the CPI is calculated using the Laspeyres formula. Thus, item and outlet substitution bias is something inherent in the CPI. Nonetheless, their quantitative effect needs to be monitored.

To do this for outlet substitution, the regression analysis approach of the first paper could be introduced into the second, permitting the determinants of outlet quality change to be understood and measured. Regression analysis could be used both to determine the adjustment that may be appropriate when outlets roll over and to shed light on the effect of switching to the ELI approach from the more narrowly defined specification formerly imposed on respondent outlets.

Fortunately, the data base for such research exists. It is the point-of-purchase survey (POPS), a survey to which I devoted considerable energy to obtaining funding for as part of the 1978 CPI revision program, precisely

5. The outlet differential range was 25 percentage points for suits.

because it seemed obvious that outlets could make a difference. Thus, regression work incorporating POPS data would strengthen research both on outlet substitution effects and on the quality adjustment of item prices. The results would also be useful when the BLS begins to compile industry-sector price indexes for the four-digit SIC industries in retailing.