ANALYSIS OF THE IMPACT OF MARKET CHARACTERISTICS ON CITY FOOD PRICES

By

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Public policy makers, consumers and other market participants have long been interested in understanding, explaining, and forecasting food prices. Efforts generally have centered at the national level, usually on a commodity basis, and at an intermediate level of production and distribution although considerable interest has been focused on average level of food prices in the U.S. as measured by the Consumer Price Index. Interest also has been expressed regarding the impact of market structure on food prices and other causes of food price changes.

The objective of the research reported in this paper was to develop a model that explains food price variation among urban markets. The principal hypothesis was that specific elements of market structure as well as basic supply and demand variables are causally linked to food prices in grocery stores and that inclusion of only concentration measures could produce specification bias.

Retail food price analyses are hampered by a lack of usable price information. A food price index can be constructed to measure the average level of prices paid by consumers for a market basket item they generally

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buy or an index can be constructed to reflect the average level of prices for a market basket of identical products. Although either index will show the effects of competitive market influences, the latter generally is preferred by economists wanting to show the effects of market structure and conduct on firm and market prices. Such a price index is not available for food products for urban areas. The former index (Consumer Price Index or CPI), however, has been constructed for selected large urban areas for several years by the Bureau of Labor Statistics.

The Consumer Price Index for food at home measures the average month to month price change of a market basket of food products purchased in grocery stores. The volume mover in each selected food category is priced in each sample store. Weights are assigned, according to sales volume, to chain supermarkets, large independents, and small independent stores. Over time the same items are price-checked in sample stores but different items may be price-checked among different stores and different urban areas. As a result CPI prices may not be strictly comparable among cities. For further discussion of CPI food prices, see Estimated Retail Food Prices by City. 1/

Definition of Variables

Annual data for census years 1954, 1958, 1963, and 1967 were available for 19 large urban areas or standard metropolitan statistical areas (SMSA's). 2/

1/ U.S. Department of Labor, Bureau of Labor Statistics, Estimated Retail Food Prices by City, monthly, Washington, D.C. Also see, for example, National Commission on Food Marketing, Organization and Competition in Food Retailing, Technical Study No. 7, June 1966, pp. 310-311.

2/ Complete 1972 data are not available.

Although most information was directly available in usable form, some variables required data generation or use of proxies. Each hypothesized structural variable will be discussed in turn.

Average city price for food expressed in dollars for a market basket of food items was calculated as follows: Using 1967 CPI data for each selected city, the city price of each food item in the market basket was multiplied by the item's average U.S. quantity weight and summed over all items in the basket to obtain 1967 city price in total dollars. Each city's price in dollar terms for 1954, 1958, and 1963 was obtained by adjusting the 1967 city market basket price by the CPI price index for food at home in each city. This variable was labeled CPRIC, and a second variable, RCPRI, with general time trends removed, was obtained by deflating each city price by total CPI for food at home in the U.S. Four firm (4FIRM), eight firm (8FIRM), and 20 firm (20FRM) concentration ratios were available from special tabulations of Bureau of Census data commissioned by the National Commission on Food Marketing and the Federal Trade Commission (FTC). Marginal 5-8 firm (5-8FM) and 9-20 firm (920FM) concentration ratios also were used. Comparable market concentration data are not available for years later than 1967. However, USDA and FTC have a contract with the Bureau of Census to obtain concentration data from the 1972 Census of Business.

Consumer income was available for SMSA's from the Bureau of Census for 1950, 1960, and 1970. 3/ These data were adjusted by State income data to

3/ U.S. Department of Commerce, Statistical Abstract, various years.

obtain estimates for 1954, 1958, 1963, and 1967. Two variables were used: per capita disposable income in the city (YCITY); and real per capita disposable income in the city (RYCTY). 4/ Population in the city (C-POP) was obtained by interpolating city population using data obtained by the Bureau of Census for the years 1950, 1960, and 1970. Similarly, population of cities within 100 miles of each selected city (SSPOP) was obtained. This measure of population density around a city indicates proximity of other metropolitan areas which would facilitate market entry. 5/ Real per capita grocery store sales (RSPOP) was used as a demand factor. 6/ It is also an interaction term for EFFIC and DENSI, explained below. The Consumer Price Index for food at home was obtained from reports of the Bureau of Labor Statistics for the census years.

Wage rates, sales per store, and number of stores per person were used to introduce the influence of operating costs of retail food stores. Average wage rate of manufacturing workers in the selected cities (CWAGE for money wage and RCWAG for real wage) was used because retail wage rates were not available for all cities all years. Larger store sales were expected to 1) result in lower unit costs while at the same time, 2) pressuring firms to maintain a low price to attract an efficient volume. Sales per

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4/ U.S. CPI, all commodities was used to deflate YCITY.

5/ SSPOP was found not significant and is not included in models reported in this paper.

6/ Although recognized as an equilibrium quantity, RSPOP was considered to primarily reflect demand.

store in the city (STORS) and real sales per store in the city (EFFIC)[7/] measure elements of both with the limitation that large store size (which may or may not decrease unit costs and prices), and high sales per square foot (which generally reduces unit operating expenses) both contribute to larger values of STORS and EFFIC. Number of grocery stores per person in the city (DENSI) is a measure of efficiency to the extent that increases in store density (DENSI), decrease average store size.

Distance from basic areas of food production was estimated using a proxy variable generated by estimating the weighted center of U.S. food production based on sales by State using a geographic grid to measure latitudinal and longitudinal distance. With the center of the value of production (near Manhattan, Kansas) being zero, the mileage distance to each selected city, labeled ADIST, was obtained. Although ADIST is not a direct measure of transportation costs, it does reflect an areal pricing pattern existing in geographical markets. Grocery store sales in the selected cities were obtained from published reports of the Bureau of Census.

Model Formulation and Analysis

Linear regression analysis (OLS) was used to test hypothesized functional relationships. Models were formulated to statistically test hypothesized relationships, determine sensitivity of estimates to alternative concentration measures, and to determine potential specification bias in models that only include market concentration as exogenous variables.

7/ To obtain EFFIC, STORS was deflated by U.S. CPI, food at home, 1967 base.

The data used in this analysis possess some inconvenient characteristics. First, because food prices were available for only 19 cities during the years studied and because market concentration data were available only for census years, the time series of cross section data were pooled to gain degrees of freedom. Second, the analysis was restricted to large urban areas. Third, limited variability of intercity prices increased the difficulty of measuring the influence of hypothesized structural variables. 8/ Fourth, because most of the variables were correlated with time, intercorrelation made it difficult to measure structural relationships among the economic variables. Fifth, as reported above, some proxy measures were required to more fully specify the hypothesized models.

To use pooled time series cross section data to analyze intercity price variation at a point in time requires that effects associated with time be controlled to reveal net relationships among hypothesized economic variables. 9/ Time effects can be accounted for explicitly by including a time or trend variable in the model or by removing time effects from each affected variable. Both options were employed although the latter was preferred because: (1) the dependent variable (CPRIC) was highly correlated with time (simple correlation was .91); (2) time was not uniformly related to each variable; and (3) time effects were not linear over the period studied, i.e. rates of change varied among the years. Problems associated with time trends will increase when 1972 data can be included in the analysis.

8/ Standard deviation as a percentage of mean using the 1954-67 pooled data was 7.2% and 2.4% respectively for CPRIC and RCPRI.

9/ This procedure specifically excludes analysis of structural relationships that are embodied in time.

The hypothesized cross section model included RCPRI, ADIST, RCWAG, DENSI, RSPOP, RYCTY, and concentration ratios. Five equations were run for model I using different combinations of concentration ratios. Model I (results are summarized in equations 1-5 in table 1), using RCPRI as the dependent variable, produced consistent results among the five equations. R-squared was .56, total F (ranging from 10 to 14) was significant at the 1 percent level. In each equation the constant term and distance were significant at the 1 percent level while real per capita income was significant at the 5 percent level. No other variable was significant at the 10 percent level. Real wage, which did not have the hypothesized sign probably does not accurately reflect operating costs of food retailers. Distance was the single most important variable (R-squared generally fell below .20 when ADIST was deleted) and had a positive effect on the average level of city prices, as hypothesized. Real per capita grocery store sales (RSPOP) had the hypothesized sign but was not significant. Although concentration ratios were not significant, the appearance of inverse relationships to RCPRI merits recognition because positive relationships were hypothesized.

Model I was modified by deleting RCWAG, DENSI, and RSPOP to obtain model II (results are summarized in equations 6-10 in table 1). The constant term and distance were highly significant as in model I but real per capita income was not significant. When DENSI was added to model II, (results not shown) real per capita income was significant at the 10 percent level while number of stores per capita (DENSI) was significant at the 5 percent level in three equations and at the 10 percent level in the other two equations.

When DENSI was substituted for RYCTY in model II, DENSI was not significant while the influence of ADIST and concentration measures were not appreciably affected. Similarly, C-POP did not make a significant contribution toward explaining variation in RCPRI. These respecifications of model II show the effects of intercorrelation and indicate the sensitivity of the models to alternative specification.

Models I and II show that when price changes due to time are removed, distance is very important in explaining intercity price variation while 4, 8, and 20 firm concentration ratios are not significant and may be inversely related to price. Other factors, such as income and operating costs, likely contribute to intercity price variation but their influence could not be measured accurately because moderate intercorrelation was encountered, and the proxy variables used were not fully satisfactory.

Models III and IV show effects of not deflating the dependent variable (CPRIC). In these models the exogenous variables should explain both spacial (intercity) and temporal variations in city prices of a market basket of food items. Although the results from models III and IV were different from models I and II, they were not inconsistent. ADIST was significant at the 5 percent level in all equations while concentration variables either were not significant or were marginally significant (10 percent level). Concentration ratios generally were positively related to CPRIC in Model III (see table 2). DENSI was not significant, and did not have the hypothesized sizn, while RYCTY and RCWAG were significant at the 1 percent level with the latter showing a sign change from model I. R-squared in model III increased to about .67 from

.49 to .56 in models I and II. The differences between the first two models and model III are largely attributed to time effects. The dependent variable CPRIC along with RYCTY, RCWAG, and concentration ratios all increased over time on average. Model II was rerun as model IV substituting CPRIC for RCPRI as the dependent variable and including dummy variables for 1958, 1963, and 1967. Results (summarized in table 2) were very similar to those of model II. R-squared was about .94, ADIST was significant at the 1 percent level, RYCTY was not significant (but its sign was positive as hypothesized), and concentration ratios were not significant and generally had negative signs as in model II. Results of model IV were not appreciably affected when undeflated city income (YCITY) was used rather than RYCTY.

To show the effects of excluding all explanatory variables other than concentration ratios, model V was run. As shown in table 3, when included alone. 8 and 20 firm concentration ratios were positively and significantly (5 percent level) related to CPRIC while 4 firm concentration was positive but not significant. When all 3 levels of concentration were included together, (either 4FIRM, 8FIRM and 20FRM or 4FIRM, 5-8FM and 920FM) 4FIRM, 20FRM, 5-8FM, and 920FM were significant at the 1 percent level while 8FIRM was not significant (see table 3). The importance of the concentration ratios are overstated because of time effects. When model V was rerun with dummy variables for years or with RCPRI substituted for CPRIC, none of the concentration ratios were significant even at the 10 percent level. Model V had very low values of R-squared, indicating that concentration ratios alone explained only a small portion of total variation in CPRIC.

Summary and Conclusion

A model that would explain intercity price variation would be of considerable interest to persons who analyze food prices, or who study market structure-performance relationships, and/or to regulatory bodies responsible for antitrust enforcement. The question of whether high market concentration of grocery retailers is positively related to prices in the city is of social importance.

This analysis does not support the hypothesis that within a given year high market concentration is associated with high levels of food prices in different cities for items consumers typically purchase. The question of whether individual firms with high market shares charge higher prices was not addressed in this study and data are not available to determine whether market concentration is positively related to <u>identical</u> items among cities. From the analysis it also could not be determined whether food prices increased over time <u>due</u> to rising levels of concentration in a given market.

Distance from production areas was positively and significantly related to intercity variation in food prices. In some models, real per capita income, real wages, and per capita number of grocery stores (DENSI) were significantly related to prices but the use of proxy variables and intercorrelation associated largely with time effects did not permit complete model specification and accurate measurement of the variables' effects.

Another important finding of the study was that when intercity food prices were related only to market concentration, specification bias occurred.

The nature and importance of concentration-price relationships were also misstated when time-related effects were not explicitly controlled. This study shows the difficulty inherent in attempting to fully specify a model that explains intercity price variation, and illustrates that intercorrelation is a problem in attempting to isolate effects among important structural variables.

Because of data limitations and model sensitivity, the findings of this study should not be considered conclusive. Additional price data are needed for more cities. Also additional price measures are needed to more adequately make price comparisons among cities and over time. Finally, more work is needed to quantify hypothesized explanatory variables including further development of proxy variables.

Further work on this project will be warranted when 1972 Census of Business data on market concentration and other characteristics of grocery stores become available in the latter part of 1976. It is hoped this paper will make a contribution to the efforts of other economists who are attempting to develop intercity price models.

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Table 1--Statistical summary of city food price variation, models I and II for 1954, 1958, 1963, and 1967

Item	Expected sign: + = positive - = negative o = sign not predicted	Model 1: Real city food prices and selected structural variables for hypothesized model					Model II: Real city food prices and selected structural variables				
		Equation--					Equation--				
		1	2	3	4	5	6	7	8	9	10
R^2		.56	.56	.55	.56	.56	.49	.49	.49	.51	.51
F ratio 1/ 2/		14.36*** (6,69)	14.39*** (6,69)	14.32*** (6,69)	10.54*** (8,67)	10.54*** (8,67)	22.98*** (3.72)	23.22*** (3,72)	23.45*** (3,72)	14.37*** (5,70)	14.37*** (5,70)
Standard error of est.		86.1	86.0	86.1	87.2	87.2	90.3	90.1	89.9	90.0	90.0
Dependent variable		RCPRI	RCPRI	RCPRI	RCPRI	RCPRI	RCPRI	RCPRI	RCPRI	RCPRI	RCPRI
Mean of dep. variable		5068	5068	5068	5068	5068	5068	5068	5068	5068	5068
Independent variables 2/ 3/											
Constant	o	5006.6 (27.10)***	5014.2 (26.80)***	5025.4 (24.73)***	4954.5 (20.73)***	4954.5 (20.73)***	4882.8 (69.70)***	4902.8 (69.11)***	4923.9 (62.10)***	4913.8 (57.73)***	4913.8 (57.73)***
ADIST	+	.226 (7.76)***	.227 (7.79)***	.228 (7.76)***	.224 (7.02)***	.224 (7.02)***	.233 (8.21)***	.233 (8.25)***	.234 (8.31)***	.240 (8.34)***	.240 (8.34)***
RYCTY	+	.596 (2.24)**	.601 (2.26)**	.595 (2.24)**	.612 (2.26)**	.612 (2.26)**	-.030 (-0.18)	-.009 (-0.05)	.025 (0.14)	.185 (0.84)	.185 (0.84)
RCWAG	+	-74.0 (-1.86)	-73.8 (-1.86)	-75.7 (-1.90)	-68.6 (-1.63)	-68.6 (-1.63)					
DENSI	+	51.5 (0.88)	47.6 (0.80)	41.6 (0.67)	63.9) (0.82)	63.9 (0.82)					
RSPOP	-	-366.8 (-0.96)	-353.9 (-0.94)	-328.4 (-0.88)	-383.3 (-0.94)	-383.3 (-0.94)					
4FIRM	+	-71.6 (-0.71)			75.8 (0.16)	-30.6 (-0.19)	-31.4 (-0.30)			533.2 (1.22)	-104.9 (-0.75)
8FIRM	+		-79.6 (-0.76)		-333.0 (-0.51)			-74.3 (-0.69)		-527.9 (-0.81)	
20FRM	+			-81.9 (-0.63)	226.7 (0.43)				-116.8 (-0.90)	-110.2 (-0.26)	
5-8FM	+					106.3 (-0.22)					-638.1 (-1.48)
920FM	+					226.7 (0.43)					-110.25 (-0.26)

1/ Degrees of freedom are in parentheses.
2/ *, **, and *** designate significance at 10 percent, 5 percent, and 1 percent levels respectively.
3/ T-ratios are in parentheses.
See text for explanation of models and definitions of terms.

Table 2--Statistical summary of city food price variation, models III and IV for 1954, 1963, and 1967

Item	Expected sign: + = positive, - = negative, o = sign not predicted	Model III: Current city food prices and selected structural variables for hypothesized model — Equation-- 11	12	13	14	15	Model IV: Current city food prices and selected structural variables — Equation-- 16	17	18	19	20
R^2		.67	.67	.67	.68	.68	.94	.94	.94	.94	.94
F ratio 1/		22.91*** (6,69)	22.89*** (6,69)	23.41*** (6,69)	17.50*** (8,67)	17.50*** (8,67)	179.88*** (6,69)	180.47*** (6,69)	180.92*** (6,69)	135.47*** (8,67)	135.47*** (8,67)
Standard error of est.		199.6	199.7	198.2	199.3	199.3	84.6	84.5	84.4	84.6	84.6
Dependent variable		CPRIC	CPRIC	CPRIC	CPRIC	CPRIC	CPRIC	CPRIC	CPRIC	CPRIC	CPRIC
Mean of dep. variable		4592	4592	4592	4592	4592	4592	4592	4592	4592	4592
Indep. variables 2/ 3/											
Constant	o	2987.4 (6.96)***	2970.4 (6.84)***	2776.4 (5.94)***	2490.4 (4.56)***	2490.4 (4.56)***	3989.9 (51.49)***	4010.8 (50.46)***	4027.5 (45.01)***	4019.4 (42.18)***	4019.4 (42.18)***
ADIST	+	.157 (2.32)**	.152 (2.25)**	.140 (2.07)**	.121 (1.67)**	.121 (1.67)**	.210 (7.77)***	.210 (7.80)***	.211 (7.82)***	.217 (7.82)***	.217 (7.82)***
RYCTY	+	2.51 (4.07)***	2.49 (4.03)***	2.50 (4.08)***	2.56 (4.14)***	2.56 (4.14)***	.172 (0.65)	.167 (0.64)	.176 (0.67)	.299 (1.07)	.299 (1.07)
RCWAG	+	275.6 (3.00)***	274.7 (2.98)***	286.4 (3.12)***	315.3 (3.29)	315.3 (3.29)***					
DENSI	+	-93.1 (-0.68)	-76.2 (-0.55)	-23.9 (-0.17)	64.9 (0.36)	64.9 (0.36)					
RSPOP	-	-77.6 (-0.09)	-154.4 (-.18)	-231.3 (-0.27)	-445.5 (-0.48)	-445.5 (-0.48)					
4FIRM	+	344.6 (1.47)*			343.2 (0.32)	745.2 (2.07)**	-9.9 (-0.10)			533.6 (1.29)	-63.2 (-0.46)
8FIRM	+		355.3 (1.46)*		-1385.9 (-0.92)			-49.1 (-0.47)		-582.1 (-0.94)	
20FRM	+			537.6 (1.79)*	1787.8 (1.48)*				-78.5 (-0.62)	-14.7 (-0.04)	
5-8FM	+					401.96 (0.36)					-596.8 (-1.45)
920FM	+					1787.8 (1.48)*					-14.7 (-0.04)
DUMM2	+						272.6 (9.48)***	274.1 (9.52)***	275.3 (9.52)***	276.5 (9.52)***	276.5 (9.52)***
DUMM3	+						390.4 (10.99)***	393.2 (11.06)***	395.2 (11.03)***	394.5 (10.95)***	394.5 (10.95)***
DUMM4	+						834.4 (19.13)***	838.3 (19.07)***	841.4 (18.87)***	847.6 (18.76)***	847.6 (18.76)***

1/ Degrees of freedom are in parentheses.
2/ *, **, and *** designate significance at 10%, 5%, and 1% levels respectively.
3/ T-ratios are in parentheses.
See text for explanation of models and definitions of terms.

Table 3--Statistical summary of city food price variation, model V for 1954, 1958, 1963, and 1967

	Expected sign: + = positive; - = negative; o = sign not predicted	Model V: Current city food prices and selected measures of market concentration				
		Equation--				
		21	22	23	24	25
R^2		.003	.05	.16	.37	.37
F ratio 1/		.26 (1,74)	4.26*** (1,74)	13.89*** (1,74)	14.05*** (3,72)	14.05*** (3,72)
Standard error of est.		332.8	324.2	305.9	268.4	268.4
Dependent variable		CPRIC	CPRIC	CPRIC	CPRIC	CPRIC
Mean of dep. variable		4592	4592	4592	4592	4592
Indep. variables 2/ 3/						
Constant	o	4503.8 (25.30)***	4164.6 (19.80)***	3647.0 (14.25)***	3365.0 (13.57)***	3365.0 (13.57)***
ADIST	+					
RYCTY	+					
RCWAG	+					
DENSI	+					
RSPOP	-					
4FIRM	+	192.98 (0.51)			-3324.0 (-2.85)	1315.6 (3.32)***
8FIRM	+		791.0 (2.06)**		1414.5 (0.74)	
20FRM	+			1537.0 (3.73)***	3225.0 (2.65)***	
5-8FM	+					4639.6 (4.30)***
920FM	+					3225.0 (2.65)***

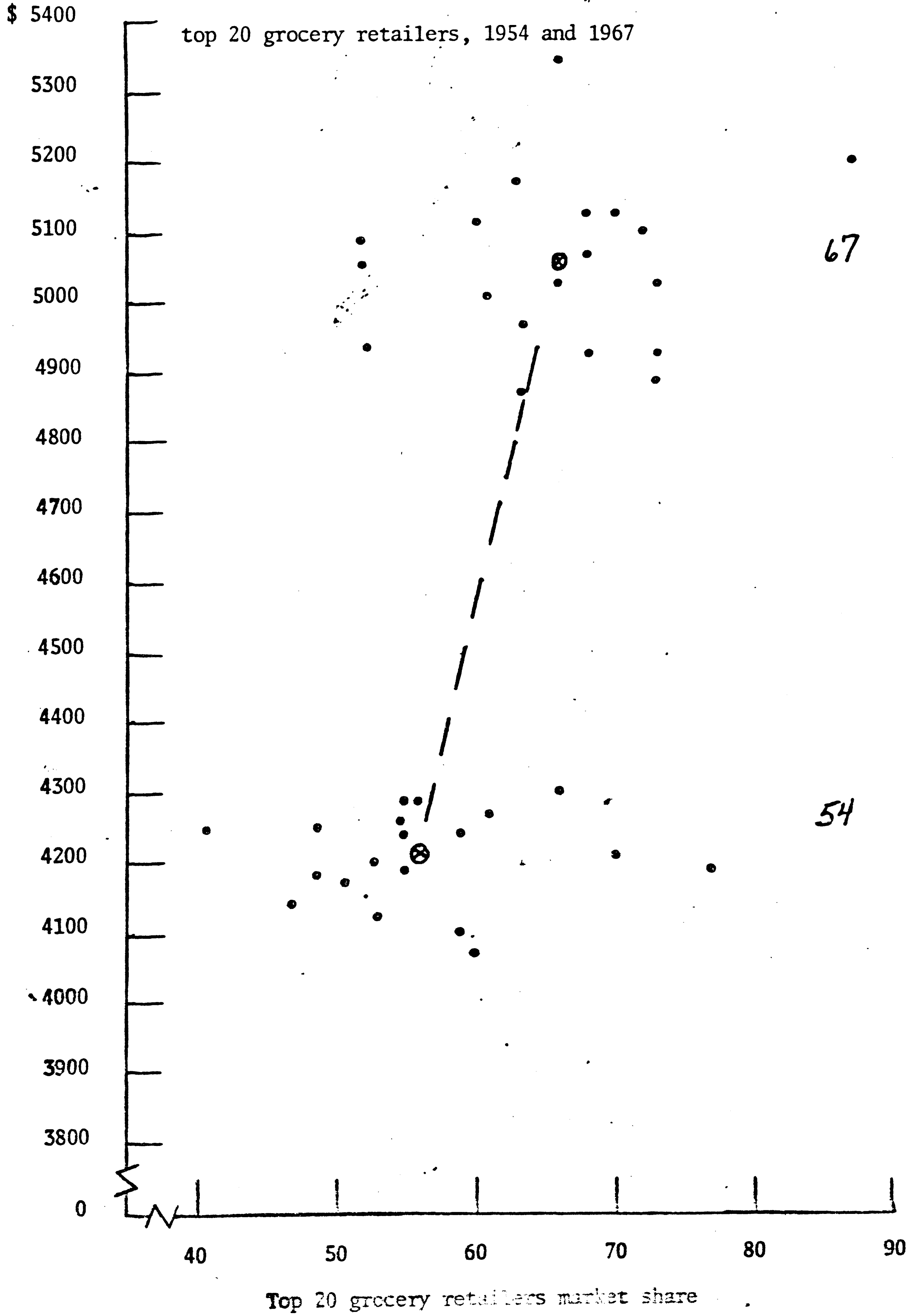
1/ Degrees of freedom are in parentheses.
2/ *,**, and *** designate significance at 10%, 5%, and 1% levels respectively.
3/ T-ratios are in parentheses.
See text for explanation of models and definitions of terms.

Table 4.--Correlation coefficients for selected market variables, 19 SMSA's, Census Years 1954-67*

	CPRIC	RCPRI	4FIRM	8FIRM	20FRM	5-8FM	920FM	CWAGE	YCITY	RCWAG	RYCTY	ADIST	DENSI	RSPOP	YEAR	C-POP	EFFIC	STORS
CPRIC	1.000																	
RCPRI	.295	1.000																
4FIRM	.059	-.065	1.000															
8FIRM	.233	-.051	.947	1.000														
20FRM	.398	-.011	.813	.931	1.000													
5-8FM	.517	.046	-.263	.062	.268	1.000												
920FM	.312	.112	-.633	-.498	-.147	.470	1.000											
CWAGE	.813	-.125	-.020	.172	.320	.576	.294	1.000										
YCITY	.839	.061	-.004	.201	.380	.613	.360	.812	1.000									
RCWAG	.682	-.150	-.068	.112	.242	.545	.272	.972	.722	1.000								
RYCTY	.760	.084	-.030	.170	.346	.603	.361	.747	.987	.678	1.000							
ADIST	.240	.699	-.057	.011	.092	.208	.188	.024	.115	.033	.141	1.000						
DENSI	-.617	.163	.032	-.186	-.427	-.656	-.511	-.716	-.755	-.667	-.736	.064	1.000					
RSPOP	.547	.015	-.190	.018	.233	.644	.506	.642	.625	.631	.612	.226	-.617	1.000				
YEAR	.907	-.061	.102	.275	.430	.508	.278	.915	.858	.818	.782	0.000	-.729	.576	1.000			
C-POP	.159	.231	-.200	-.093	.034	.340	.170	.038	.201	.015	.225	.304	-.077	.109	.083	1.000		
EFFIC	.635	-.066	-.081	.153	.418	.710	.579	.710	.770	.661	.749	.040	-.929	.753	.698	.111	1.000	
STORS	.708	-.061	-.059	.175	.434	.707	.555	.762	.813	.695	.779	.034	-.922	.743	.762	.109	.992	1.000

*See text for explanation of terms.

City prices for a market basket of food items, by market share of top 20 grocery retailers, 1954 and 1967



SELECTED CITIES, 1954-67 AVERAGE MARKET BASKET PRICE BY DISTANCE FROM U.S. CENTER OF AGRICULTURAL PRODUCTION