MARKET COMPETITION,
AND METROPOLITAN-AREA GROCERY PRICES

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Abstract

This paper examines the relationship of 1987 retail grocery prices to supermarket sales concentration across 95 U.S. metropolitan areas. The regression model incorporates a large number of population, retail-cost, and retail competition factors. We find that the concentration-price relationship is highly sensitive to the first two principal components of prices: positive for packaged, branded, dry groceries and unrelated for produce, meat, and dairy product prices. As for market rivalry, we find that small grocery stores and supermarkets owned by chains provide no grocery price competition for supermarkets. However, branded grocery prices are driven down by fast-food places and by rapid price churning, whereas for unbranded foods the presence of warehouse stores places downward pressure on supermarket prices while fast-food presence does not. For the branded-groceries component, we also find prices higher in large, fast-growing, low-income, Eastern cities. We also find that cities where rents, wages, and electricity costs are high tend to have high dry grocery prices. However, for the unbranded-products component, cities in the South have the highest prices and retail costs are unrelated to prices.

Keywords: retail grocery trade, pricing policy, variable price merchandising, market competition, category management, market structure, sales concentration, price discrimination, price rivalry, oligopoly, food demand, food prices

Market Competition and Metropolitan-Area Grocery Prices

The Supermarket Revolution — the replacement of small grocery stores by large, multidepartment grocery stores — came to an end in the 1970s (Marion, *et al.* 1986: Table 5-1). Since then the industry has witnessed a proliferation of retail food outlets. The 1987 annual report of *Progressive Grocer* declared that "the supermarket industry is moving faster to accommodate changes in consumer shopping and eating patterns." The traditional supermarket design is being supplemented by warehouse stores, supercenters, and combination stores that often incorporate food courts. Such retail formats imply a recognition that conventional supermarkets face a more diverse set of market rivals. With a changing market environment and accompanying changes in cost structures, supermarket pricing practices may be changing as well. The purpose of this study is to examine supermarket pricing with special attention to this new competitive environment.

The question of pricing practices in the retail grocery industry has long been of interest in both the business management and economics literatures. Business-management studies tend to focus on the store or product-category level and emphasize the roles of competitive rivalry and customer demographics but pay less attention to inter-store or inter-market cost differences. Empirical studies by economists tend to utilize somewhat more aggregated price data in their analyses, such as weighted average prices of a large sample of grocery products sold in a store. Economists' models are usually derived from industrial-organization theories that emphasize measures of market structure or the degree of competitive rivalry in the market, taking pains to account for store-level or market-level variation in cost conditions in order to avoid confounding effects. Recent theoretical models of retail pricing in both literatures assume that sellers exploit differences in local demand characteristics in setting store-wide or category prices. However, sampling limitations have prevented the introduction of many factors to account for variation in demand conditions facing grocery sellers.

This study draws on both literatures by developing and testing a model of retail grocery pricing that incorporates concepts from both the business and industrial-organization traditions. We examine retail food pricing using a large sample of metropolitan areas from the latter part of the 1980's. The data set is novel, incorporating a sample of markets with widely varying characteristics. While a market-level analysis is limiting in some respects (store-specific factors cannot be studied), it is dictated by our decision to focus on the changing market environment of U.S. supermarkets.

There are two contributions of this study that we view as of special importance. The first is the attention we pay to the possibility that supermarkets employ different pricing rules across different store departments. Our reading of the current economics and management literature is that stores price discriminate by setting the gross margins of individual products in accordance with market conditions. Our results support this hypothesis: We find that the factors that affect the pricing of dry grocery products are significantly different from those determining the pricing of fresh and chilled foods.

Second, one of the most significant changes in food retailing is the increasing importance of restaurants in total food expenditures, a trend that has "increasingly disturbed" industry leaders, according to the *Progressive Grocer* report. Indeed, its survey found that two-thirds of store managers rated the competitive threat from fast food outlets as at least moderate. It is certainly reasonable to expect that the low-priced segment of the restaurant industry, since ultimately it serves much the same purpose as do grocery retailers, provides potential competition. Our model allows for food service competition, and we indeed find that metropolitan-area grocery prices are affected by competition from the fast-food segment of the restaurant industry.

Literature Review

Business-management studies of retail grocery pricing have tended to focus on determining and evaluating rules for price-setting used in the industry. The managerial optimization problem facing grocery retailers is to maximize store-wide or city-wide profits by setting an optimal mix of product prices. Although there are broad differences for chains relative to independents, price-setting is primarily determined by demand facing the selling unit. For chains, everyday selling prices are often determined for an entire division (roughly equivalent to a metropolitan area), with each store placed into one of three to five price zones. Price zones essentially rank local trading areas according to the intensity of price competition and possibly local demographic characteristics that affect the nature of demand. Promotional or "sale" prices are fixed uniformly across the chain within a city. For independents, the store owner-manager sets both everyday and promotional prices according to the degree of local price rivalry and customer characteristics.[1]

Thus, the business-management tradition places greatest emphasis on competitive conditions and demographics as determinants of retail selling prices. Unit costs of goods sold and unit operating costs are considered to be essentially independent of volume, at least for the short-run pricing decisions that are of most interest to business-management analysts. The retail pricing problem is then formally the same as setting product-category gross margins (Cassady, Leed and German).[2] The gross margin can be viewed as the price of retailing services, with operating costs that vary across product categories as the only relevant costs. Variable-margin pricing is virtually universal among grocery retailers and has been analyzed using "category management" models. Category management decision models place almost exclusive emphasis on the elasticity of demand by customers and on competitive conditions for pricing (Blattberg and Neslin, Kim *et al.*). Gross margins in U.S. supermarkets have averaged about 20 percent of sales since the 1950's, with the highest margins (20 to 30 percent) in the meat and produce departments and the lowest (15 to 17 percent) in dry groceries. At the category level, gross margins vary from 5 to 50 percent.

The price elasticity of demand incorporates complex information about consumer buying habits in the trading area. From his review of grocery pricing practices, Cassady concluded that the absolute value of demand elasticity is higher at low priced stores located in trading areas with older, more highly educated, and higher income consumers. He also suggested that elasticities might vary according to frequency of product purchase, car ownership, and time of week. Many of these variables are related to household price searching effort. A more general model that explains the influence of demographic variables on the elasticity of demand is Becker's household production theory: benefits are lower prices but costs include price search, transportation, home inventory management, and the opportunity cost of shopping time.

Empirical studies in the business-management literature have found retail price responsiveness[3] to be only weakly related to demographic factors. Nine panel-data studies reviewed by Hoch, *et al.* found price responsiveness positively associated with age, education level, household size, wealth, car ownership, and single-earner households. Five additional studies of search effort[4] found positive associations with age and some attitudinal variables and a negative association with income, but the degree of explanatory power was low. Hock, *et al.* found that price responsiveness in 18 grocery product categories was generally positively related to family size, minority ethnic composition, and income; but was negatively related to education level and wealth of households in the immediate trading area. Responsiveness was unrelated to household age and dual-career status. Litvack, *et al.* found that supermarket prices were significantly more price responsive for "stock-up" goods than for perishable grocery products.

As noted previously, chain grocery companies recognize the importance of local competition on prices or gross margins by placing their stores in one of several price zones within a city market (Leed and German). For example, Hoch, *et al.* studied a leading grocery chain that used three zones, with the lowest-price zone being a trading area containing warehouse-type grocery stores. The most intense price competition for a given grocery store comes from stores offering the same array of goods in the same trading area (in cities, areas of one or two miles radius; in rural areas, larger areas) (Cassady). Less intense price rivalry is generated by neighborhood groceries, convenience stores, specialty food shops, or grocery stores in adjacent trading areas. Significant but weak price competition may arise from gasoline stations, drug stores, discount department stores, and food service retailers. These rival retailers became of increasing importance in the 1980's. The size and boundaries of retail trading areas have been formalized by retail-industry consultants with proprietary models that take into account population density, competitive store locations, road layouts, and other geographic characteristics (Hoch, *et al.*: 20). These models indicate that metropolitan area like Chicago has dozens of trading areas; a city with one million population like Indianapolis may have about four trading areas (Knebel).

Despite such conceptual developments, there are few management studies explicitly incorporating competitive intensity in empirical models of price responsiveness. Hoch, *et al.* developed four competitive variables to explain store-level price elasticities of 18 branded grocery products. The size of warehouse stores in the trading area increased the elasticity of demand, while the distance from such stores (including those outside the immediate trading area) negatively affected responsiveness of demand. Unexpectedly, the store's own market share had no significant effect on elasticity.

Most early writers on grocery pricing policies are highly skeptical that operating costs have any effect on gross margins (Cassady, Holdran). Leed and German presented data showing that operating costs in the meat and produce departments (9 to 12 percent of sales) were much higher than any other department, but still downplayed their importance. More recent studies in the business-management literature likewise omit operating costs from most models of price or margin determination.

In the second or the two broad analytical frameworks, that of IO economics, the focus has been on the market-performance implications of retail pricing conduct. An early issue was whether the retailing industry was perfectly or imperfectly competitive. Most early writers agreed with Smith, who judged retailing to be monopolistically competitive because consumer search costs were substantial and because stores were spatially differentiated. The role of consumer search costs in conditioning monopolistically competitive retail market structures was analyzed more formally by Salop and Stiglitz. Benson and Faminow developed a spatial model of competition with consumer search costs and showed that monopolistic competition is the result of sellers' conjectures that rivals' prices will not respond to one firm's change in price (the

Hotelling-Smithies assumption); if, on the other hand, sellers assume that price changes will be matched by rivals (Löschian competition) but entry barriers exist, retail prices will be higher than the monopolistic competition case.

Smith also suggested that assisted-shopping retailers (such as old-fashioned general stores) would have different competitive impacts than "convenience-goods" retailers, of which the modern self-service supermarket is an exemplar. Porter revived this notion in research showing that manufacturers selling through shopping-goods retailers achieved significantly less market power than manufacturers selling through convenience-goods retailers because only the latter permitted manufacturers to create consumer loyalty for their brands. Many other economists judged grocery retailing to be essentially oligopolistic in its pricing behavior (Baumol, *et al.*, Holdren, and Marion, *et al.* (1979)). Dickson and Urbany collected grocery-manager survey responses that indicate that price cuts are much more likely to be followed than price increases – behavior consistent with the "kinked demand" model. However, other IO economists judged most retailing, including large-scale grocery retailing, to be workably competitive (Adelman, Stigler).

Increasingly, theoretical treatments of optimal retail pricing or margin behavior follow the third-degree, price discrimination model. Such models assume that firms with identical costs enjoy some localized monopoly power because of enterprise reputation or spatial differentiation, that consumer search costs are significant, and that sellers use posted pricing systems (Katz, Holmes, Bliss).[5] These assumptions would seem to describe the "one-stop shopping" behavior of most of supermarket shoppers (Guiletti). Except for the early model developed by Holton (1957), the price discrimination models demonstrate that retail prices or margins are positively related to the own-price inelasticity of product demand. These results hold even if entry is free (Borenstein 1985).

Discriminatory pricing models are more likely to apply when there are multiple goods, because different goods generally have different demand elasticities. Then oligopoly models such as those of Hess and Geisner (1987) and of Lal and Matutes (1989, 1994) are especially useful. The latter, a duopoly model with two goods and two consumer types, is particularly useful here for two reasons. One is that it is axiomatic within the food industry that there are a small number of well-defined consumer types, with different demand characteristics. Coupled with this is our interest in non-traditional sources of supermarket competition, which may be specific to consumer types and/or sets of supermarket commodities. Unfortunately, models incorporating such features tend not to yield tight analytical solutions, even when restrictive assumptions, such as identical costs are invoked. As a consequence, authors usually resort to specific cases. It is clear from these models that a priori expectations concerning empirical outcomes become much more difficult, exemplified by Lal and Matutes summary statement that "multimarket rivalry substantially alters the nature of competition" (1989, p. 532).

Most empirical IO studies of pricing behavior focus on manufacturing firms or industries (Bliss). Except for a growing literature on gasoline and airlines, only a few studies address pricing by firms with the special characteristics of retail service firms (Weiss, Borenstein 1991, Borenstein and Rose 1994, Shepard). There are four published cross-sectional empirical studies of supermarket price indexes in the IO tradition. Each of the studies summarizes the degree of competitive rivalry with a metropolitan-area sales concentration index, and three of the four also include company market share. The first concentration-price study was prepared for the Joint

Economic Committee of the U.S. Congress in 1978 and subsequently published in book form (Marion, *et al.* 1979). The JEC study used extensive price-checks data generated in the normal course of business by grocery retailers and subpoenaed from the firms by the JEC. A market-basket price index was developed from 94 finely matched, branded food items (meat and produce were excluded), obtained from three large grocery chains operating in 36 metropolitan areas (SMAs). Both four-firm concentration (C4) and firm market share were positively related to the index of grocery prices. Cotterill (1986) verified these results, also using subpoenaed price data, for a sample of 35 stores in 18 mostly small, isolated Vermont towns and cities. Cotterill and Harper (1995) further verified the concentration-price relationship for a sample of 34 local markets in and around Arkansas. A fourth study, drawing on highly aggregated retail food price indexes published for only 18 large U.S. metropolitan areas by the Bureau of Labor Statistics also found that concentration was positively related to food prices (Lamm 1981). Cotterill and Harper also found that the presence of warehouse-type stores significantly reduced grocery prices.[6]

A different approach to measuring price responsiveness was taken by Walden. He examined the price response in six grocery stores for 18 food products when a new grocery store entered the Raleigh, North Carolina market. Because the new store reduced concentration in the trading area, the expected effect on prices was negative. The expected result was found in the majority of cases and was strongest in the closest existing stores. Entry effects like these might well vary across state jurisdictions. For example, Mueller and Patterson examined the effects of state sales-below-cost laws, which were passed with the intent of deterring predatory pricing in retailing. They found that the laws limited the losses that new entrants incurred, thereby reducing metropolitan-area concentration over time.

Unlike the business-management studies, economic models of retail prices include few variables meant to capture differences in retail demand conditions. Cross-city studies by Cotterill and Harper and Lamm found that average incomes significantly raised local grocery prices; Cotterill found no significant relationship. On the other hand, economic studies nearly always include some local cost variables, which is certainly appropriate in a multi-city analysis of long-run price analysis. Labor costs, the largest cost of store operation, were included in the studies by Marion, *et al.(1979)*, Lamm, and Cotterill and Harper, but in the last study unionization had a positive effect on prices whereas overall wages did not. Another common cost variable is store size, a proxy for economies of scale, which may vary either within or across geographic markets. In data sets containing a variety of retail formats, dummy variables can capture cost differences among store types (e.g., Cotterill and Harper). One study included a proxy for the cost of goods sold (metropolitan-area wholesale grocery prices) as an explanatory variable (Lamm). Cotterill incorporated distance from grocery warehouse to account for variation in delivered costs of goods sold. It is possible that regional or state dummy variables may also capture variation in prices due to either retailing costs or demand characteristics.

Food Prices Model

The model employed in the analysis was of the general form:

$P = f(C,D,S)$,

where P is a measure of retail food price in a given market, C is a vector of variables measuring the competitive climate of the market, D is a vector of demand or demographic factors expected to influence market price, and S a vector of supply-side or cost factors for sellers. Within C we include a standard measure of concentration, but non-traditional factors, such as the measure of restaurant activity just noted, are incorporated as well.

Our primary concern is the effect of the competitive climate on pricing, but the demand and supply variables are themselves of interest and they may yield insights into the pricing behavior of retail grocery firms. The cost variables are important because our sample is geographically extensive and costs can vary widely over large areas. The majority of the variables are measured at the SMA level. The balance are data taken from *Progressive Grocer's* 1988 Marketing Guidebook or 1987 Annual Report, which apply to their marketing regions. The specific variables are as follows:

P -	An ACCRA supermarket price index, three versions of which were used. These are discussed more extensively in the next section.
C4 -	The 1987 four-firm supermarket concentration ratio, taken from Franklin and Cotterill. It is based on a special tabulation of the 1987 U.S. Census of Retail Trade.
SIZE -	Metropolitan-area 1987 retail grocery sales (SIC 541), from the Census of Retail Trade (millions of dollars).
GRO -	The population growth rate, 1980-86, from the 1987 U.S. Census Bureau's County-City Data Book.
INCOME -	1985 per-capita income ($1,000's), taken from 1987 County-City Data Book.
REGION -	Regional dummy variables, specified below.
WAGE -	Annual Retail trade payroll ($1,000's) divided by total retail employment. Data is for 1982, taken from the 1987 County-City Data Book.
DENSITY -	1986 Population (1,000's) per square mile, taken from the 1987 County-City Data Book.

SUPER - Supermarket sales in 1987 as a percent of total grocery sales, computed from data in Franklin and Cotterill. SUPER is inversely related to convenience-stores sales.

FAST - Metropolitan fast food sales, measured by sales of SIC code 5812 with average per person check size of two to five dollars. This category is dominated by the major fast food chains. This was taken from Eating Place Sales by Check Size (National Restaurant Association), which is based on the Census of Retail Trade.

CHURN - A measure of price adjustment activity for each market obtained by counting the number of quarter-to-quarter price changes in each ACCRA item outside the bounds of 90 to 110 percent of the average price for that item over the three quarters.

EMP - The average number of employees per store for supermarkets in the market area.

SQFT - The average size of market area supermarkets (1,000 square feet).

WHS - A measure of warehouse store presence. This was calculated by tabulating the number of supermarkets and warehouse stores operated by firms based in the market area and taking the ratio of the latter to the sum of the two.

CHAIN - The percentage of supermarkets that are owned by chains.

RENT - The rental housing cost index (U.S.=100) developed by ACCRA for the second quarter of 1987.

ELEC - Commercial electricity costs in the metro area from the 1987 County-City Data Book.

Dependent Variable and Sample

Supermarket price indexes were taken from a quarterly commercial publication sold by an organization called ACCRA. ACCRA is an acronym for American Chamber of Commerce Researchers' Association, the research arm of the U.S. Chamber of Commerce. ACCRA's major activity is collecting, tabulating, checking, organizing and publishing the *Inter-City Cost of Living*

Index. In their words, "This survey, which the American Chamber of Commerce Researchers Association has published quarterly since 1968, is the only generally available source of data on living cost differentials among U.S. urban areas." (p. 1.1).[7] The primary purpose is to provide information on a market basket of goods and services typical of the purchases by mid-management executive households, with an eye toward assisting firms in relocating employees to another city. One previously published empirical analysis has examined intercity ACCRA grocery price data (Chevalier).

The ACCRA data consists of an all-item index; indices for food, housing, utilities, transportation, health care, and miscellaneous goods and services; and prices for 59 individual items, 27 of which are grocery items. Enumerators are personnel from local Chambers of Commerce, whose participation is strictly voluntary — there is no national mandate. Thus, cities participating in one quarter may not do so in the following quarter, then may reappear later, and so on. But ACCRA provides very strict guidance concerning the items and methods of data collection. For example, one of the grocery items is "corn flakes," described as "18 oz. Kellogg's or Post Toasties." Enumerators are instructed to obtain prices from at least five supermarkets; doing so on Thursday, Friday, or Saturday; using the lowest price at each store, exclusive of coupons. These are then averaged to obtain the price reported for the item for the city.[8]

Because the concentration data are based on 1987 census data, we centered attention on that year and used ACCRA price data from the Spring quarter for the three year period 1986-88. We used data only from those cities reporting in all three quarters. There were 153 such cities. Because only the price date came from ACCRA, and since sources for other variables did not include all ACCRA cities (especially for the concentration data) the final sample was composed of

97 cities, those for which we had measures for all variables. (A list of the cities appears in an Appendix.) The three price measures we used were ACCRA's overall price index and two we created from the prices of the individual items. These are described below.

Independent Variables

Reasons for inclusion of most of the independent variables are fairly obvious, and there are generally strong *a priori* notions concerning the directions of their effects. In this section we present the justifications for our choices.

Market Competition

C4. Most imperfect market models predict that greater concentration leads to greater price, which suggests a positive relation (Cotterill, Weiss). While this is the prevailing view, Salop and Stiglitz have posited a reverse effect. They argue that consumer costs of price search are lower when there are fewer firms, so high concentration may encourage retail sellers to price closer to perfectly competitive levels. Thus, Cotterill states that the nature of the price-concentration relation is an "empirical question" (p. 380).

C4*SIZE. This interaction variable is designed primarily to correct for understatement in published metro-area concentration data. The largest cities consist of many trading areas, some so distant from one another that distinct geographic markets emerge. If leading grocery retailers are found proportionately in each trading area, published metro-area C4 will be identical with the "true" C4 in properly delineated markets. If, however, large retailers tend to congregate in only certain trading areas (the suburbs, say) and independents are found disproportionately in the inner city, then reported C4 is systematically lower when SIZE is large and the sign of C4*SIZE is likely to be positive. Finally, if search costs are higher in large cities, then the Salop-Stiglitz hypothesis, if correct, would contribute to a negative effect for C4*SIZE.

SUPER. If convenience-type and other small stores represent viable competition for supermarkets, then it is possible that as supermarkets' share of the market increases, so do prices. We doubt if such an effect is strong in retail markets with effective inter-supermarket competition unless supermarket prices were particularly elevated (Marion, *et al.* 1986). Furthermore, because operating costs for supermarkets are lower than small stores costs, when SUPER is high, heightened price competition should drive down prices. Marion, *et al.* (1979) included average stores size "to adjust for differences in the importance of supermarkets *vis-a-vis* small stores," expecting (and finding) a negative relation.

WHS. Since warehouse stores typically stock fewer items than do standard supermarkets, while also providing fewer services, they have lower operating costs and hence lower prices. This should result in a negative sign, both directly because of the effect of warehouse stores in lowering average SMA prices and indirectly because of competitive responses by conventional supermarkets.[9]

FAST. If supermarkets consider fast food outlets as a source of direct competition, they may respond with lower prices when fast food presence is strong. Although supermarkets during our sample period were clearly concerned with fast food competition, a strong effect of this nature seems unlikely to us. Further, markets with high supermarket prices increase incentive to consume food-away-from-home (reverse causality), which would generate a positive relation between fast food sales and supermarket prices.

CHURN. This variable is open to several interpretations. However, we believe that during the period of the sample the industry was in transition, adjusting to a new environment. We expect this to increase market competition, at least in the short run, and so to increase the numbers and magnitude of price adjustments. Since greater competitive activity will lower prices, we expected the effect of CHURN to be negative.

CHAIN. The argument can be made that increasing the presence of chain operators in retail food markets reduces competition by reducing the number of firms, which should lead to higher, less competitive prices. Certainly it is true that chains are in a better position to wield power than are independents. For example, they can attack competing stores in one market with dramatic price reductions subsidized by elevated prices elsewhere. On the other hand, because chain pricing may in part reflect chain-wide or sub-district factors, chain-ownership may reduce the likelihood of collusive behavior at the local level. Furthermore, economies of scale in management and distribution will tend to lower costs and, *ceteris paribus*, prices.
In short, the direction of effect of this variable is essentially an empirical question. Our expectation is that the factors generating downward price pressures will predominate, especially given our belief that the period under analysis was not a particularly stable one for the supermarket industry.

Retail Cost Factors

WAGE. Wages are the primary component of operating costs, which eventually will be passed on as higher prices.

EMPL/STR. The Progressive Grocer data indicates differences in average employees per supermarket ranging from 31 to 60. It is unlikely that such large differences are due to wages or store size, variables which are included in the model. They may reflect differences in union strength across areas or in availability of minimum-wage labor, different store practices (such as twenty-four-hour operation), differences in the speed of adopting new technology, and so on. In any case, the differences are likely to affect costs and hence price. The direction of any such effect is purely an empirical question.

SQFT. If there are significant economies of scale in grocery retailing, then larger stores can charge lower prices. On the other hand, larger stores stock more kinds of items and often provide more services, which can increase unit costs. Also, larger stores presumably reduce the total number of stores, which along with the increased opportunities for differentiating themselves from competitors, can facilitate non-competitive pricing. For these reasons, the sign on this variable is indeterminate *a priori*.

RENT. In place of unavailable commercial rents, we use ACCRA data on the cost of rental housing in the metro area. Assuming commercial and housing rents are somewhat correlated, we expect rental costs to be positively related to grocery prices.

ELEC. Electricity costs are a fairly minor portion of retail operating costs, but they may affect the prices of refrigerated foods. From the City-County Data Book, we obtained average monthly costs of electricity for commercial accounts using 6,000 kwh. For several cities with missing information, comparable cities in the region provided these data. We expect high energy prices to result in high grocery prices.

Demand and Population Factors

SIZE. The Salop-Stiglitz hypothesis may be expected to apply to large markets where consumer search costs are especially high. On the other hand, large markets may permit scale economies in distribution and retail advertising, which would lower costs and, under competitive conditions, prices. Of course, huge urban agglomerations could exceed the size at which selling costs are minimized, which calls for a curvilinear specification.[10] Thus, the effect of this variable is best viewed as an empirical question.

DENSITY. This is included to capture differences in urban congestion. *Ceteris paribus*, density will raise rental costs for retail selling spaces and will make intracity delivery costs higher because of street congestion, the use of smaller trucks, and more frequent deliveries. Density will also impose search costs and hauling costs on consumers. On the other hand, more dispersed urban settlement patterns will lower sales per square foot of store space because larger, more spacious store designs are utilized in cities that have experienced most of their growth since the 1950s; moreover, more widely dispersed store sites will increase delivery costs as a percent of sales. Therefore, *a priori* notions concerning urban density lead to competing hypotheses about the expected sign of DENSITY.

GRO. It is common to include a variable measuring growth in market size in supermarket pricing studies, (as did Cotterill and Marion, *et al.*). Unanticipated growth in the face of fixed capacity can result in higher prices. But a growing market may be characterized by entry of new stores and possibly new firms, which we would expect to lead to lower prices. Which (if either) prevails is an empirical question.

INCOME. Average market-level income can affect prices because "upscale" markets with more services are likely to be present. Also, income elasticities for food will tend to have less price-elastic demand (since food represents a smaller portion of consumption, thus facilitating the exercise of market power. Citing these reasons, Cotterill included income in his equations and expected a positive effect. His estimates were predominantly positive, but the associated t-values were microscopic. Nevertheless, because we agree with Cotterill's expectation, we included income in our model. Cotterill's sample was confined to a small geographic area, whereas ours is not. Thus, we expect greater variation in income and more evidence of any influence.

REGION. A set of dummy variables was included to allow for differences in average price levels over broad geographic areas. Which markets are included in the same region is usually somewhat arbitrary. However, ours are based on regions known to have significant differences in food consumption (Larson and Binkley). We constructed four regions: (1) the East: all northeastern states up to and including New York, Pennsylvania, and Maryland; (2) the Midwest: bordered by (and including) Ohio, West Virginia, Kentucky, Missouri, and the states from Oklahoma to North Dakota; (3) the South: Louisiana, Arkansas and everything east of the Mississippi not in the Midwest or East; and (4) the West: everything else.

Results

Price Components

We begin with an examination of price correlations. If supermarkets place similar price markups on all items, then cities with high prices for one item would tend to have high prices for all items. Prices would be highly positively correlated. This is not what we found. The 26

ACCRA grocery items generate 378 unique price correlations. We ranked these from large to small (not absolute value), and the results are somewhat surprising. In table 1 we present the ten largest and ten smallest. The largest is an unexpectedly low .65; the smallest is -.38! In all, only 50% were significantly (.05) positive. There are evidently numerous commodity pairs such that when the price of the first is higher than average, the price of the second tends to be lower than average, evidence that firms indeed do not set prices in a uniform manner. To the extent this is true, a single-price measure has limitations.

There is an indication in the table that when pricing commodities, an important characteristic is whether they are predominantly prepackaged, branded items generally found in the "dry grocery" or "health and beauty aids" departments. In our sample, these prices tend to be positively correlated among themselves, and negatively associated with prices of items sold unbranded, especially fresh items. This is the only pattern discernible in the correlations in table 1 and in those not presented, and it suggests combining items by categories ("produce," "dairy," etc.) is not likely to serve present purposes. One alternative is to use prices of individual items. We did not take this avenue because of the unmanageably large number of models and consequent difficulty in arriving at meaningful generalizations. Lacking any strong basis for forming combinations of the item prices, we let the data itself do this through the use of principal components analysis.

Principal components is a multivariate statistical technique whose purpose is to capture the majority of variation in p variables with $q < p$ variables, the principal components. The principal components are ordered orthogonal linear combinations of the original p variables. The

Table 1. Ten Highest and Ten Lowest Price Correlations.

Items	Correlations
Highest	
Canned tuna - margarine	.652
Sugar - Crisco	.638
Canned tuna -Crisco	.635
Laundry detergent - baby food	.621
Crisco - baby food	.587
Canned tuna - laundry detergent	.587
Coffee - laundry detergent	.563
Parmesan cheese - tissue	.561
Canned tuna - baby food	.557
Canned peas - tissue	.548
Lowest	
Potatoes - laundry detergent	-.376
T-bone steak - laundry detergent	-.357
T-bone steak - coffee	-.344
Milk - laundry detergent	-.301
Hamburger - coffee	-.281
Potatoes - coffee	-.277
Milk - canned tomatoes	-.265
Whole chicken - milk	-.259
Lettuce - laundry detergent	-.243
Whole chicken - lettuce	-.241

Note: The total number of correlations is 378.

first is the linear combination capturing the maximum variation in the original variables, the second captures the maximum of the remaining variation, and so forth. Because of the orthogonality, variation arising from different sources within the original data would tend to be associated with different principal components. This makes the technique useful for present purposes. If there are groups of items with pricing patterns similar within groups but different across groups, members of different groups may be associated with different principal components. These associations are measured by "loadings" of the original variables on the components.

Principal components were constructed for the 26 prices. The first principal component (hereafter P1) accounted for 27% percent of the price variation. A proportion this small indicates that the overall correlation among the prices is not particularly high. Given that the largest simple correlation is only .65, it is not surprising, but it is certainly less than we would have expected *a priori*. The cumulative total variation captured by the first two components is 38%, and the first three account for 47%. From there it increases in small, slowly decreasing increments, further evidence of low price correlations.

If components have segmented price variation in a meaningful way, we expect important ones to be related to commodity groups which share identifiable characteristics. In table 2 are presented correlations between the first two principal components (the third is of considerably less interest) and the prices for individual items. There is a clear pattern, one that is consistent with the pattern in price correlations. The first component tends to have relatively large positive correlations with prepackaged, branded, dry grocery products; the second primarily with fresh meat, produce, and milk. The pattern for the second is especially strong: its correlation with many of the branded goods is often zero or negative. This price partitioning is striking, providing evidence that factors governing supermarket pricing differ across items—at least groups of prices do not move together, and in some cases may move in opposite directions. We thus used the first two principal components, P1 and P2, to construct two additional price indices. This was done by multiplying each city's vector of item prices by the corresponding vector of coefficients ("scores") associated with the principal components. These and ACCRA's grocery price index served as the dependent variables in our equation. The ACCRA index is a weighted average of all the individual grocery prices, with weights based on middle class expenditure patterns.

Grocery Price Regressions

In this section we present the results, of the overall price regressions, and in the next section consider the component regressions. We devote the majority of the discussion to the price model, which we consider a standard of comparison. For the models based on principal components, what is of interest are differences, both with the price model and with respect to each other.

In table 3 appear the price regression estimates. The explanatory power (as measured by R^2) is reasonable, particularly given the utilization of data on a wide spectrum of city types. We begin with the group of variables measuring the competitive climate. The concentration variable has the expected positive effect, but unless one takes a one-tailed view, it cannot be adjudged a significant effect. Furthermore, the sign on the concentration-market size interaction term is negative and almost significant. We take this as weak evidence that larger cities with

Table 2. Correlations between First Two Principal Components and Prices.

PRICE	CORRELATION	
	P1	P2
T-bone steak, USDA Choice	-.043	.403
Hamburger, lowest price	.074	.393
Bacon, 12 oz., rashers*	.145	.134
Frying chicken, whole, lowest price	.233	-.027
Canned tuna, 6½ oz., in oil*	.297	.018
Milk, ½ gallon, whole	-.062	.335
Eggs, dozen, grade A, large	.220	.049
Margarine, 1 lb., stick*	.293	.019
Parmesan, grated, 8 oz. canister*	.255	.013
Potatoes, 10 lb. sack, white or red, lowest price	-.087	.385
Bananas	.092	.264
Lettuce, iceberg, 1¼ lb. size	-.063	.336
Bread, white sliced, lowest price	.169	-.005
Coffee, 13 oz. can, vacuum*	.193	-.207
Sugar, 5 lb., cane or beet, lowest price	.249	.201
Corn Flakes, 18 oz.*	.113	-.069
Canned peas, 17 oz. can*	.253	-.034
Canned tomatoes, 14½ oz. can*	.178	-.058
Canned peaches, 29 oz. can, whole or slices*	.097	-.010
Tissue, 175-count box*	.258	0.16
Laundry detergent, 42 oz.*	.258	-.234
Shortening, 3 lb. can, all-vegetable oil*	.270	.155
Frozen orange juice, 12 oz. can*	.250	.172
Frozen corn, 10 oz. package, whole kernel, lowest price	.107	.080
Baby food, 4½ oz. jar, strained vegetable, lowest price	.272	-.034
Cola, 2 liter, excluding deposit*	.083	-.095

* One or more major brands specified. Items without asterisk may include unbranded or private label products.

many trading areas may frustrate consumer price-searching. Because we normalized the interaction variable on the average market size in the sample, the net effect of concentration at that value is the sum of the two coefficients. This is seen to be very nearly zero. Indeed, for neither the smallest nor the largest market in the sample was this net effect found to be significantly different from zero at $\alpha = .1$ using a t-test. Similarly, a joint F-test of these two variables was not significant at standard levels.

We obtained strong results for several of the remaining market competition variables. Only SUPER, the percent of the grocery market held by supermarkets, is estimated to have no perceptible effect. This result supports the view of many experts that supermarkets and convenience stores are members of noncompeting strategic groups (Marion, *et al.* 1986:300-306). WHS, the measure of warehouse store penetration into the region, has the expected negative sign, with a robust level of statistical significance. Indeed, given that this measure is taken at the regional level, the effect is almost unexpectedly strong. It certainly supports a view that warehouse stores were a positive competitive force in the industry in the late '80's. A second regional measure is CHAIN, the percentage of regional supermarkets that are chain-owned. We noted above that one can adduce reasons that chain-prevalence is both price enhancing and price lowering. Our prior belief was the latter, and this is borne out in the results: the coefficient is negative, again with a rather emphatic level of significance. We interpret this as a reflection of cost efficiencies in purchasing and warehousing, which are the primary economic benefits of the chain form of retail organization.

We also expected a negative coefficient on CHURN, our measure of price turbulence, regarding it as a reflection of competitive pressures. The results support this view. The

Table 3. Regression Results Explaining Grocery Prices Across 95 Metropolitan Areas.

Variable	Coefficient	t-value[1]
Intercept	87.662	8.46[a]
Market Competition Factors:		
C4	0.047	1.35[c]
C4*SIZE	-0.041	-1.62
SUPER	-6.582	-0.76
WHS	-22.390	-3.35[a]
FAST	-16.484	-1.59
CHURN	-0.250	-3.42[a]
CHAIN	-0.127	-2.71[a]
Retail Cost Factors:		
WAGE	2.032	2.90[a]
EMPL/STR	-0.244	-2.12[b]
SQFT	0.001	3.39[a]
RENT	0.055	1.61[c]
ELEC	-0.001	-0.31
Population Factors:		
SIZE	0.004	1.86[c]
DENSITY	-0.461	-1.40
GRO	0.057	1.20
INCOME	-0.640	-2.13[b]
EAST	6.938	3.62[a]
SOUTH	0.424	0.33
WEST	-2.183	-1.21
R^2	0.62	
$\overline{R}^2$	0.51	
F	6.16[a]	

[1] a, b, and c represent significance from zero at the 1, 5, and 10 percent levels. The following variables are tested using a one-tail test: WAGE, RENT, ELEC, C4, SUPER, WHS, and CHURN.

coefficient is strongly negative, and is the statistically most important of the rivalry variables. Thus, CHURN appears to be an appropriate measure for markets in the process of adapting to a changing competitive environment.[11]

The last of the market-competition variables is FAST, metro area per capita fast food sales. This estimated coefficient is also negative, with a level of significance approaching conventional levels. This invites an inference that supermarkets in fact were responding to perceived competition from the fast food industry in the late 80's. However, the component price results discussed in the next section suggest that such an interpretation may be facile.

The results for the five variables which are classified as grocery-industry cost measures are in line with prior expectations. In two cases we had no firm priors, because they are only indirect measures of cost, subject to competing hypotheses, with quite different observable implications. These measures relate to store characteristics. Store size, with a positive coefficient, and employees per store, whose coefficient is negative, are each significant at least .05, again despite being region-level measures. A direct interpretation generates the inference that unit costs are simply higher in large stores and lower in stores with many employees, the latter perhaps reflecting "busier" stores. However, this implies overcapacity in some regions. An inspection of the data shows that areas with many employees per store tend to be those with either the smallest or largest stores. This suggests a possible non-linear effect between these variables, but an attempt to capture this by including an interaction variable failed due to multicollinearity. Because of our city-level approach (and *a fortiori* because the variables involved apply not to those cities but to their *Progressive Grocer* region) we were unable to pursue this further.

Two of the coefficients on direct measures of cost, WAGE and RENT, have the expected positive sign. The first is highly significant, and the second achieves 5% if an (appropriate) one-tailed test is employed. A third direct measure, ELEC, is indistinguishable from zero, perhaps partly because of our imperfect measure.

Seven variables in the model relate to the population or demographic characteristics of the metropolitan areas or the regions in which they are located. Three of these variables, city size, density, and growth, may also affect pricing because they affect intercity costs of grocery retailing. Because these variables may affect either the demand for food or costs of grocery retailing services, we group these variables into a factor we call "city characteristics." If the group has no significant influence, it suggests that supermarket pricing differs little across cities having different inherent characteristics not measured by other variables.

We find that densely populated cities have (insignificantly) lower retail grocery prices, but cities with large supermarket sales have significantly higher prices (Table 3). Fast-growing cities have slightly higher prices, as expected, but the relationship is of only borderline significance. Thus, these single-variable results suggest that large, fast-growing, spread-out cities may have the highest U.S. grocery prices. Perhaps the most relevant test of city characteristics is a joint F-test of significance of the three variables. We conducted this test, and could not reject the null ("no city effect") even at $\alpha = .10$. In short, city characteristics *per se* evidently have little influence on retail food pricing.

The coefficients on the regional dummies are measures of price differences between the region in question and the Midwest, the "omitted" dummy. These coefficients indicate that, corrected for effects due to variables in the model, prices are highest in the East Coast and lowest in the West, and broadly similar across the Midwest and South. A joint F-test of the three dummies was significant at .01.

The final variable is average metro area household income. Results for this variable - a negative, quite significant coefficient - are puzzling. As discussed above, our prior was a positive effect, if any, a prior based on market power arguments. All we can confidently conclude is that there is certainly no evidence of a market power effect operating through income elasticity differences.

Component Regression Results

We now consider the two price component regressions. We will denote the first as the P1 or "dry grocery" component and the second as the P2 or "fresh" component. These designations reflect the dominant item types composing each, made evident by the correlations presented in Table 2.

The results appear in Table 4. Comparing them to the price regression just presented, it is evident that results for the first component are largely similar to those for the general price index, which those for the second are quite different from both. The similarity between P1 and the price index is because most of the ACCRA items are in the dry grocery category. But by design, P2 is dominated by commodities with very different pricing patterns, to the point— as the simple price correlations suggest—of moving in opposite directions. Hence, the different behavior of P2. The discussion will center upon the differences between the two components, which are strong and many. These differences tend to pose new questions rather than answering old ones.

Comparing the P1 and P2 equations, the variable with the most similar effect is CHURN, whose coefficient is both cases is negative, and reasonably significant. We have stated that we view a high level of price change activity as evidence of a highly rivalrous market: it suggests a response to the structure of competition. Under this interpretation, the CHURN variable would be particularly useful as a signal of price competition among markets for a commodity subject to high levels of outside change. This is consistent with the result that the coefficient on CHURN is more important in the P2 equation. Wholesale prices of fresh commodities, i.e., the main P2 constituents, change much more frequently than wholesale prices of dry grocery items.[12]

Among results for the other variables in the "market competition" group there are several that warrant discussion. The market power measure C4 is of much stronger effect in P1 than it is in the original price equation and certainly than for P2. The interaction of C4 with SIZE is also stronger. Signs are reversed in the P2 equation but significance levels are the smallest of the three models. What is important is the clear suggestion that the items subject to higher prices due to market concentration tend to be "grocery" items, which are also most likely to be branded, nationally-advertised goods themselves manufactured in concentrated markets. Previous studies of the impact of market power on retail food prices have focused on this type of commodity.

The coefficient on WHS is negative in both models; however, it is estimated to be of greater importance for P2. Because warehouse stores emphasize packaged items in the grocery category (P1 goods), and at best stock only a limited selection of fresh items, this result might be unexpected. It implies that supermarkets respond to warehouse store competition by lowering prices more for the goods that warehouse stores do not stock.

However, this expectation essentially reflects a model with one commodity and identical buyers and sellers. A more appropriate interpretation is based on discriminatory pricing, a point that we illustrate with a stylized case. Consider a supermarket with some degree of market power selling two goods, a necessity P1 and a convenience good P2, to two groups of consumers, "rich" and "poor." The poor consumers purchase only P1 and have an elastic demand. The rich purchase both, and are not price sensitive. Under these conditions, the optimal (from the perspective of the supermarket) P1 price would be set to exploit the different demands the store faces and price discriminate by charging a lower price to the poor. But this is not possible because the two markets cannot be segmented (except imperfectly, e.g. with coupons). Hence, it will charge the same P1 price to all consumers, a price between those two that would obtain under price discrimination.

Table 4. Regression Results Explaining Grocery Price Components Across 95 Cities.

	Dry Groceries (P1)		Fresh & Chilled (P2)	
Variable	Coefficient	t-value[1]	Coefficient	t-value[1]
Intercept	79.623	5.23[a]	112.373	5.52[a]
Market Competition Factors:				
C4	0.100	1.93[b]	-0.063	-0.91
C4*SIZE	-0.062	-1.68[b]	0.060	1.21
SUPER	-15.348	-1.21	4.944	0.29
WHS	-10.929	-1.15	-47.287	-3.61[a]
FAST	-37.080	-2.44[b]	38.388	1.89[c]
CHURN	-0.168	-1.56[c]	-0.354	-2.46[a]
CHAIN	-0.092	-1.34	-0.029	-0.32
Retail Cost Factors:				
WAGE	2.782	2.70[a]	-0.327	-0.24
EMPL/STR	-0.326	-1.93[c]	0.020	0.09
SQFT	0.002	3.68[a]	-0.001	-1.57
RENT	0.080	1.61[c]	-0.020	-0.30
ELEC	-0.006	-0.91	0.015	1.70[b]
Population Factors:				
SIZE	0.006	1.86[c]	-0.005	-1.09
DENSITY	-0.776	-1.60	0.741	1.14
GRO	0.129	1.83[c]	-0.022	-0.24
INCOME	-1.001	-2.27[b]	0.449	0.76
EAST	9.319	3.31[a]	1.998	0.53
SOUTH	-4.122	-2.18[b]	12.934	5.11[a]
WEST	- 2.478	-0.94	-4.369	-1.24
R^2	0.63		0.75	
$\bar{R}^2$	0.53		0.69	
F	6.58[a]		11.84[a]	

[1] a, b,, and c represent significance from zero at the 1,5, and 10 percent levels.

Now suppose a new store enters the market. If the entrant is identical to the incumbent, prices for both goods would be expected to fall (at least in the absence of collusion). However, suppose the new store is a warehouse store, selling only P1. With lower costs, it will set a P1 price below that of the incumbent, and all the poor consumers (who consume no P2) will migrate to the new store.

In this case, even the direction of the P1 price response by the existing supermarket is unpredictable. Attempting to regain poor customers by matching the entrant's price is not a viable long run response since it implies pricing below cost, and any price above this will not entice any poor consumers back. Hence, the optimal price for P1 is determined purely by the elasticity of P1 demand by the rich. Although this elasticity may be higher than before (given the warehouse penetration), it may still be optimal for the existing supermarket to *increase* the price of P1, given the inconvenience that the rich perceive in shopping at two stores. In effect, the warehouse store has segmented the market such that supermarket pricing depends solely on the demand exercised by rich customers. As a consequence, the magnitude and direction of the supermarket's P1 response depends upon three factors (pre-entry level of P1, the warehouse price, and the elasticity of demand by the rich), each of which is case-specific.

Under the more realistic case of a continuum of consumer types, all (at least potentially) consuming both goods, matters are yet less clear. For example, the incumbent supermarket may keep its P1 price intact, or at least considerably above the new competitor's, and lower its price of P2, hoping to attract new P2 consumers, who (due to the cost and inconvenience of shopping at two stores) then remain to purchase P1, despite a higher price. If the price of P2 were lowered below cost, we have the loss-leader case, which has been shown to be optimal under some conditions.

In short, the nature of competitive price responses in multiproduct markets with non-identical firms serving non-identical consumers are difficult to predict: they depend upon the market parameters. Such markets allow discriminatory pricing, and it is no accident that models of such markets, even when highly simplified, yield few unambiguous implications. Thus, the results, with respect to WHS, viewed in this light, are not necessarily surprising.

The relative results for FAST, metropolitan area fast food sales, are somewhat problematic. In the P1 model, as in the original model, the coefficient is negative, but now it is highly significant. In sharp contrast, for P2 it is positive, and nearly significant at .05. Yet it is fresh items (e.g., meat) that are more directly competitive with food away from home. While it is conceivable that discriminatory pricing along the lines of that just discussed is involved in this result, we believe it most unlikely that it has a major role. Indeed, it seems unlikely that the strong results for either P1 or P2 are measures of supermarket reaction to fast food competition, despite industry avowal that it is viewed as a serious competitive threat. A much more reasonable interpretation of the P2 result is reverse causality: high supermarket prices for meat and other fresh items are an incentive for consumers to switch to fast food (the "you might as well eat out" effect). But this is not consistent with the negative P1 response. The latter cannot be dismissed as a spurious effect, given the strong statistical measures.

It is fruitless and inappropriate to speculate further. But it is not inappropriate to state there is clear evidence of competition between supermarkets and fast food, and at a minimum this corroborates the stated industry view. To determine the nature of this relation will require a more complex model, specific to that purpose.

For the five variables in the cost group — wage, employees per store, store size, rent, and electricity — the P1 results are indistinguishable from those for overall price. Continuing the trend, those for P2 are quite different: the variables generally have little effect, and then in the opposite direction. The coefficient on ELEC is positive and significant at .10. This is reasonable, since electricity is a relatively important input for fresh, temperature-controlled commodities. However, such commodities also require more handling, so the same argument suggests that wages should be an important positive factor in their prices, more important than in the case of P1. But it is none of these. Overall, the results suggest that costs play at most a limited role in price-setting for P2 commodities. A joint F-test of significance of the five cost variables yielded an F-statistic of 2.11, which is significant at .10. The same test for P1 yielded a value of 6.05.

The finding that retail costs play a smaller role in the case of more service-oriented grocery departments is *prima facie* disturbing. However, when we turn again to the 1987 *Progressive Grocer* annual report, an *ad hoc* explanation is again provided: "We have to wonder how much longer grocers can opt for price-cutting programs while simultaneously adding cost-increasing services (p.4)."

For the remaining cost variables there is not a great deal to be said. In most cases, results in the P1 regression mirror those in the original price regression; coefficients in the P2 model generally indicate opposite effects. We see nothing meaningful in this and view it as simply a reflection of the price correlations. The coefficient on CHAIN is negative in both models but in neither case as significant as in the original price equation. Thus, the final conclusion with respect to this variable can only be that, *if anything,* markets with a high percentage of chain stores will tend to have lower prices. Finally, it is reasonable to expect that regional price differences at a more disaggregate item level may not reflect average regional price differences. There is a strong indication that this is the case; e.g., the component models suggest that, beneath the original result that the South and Midwest have similar levels of supermarket prices, lies a more disaggregate one: dry grocery items are cheaper in the South but fresh items dearer. However, here we will not speculate on reasons for regional differences.

As a final statistical exercise, we performed a formal test of the hypothesis that supermarket pricing is uniform across goods (though it hardly seems necessary). We did this with tests of coefficient equality across the P1 and P2 equations, using a seemingly unrelated regression procedure. Since the same explanatory variables are the same in each equation, all estimated coefficients for both were precisely the same as those of OLS. But the SUR procedure is needed for cross-equation tests, since it incorporates the covariance of estimated coefficients across the two equations (and certainly one would expect the errors to be correlated).

The results are not surprising. An F-test of over-all coefficient equality was rejected at a level of significance far exceeding .01. In the case of individual coefficients, equality was rejected at least .01 for fast food, store size, and South; at least .05 for warehouse store presence; and at least .10 for income, density, wage, concentration and its interaction, and electricity cost. The equations clearly differ.

Market Competition: An Illustration

The effects of market competition differ remarkably across our three measures of price. We illustrate the effects on grocery prices by contrasting the lowest and highest observed levels of the competition variables and observing the predicted effects on price. For example, the least concentrated city (Visalia, CA) had C4=37.2% while the most concentrated (Casper, WY) had C4=100%; this range (100-37.2=62.8) was then multiplied by the appropriate regression coefficient to determine the maximum percentage effect on prices. For a factor like fast-food restaurant presence, the highest level was considered to be the most competitive situation. Naturally, no one city displays all of these extreme values.

All six of the factors predict that the price index of all grocery products will rise when competitive conditions are the most monopolistic (Table 5). *Ceteris paribus*, the most concentrated city is predicted to have grocery prices 2.97 percent higher than the least concentrated; when warehouse stores are not present, grocery prices are expected to be 6.25 percent higher than in the city with the greatest level of penetration; low fast-food restaurant presence can cause grocery prices to rise by almost four percent; and so forth. As a group, the seven variables have a highly significant joint effect on grocery prices.

The effects of market competition on price component P1 (dry and frozen grocery products) are similar to those for the grocery price index. Indeed, the effects of market concentration and fast-food places are even more pronounced than the effects on all grocery prices. (For comparisons to other studies, see Table A3). However, for fresh and chilled foods, market competition as a whole has no significant impact on prices; indeed, for four of the six variables more competition is actually associated with rising prices.

Concluding Remarks

The purpose of this study was to examine grocery pricing in the changing market environment in which modern supermarkets are operating. To accomplish this we estimated pricing models using a sample of city data from a wide range of metropolitan areas, with a corresponding variety of market characteristics. We included several variables not previously considered in pricing studies, variables meant to measure aspects of what we view as the "new" competitive environment facing the supermarket industry.

In addition, for *a priori* and empirical reasons (the latter being an examination of simple price correlations) we did not confine the analysis to a single measure of metropolitan-area supermarket price. Principal-components analysis revealed the presence of two quite different groups of prices: (i) a set of packaged, branded grocery products in the "dry grocery" and "health and beauty aids" departments and (ii) a group of essentially nonbranded, refrigerated products consisting primarily of fresh red meats, milk, and produce departments.

Using our model explaining variation in an overall price index, we obtained results similar to those of previous studies for factors previously considered, and in line with our expectations for those not hitherto examined. Results for the dry grocery component mirrored the general grocery price index model, not surprising given that the majority of index goods are in the dry group. Results for the nonbranded/refrigerated group were quite different, suggesting little if any effects of cost factors and presenting some unexpected rivalry effects. Overall, the evidence is very strong that supermarket pricing varies markedly over different kinds of goods. We suggest that the large differences observed reflect in part discriminatory pricing as set out in recent theoretical models. Such pricing is especially likely in markets with non-identical competitors perhaps serving specialized segments, such as that of the working hypothesis of this study.

Overall, the results depict a changing market, with the degree of rivalry among supermarkets no longer the only important competitive force shaping supermarket pricing decisions. Our evidence is that serious competition has arisen not only from new formats of grocery retailing — warehouse stores, for example — but also from the restaurant industry. In a world in which large changes in the retail landscape are bringing about corresponding changes in consumer shopping behavior, and in a world which food eaten outside the home now accounts for almost one half of consumer food expenditures, this should not be a surprising outcome.

Table 5. Predicted Effects of Imperfect Competition on Metropolitan Food Prices.

Source of Competition	All Grocery Prices	Dry Grocery Products (P1)	Fresh and Refrigerated Products (P2)
1. Supermarket sales concentration	2.97[c]	6.24[b]	-3.96
2. Small grocery store	1.47	3.42	-1.10
3. Chain supermarkets rivalry	7.98[a]	5.80[c]	1.86
4. Warehouse stores rivalry	6.25[a]	3.05	13.19[a]
5. Fast-food places rivalry	3.87[a]	8.71[a]	-9.02[c]
6. Grocery price churning	6.51[a]	4.36[c]	9.20[a]
Total competitive effect	28.90[a]	31.58[b]	10.17
Group F test	3.85[a]	2.55[b]	1.77

[a]Superscripts a, b, and c indicate that the coefficient(s) differed from zero at the 1, 5, and 10 percent levels. The effects are calculated by multiplying the observed ranges in the sample by the regression coefficients; the range is negative if the most competitive level is large and the least competitive is small.

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APPENDIX TABLES

Table A1. The 95 Cities in the Sample, (Alphabetically by State Zip Code).

City, State	City, State	City, State
Anniston AL	Omaha NE	Yakima WA
Birmingham AL	Albuquerque NM	Appleton WI
Dothan AL	Reno NV	Green Bay WI
Huntsville AL	Binghamton NY	Janesville WI
Mobile AL	Buffalo NY	LaCrosse WI
Fayetteville AR	New York NY	Charleston WV
Fort Smith AR	Syracuse NY	Casper WY
Phoenix AZ	Cleveland OH	
Fresno CA	Columbus OH	
Merced CA	Lorain OH	
Sacramento CA	Youngstown OH	
San Diego CA	Oklahoma City OK	
Visalia CA	Portland OR	
Boulder CO	Salem OR	
Denver CO	Altoona PA	
Fort Collins CO	Erie PA	
Wilmington DE	Harrisburg PA	
Pensacola FL	Lancaster PA	
Atlanta GA	Philadelphia PA	
Augusta GA	York PA	
Macon GA	Greenville SC	
Cedar Rapids IA	Rapid City SD	
Boise ID	Chattanooga TN	
Decatur IL	Jackson TN	
Rockford IL	Memphis TN	
Springfield IL	Abilene TX	
Anderson IN	Amarillo TX	
Indianapolis IN	Brownsville TX	
South Bend IN	Dallas TX	
Wichita KS	El Paso TX	
Lafayette LA	Houston TX	
New Orleans LA	Lubbock TX	
Jackson MI	McAllen TX	
Lansing MI	Odessa TX	
St. Paul MN	San Antonio TX	
Columbia MO	Sherman TX	
Joplin MO	Tyler TX	
St. Louis MO	Waco TX	
Gulfport MS	Wichita Falls TX	
Great Falls MT	Salt Lake City UT	
Charlotte NC	Richmond VA	
Greensboro NC	Roanoke VA	
Raleigh NC	Richland WA	
Wilmington NC	Tacoma WA	

Table A2. Descriptive Statistics for Variables used in Regression Analyses.

Variable	Mean	Standard Deviation	Minimum	Maximum
Dependent:				
Price index (PI) (U.S. = 100)	99.425	4.608	87.833	111.033
Price Component One (P1)	100.007	6.755	86.287	113.378
Price Component Two (P2)	99.991	11.063	71.710	122.325
Independent:				
Sales concentration (C4)%	77.211	13.381	37.200	100.0000
Demographic Factors:				
SIZE ($millions)	834.522	1,147.956	94.957	6,679.641
GRO (percent)	4.631	8.855	-9.500	30.900
INCOME ($ thousands)	10.275	1.470	5.490	13.378
EAST (ratio)	0.118	0.322	0	1
SOUTH (ratio)	0.400	0.492	0	1
WEST (ratio)	0.211	0.410	0	1
MIDWEST (ratio)	0.274	0.448	0	1
Retail Cost Factors:				
WAGE ($ thousands)	8.472	0.663	7.220	10.571
DENSITY (person/sq. mi.)	3.303	2.879	0.737	24.089
EMP/STR (persons/store)	42.452	7.1-3	31.300	57.600
SQFT (sq. footage/store)	20,598.850	2,353.110	16,160.000	26,275.000
RENT (U.S. = 100)	98.064	19.403	77.000	210.900
ELEC (dollars per mo.)	474.575	115.283	278.450	939.480
Rivalry:				
SUPER (ratio)	0.894	0.047	0.750	0.973
WHS (ratio)	0.060	0.069	0	0.279
FAST ($thousands/person)	0.224	0.054	0.102	0.337
CHURN (index)	20.295	4.981	11.000	37.000
CHAIN (percent)	54.158	12.997	20.000	83.000

Table A3. Predicted Effect of Concentration on U.S. Metropolitan-Area Grocery Price, Fives Alternative Statistical Studies.

Source	Price Data	Local-Market Concentration[a]		Predicted Extreme Price Difference
		Lowest	Highest	
Marion, *et al.* (1979: Table 4.6)	Dry grocery foods, October 1974	C4=40, FRMS=10	C4=70, FMRS=55	8.6
Lamm (1981: Table I)	All foods, 1974-1977	C3=30	C3=70	1.9
Cotterill (1986: Table 2, Equa. 2)	Dry grocery foods, August 1981	HHI=193	HHI=10,000	6.3
Cotterill (1986: Table 3, Equa. 1)	Dry grocery foods, August 1981	C4=80.5	C4=100	3.3
Cotterill (1986: Table 2, Equa. 3)	Dry grocery foods, August 1981	MS1=12.5	MS1=100	5.3
Cotterill (1986: Table 3, Equa. 3)	Dry grocery foods, August 1981	C4=80.5, FRMS=13.1	C4=100, FRMS=100	6.3
Cotterill and Harper (1995: Table 2, reduced form)	Dry grocery foods, May 1982	C3=45	C3=100	4.9
Cotterill and Harper (1995: Table 2, structural price model)	Dry grocery foods, May 1982	C3=45	C3=100	9.9
Cotterill and Harper (1995: Table 2, chains and affiliates subsample)	Dry grocery foods, May 1982	C3=45	C3=100	5.1
Binkley and Connor (1996: Table 4)	Dry groceries, Spring 1986-88	C4=37	C4=100	6.3
Binkley and Connor (1996: Table 3)	All groceries, Spring 1986-1988	C4=37	C4=100	3.0

[a] Market concentration is measured using the following indexes (all in percentages):

C3 - the sum of the market shares of the three leading supermarket companies in the metro area,
C4 - same as C3, except for four leading retailers,
HHI - the Herfindahl-Hirshman index of supermarket company sales concentration,
FRMS - the ratio of a firm's market share to C4, and
MS1 - the market share of the leading supermarket company in the metro area.

Table A4. Comparison of Studies Explaining Variation in U.S. Retail Grocery Prices.

Variables	Marion, *et al.* 1979: Table 4.3 Equa 1	Lamm, 1981: Table I, Equa. 3	Cotterill, 1986: Table 2, Equa. 2	Cotterill and Harper, 1995: Table 2, Equa. 1	Binkley and Connor, 1996	
					Table 3	Table 4
Dependent[a]	P1	P	P1	P1	P	P1
Independent:			*Coefficient (t-statistic)*			
Market concentration	16.07 (4.6)***	0.06 (2.6)**	7.78 (5.4)***	0.09 (2.8)***	0.047 (1.35)*	0.100 (1.93)**
Relative market share	6.26 (2.8)***					
Market Population:						
Growth	-0.08 (-4.1)***		-0.04 (-0.9)	0.001 (0.0)	0.057 (1.20)	0.129 (1.83)*
Income level			0.18 (0.8)	0.001 (1.8)*	-0.640 (-2.13)**	-1.001 (-2.27)**
Size	-0.2 (-0.4)				0.004 (1.86)*	0.006 (1.86)*
Northeast region		0.14 (7.5)***			6.938 (3.62)***	9.319 (3.31)***
Midwest region		-0.00 (-0.4)				
South region		-0.03 (-1.7)			0.424 (0.33)	-4.122 (-2.18)**
West region					-2.183 (-1.21)	-2.478 (-0.94)
Costs of grocery retailing:						
Retail wages	0.59 (0.6)	0.17 (3.7)***		0.44 (0.7)	2.032 (2.90)***	2.782 (2.70)***
Store size	-0.01 (-1.8)**	-0.07 (-3.8)***	-0.73 (-2.4)**	-0.48 (-2.8)***	0.001 (3.39)***	0.002 (3.68)***
Store size squared			0.03 (2.4)**	0.01 (2.4)**		
Labor/capital ratio					-0.244 (-2.12)**	-0.326 (-1.93)*
Unionization level				2.17 (2.1)**		
Population density					-0.461 (-1.40)	-0-776 (-1.60)
Cost of goods sold		0.64 (5.6)***				
Rent levels					0.005 (1.61)*	0.080 (1.61)*

Store independently owned			2.07 (2.5)**	-2.87 (-1.6)		
Distance to warehouse			0.002 (0.3)	-0.00 (-0.1)		
Store is warehouse type				-8.83 (-3.0)***		
Electricity costs					-0.001 (-0.31)	-0.006 (-0.91)
Market rivalry:						
Warehouse stores				-2.66 (-2.2)**	--22.39 (-3.35)***	-10.93 (-1.15)
Small grocery stores					6.582 (0.76)	15.35 (1.21)
Fast food stores					-16.48 (-1.59)	-37.08 (-2.44)**
Chain grocery stores					-01.27 (-2.71)***	-0.092 (-1.34)
Churning of prices					-0.250 (-3.42)***	-0.168 (-1.56)*
Market-share changes	-0.52 (4.7)***					
R^2 (percent)	69	78	64	29	62	63
F	11.9	----	6.8	3.2	6.2	6.6
Number of observations[b]	36	18	35	107	95	95

---- = Not available.

***,**,* = Significance from zero at the 1%, 5%, and 10% levels, respectively.

[a] PI is an index of prices of all grocery products sold in a metropolitan area; P1 is a similar index for branded, dry groceries only.

[b] The number of observations is *stores* in Cotterill and Cotterill and Harper, but metropolitan areas in the other studies.

ENDNOTES

1.According to Leed and German, only about 4 percent of the stock-keeping units of a grocery store are ever placed on temporary promotional prices.

2.The gross margin is the difference between retail price and cost of goods sold; alternatively, it is operating costs plus before-tax profits. The reason that the delivered wholesale prices are equal across retailers is because wholesalers (or manufacturers delivering directly to retailers) wish to avoid charges of price discrimination under the Robinson-Patman Act (1936). Discounts to large buyers must be cost-justified, but the frequency of delivery and small size of such deliveries (typically a case or two of an item) makes quantity discounts difficult to justify in grocery retailing.

3.Measured by demand elasticity or household deal-proneness.

4.Measured by number of stores visited or low price paid.

5.Bliss also assumes that there are well defined product categories sold in the stores (i.e., there are low cross-price elasticities of demand across goods). One would think that independence in demand would apply to dry groceries as a group and fresh or chilled foods.

6.Because these studies support the inference of significant market power over selling prices in grocery retailing, they have not gone unchallenged. A study conducted by the Economic Research Service (ERS) of the USDA did not find a significant positive relationship between an index of store-level grocery prices and metropolitan-area C4; indeed, the relationship is significantly negative in some of the models that were tested. The merits of the is study were extensively debated in a panel discussion reported in Cotterill (1992). Among the criticisms mentioned were the small (ten) and possibly biased sample of cities, the inclusion of items whose quality varies considerably across stores (primarily fresh meats and product), inclusion of a wide variety of possibly noncompeting store types, and a host of probable procedural errors in developing the sample.

7.The U.S. Bureau of Labor Statistics publishes cost-of-living data for urban workers, not managers, and covers few cities, whereas ACCRA currently makes available indexes for about 250 cities.

8.We used 26 of the 27 grocery items, omitting only cigarettes. The 26 grocery items are shown below in Table 4.

9.Even if this measure referred to the individual SMAs, the direct effect may be absent. The ACCRA data is collected only in stores selling all products priced. The latter include meats and produce, items often not carried by warehouse stores. Hence, few warehouse stores are likely to be in the sample.

10.Some experimentation with a quadratic term in SALES provided little indication of a nonlinear effect.

11.It is worth pointing out that the correlation between CHURN and concentration was virtually zero.