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Food Prices

THE EFFECTS OF MARKET CONCENTRATION ON URBAN FOOD PRICES

by

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Abstract

This paper explores the effects of market concentration on urban food prices utilizing different market structure measures. An econometric model of urban food price determination is developed and estimated using pooled cross section and time series data for 18 metropolitan areas in the U.S.

Results indicate that food prices are higher in markets where concentration is greatest, confirming general oligopoly theory, but do not necessarily indicate the need for anticoncentration policy in urban food markets. This finding is highly conditional on the concentration measures used in the analysis, however.

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A basic contention of industrial organization theory is that firm numbers and the distribution of market shares among firms are determinants of industry profits. This proposition is supported by numerous empirical studies showing a positive relationship between concentration and profitability, and between concentration and price-cost margins. Most of these studies utilize 4-firm concentration ratios as measures of firm share distributions. As Kwoka has recently noted, there is no theoretical basis for supposing that only 4 firms are relevant to industry performance, nor is there any reason to presume that 4 firms are equally important, as is implied in the construction of concentration ratios.

In addition, most empirical studies of market structure have focused on the analysis of cross-section data with industries as the unit of observation. While this approach yields general implications for industrial organization theory, little detail on the structure of individual industries results. The food retailing industry has been represented as an observation point in these broad cross-section studies, but there has been only a limited effort to examine the structure of the industry separately. Often overlooked is the fact that while the food retailing industry is not highly concentrated at the national level, many urban markets are dominated by 3 or 4 large chains. This has important implications for urban food prices.

The limited number of studies dealing with the effects of food retailing concentration on profits and urban food prices (Marion and others (1977), and Grinnell, Crawford, and Feaster (1976)) have utilized concentration ratios as measures

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of firm share distribution. The results have been mixed, with no clear consensus on whether high levels of concentration cause higher food prices in some urban areas. This paper explores the effects of concentration on urban food prices utilizing ten alternative measures of market concentration. A model of urban food price determination is developed and estimated, correcting for specification biases present in previous studies. A pooled cross section and time series data set consisting of information on 18 urban areas covering the period from 1974 to 1977 is the basis of the analysis.

The Focus of the Study

Though there are many competing theories of oligopoly (Cournot, Chamberlain (1933) and Stigler (1964), for example), no single theory has been generally accepted as predominant. Nevertheless, most theories of oligopoly are in general agreement regarding the existence of a positive relationship between concentration and profits. Consequently, most empirical studies of market structure, in an attempt towards general acceptance, are not based on specific rigorously derived models. Rather they are "inductive" (as Comanor (1971) refers to them), reflecting the basic postulates of oligopoly theories in general. This approach has been criticized by Jaskow (1975), but few alternatives are available given the limited viability of different oligopoly theories.

The inductive approach of most industrial organization studies is followed here, with a general theoretical structure serving as the basis for model specification. The major emphasis is on testing for relationships, with a lesser concern regarding the magnitude of estimated coefficients. This is probably the limit to which conclusions can be reached on the basis of the econometric evidence.

The Model

Most empirical industrial organization studies have utilized profit or price-cost margins as the dependent variable in structural model specifications, with concentration measures, scale economy proxies, unanticipated growth variables, capital-output ratios, entry barrier measures, and other variables included on the right hand side. Some analysts have attempted to explain market prices or price changes in terms of these same variables since a basic postulate of oligopoly theory is that prices will be higher the greater is market concentration (Marion and others, and Peltzman (1977), for example). This is the approach taken in this study since it allows a response to the question of why prices for the same market basket of foods differ accross major metropolitan areas in the United States.

The prevailing view of the effects of market structure on prices can be summarized as follows. On the demand side, through the inverse demand function, price (p) is determined by quantity and income (y). On the supply side, oligopolists select output on the basis of their knowledge about market demand and on the basis of marginal costs. This yields a reduced form equation giving price as a function of income and firm costs. Industrial organization theory implies, however, that the extent to which oligopolists can select output (and price) depends on the degree of market concentration. Consequently, a market structure variable must enter the reduced form price equation. A related issue is the extent to which the realization of scale economies through increased concentration offsets the market power effects of concentration. It is possible that higher levels of concentration cause lower prices and higher profits, if scale economy effects outweigh the collusion effects of concentration. For this reason, a scale economy measure must also enter the reduced form price equation.

Combining these considerations leads to the specification

(1) $p = \phi(y, r, w, c, u)$ $\phi_y, \phi_r, \phi_w, \phi_c \geq 0; \quad \phi_u \leq 0,$

where r is the cost of goods sold, w is the wage rate, c is a market concentration measure, and u is a measure of scale economies. Increases in income, the cost of goods sold, wage rates, and concentration are expected to cause higher prices; an expansion in operational scale is expected to result in cost declines, allowing some price reduction.

Measures of Concentration

A particular problem with the interpretation and empirical implementation of equation (1) involves the identification of an appropriate market concentration measure. The 4-firm concentration measure normally used in industrial organization studies is only one of many proposed alternatives. Unless there are definite theoretical justifications for its use, and there do not appear to be, other concentration measures should not be arbitrarily excluded. Ten competing measures of concentration are considered in this study. Choices between these measures can be viewed as selecting an appropriate market share weighting scheme.

One alternative method of measuring market concentration, recently proposed by Kwoka, is the use of individual firm market shares directly. This provides for a detailed examination of the role of the largest firms in an industry, and allows a determination of the number of firms sufficient for price setting power since the estimated coefficients of firms incapable of influencing prices will not be statistically different from zero. Another measure of concentration, proposed by Hart (1971), is a summary statistic equal to the average of all firm concentration ratios. This measure gives more weight to larger firms and requires share data on all firms in the industry.

Another measure designed to give more weight to larger firms is the Herfindahl Index, defined simply as the sum of all firm shares squared. This index ranges in value from 0 (in the case of perfect competition) to 1 (pure monopoly) and has a theoretical basis in the Cournot model (see Cowling and Waterson (1976)). Hart has also discussed the use of entropy (e) as a measure of concentration. Entropy is a measure of "disorder" or uncertainty and is usually viewed as a measure of industry competitiveness. It is negatively related to concentration and is defined as

$$(2) \quad e = \sum_{i=1}^{I} m_i \log_2 m_i$$

where m_i is the ith firm's market share and I is the number of firms in the industry. Relative entropy (re) is defined as $re = e/\log_2 I$. When firm shares are equally distributed, re = 1; when there is complete inequality, re = 0. Related to entropy is redundancy (r) which is defined as $r = \log_2 I - e$. This measure is positively related to concentration (see Aaronovitch and Sawyers (1975) for a review of these measures).

The gini coefficient (g) has also been used as a measure of concentration. Its discrete approximation is

$$(3) \quad g = (I + 1 - 2 \sum_{i=1}^{I} i m_i) I^{-1}$$

which has zero value when firms have equal market shares and unity when there is complete inequality. A related measure proposed by Hall and Tideman (1974) is a monotonic transform of the gini coefficient: $h = (I(1-g))^{-1}$. An index which combines both absolute and relative characteristics is Horvath's (1972) comprehensive index (ci) with definition:

$$(4) \quad ci = m_1 + \sum_{i=2}^{I} m_i^2 (1 + (1 - m_i)).$$

This measure places a large weight on the share of the largest firm and less on smaller firms.

In addition to a market concentration measure, an instrument or proxy for scale economies is necessary before equation (1) can be estimated. Two variables are utilized for this purpose: market output (q), under the assumption that opportunities for scale economy exploitation are directly related to market size; and average store size (s), under the assumption that larger stores characterize firms with large scale food retailing operations. These considerations yield the specification

(5) $p = \phi(y, r, w, c, q, s)$

which is assumed to describe static market equilibrium.

Empirical Implementation

Under the assumption that equation 5 is a suitable generalization of the price determination process in major metropolitan food markets at different points in time, a pooled cross section and time series data set is used for estimation. The data set consists of 18 Standard Metropolitan Statistical Areas (SMSA's) and covers the years 1974 through 1977 (72 observations). Ten alternative models are specified, each including a different market concentration measure. In addition to the variables included in equation (5), 2 binary variables are added to reflect regional characteristics of the food marketing system. One binary variable (tex) is included to represent SMSA's located in Texas (Houston and Dallas). Texas is a surplus cattle producing area with nominal food transportation costs when contrasted with other SMSA's. A second binary variable (ne) is included to represent SMSA's located in the Northeast (Boston, Philadelphia, and New York). The Northeast is a deficit food producing region, and food transportation costs are a significant component of marketing costs.

Each equation is estimated using generalized least squares (GLS) under the assumption of first order autocorrelation over time for each cross section, mutual cross section independence, and homoskedasticity. First order autoregression coefficients are estimated following Parks (1967), with the resulting parameters utilized to obtain the GLS estimators.

Estimation Results

Table 1 presents GLS estimates of equation 5 with the 2 regional binary variables included in each specification. The use of alternative concentration measures gives 10 different versions of the model. Table 2 gives definitions of the variables used in the analysis.

The results are generally consistent with expectations—all estimated coefficients are of the appropriate sign. In addition, all estimated coefficients are highly significant statistically with the exception of the 4-firm concentration ratio in equation (a), the share of the third largest firm in equation (b), and the Herfindahl index in equation (d). In addition, the binary variable representin SMSA's located in Texas is not statistically significant in any equation. If the low level of confidence associated with the 4-firm concentration ratio in equation (a) and the Herfindahl index in equation (b) is disregarded, the results represent an explicit verification of general oligopoly theory—higher concentration levels are positively related to retail food prices in major metropolitan areas.

An important question concerns the interrelationships between the alternative concentration measures. If any 2 measures are highly colinear, then the same information is generated by using either series. Correlation coefficients between all pairs of concentration measures indicate a limited association, however, except between entropy and redundancy (correlation coefficient equal to -.94), entropy and relative entropy (.97), and entropy and the gini coefficient (-.92). Redundancy and relative entropy were almost colinear (-.99), as were redundancy and the gini coefficient (.98). For this reason, any one of these 3 measures could be substituted for each other with similar results since they yield essentially

Table 1. Generalized Least Squares Estimates of Equation (5)

Concentration measure	Estimated coefficient of											
	Intercept	y	r	w		c		q	s	tex	ne	R^2
(a) Four-firm concentration ratio	525 (138)	4.26 (1.21)	11.5 (0.8)	68.1 (14.1)		38.1 (58.6)		-116 (32)	-31.5 (9.1)	-127 (99)	246 (16)	.830
(b) Market shares (3 largest firms)	462 (146)	4.25 (1.39)	11.5 (0.9)	42.8 (17.3)	149 (72)	391 (110)	85 (105)	-87.4 (37.0)	-32.1 (11.1)	-71.3 (83.0)	258 (16)	.857
(c) Average concentration ratios (4-firms)	441 (104)	4.92 (1.17)	11.6 (0.7)	43.6 (13.3)		247 (67)		-112 (31)	-24.9 (7.9)	-58.7 (103.1)	245 (12)	.839
(d) Herfindahl index (4 firms)	554 (115)	3.75 (1.16)	11.3 (0.8)	56.7 (14.2)		167 (108)		-95.2 (33.2)	-33.4 (8.8)	-103 (73)	242 (12)	.826
(e) Entropy	672 (117)	4.76 (1.09)	11.9 (0.8)	57.7 (12.9)		-57.7 (21.2)		-119 (30)	-27.6 (8.3)	-71.3 (90.7)	249 (12)	.833
(f) Relative entropy	715 (122)	5.45 (1.68)	11.8 (0.8)	56.1 (12.9)		-225 (77)		-132 (38)	-26.8 (8.9)	-68.3 (110.9)	251 (14)	.843
(g) Redundancy	509 (115)	5.48 (2.55)	11.6 (0.8)	53.9 (13.7)		74.6 (24.9)		-132 (54)	-26.5 (9.3)	-73.6 (122.6)	251 (16)	.848
(h) Gini coefficient	469 (115)	6.15 (2.07)	11.6 (0.8)	53.9 (13.6)		182 (63)		-139 (47)	-27.6 (9.0)	-70.1 (105.2)	249 (16)	.847
(i) Hall-Tideman index	432 (108)	4.77 (1.06)	12.0 (0.8)	57.5 (12.3)		376 (135)		-120 (29)	-27.1 (8.1)	-74.7 (83.8)	246 (11)	.830
(j) Comprehensive index	447 (105)	4.82 (1.13)	11.6 (0.7)	45.4 (13.2)		281 (80)		-111 (30)	-26.7 (7.9)	-58.0 (105.6)	245 (12)	.837

Estimated standard errors are presented in parentheses. Multiply the estimated coefficients for y by 10-6 and s by 10-3.

Table 2. Definitions of Variables

Variable	Definition	Source	Unit of measure
p	Price of a fixed market basket of food for a 4-person family living on an intermediate budget, by SMSA for each year.	Bureau of Labor Statistics	1967 dollars
y	Total personal income by SMSA for each year.	Bureau of the Census	1967 dollars
r	Producer Price Index for finished consumer foods by year.	Bureau of Labor Statistics	1967 = 100
q	Annual market basket consumption by SMSA for each year derived by dividing retail food sales by the annual price of the market basket in each SMSA.	Sales Marketing Management's Survey of Buying Power	Millions
s	Market baskets sold annually per store by SMSA for each year, derived by dividing q by the number of stores per SMSA.	Sales Marketing Management's Survey of Buying Power	Actual number
w	Hourly wage rate for journeymen clerks by SMSA for each year.	Retail Clerks International Union	1967 dollars

All values and price indices are deflated using the CPI for each SMSA. Concentration measures were constructed using market share data for major food chains from Grocery Distribution Guide published by Metro Market Studies. The 18 SMSA's included in the study are Atlanta, Baltimore, Boston, Chicago, Cleveland, Dallas, Detroit, Houston, Kansas City, Los Angeles, Milwaukee, Minneapolis, New York, Philadelphia, St. Louis, San Francisco, Seattle, and Washington.

the same information. Correlation coefficients between all other concentration measures were less than .90.

Implications

The low confidence level associated with the coefficient on the 4-firm concentration ratio in equation (a) has important implications for empirical industrial organization studies in general. Clearly, if no alternative concentration measures were available in this study, the result would be a rejection of the hypothesis that increasing concentration causes higher prices in the retail food industry. The choice of a concentration measure then is crucial to the analytical results.

Regarding the relative impacts of changes in independent variables on food prices, Table 3 presents elasticities associated with each of the estimated coefficients in Table 1 (except the binary variables), all evaluated at mean sample levels. Each coefficient represents the percentage change in food prices given a 1 percent increase in the independent variable. For example, for equation (a), a 1 percent increase in real income for a typical SMSA implies a .032 percent increase in retail food prices; a 1 percent increase in the wholesale cost of food to retailers leads to a .631 percent increase in retail food prices; a 1 percent increase in real wages for foodstore clerks causes a .113 percent rise in retail food prices; a 1 percent increase in the 4-firm concentration ratio leads to a .010 percent increase in food prices; a 1 percent increase in output leads to a .031 percent decline in food prices; and a 1 percent increase in average store size leads to a .036 percent decline in food prices. The magnitudes of these impacts are similar for the other equations. Indications are that changes in wholesale food prices and wages have a dominant impact on retail food prices. This is consistent with prior expectations—these inputs represent virtually all of the variable costs associated with food retailing.

Table 3. Elasticities of Independent Variables Evaluated at Mean Sample Levels

Concentration measure	Price elasticity with respect to						Mean of concentration measure
	y	r	w	c	q	s	
(a) Four-firm concentration ratio	.032	.631	.113	.010	-.031	-.036	.740
(b) Market shares (3 largest firms)	.032	.631	.071	.023 .041 .006	-.024	-.037	(.31, .21, .14)
(c) Average concentration ratio (4 firms)	.037	.637	.072	.070	-.030	-.029	.566
(d) Herfindahl index (4 firms)	.028	.621	.094	.026	-.026	-.038	.306
(e) Entropy	.036	.653	.096	-.078	-.032	-.032	2.71
(f) Relative entropy	.041	.648	.093	-.093	-.036	-.031	.822
(g) Redundancy	.041	.637	.090	.022	-.036	-.030	.582
(h) Gini coefficient	.046	.637	.090	.042	-.037	-.032	.463
(i) Hall-Tideman index	.036	.659	.096	.038	-.032	-.031	.198
(j) Comprehensive index	.036	.637	.075	.068	-.030	-.031	.482
Mean of independent variable	$15.0\ 10^{6}$	109	3.30	--	.535	2273	

The mean price of the market basket is $1985.

Conclusion

Two conclusions are apparent on the basis of the empirical results. First, it is clear that food prices are higher in more concentrated urban markets, provided measures other than the 4-firm concentration ratio are accepted as indicators of concentration. This represents a confirmation of general oligopoly theory for the food retailing industry, an empirical issue which has been the subject of dispute in the past. Second, it is obvious that the results of empirical studies of industrial organization are highly conditional on the concentration measures used in the analysis. Unless theory implies that one measure is preferred over another, the use of any single measure is arbitrary. The use of 4-firm concentration ratios may lead to erroneous conclusions.

The finding of a positive relationship between increasing market concentration and urban food prices cannot be taken as a foundation for the implementation of anticoncentration policy in the food retailing industry, however. Although a reduction in concentration in major urban markets is consistent with lower food prices, it is not clear to what extent a decline in concentration is related to higher prices resulting from reduced opportunities for scale economy realization. For this reason, the use of anticoncentration policy in specific urban markets might cause lower food prices, but this is not necessarily the case.

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