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VARIATIONS IN RETAIL SALES BETWEEN CITIES

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Variations in the level of retail sales between cities are governed by a different set of forces than are variations in sales to individual consumers. This study seeks to determine the factors influencing city variations in retail sales in Illinois. Influencing factors are found to vary markedly with the category of sales studied. Also, contrary to preliminary indications, income turns out to be an important variable.

BACKGROUND

The factors which influence variations in retail sales to individual consumers are not likely to be the same as those which influence variations in retail sales between cities. Where the same general factors are involved, their influence is not likely to be the same.

Although this is fairly evident from even a cursory examination of the various government cost-of-living studies,[2] it is brought out dramatically in a recent study by Mrs. V. K. Russell.[3] This report showed a virtual absence of correlation between retail sales and the traditional determinant of sales, namely, income, when comparisons were made between median measures of these variables for cities.

This result may not be so striking to market analysts, some of whom have attempted to explain the division of retail sales between towns solely in terms of population and distance.[4] It is also not too surprising in the light of the different perspective that must be taken in evaluating differences in, say, per capita sales between cities as against differences in sales to (purchases of) individual households. Also, consider the fact that the variability in sales to individuals is so much greater than the variability in city-wide sales.

THE QUESTION

Nevertheless, this result serves to raise the question of what *does* influence variations in retail sales between cities. The

[1] Appreciation is expressed to the Bureau of Economic and Business Research of the University of Illinois for providing the facilities for carrying out this study; and to Patricia P. Webber and Rikuymo Ito for their assistance in the statistical analysis.

[2] See, for example, the tabulations of the 1950 Consumer Expenditures Study, "Study of Consumer Expenditures, Income and Savings," University of Pennsylvania, 1956-57.

[3] V. K. Russell, "The Relationship Between Income and Retail Sales in Local Areas," THE JOURNAL OF MARKETING, XXII (January, 1957), pp. 329-332.

[4] Reilly, W. J., *The Law of Retail Gravitation* (New York: William J. Reilly, 1931); Converse, P. D., "New Laws of Retail Gravitation," THE JOURNAL OF MARKETING, XIV (October, 1949), pp. 370-384.

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present study attempts to answer this question.

The objective is to identify factors influencing variations in retail sales between Illinois cities in 1954,[5] and to measure the relative importance of each in affecting (a) total sales and (b) major types of retail sales. The scope of the study is more comprehensive than that of Mrs. Russell in dealing with individual categories of retail sales, and is at the same time less so in being applicable to Illinois rather than to the United States as a whole. On the other hand, the multivariate correlation method of approach followed in this study is far more general than that used in others. This permits identification of several pertinent variables at a time, and also leads to a more precise estimate of the influence of any one variable by extracting its net influence from the interacting effects of other variables.

ANALYSIS ON TWO LEVELS

The analysis was carried out on two levels—(1) factors influencing the variation in *total* sales between cities, and (2) factors influencing the variation in *per capita* sales between cities.

In each case, the procedure was to advance hypotheses regarding the factors that were thought to influence the variable in question; translate these factors into corresponding variables; and then test by correlation analysis the effect if any of each of these variables on the dependent variable being considered. Contrary to other studies in this area, no *a priori* assumptions are made about the values of any of the parameters of these regression equations.

[5] This is the date of the most recent available Census of Business.

Also, the objective of these analyses is *not* to derive demand functions for retail sales or supply functions for retail goods, in the sense that such functions are defined in economic theory. Rather, the objective is to determine what factors are most instrumental in accounting for (city-by-city) variation in retail sales, regardless of whether the variables are on the supply side or on the demand side. Indeed one aim of the present study may be said to be to ascertain whether demand factors or supply factors are most important in explaining city fluctuations in retail sales. Considering the different perspective necessitated by studying city variations rather than individual variations in retail sales, this question becomes highly meaningful.

The cities studied include all those in Illinois with populations exceeding 25,000, plus a random systematic sample of one-half of the cities having between 10,000 and 25,000 population in 1950. Altogether, fifty-one cities were included, which is a fairly large sample for multivariate analysis of this type. Some rough calculations indicated that inclusion of all Illinois cities of this size would have had no noticeable effect on the results. Communities with less than 10,000 population had to be excluded because the necessary sales and income data were not available.

(1) TOTAL SALES

Considering the wide range of the size of cities included in the sample—from towns of 10,000, to Chicago with its population of almost 4,000,000—fairly close correlation would be expected between total retail sales and total income by city. The extent of this correlation is shown in Table 1 for various categories of retail sales and for total sales. Because of

TABLE I

COEFFICIENT OF DETERMINATION BETWEEN TOTAL SALES AND TOTAL INCOME OF ILLINOIS CITIES

Type of store	Coefficient of determination	
	Including Chicago	*Excluding Chicago*
Food	.92	.85
Eating and drinking	.73	.56
General merchandise	.66	.54
Apparel	.84	.74
Furniture	.68	.50
Automotive	.68	.53
Gasoline	.85	.73
Lumber, building, hardware	.73	.56
Drug	.84	.75
Total sales	.91	.85

Source of date: Sales—U. S. Census of Business, 1954. Retail Trade—Illinois. Income—*Sales Management*, May 10, 1955, p. 327 ff.

the dominance of Chicago—the second largest city, Peoria, has less than one-twentieth the population of Chicago—correlations are presented with and without this city, although all correlations were carried out in terms of logarithms.

All the correlations shown in Table 1 are fairly high, accounting for 50 per cent or more of the variation in total retail sales in every case. Yet they are generally not as high as the determination coefficients of .95 and above invariably obtained from correlating individuals' expenditures with individuals' incomes. This may be due to the different perspective involved—that income may not be as closely associated with sales on a citywide basis as on an individual basis. Or it may be due to various erratic factors brought about by the different sources for each series and possible errors of estimation in the individual series, particularly in the income estimates. Or it may be due to failure to take into account other pertinent factors affecting retail sales. The income estimates used here relate to personal disposable income, that is, after allowance for income taxes; but such estimates on a local area basis are at best in the nature of rough approximations. The fact that such estimates pertain to the corporate areas of each community, which in many instances are outmoded for analytical work, is yet another source of error in these correlations.

Clearly, a much more valid approach to ascertaining the influence of income is to include income in a relationship containing what are thought to be all the more important relevant variables. On the demand side, this would include population, income, advertising outlays, and possibly income distribution. On the supply side, it would include distance to nearest city with competing shopping facilities, and number, size, and facilities of stores in both the given city and in possible competing cities.

Because of lack of information, data on all of these variables were not obtainable, and the analysis was restricted to the following variables: Total 1954 income in given city (Y); total population (P); per cent of families earning over $4,000 in 1954 (K); per cent earning over $7,000 (L); distance to nearest larger city (M); ratio of number of stores in given city to number of stores in nearest larger city (T); and distance to St. Louis or Chicago, whichever is the nearer metropolitan area (C). The latter variable was selected to ascertain the "pulling power" of the metropolitan areas. Most of the state of Illinois lies within 150 miles of one or the other of these two big cities, both of which have shopping facilities far superior to those of any other cities in Illinois.

Three multiple regressions were computed on total retail sales (S), using various combinations of the variables listed above.[6] On the basis of these regressions, it appeared that only population and distance between cities influences the intercity variation in total retail sales. The other four variables, including income, were clearly not statistically significant either at the .05 probability level, at the .10 level, or at various higher levels.[7]

Almost 95 per cent of the variation in total retail sales is explained by the two variables of population and distance. Computation of standardized regression coefficients revealed that population is by far the more important of the two, having an influence on sales more than eight times as large as distance.[8]

The results obtained so far provide support for the general formulation of Reilly's "Law of Retail Gravitation," in that only population and distance are found to influence variations in retail sales between cities. Reilly's basic formulation says that two cities attract trade from an intermediate town roughly in proportion to the populations of the two cities and in inverse proportion to the squares of the distances from the cities to the intermediate town. The results here conflict with Reilly's "Law" in that population is found to be of considerably greater importance than distance. The extent of this conflict remains to be determined, however, particularly since Reilly's formulation excludes convenience items, which are included here.

The results also seem to conflict with the usual type of income analysis, since none of the income variables influence retail sales to any noticeable extent. This finding has to be interpreted, however, in the light of the different perspective of this study. All it indicates is that variations within the range of the observed city income data had little noticeable effect on sales. This does not mean that income is of no importance to retail sales, for clearly if people had no income or there were no stores in a particular city, retail sales in the city would dwindle to the vanishing point. These findings, like so many others, are valid in a relative sense only—relative to other variables included in the analysis, and relative to the time, location, and range covered by the data.

The above findings are modified somewhat when the same analysis is carried

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[6] The results are shown below, all the regressions being in terms of logarithms.

$$\begin{array}{llllllll}
(1.1)\ S = & .0872Y^{.185} & & P^{.809} & T^{.00465} & K^{.0475} & M^{.113} & R^{*2} = .952 \\
& (6.27) & (.98) & (4.09) & (.21) & (.32) & (3.79) & \\
(1.2)\ S = & .0380Y^{.163} & & P^{.831} & T^{.00428} & L^{.0321} & M^{.113} & R^{*2} = .952 \\
& (2.73) & (.59) & (2.95) & (.18) & (.21) & (3.64) & \\
(1.3)\ S = & .0374Y^{.202} & & P^{.776} & T^{.0201} & K^{.0427} & M^{.145}C^{-.0476} & R^{*2} = .953 \\
& (2.73) & (1.07) & (3.88) & (.76) & (.29) & (3.50) & (1.10)
\end{array}$$

R^{*2} is the coefficient of determination adjusted for degrees of freedom. The figure in parentheses below the estimate of each regression coefficient represents the ratio of the coefficient to its standard error. This ratio has to be at least 1.96 for the coefficient to be statistically significant at the (usual) .05 probability level, and at least 2.58 for the coefficient to be statistically significant at the .01 probability level.

[7] Using shopping goods stores instead of total stores in T provides a somewhat better correlation, but the coefficient is still nowhere near statistical significance at the .05 probability level. Eliminating the four variables mentioned from the regressions yielded the following "final" equation:

$$\begin{array}{llll}
(1.4)\ S = .0436 & P^{1.005} & M^{.105} & \\
\quad (3.14) & (30.5) & (3.82) & \\
& & & R^{*2} = .949
\end{array}$$

[8] This is also brought out in (1.4), which indicates that a 10 per cent change in population is accompanied by a 10 per cent change in sales, while a 10 per cent change in distance is accompanied by a change in sales of only 1 per cent.

TABLE 2

MULTIPLE REGRESSION OF TOTAL SALES ON INCOME, POPULATION, AND DISTANCE, BY TYPE OF STORE

Type of store	*Estimate of coefficient (elasticity) of*[a]			R^{*2}[b]	*Standardized regression coefficient*		
	Income	*Population*	*Distance*		*Income*	*Population*	*Distance*
Food	—.009	.968**	.024	.95	—.010	.990	.030
Eating and drinking	—.755*	1.83**	—.021	.81	—.704	1.58	—.021
General merchandise	—.019	1.35**	.382**	.77	—.014	.923	.308
Apparel	.582	.508	.166**	.87	.531	.431	.162
Furniture	—.303	1.36**	.155*	.75	—.279	1.16	.157
Automotive	.696	2.58	.219**	.72	.655	.226	.232
Gasoline	—.355	1.27**	.070*	.92	—.415	1.38	.091
Lumber, building, hardware	.053	.753*	.077	.76	.063	.828	.102
Drug	.913*	.109	.145**	.86	.852	.117	.151
Total sales	.204	.791**	.109**	.93	.217	.780	.129

[a] One asterisk indicates significance at the .05 probability level, two at the .01 level.
[b] This is the coefficient of determination adjusted for sample size.

out on different components of retail sales. To this end, Table 2 presents results obtained from fitting a regression function to sales of different type of retail stores in the various cities as taken from the 1954 Census of Business.[9]

The results in Table 2 indicate that income does influence sales rather substantially in a number of cases—particularly eating and drinking, automotive, and drug store sales—but only for eating and drinking and for drug sales are the coefficients statistically significant. The negative, and statistically-significant, income elasticity is somewhat of a surprise, and one for which no ready explanation is evident from the data other than the possibility of interaction effects. Population continues to be the dominant variable in the relationship with the exception of the apparel, automotive and drug categories. Distance also makes a significant contribution to the relationship for most types of sales, particularly for general merchandise and automotive sales.

[9] The regression function used was:

$$(1.5)\ S = a\,Y^b\,P^c\,M^d$$

This function is essentially (1.4) with income added, the purpose of the addition being to determine the significance of income in influencing sales of the different types of stores.

(2) PER CAPITA SALES

Study of the factors influencing variations in per capita sales among cities is more useful in an analytical sense than studying fluctuations in total sales because of elimination of the population factor, which otherwise tends to conceal the presence of other significant variables. For some commodities, sales per family or per household would be more meaningful than sales per capita, but the latter concept was used throughout this part of the study because of the more questionable nature of family estimates for individual cities.

The simple correlation between per capita sales and per capita income reveals a virtual absence of correlation for all types of retail stores studied. Coefficients of determination varied from .0001 to .15.

However, these results may not be too meaningful because of the omission of other relevant factors. Accordingly, income was incorporated as an independent variable in a series of multivariate regressions containing various combinations of the following other independent variables: per cent of families earning over $7,000, distance to nearest larger

TABLE 3
REGRESSION OF TOTAL PER CAPITA SALES ON ALTERNATIVE SETS OF INDEPENDENT VARIABLES[a]

Function no.	Estimate of coefficient (elasticity) of[b]						R^{*2}
	Constant term	Distance	Income per capita	Ratio of stores in given city to stores in larger city	Stores per 10,000 population	% earning over $7,000	
2.1	3.05**	.102**		.00550			.30
2.2	2.86**	.0719**			.283**		.41
2.3	2.82**	.0555*		.0231	.318**		.41
2.4	2.79**	.0655**	.714**		.583**		.64
2.5	2.36**	.0871**			.468**	.269**	.57
2.6	2.30**	.108**		—.0251	.467**	.322**	.57
2.7	5.58**	.0702**	.604**		.581**	.0646	.63
2.8	5.87**	.0863**	.579**	—.0184	.576**	.112	.63

[a] All regressions carried out in logarithmic terms.
[b] One asterisk indicates statistical significance at the .05 probability level; two at the .01 level.

city, number of shopping goods stores[10] per 10,000 population, and ratio of "shopping goods" stores in given city to number in next larger city. A number of regressions using different sets of these variables is presented in Table 3.

The main results from Table 3 can be summarized as follows:

1. Contrary to the previous findings, income turns out to be highly significant in every instance. The elasticity of sales with respect to income is in fact higher than the elasticity for any other variable: a 10 per cent increase in income is associated with an increase of 6 to 7 per cent in per capita retail sales.

2. The income distribution variable—per cent earning over $7,000—is statistically significant only when it does not appear in conjunction with income per capita. This phenomenon is clearly due to the intercorrelation between these two variables (the simple coefficient of determination is .68). On the basis of general considerations as well as on an examination of such statistical measures as the (standardized) beta coefficients, income per capita appears to be a dominant factor; once income is included, income distribution makes little net contribution to the relationship.

3. Distance remains a highly important variable. Nevertheless, the *magnitude* of its effect on sales is not high, a 10 per cent increase in distance being associated with a less than 1 per cent rise in sales.

4. The number of retail stores in relation to a city's population is an important determinant of per capita sales, while the number of stores in a given city relative to those in the closest larger city is not. As in the case of total sales, the latter variable is not statistically significant. Within the range of observation, however, the number of stores in the given city in relation to population becomes of major importance, a 10 per cent rise in this variable being associated with an increase of about 5 per cent in per capita sales.

These findings point to income, distance, and number of stores relative to population as major determining factors in the intercity variation in per capita sales.[11] These three variables, incorpo-

[10] Included are eating and drinking places, apparel stores, general merchandise stores, furniture stores, and auto dealers.

[11] In the case of the stores variable, it can be argued that sales is as likely to be a cause of the number of stores as vice-versa. Use of the latter interpretation in this study is predicated on the focus of the study on short-run (one-year) relationships and the likelihood that relatively little change takes place in the number of stores in an area within the course of a year.

rated in equation (2.4) in Table 3, account for nearly two-thirds of the variation in per capita sales. The relative importance of these variables in influencing sales is indicated by the following standardized regression coefficients:

Income	.605
Distance	.359
Stores per 10,000 people	.757

An attempt was made to detect additional significant variables through simple correlations with the residuals of (2.4). However, none of the variables tested proved significant; included were recent increase in population, recent increase in per capita income, the ratio of population in the next larger city to that in the given city, and all retail stores per 10,000 population.

To what extent do the above findings remain valid for individual categories of retail sales? Application of the function form represented by (2.4) to each of the categories of retail sales used in this study reveals considerable variation in goodness of fit and in the relevance of these variables in each case. The coefficients of determination range from .12 and .21 for lumber and for food, respectively, to .55 for furniture, with most values between .35 and .45—a considerable drop from the proportion of variance in all per capita sales explained by these three variables. In addition, each variable failed to influence significantly one or more categories of retail sales, as shown below:

Distance	*Stores per 10,000 people*	*Income*
Food	Lumber	Eating and drinking
Gasoline		Gasoline

The evidence is, therefore, fairly clear that the forces influencing intercity variations in per capita sales differ by type of sales, and that a more or less individualistic approach is needed in each case. In line with this approach, hypotheses were advanced to account for the intercity variation in each category of retail sales, and several regressions tested for each category. Variables studied included, besides those already mentioned: stores in the given category per 10,000 people, age distribution of population, and distance to the nearest metropolitan area (Chicago or St. Louis). By means of the same general approach followed in examining the regression functions for all retail sales per capita (Table 3), a set of "best" regression functions was se-

TABLE 4

REGRESSION OF PER CAPITA SALES ON SELECTED INDEPENDENT VARIABLES, BY TYPE OF RETAIL STORE[a]

	Estimate of coefficient (elasticity) of[b]							
Type of store	*Function no.*	*Constant term*	*Distance*	*Income*	*Stores per 10,000 population*	*Stores of given type per 10,000 population*	*% of population aged 20–50*	R^{*2}
All	2.4	2.79**	.0655**	.714**	.583**			.64
Food	2.9	1.30**		.283	.400**			.21
Eating and drinking	2.10	−1.46**				.728**	1.50**	.62
General merchandise	2.11	−3.90**	.263**	1.44*	1.11*			.39
Apparel	2.12	−2.09**		.884**	1.13**			.64
Furniture	2.13	−1.02**	.111*	.561*	.536*	.537**		.64
Automotive	2.14	−2.80**	.0725	1.39**		.714**		.50
Gasoline	2.15	1.35**				.540**		.57
Lumber	2.16	1.51**				.606**		.37
Drug	2.17	− .038**	.0934**	.522**		.407**		.51

[a] All regressions carried out in logarithmic terms.
[b] One asterisk indicates statistical significance at the .05 probability level; two at the .01 level. Coefficients without asterisks are significant at the .10 level.

lected for retail sales by category. These functions are presented in Table 4.

The variables appearing in this table are in general the same as those used earlier, for the only other variable to prove statistically significant was age distribution for eating and drinking stores. At the same time, however, it is clear that the magnitude and nature of the effect of these variables differ substantially by type of retail sales. Curiously enough, distance (which was so influential for total sales) influences significantly per capita sales of only four of the nine categories; and the elasticity in those instances is fairly low. On the other hand, income now appears to be a major determinant of five categories of sales, and possibly a sixth as well. For two categories of sales—general merchandise and automotive—a given (relative) change in income produces a more-than-proportionate change in sales, indicating that sales of these goods are highly sensitive to changes in per capita incomes.

At least as important as income in influencing variations in per capita sales is the availability of goods, as reflected in the significance of stores-per-10,000-population variables in every case. One or the other of these variables was found to account for the most influence in every one of the nine categories. These variables appear to have a particularly strong effect on the sales of apparel, automobiles, and furniture, besides being the only significant factor in influencing gasoline and lumber sales.

It is interesting to note the significance of both variants of the stores variable in the case of furniture and the almost identical elasticities although the two variables are not closely correlated with each other ($r^2 = .40$). Evidently, in the case of furniture sales there is both the drawing power of the overall shopping facilities that are available, as well as of the facilities for purchasing that particular type of goods. As a general rule, the number of stores of a given type is most influential for sales of specialty items, whereas city sales of stores carrying broad lines of goods are most affected by the breadth of available shopping facilities, as reflected in the more general stores variable.

A major point evident from Table 4 is that the extent to which the explanatory variables account for the fluctuations in sales varies substantially by type of sales. The proportion of variance explained varies from about one-fifth in the case of food to nearly two-thirds in the case of apparel and furniture. Clearly, for such categories of sales as lumber and general merchandise as well as for food, there is considerable room for improvement in the effectiveness of the relations. To what extent the large unexplained variances are due to the absence of other relevant variables and to what extent they are due to errors of observation in the original data is a matter for future study.

CONCLUSION

The present analysis reaffirms the importance of income in one sense, and supports its unimportance in another sense. The multivariate approach used indicates that total income is of little importance in accounting for variations in total retail sales between the communities studied, both for individual categories of sales and for all categories combined. The two variables included in Reilly's Law and in subsequent formulations—*population* and *distance*—account for almost all the variations in sales between cities. On the other hand, the estimates obtained of the coefficients of these variables in the multiple regressions do not seem to provide much support for the values attached to the variables in these other formulations.[12]

[12] A rigorous test of the validity of these retail gravitation principles is a major study in itself and because of differences in comparability of the data is not possible with the present findings. The nature of these differences is, however, rather fundamental to studies in this area, and can be highlighted as follows:

Let

E_{ij} be expenditures in city *i* stores by people living in city *j*.
D_{ij} be the distance between cities *i* and *j*.
I be the "inertia factor," D_{ii}.
P_i be the population of city *i*.
S_i be total retail sales of the stores in city *i* ($= E_{ii} + \Sigma_j E_{ij}$)

The Converse adaptation of retail gravitation is most convenient for the present purposes. If *1* represents the home town and *2* the competing town, we have:

$$(3.1)\quad \frac{E_{11}}{E_{21}} = \frac{P_1}{P_2}\left(\frac{D_{12}^2}{I}\right) = \frac{P_1}{P_2}\, D^2_{12}, \text{ if I is truly a constant.}$$

The results obtained in this study are contained in the formulation involving S, i.e.:

$$(3.2)\quad S_1 = \alpha\, P_1^{\beta} D_{11}^{\gamma}$$

where D_{11} represents the distance between city *1* and the closest town of equal or larger size, city *i*.

Applying (3.2) to cities *1* and *2*, and dividing one by the other, we have:

$$(3.3)\quad \frac{S_1}{S_2} = \frac{E_{11} + E_{12}}{E_{21} + E_{22}} = \alpha \left(\frac{P_1}{P_2}\right)^{\beta} \left(\frac{D_{12}}{D_{2j}}\right)^{\gamma}$$

Conceivably $D_{2j} = D_{21}$, in which case the distance term drops out altogether. We shall assume, however, that this is not the case.

The comparability of (3.3) with (3.1) is confounded by the presence of E_{12} and E_{22} in (3.3).

If the parameters of (3.1) and (3.3) nevertheless are directly comparable (which is obtainable by assuming, say, that the extent to which a town retains its residents' trade is in direct proportion to the ratio of its total sales to that of its competitor town), the distance exponent of 2 is clearly not supported by the data in Table 2, and the validity of the population exponent of 1 varies with the category of sales being studied. In addition, the high significance of the constant term in all cases where (3.2) was tested indicates that additional factors are missing from the present formulations of retail gravitation.

The results of this study also indicate that, contrary to initial impressions, income is a major factor influencing variations in per capita retail sales between cities for most categories of sales. The relationship only becomes apparent after the interacting influence of other variables has been removed. At the same time, the influence of income, as of other factors, varies substantially by type of sales. The same set of variables does not supply the best explanation of variations in sales or expenditures for different categories.[13]

Finally, this study indicates that supply factors are at least as important as demand factors in influencing sales variations between cities in the range of observations covered in a prosperity year such as 1954.

All of these results, of course, apply primarily to the locale and period of this study. Applicability to other conditions needs to be investigated.

[13] R. Ferber, *Expenditures for Services in the United States: Their Growth and Some Factors Influencing Them.* Conference on Consumption and Economic Development, Universities-National Bureau Committee for Economic Research, Princeton, N. J., October, 1955.