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The Growth of Sales Per Man-Hour in Retail Trade, 1929–1963

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NEW SCHOOL FOR SOCIAL RESEARCH

INTRODUCTION

THIS paper reports some of the results of an analysis of the growth of constant-dollar sales per man-hour in retail trade between 1929 and 1963. I will estimate the contribution of the reduction of service per transaction and of the growth of average transaction size. Quantity of service is not directly observable; therefore the estimates are obtained by roundabout procedures. An analysis of the change indicates that the price of retail service increased greatly during the period with the consequence of a decline in the quantity of service per transaction and thus an increase in constant-dollar sales per man-hour. The effect of the price increase was not offset by the greater demand for service produced by the growth of average family income. In addition, the large increase in average transaction size contributed an important part of the gain in sales per man-hour.

A variety of services accompany the goods distributed by retailers: delivery, credit, help in obtaining items from shelves, advice in the selection of goods, a variety in goods stocked, processing (e.g., meat cutting, compounding of drugs, preparation of meals, fitting clothes), judgment of quality, search for merchandise desired by customers.

NOTE: The study of retail trade, of which this paper is a product, is part of the service industries project of the National Bureau of Economic Research. Victor Fuchs, the director of the project, has been a very helpful colleague. I wish also to acknowledge the research assistance of Lynda Psachie, Linda Nasif, Judy Mitnick, and Avrohn Eisenstein, who worked with me at various times. The project has had the support of the Ford Foundation. Neither the staff nor the Directors of the National Bureau have reviewed the present paper; it represents only my own views.

The different dimensions make it difficult to measure the quantity of retail service; and the quantity of components such as sales help cannot be measured in units of any easily observed scale. These problems are not peculiar to retail trade. Manufacturers of industrial equipment supply, along with goods, technical and other services whose measurement presents similar problems. The quantity of service is ignored in the measurement of manufacturing output, presumably with no great loss of accuracy. The potential error in the case of retail trade, however, is relatively large.

The procedure of the U.S. Department of Commerce and others for the measurement of retail output recognizes that it consists of the services associated with the distribution of goods. Establishments are grouped according to the store-type classification of the Census Bureau: e.g., "Eating places," "Gasoline service stations," and "Furniture stores." Across store-types the quantity of service per dollar of sales varies with the quantity of factors employed per dollar of sales. The measure of the quantity of service per dollar of sales therefore is the gross margin percentage, which is

$$\frac{\text{Total sales} - \text{cost of goods sold}}{\text{Total sales}},$$

or "the margin" for short. Thus, across store-types output per dollar of sales is assumed to be proportional to the margin. The procedure also assumes that the quantity of goods sold as measured by constant-dollar sales is a good measure of the output of individual store-types. Current-dollar sales are corrected for the changes in prices of goods as measured by Consumer Price Index (CPI) components, which, it should be noted, ignore changes in the retail services associated with the goods. It is very important to observe that the change in constant-dollar sales is less than the change in output if service per dollar of sales increases within store-types, and the opposite is true if service per dollar of sales declines.

The method just described is followed despite obvious objections because it is not clear that others are superior. The Commerce method assumes that the growth of constant-dollar sales per man-hour within store-types is due entirely to technological changes or other sources

of change on productivity: output per dollar of sales remains constant. If output were measured by man-hours the assumption would be that constant-dollar sales per man-hour varied inversely with service per dollar of sales.

The census classification, on which the Commerce procedure is based, groups stores according to type of goods sold. Its major purpose is to assist the analysis of the sales of goods by retailers rather than the measurement of the quantity of service. The defense of the use of this classification for the estimation of retail output method is that the sale of a dollar's worth of goods in a particular class is associated with a typical quantity of service. But the classification does not recognize delivery service or credit service. Nor does it recognize the developments signified by popular and trade usage, such as supermarkets, chain stores, and discount stores. Margin-weighting thus may be only token service to the principle that retail output consists of services. This possibility is supported by the fact that margin-weighting makes little difference despite the changes associated with the developments already referred to. The differences in margins and the shifts in sales have not been sufficiently large for margin-weighting to significantly influence the estimate of the rate of growth of retail output. Between 1929 and 1963 the average annual rate of growth of unweighted constant-dollar sales was 2.86 per cent; the average annual rate of growth of margin-weighted constant-dollar sales was 2.79 per cent.[1] The small difference may reflect the failure of the classification to reveal shifts in sales between stores offering different quantities of service per dollar of sales.

Doubt concerning the validity of the margin-weighted sum of constant-dollar sales as a measure of output arises also from the difficulty of explaining its growth. Employment in retail trade grew at an average annual rate of 1.56 per cent between 1929 and 1963, and average weekly hours declined by .50 per cent per year. Margin-weighted con-

[1] Both estimates are my own. They are based on the censuses of 1929 and 1963. The measurements of the OBE are based on the Bureau of Census's *Annual Survey of Retail Sales,* and the OBE estimates of retail sales in constant dollars do not go back as far as 1929. Since the weighting system and the store-types used in obtaining the estimates presented here are similar to those used by the OBE, the effect of weighting on the estimate which is reported here should be approximately the same as the corresponding effect on the OBE estimate.

stant-dollar sales increased by 2.79 per cent per year, as I have already mentioned. Thus margin-weighted constant-dollar sales per person engaged-hour increased at an average annual rate of 1.73 per cent. Various studies attribute the growth of output per man-hour in the economy as a whole and in individual industries to growth in the quality of labor, in the quantity of capital, in the utilization of capacity, and in the utilization of scale economies. The contribution of technological change is estimated as a residual, therefore, unless it represents a small share of the total growth in output per man-hour, the other estimates are doubtful. Table 1 reports my estimates of the contribution of each of these components to the increase in output per man-hour in retail trade, and compares the sum with the growth of margin-weighted constant-dollar sales per man-hour. As the table shows, the change in margin-weighted constant-dollar sales per man-hour remains unexplained.

One possible explanation for the large positive residual is that the quantity of service per dollar of sales has declined. Suppose the quantity of service per dollar of sales remained the same. The residual

TABLE 1

The Average Annual Rate of Growth of Output Per Man-Hour in Retail Trade Between 1929 and 1963 Due to Various Components Compared to the Average Annual Rate of Growth of Margin-Weighted Constant-Dollar Sales Per Man-Hour
(per cent)

The quality of labor	−.63	
The quantity of capital	.20	
Utilization of capacity	.16	
Utilization of scale economies	.06	
Total	−.21	
Margin-weighted constant-dollar sales per man-hour		1.73
Excess over the sum of components of growth in output per man-hour		1.94

NOTE: Estimates based on unpublished study for National Bureau of Economic Research.

then would be an estimate of the contribution of technological progress. To ascribe an average annual rate of growth of sales per man-hour of 1.94 per cent to technological progress appears excessive.

This paper focuses on the estimation of service per dollar of sales, space and time limitations prohibit a description of the procedures underlying the estimates shown in Table 1. I cannot, however, pass over the estimate of the change in the quality of labor without comment: readers may find it hard to believe that the quality of retail labor deteriorated, while, as various studies have indicated, the quality of labor in general improved.

The procedure included a measurement of the change in quality of labor in the economy as a whole based on the age, sex, and education characteristics of the labor force. I relied on estimates of average hourly earnings of employed persons in nonagricultural industries, based on the 1/1,000 Sample of the 1960 Censuses of Population and Housing. The average earnings were estimated for individual age, sex, and education characteristics. These estimates were the weights for the measurement of the change in the quality of the labor force associated with changes in the socio-demographic composition. The resulting estimated gain in the quality of labor in the entire economy between 1929 and 1963 was 10.4 per cent.[2]

The estimated change in the quality of labor in retail trade was

[2] This is much less than Denison's estimate of a 35 per cent gain between 1929 and 1957 (Cf. E. F. Denison, *The Sources of Economic Growth in the United States and the Alternatives Before Us*, New York, Committee for Economic Development, 1962, Chapters 6–9.) Denison used Houthakker's estimates of average annual income in 1950 of males between the ages of 25 and 64 by years of schooling to estimate the association between quality of labor and education. These figures indicate an increase in earnings of 40 per cent between those with eight and those with twelve years of schooling. The estimates which I used indicated an increase of 18 per cent between seven and twelve years of schooling. I select these figures for comparison because the shift of the distribution of employed persons by years of schooling was largely within the interval seven to twelve years. Denison's figure is higher because he includes as part of the quality of labor the effect of differential unemployment, weekly hours, immobility on agricultural wages, and property income. (Cf. my "Contribution of Education to the Quality of Labor, 1929–1963," *American Economic Review*, June 1968, pp. 508–514.) In addition, Denison estimates a large improvement in the quality of labor resulting from the reduction in fatigue associated with the reduction in hours. The evidence that there was a significant increase in productivity from this source is very doubtful. (Cf. Irving Leveson, "Reductions in Hours of Work as a Source of Productivity Growth," *Journal of Political Economy*, April 1967, pp. 199–204.)

obtained by multiplying the index 110.4 by an index of relative average hourly earnings in retail trade, which was 73. The product was 80.6, which is the index of the quality of labor in retail trade in 1963 on base 1929. Earnings in retail trade did not advance as rapidly as elsewhere, and the slow growth of unionism in retail trade does not appear to explain the relative decline.[3] I therefore interpret the index of relative earnings as signifying a decline in the relative quality of retail labor. The conclusion that the absolute level of quality also declined is consistent with observed changes in the age, sex, and education characteristics of retail labor.[4]

[3] H. G. Lewis estimates a relative decline of 3 per cent in earnings in the nonunion sector owing to increases in unionism elsewhere between 1929 and 1958. The estimate is not corrected for the association between the relative change in unionism and the relative change in the quality of labor. (Cf. H. G. Lewis, *Unionism and Relative Wages in the United States,* Chicago, 1963, p. 193.) Greater unionism in some sectors may have been an expression of improved labor quality. In addition, firms which became unionized and raised wages probably improved the quality of labor which they were able to obtain. They retained the freedom to choose among applicants for employment, and they were able to make greater demands. The relative decline in quality in the nonunion sector thus could easily have offset the relative drop in earnings of 3 per cent.

[4] Readers may feel that the estimated rate of change of the quality of labor, −.63 per cent per year, exaggerates the actual change. Thus they may feel that the quality of labor in the entire economy improved by more than 10.4 per cent because of a reduction of fatigue associated with the shortening of hours; in the absence of satisfactory evidence they may be inclined to accept at least part of Denison's estimate of an improvement of .36 per cent per year from this source. They may also believe that unionism did result in a relative decline in earnings in retail trade for labor of constant quality. Moreover, the relative decline in average earnings of retail labor of 27 per cent reflects in part a shift of labor from agriculture to other industries, and earnings in agriculture have been low because of immobility and other reasons. The figures may be adjusted to conform to alternative assumptions, if those on which the estimate is based are found unacceptable. There may be other biases, however, which tend to produce an underestimate of the decline in the quality of labor in retail trade. I have used Denison's figure, .6, as an estimate of the contribution of education to the differentials in earnings associated with years of schooling: the remainder is attributable to associated ability differentials. Becker presents some data which indicate that Denison's figure is too high. (Cf. G. S. Becker, *Human Capital,* New York, NBER, 1964, p. 125.) If I had used the figure .5, the estimated improvement of the quality of labor in the entire economy would have been smaller. In addition, on-the-job education appears to have grown more slowly than formal education (Cf. Jacob Mincer, "On-the-Job Training: Costs, Returns, and Some Implications," *Investment in Human Beings,* Universities-National Bureau Conference 15, New York, NBER, Supplement to Journal of Political Economy, October 1962): a measure of the quality of labor based on the change in formal education uncorrected for on-the-job training will exaggerate the improvement. Finally, average earnings in retail trade tended to increase with the withdrawal of small stores. As I demonstrate in the study, from

Let us return to the main question, the analysis of the change in margin-weighted constant-dollar sales, which as we have just seen is not explained by the changes in the quality of labor, the quantity of capital, and other components of growth of output per man-hour. We will explore the importance of service per dollar of sales.

We can analyze constant-dollar sales per man-hour (S/H) as follows:

$$\frac{S}{H} = \frac{AN}{H}$$

where S = sales in constant dollars; H = man-hours; A = average transaction size in constant dollars; N = number of transactions. Between 1929 and 1963 retail purchases per family increased, and it is unlikely that the number of purchases (N) rose proportionally. Assuming that average transaction size (A) rose, S/H, sales per man-hour, increased proportionally, unless the change produced an offsetting decline in the number of transactions per man-hour (N/H). Later I present an estimate of the change in average transaction size, and I consider the relation between transaction size and the service per transaction. In addition S/H, constant-dollar sales per man-hour, will increase with the number of transactions per man-hour (N/H). A man can handle more transactions in an hour if the amount of service per transaction declines. It will be argued that the price of retail service rose resulting in a decline in the quantity of service per transaction.

The foregoing analysis illuminates the relation between constant-dollar sales per man-hour and service per dollar of sales. An increase in average transaction size without an offsetting growth in service per transaction represents a decline in service per dollar of sales. A decline in the service per transaction has the same implication. Thus the growth of constant-dollar sales per man-hour may reflect a decline in the quantity of service per dollar of sales.

which this paper is derived, proprietors and employees of small stores have earnings below the level that persons of similar skills receive in other industries. The change is similar to that observed in agriculture, where earnings also have been less than in other industries. The index of relative earnings in retail trade thus may understate the relative decline in labor quality. These considerations suggest that the index of quality of labor in Retail Trade does not exaggerate the change which has occurred.

If the quantity of service per dollar of sales was the same over the period, then the growth of constant-dollar sales per man-hour reflected technological progress. The most dramatic development in retail trade was the widespread adoption of self-service: Food stores were followed by department, variety, hardware, drug, and other store-types. The trend may have manifested technological progress, for surveys in food stores suggest that consumers prefer self-service to clerk-service. The technological interpretation regards the check-out counter and the pushcart as important innovations, i.e., the failure to adopt self-service earlier was due to ignorance.

Another interpretation is that the trend to self-service was a response to the increased price of labor. Retailers were aware of the possibility of self-service much before the forties, when it began to spread rapidly. Experiments were conducted in the teens and twenties especially in southern California and Texas. The Piggly Wiggly stores adopted self-service and grew to be a national chain with 2,660 stores and $180 million in sales.[5] The firms which acquired the Piggly Wiggly stores after the company went into bankruptcy, however, discontinued the policy. The importance of market conditions is also seen in the fact that the most successful and persistent self-service food stores were located in the Los Angeles area where wages were high and the ownership of automobiles widespread. The effect of high wages on the cost and therefore the price of service and its consumption is evidenced by the high sales per worker in nonfood as well as food stores in California throughout the whole period under study. Moreover, the spread of self-service has been extended into other store-types, where consumers appear to welcome it less readily. The adoption of self-service by other store-types has been slow: department stores did not adopt self-service techniques widely until the late fifties, and the discount drug store is a newcomer. Evidence of the importance of the price of service in the shift to self-service is seen also in the slowness of the change in countries other than the United States, and the rate of adoption appears to be correlated with the wage level across countries.

The next section estimates the change in average transaction size,

[5] M. M. Zimmerman, *The Super Market: A Revolution in Distribution*, New York, 1955, p. 22.

in the quantity of service per transaction, and the resulting increase in constant-dollar sales per man-hour. Here we will estimate the actual change in average transaction size and in the quantity of service per transaction. No attention will be given to the effect of average transaction size on the quantity of service per transaction. In subsequent sections we will analyze the sources of the change in service per transaction, including the change in average transaction size. In addition, we will estimate the effects of price and income changes on the quantity of service per transaction.

TRANSACTION SIZE, THE QUANTITY OF SERVICE PER TRANSACTION, AND SALES PER MAN-HOUR

We will consider transaction size first. Indexes of average transaction size in constant dollars in 1963 on base 1929 for various store-types are shown in Table 2 together with notes on methods of estimation and sources of data. The index for food stores, 384, was much higher than that for any other store-type. Changes other than the growth of incomes contributed to the change in food stores: the increase in automobile usage, the frequency of food shopping, the increased cost of time associated with the increase in the wage level, and the increase in the fraction of married women in the labor force. Special factors can also be seen in the large increases in average transaction size in gasoline stations, drug stores, and furniture stores. The quantity and quality of gasoline consumed increased greatly. The introduction of new drug products after World War II brought about much larger transactions. The sales of such high-unit price items as major household appliances, television sets, the air-conditioners grew rapidly in furniture stores. At the other extreme, apparel stores experienced a decline.[6]

To combine the indexes of average transaction size of individual store-types, I weighted each of them by employment and obtained an

[6] The index for apparel stores may reflect the inadequacy of the CPI correction for quality improvement. Moreover, consumers may now prefer more variety than in 1929 and purchase a larger number of individual items rather than better quality. In addition, the increase in the wage level has raised the relative price of well-tailored clothes along with other labor-intensive goods which are produced by industries where productivity growth has been slow.

TABLE 2

Indexes of Average Transaction Size in 1963 on Base 1929 by Major Store-Type and Sources

Store-Type	Index	Sources
General merchandise	106	1929: M. P. McNair and E. G. May, *The American Department Store, 1920–60,* Cambridge, Mass., 1963, p. 11. 1963: National Retail Merchants Association, *Operating Results of Department and Specialty Stores, 1963*, p. 4.
Food stores	384	1929: U.S. Federal Trade Commission estimate for 1938 in *Economic Inquiry into Food Marketing*, Part I, Jan. 1960, p. 55. Assumed to be approximately equal to average purchase in 1929. 1963: Estimate based on surveys by Supermarket Institute, Progressive Grocer, and Leland E. Ott (Ph.D. Dissertation, Indiana University, 1964).
Automotive dealers	145	New automobile sales divided by number sold, as reported by Automobile Manufacturers' Association, deflated by CPI component for new automobiles.
Gasoline stations	223	Change in quality estimated from change in average octane rating derived from industry sources and from Bureau of Mines. Quantity estimate based on change in average size of automobile gas tank.
Apparel, accessory stores	83	National Retail Merchants Association, *Departmental Merchandising and Operating Results*, 1950 Edition, p. 365 and 1964 edition, p. 4.
Furniture stores	170	National Retail Furniture Association reports of average sale.
Drug stores	224	Wroe Alderson and N. A. Miller, *Costs, Sales, and Profits in the Retail Drug Store,* U.S. Foreign and Domestic Commerce Bureau, Domestic Commerce Series No. 90, 1932; Orin E. Burley, Albert B. Fisher, Robert Cox, *Drug Store Operating Costs and Profits,* New York, 1956; Speech of J. O. Peckham of A. C. Nielsen Company on May 11, 1959.

average index of approximately 200. This is our index of average transaction size for retail trade in constant dollars.

The change in the quantity of service per transaction can be estimated on the basis of the change in the value of retail service, the price of retail service, and the number of transactions. Thus

$$P_rQ_r/P_r = Q_r,$$

where P_r = index of the price of retail service; Q_r = index of the quantity of retail service; and

$$P_gQ_g/A = N,$$

where P_g = index of the average price of goods; Q_g = index of the quantity of goods; A = index of the average transaction size in current dollars; N = index of the number of transactions. To obtain the change in the quantity of service per transaction we need to estimate the value of Q_r/N, or

$$\frac{P_rQ_r}{P_r} \times \frac{A}{P_gQ_g}.$$

It should be noted that P_rQ_r/P_gQ_g is the index of the gross margin percentage.

We have estimated the index of A in constant dollars at 200. In current dollars this is equivalent to 356. The gross margin percentage for retail trade has remained approximately the same: the index is 100. This leaves only the index of P_r to be estimated. I will assume the following:

1. The quantity of service per transaction did not increase in any store-type, except insofar as an increase in the number of items and the associated change in the nature of the merchandise required more service. The later discussion of the change in average transaction size in relation to the quantity of service will defend this assumption.

2. The prices of factors to the different store-types changed by the same proportion.

3. The rate of technological advance was uniform among the store-types.

The estimate of the change in the price of retail service will be based on an analysis of the changes in the gross margin and in average transaction size. I first will estimate the change in P_r/P_t, where P_t stands for the general price level. It is convenient to approach the problem by way of the change in the gross margin of the average transaction. The gross margin percentage for the average transaction in any store-type is the same as that of total sales. Hence the gross margin percentage for total sales P_rQ_r/P_gQ_g can be used to estimate the change in the gross margin of the average transaction. To remove Q_g, I multiplied the index of the margin by the index of average transaction size, which measures the quantity of goods per transaction. Here Q_g is represented by the index of average transaction size. The product, P_rQ_r/P_g, was multiplied by P_g/P_t, the relative price index of goods sold by the store-type, in order to arrive at P_rQ_r/P_t. I have assumed that the rate of technological advance was the same among store-types and that factor prices changed by the same proportion. It follows that the rate of change of P_r/P_t is the same among the store-types, and variation in P_rQ_r/P_t reflected differences in the change in Q_r, the quantity of retail service per transaction. The index of Q_r was adjusted in the case of food stores for the change in service entailed by the change in transaction size. The evidence relating to the effect of transaction size on the quantity of service is presented later. I have assumed that the quantity of service per transaction did not increase, apart from the effect of transaction size. It follows that the store-type showing the highest index of P_rQ_r/P_t, after adjustment in the case of food stores, was the one in which Q_r declined the least. The index for that store-type then should be the best measure of P_r/P_t for retail trade.

The highest index was the one for drugs, 236. The next highest one, 225, was for gasoline stations, and the closeness of the two figures supports each of them as an estimate of the change in the relative price of retail service. I interpret the low values of the index (Table 3) in the other store-types as indicating a large decline in the quantity of service per transaction. As I suggested earlier, the trend towards less service per transaction in drug stores appears to have accelerated since 1963. An index of P_rQ_r/P_t in drug stores based on more recent data probably would be lower. The experience of drug stores thus

TABLE 3

Indexes of $\frac{P_rQ_r}{P_gQ_g}$, Q_g, $\frac{P_g}{P_t}$, and $\frac{P_rQ_r}{P_t}$, by Store-Type in 1963 on Base 1929

Store-Type	$\frac{P_rQ_r}{P_gQ_g}$	Q_g	$\frac{P_g}{P_t}$	$\frac{P_rQ_r}{P_t}$
General merchandise	103.8	106	98	108
Food stores	98.3	159	104	163
Automobile dealers	88.2	145	115	148
Gasoline stations	132.6	223	76	225
Apparel stores	108.2	83	110	99
Furniture stores	91.3	170	77	119
Eating places	–	–	–	157
Drug stores	98.6	224	107	236

P_rQ_r/P_gQ_g is the index of the gross margin.

Q_g is the index of average transaction size. In the case of food stores it represents the index after adjustment for the association between transaction size and service per transaction.

P_g/P_t is computed by dividing the store-type price index by the CPI.

P_rQ_r/P_t is the product of the three preceding indexes. The estimate for eating places measures P_r/P_t. See text.

suggests that an index based on the data for this store-type would be a good measure of the change in the relative price of retail service. An alternative interpretation of the high value of the index in drug stores is that technological advance here was less rapid than in other store-types.

In order to make a conservative estimate of the rise in the price of retail service, I selected the index of P_rQ_r/P_t for gasoline stations rather than that for drug stores. The estimate of the index of the relative price of retail service in 1963 on base 1929 therefore is 225.

The change in P_r, the price of retail service, is estimated by the product of 225 and the CPI for 1963 on base 1929, which is 178, and the result is 400.

The change in the quantity of service per transaction is the index of the average transaction size in current dollars, 356, divided by the index of the price of retail service, 400. The index of retail service per transaction is 89.

The increase in constant dollar sales per man-hour due to the

growth of average transaction size in constant dollars was 100 per cent, which is equivalent to an average annual rate of growth of 2.04 per cent. The increase which was due to the decline in service per transaction was 12 per cent, which is equivalent to an average annual rate of growth of .33 per cent. Thus constant dollar sales per man-hour grew at an average annual rate of 2.37 per cent as a result of both factors.

The estimate of the change in sales per man-hour due to the growth in transaction size is uncorrected for the associated change in service per transaction. The estimate of the contribution of the change in service per transaction includes this change as well as that originating from income and price movement. Later sections of the paper correct the estimate of the contribution of average transaction size for the associated change in service per transaction and estimate the change in service due to increases in income and the price of service.

The estimate of the contributions of average transaction size and of service per transaction more than account for the estimated growth of constant-dollar sales per man-hour, perhaps because I exaggerate the growth of average transaction size. Such an error would not only overstate the contribution of transaction size, but also would lead to an overestimate of the decline in service per transaction, through its effect on the computed price change. On the other hand, the reason for the excess of the apparent change in service per dollar of sales over that of sales per man-hour may be an underestimate of the growth in constant-dollar sales: others have suggested that the CPI components used to deflate sales underestimate the increase in the quality of goods. In any case, I do not claim accuracy; the estimates are used only to indicate that the change in average transaction size and the service per transaction have been responsible for a major share of the change in sales per man-hour.

THE EFFECT OF TRANSACTION SIZE ON THE QUANTITY OF SERVICE PER TRANSACTION

We must consider the impact of transaction size on the service per transaction, apart from the effect of the associated increase in income. Large transactions may entail more handling, perhaps because they represent a larger number of items.

The increased size of the transaction in food stores contained an increase in the number of items which required additional handling per transaction. The index of the number of items is estimated at 269.[7] Accordingly, I adjusted the index of average transaction size by a factor representing the number of additional man-hours required at the counter to handle the greater number of items, which was based on studies of operations of check-out counters.[8] In addition, an allowance was made for shifts in expenditures to items, such as frozen foods, requiring more service per item. The allowance was based on a regression analysis of the relation between gross margins and average price per item in a supermarket chain. The index of average transaction size adjusted for the associated change in service is 159.

I did not adjust the index of average transaction size of any other store-type. Trade sources indicate that there is less compounding done in drug stores today than in 1929. The trend to self-service in department, apparel, drug, hardware, and other stores represents less service per transaction. Furniture stores appear to offer less service per transaction. Discount stores with little sales help and small displays, which relied on manufacturers' catalogues to describe merchandise, appeared early among furniture stores selling major household appliances, and other furniture stores followed in reducing sales help.

A judgment of the likelihood of an increase in the quantity of service per transaction can be based on the proportion of the growth in constant-dollar sales per man-hour accounted for by other components. Table 4 compares the average annual rate of growth of constant-dollar sales per man-hour in each of eight major store-types with the sum of

[7] In 1929 average per capita food consumption weighted approximately 5 per cent more than in 1963 (U.S. Department of Agriculture, *Consumption of Food in the United States, 1909–52*, Agricultural Handbook No. 62, Supplement for 1956). Per capita food expenditures increased by 153 per cent over the same period (*Economic Report of the President, 1966*, Tables C8, C19), which corrected for the change in weight represents an increase in expenditure per pound of 165 per cent. Correction of the increase by the CPI food component gives us the change in price per pound due to quality improvement, 43 per cent. The index of average transaction size 384 divided by the index of quality yields an index of the number of items of 269. The index overstates the gain to the extent that it reflects the growth in average weight per item which appears to have taken place, e.g., bread now comes in two-pound loaves as well as the traditional one-pound size.

[8] Edward M. Harwell and Paul Shaffer, *Checkout Operation and Self-Service Retail Food Stores*, U.S. Department of Agriculture, Information Bulletin No. 31, Washington, D.C., 1951, p. 59, Table 14.

TABLE 4

The Average Annual Rate of Growth in Constant-Dollar Sales Per Man-Hour Due to Average Transaction Size, Quality of Labor, Capital, Utilization of Capacity and Economies of Scale 1929–63 Compared to the Rate of Growth of Constant-Dollar Sales Per Man-Hour Due to All Factors by Store-Type

	Annual Rate of Growth of Sales Per Man-Hour Due to							
Store-Type	Transaction Size (1)	Quality of Labor (2)	Capital (3)	Capacity (4)	Scale (5)	Sum of Components (6)	Sales Per Man-hour (7)	Residual (7) − (6) (8)
General merchandise	.16	−.45	.26	–	–	−.03	1.89	1.92
Food	1.35	+.06	.43	.46	.31	2.61	2.57	−.04
Automotive	1.10	−.30	.09	–	–	.89	1.97	1.08
Gasoline	2.36	−.62	.34	.31	–	2.39	3.06	.67
Apparel	−.54	−1.24	−.04	.09	–	−1.73	.94	2.67
Furniture	1.56	−.87	.16	–	–	.85	2.28	1.43
Eating and drinking places	–	−.34	.15	–	–	−.19	.96	1.15
Drug	2.37	−.28	.15	–	–	2.24	1.99	−.25

the components, except for the change in the quantity of service per transaction and that due to technological change. If the quantity of service per transaction did not decline, all of the residual would be due to technological change; if it increased, the contribution of technological change would be larger than the residual. A large residual thus is evidence of a decline in service per transaction.

The estimated contribution of average transaction size in food stores has been adjusted by the estimated increase in service entailed by the increase in transaction size. The increase in constant-dollar sales per man-hour in eating and drinking places due to the increase in transaction size, which represents the quantity of food and drink adjusted for quality rather than the quantity of service, is estimated at zero.

The average annual rates of change of the quality of labor in the individual store-types are shown in column 2. They are based on indexes of the quality of labor obtained by the multiplication of the index of the quality of labor for retail trade as a whole by indexes of the ratios of average hourly earnings in each store-type to that of retail trade. The ratios are estimated from data on annual earnings of employees in the censuses of Retail Trade in 1929 and 1963, and on estimates of average weekly hours based on data in the Censuses of Population for 1940 and 1960. The change in the quality of labor varied considerably among store-types: the average quality in food stores appears to have remained unchanged; but the decline was especially large in apparel.

Estimates of the quantity of capital were based on IRS data. They reveal that capital growth contributed significantly to the increase of constant-dollar sales per man-hour in food, gasoline, and general merchandise. The reduction of excess capacity which was associated with the withdrawal of small stores was important in food and gasoline, and greater utilization of scale economies was important only in food stores.

The table shows a large positive residual for six of the eight store-types shown. In three store-types—general merchandise, apparel, and eating and drinking places—the residual exceeds the rate of change of constant-dollar sales per man-hour. Drug and food stores show small residuals. The estimates suggest that in these two store-types there was little change in the quantity of service before 1963. The decline

may have set in in drug stores after 1963, for the trend toward discount drug stores appears to have accelerated since then. The large size of the residuals in most store-types means that a major part of the growth of constant-dollar sales per man-hour remains unexplained after taking into account the components listed. This result signifies that it is unlikely that output grew faster than measured output in general: service per transaction did not increase.

We therefore can accept the change in transaction size as representing an important element in the growth of constant-dollar sales per man-hour, even after adjustment for the associated increase in service in food stores. The importance of transaction size is indicated as well by the value of the correlation coefficient, .85, measuring the relationship across store-types between the average annual rate of growth of constant-dollar sales per man-hour and average transaction size after the adjustment for food stores.

Assuming that the change in average transaction size was the same in the lumber-hardware group and in other retail stores (for which we have no estimates) as the average for the store-types listed in Table 3, the estimated contribution of the growth of average transaction size is .78 per cent per year, or 45 per cent of the total growth in sales per man-hour in retail trade as a whole. The estimate of the contribution of the growth of average transaction size is much less than that made earlier, when no allowance was made for the associated growth of service per transaction.

INCOME AND PRICE ELASTICITIES OF DEMAND FOR RETAIL SERVICE PER TRANSACTION

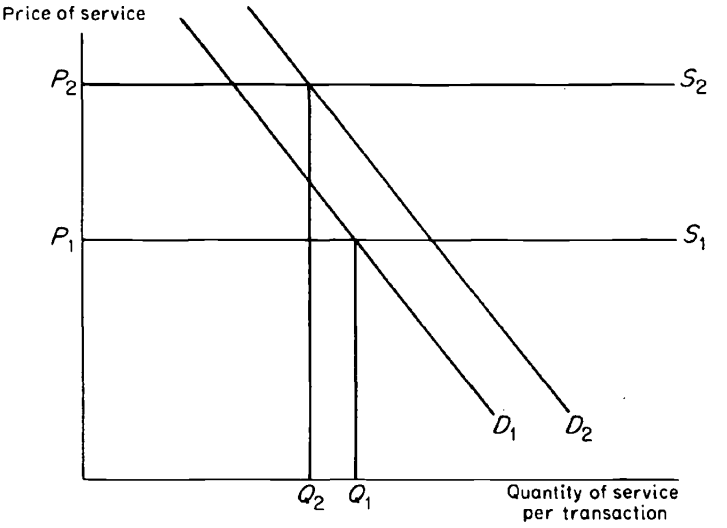
We turn now to the estimation of the change in service per transaction which was due to the price and income changes. We need the income and price elasticities of demand. The elasticities are obtained from cross-section regression analysis of variation in sales per person engaged among Standard Metropolitan Statistical Areas (SMSA's). The cross-sectional approach has some advantages over the analysis of time series. Technology appears to have been an important source of productivity growth in other industries, and it may be associated over time with the growth in sales per person engaged. There is far less risk that the association between sales per person engaged and average

family income, or the price of retail service, reflects differences in knowledge among SMSA's at any one time. The growth of sales per person engaged over time may also reflect the changes in products and packaging which were designed to facilitate self-service; the cross-sectional approach is free from this source of bias.

Figure I represents the model for the analysis of the change in the quantity of service per transaction. The curve D_1 is the demand for service per transaction at time 1, and the effect of a change in income is shown by the shift from D_1 to D_2. I assume that the period 1929–63 is best represented by a long-run model: the supply curve is shown as horizontal. If productivity in the economy as a whole grew faster than in retail trade, then the supply curve of retail service shifted upward, as is shown by the shift from S_1 to S_2. The magnitude of the change in the quantity of service per transaction depends on the change in price, the change in income, and the price and income elasticities of demand for service.

The major difficulty is that we have no measure of the quantity of service. The procedure for the estimation of demand elasticities therefore is indirect, and it relies on an interpretation of the association between sales per person engaged and variables representing income

FIGURE I



and the wages of retail employees which is based on demand relations. The regression equation is a combination of demand and production functions.

The market demand equation for retail service, which is assumed to be linear and logarithmic, is expressed as follows:

$$r = a_0 + a_1 i + a_2 p + a_3 a + a_4 s + a_5 t \tag{1}$$

The variables are expressed in logarithms, and the symbols are as follows: i = average family income; p = price of retail service; a = automobile usage; s = retail sales; t = average transaction size; r = quantity of retail service.

The demand for location service varies inversely with automobile usage, and therefore a is introduced. The variable s, retail sales, is a measure of market size. Since the related goods are difficult to identify, their prices are not introduced.

The production function for retail service is represented as follows:

$$r = b_0 + b_1 e + b_2 o + b_3 f + b_4 s + b_5 t \tag{2}$$

e = quantity of labor; o = quantity of other factors; f = average establishment size; s = retail sales; t = average transaction size.

This equation can be written so that e appears on the left and r on the right:

$$e = \frac{1}{b_1}\left[r - (b_0 + b_2 o + b_3 f + b_4 s + b_5 t)\right] \tag{3}$$

Substituting the right side of the demand equation (1) for r we obtain:

$$e = \frac{1}{b_1}\left[(a_0 + a_1 i + a_2 p + a_3 a) - (b_0 + b_2 o + b_3 f) + (a_4 - b_4)s + (a_5 - b_5)t\right] \tag{4}$$

We want to analyze variation in sales per person engaged whose logarithm can be written as $(s - e)$. Thus equation (4) becomes:

$$s - e = \frac{1}{b_1}\left[(b_0 + b_2 o + b_3 f) - (a_0 + a_1 i + a_2 p + a_3 a) + (b_1 - a_4 + b_4)s + (b_5 - a_5)t\right] \tag{5}$$

We thus have an equation which provides a basis for estimating the income and price elasticities of demand for service per transaction.

We lack data for the price of retail service (p), transaction size (t), and the quantity of other factors (o). The variable chosen to measure price is the average annual earnings of full-time employees (w). If average earnings is independent of technology and of the quality of labor, then it will be correlated with the price of retail service. As I have already suggested, variation in technology among SMSA's is small, and variation in the quality of labor does not appear to bias significantly average earnings as a measure of price.[9] The relation between average earnings and price need not be proportional, however, so the net regression coefficient associated with average earnings may not be a correct estimate of the price elasticity. A range estimate of the price elasticity based on the net regression coefficient and assumptions concerning the relation between average earnings and prices of other factors employed by retailers will be made.

Average sales per family (j) varies with average transactions size (t). The regression equation therefore contains the variable j. We can expect a better measure of price and income elasticities of demand for service per transaction when we include average sales per family as an independent variable.

The regression equation does not include o representing the quantity of other factors. The assumption is that the major effect of high wages in retail trade is to increase the price of retail service rather than the quantity of other factors per unit of service. We have evidence that this is the case.[10]

[9] In a set of regression equations based on equation (5) $[w - q]$ replaced w: q represented an index of quality based on age, sex, and education. The resulting net regression coefficients were virtually the same as those in the original set of equations.

[10] Inventory is a little over one-fifth of total assets in retail trade. If capital is substituted for labor when w is high, then we would expect inventory to be substituted, especially since the cost of inventory is less likely to be correlated with wages than the cost of other factors, such as the cost of building. The introduction of inventory as an additional variable in the regression equation would reduce the value of the regression coefficient of w, if the coefficient of w reflected the substitution of inventory for labor. The introduction of inventory had little effect. Moreover, the sign of the coefficient of inventory was negative in four out of five equations. The regression equations were run for five store-types in 1929, for which year the Census published data on inventories.

Equation (5) indicates that the coefficients of the income and price variables must be adjusted by $1/b_1$, the reciprocal of the labor coefficient in the production function, in order to obtain income and price elasticities. The value of b_1 is less than 1 because the quantity of other factors is kept constant: increments to the quantity of labor will produce less than proportional additions to output when the quantity of other factors is constant. When o, representing the quantity of other factors, is omitted from the regression equation which describes the behavior of establishments, then output will be approximately proportional to employment, providing economies of scale of establishment, market size, and transaction size are small. As will be seen, the regression equations show their effect to be small. Hence the regression equation will give us the estimates without requiring the adjustment indicated in equation (5).

The regression equation is as follows:

$$s - e = g_{10} + g_{11}i + g_{12}w + g_{13}a + g_{14}f + g_{15}s + g_{16}j \qquad (6)$$

The data were drawn from the Census of Business for 1958. The observations were the 188 SMSA's for which statistics were reported by the Census. Separate regression equations were run for each of five major and three minor store-types. The five major store-types include food, apparel, furniture, gasoline, and drugs. The three minor store-types were eating places, meat markets, and variety stores. The income and price elasticities are estimated from the means of the coefficients of the regression equations for the various store-types rather than from a single equation for all retail trade. The model assumes that the supply curve of retail service is perfectly elastic: if it is not, we have an identification problem. This condition is more likely to be fulfilled by equations for individual store-types than one for the entire industry. The variables were measured as follows: s = total sales; e = persons engaged; i = median family income; w = mean annual earnings of full-time employees; a = gasoline station sales per family; j = sales per family. All variables were expressed in logarithms.

The results are shown in Table 5. Earnings are seen to have a very strong influence on the dependent variable, sales per person engaged, represented by $(s - e)$. Where employees' earnings were high, sales per person engaged were also high. The coefficient g_{12} varies between .513,

TABLE 5

Net Regression Coefficients, Standard Errors, and Coefficients of Multiple Determination for Eight Store-Types in 1958

Variable Coefficient	i g_{11}	w g_{12}	a g_{13}	f g_{14}	s g_{15}	j g_{16}	— R^2
Store-Type							
Food	−.148	.513	.069	.197	−.007	−.104	.78
	(.044)	(.039)	(.028)	(.018)	(.004)	(.039)	
Apparel	−.079	.578	.094	−.023	.011	.033	.52
	(.046)	(.063)	(.029)	(.023)	(.005)	(.021)	
Furniture	−.052	.734	.029	.025	.031	.121	.63
	(.058)	(.084)	(.035)	(.034)	(.007)	(.040)	
Gas	.152	.692		.260	−.021	−.106	.76
	(.056)	(.068)		(.038)	(.006)	(.034)	
Drug	.267	.846	.010	−.054	−.018	.093	.81
	(.065)	(.055)	(.049)	(.038)	(.007)	(.037)	
Eating	.062	.650	−.204	−.019	−.011	.125	.87
	(.044)	(.032)	(.029)	(.026)	(.006)	(.024)	
Meat markets	−.018	.599	−.012	.132	−.018	.054	.59
	(.121)	(.069)	(.070)	(.029)	(.011)	(.020)	
Variety	−.147	.774	.039	.016	−.002	.045	.55
	(.055)	(.057)	(.036)	(.021)	(.007)	(.028)	

in the case of Food stores, and .846 in Drug stores; the corresponding standard errors are .039 and .055. The mean of g_{12} over the eight store-types is .70. In other words, on the average sales per person engaged increased .7 per cent with an increase of 1 per cent in the average earnings of employees. I interpret the mean coefficient as signifying that high wages in retail trade bring about a high price of retail service, which in turn results in a reduction of the quantity of service purchased per dollar of goods. The mean coefficient will be used shortly to estimate the price elasticity of demand for retail service.

The coefficient (g_{11}) of the income variable (i) varies from −.148 in food stores to .267 in drug stores, and the arithmetic mean of the coefficients in the eight store-types is .01.[11] Thus income appears to

[11] The effect of automobile usage is measured by the value of g_{13}, which is significant and positive only in the food and apparel equations. The value of g_{14} indicates large economies of scale in food, gasoline, and meat; g_{15} shows important economies of size of market only in furniture; g_{16} indicates transaction-size economies in furniture, drugs, eating places, and meat.

have a small influence on sales per person engaged in retail trade as a whole.

The coefficient of average earnings of employees may be large because small, independent stores are inefficient and pay low wages, not because high wages result in less service per transaction. Hence, data for multiunits in the five major store-types also were analyzed. Firms operating multiunits have few small, inefficient establishments; their store managers are not proprietors eking out a livelihood. The observed relation between sales per person engaged, and average earnings among multiunits, therefore is less likely to be biased than the corresponding relation among all establishments. The figure equivalent to the mean coefficient of average earnings, w, in equation (6) is .74, which indicates a higher price elasticity than is estimated from the equations for all stores. The mean coefficient of the income variable, i, was close to zero, as in the case of the equations for all stores.

The coefficients of w and i may have been the accidental result of rapid technological advance in centers where w was high. If technological progress, rather than the rising price of service, caused the shift from clerks to self-service, it is possible that the coefficients which are based on data for 1958 reflected varying rates of progress correlated with wages. Hence I made similar measurements based on the data for 1929, which preceded the great shift to self-service.

Data for median family income by cities were not available for 1929, and I substituted therefore mean personal income by states, i_s, and mean earnings of manufacturing production workers, m. The results appear in Table 6. The mean of g_{22}, the coefficient of w, average earnings of employees, is .55. The mean coefficient of i_s, is .02, and that of m is .14. These results are similar to those for 1958, and thus they support the interpretation of the association between sales per person engaged and w as an expression of the price effect.

We now proceed to use these results in the estimation of the income and price elasticities of demand for retail service per transaction. We have seen that the income elasticity of sales per person engaged is approximately zero. Now it is reasonable to assume the elasticity of sales (s) by retail trade with respect to income is approximately 1. Hence the elasticity of the number of persons engaged (e), which we can take to measure service, is approximately $1 - 0 = 1$. Since trans-

TABLE 6

Net Regression Coefficients, Standard Errors, and Coefficients of Multiple Determination for Five Store-Types 1929

Variable Coefficient	i_s $g_{21.1}$	m $g_{21.2}$	w g_{22}	a g_{23}	f g_{24}	s g_{25}	j g_{26}	$-$ R^2
Store-Type								
Food	−.007	−.004	.405	.002	.422	−.006	.008	.85
	(.011)	(.038)	(.057)	(.017)	(.026)	(.006)	(.034)	
Apparel	.005	.117	.679	−.023	.072	−.030	.021	.52
	(.011)	(.040)	(.063)	(.020)	(.028)	(.007)	(.027)	
Drugs	.075	.254	.157	.100	.241	.004	−.140	.49
	(.019)	(.070)	(.054)	(.036)	(.056)	(.012)	(.048)	
Gas	.008	.092	.712		.333	−.016	.060	.74
	(.015)	(.058)	(.062)		(.031)	(.009)	(.026)	
Furniture	.010	.285	.786	−.007	−.005	−.010	.073	.67
	(.014)	(.056)	(.074)	(.026)	(.015)	(.009)	(.025)	

action size is held constant, the income elasticity of demand for service per transaction is estimated at 1.[12]

Consider the price elasticity. Upper-limit and lower-limit estimates have been made which are based on the different equations, and two assumptions concerning the cross-sectional relation between wages in retail trade and the price of retail service. If the prices of other factors employed in retail trade vary proportionally with retail wages among

[12] Average transaction size (in constant dollars) in retail trade approximately doubled between 1929 and 1963, while per capita disposable income in constant dollars increased by 62 per cent. The income elasticity of transaction size indicated by these changes is 1.6. We can obtain an estimate of the income elasticity of demand for retail service by combining this estimate and that of the elasticity of demand for retail service per transaction: let r = retail service; t = average transaction size; i = income; and all variables be expressed in logarithms. Then

$$t = a + 1.6i$$

$$r - t = b + 1.0i$$

and

$$r = (a + b) + 2.6i.$$

The implicit estimate of the income elasticity of demand for retail service then is 2.6. Despite the high estimate and the large growth in per capita income, the increase in the price of retail service was sufficiently large, as we will see, to bring about a decline in retail service relative to goods and services in general. If I had interpreted the coefficient of i in the regression equations as the income elasticity of demand for retail service rather than as the income elasticity of retail service per transaction, the resulting estimate of the relative decline in retail service would have been far greater.

SMSA's, then substitution will not occur where wages are high, and the price of retail service will be proportional to wages. This assumption yields an estimate of the price elasticity which is the same as the mean of the wage coefficients with a negative sign, $-\bar{g}_{12}$. The mean is taken across the three equations referred to earlier: the 1958 and 1929 equations for all stores, and the 1958 equation for multiunits. If substitution does not occur because the elasticity of substitution of other factors for labor is zero, then an increase in wages of X per cent will raise the price of retail service by $X(W'/P)$ per cent, where W' is total payroll including proprietors' earnings, and P represents the gross margin. The estimated price elasticity then is $-\bar{g}_{12}P/W'$. To the extent that substitution takes place, the price of retail service will rise by less than $X(W'/P)$ per cent, and the price elasticity then is between $-\bar{g}_{12}$ and $-\bar{g}_{12}P/W'$. The ratio P/W' is estimated at 1.82.[13] The range of the estimates is $-.55$ to -1.35. It is unlikely that the prices of all factors employed in retail trade vary proportionally with wages. Geographically, wages increase with city-size; interest is an important element in retail costs, and it is independent of city-size. The prices of fuel and power, wrapping materials, and professional services will not vary proportionally. Hence it is unlikely that the price elasticity is at the lower limit of the estimated range. The midpoint of the range is $-.95$, and I choose the value -1.0 as the estimate.

THE CHANGE IN THE QUANTITY OF SERVICE PER TRANSACTION DUE TO INCOME AND PRICE CHANGES

We now are in a position to estimate the part of the change in constant-dollar sales per man-hour that was due to the change in the demand for service per transaction. It will be recalled that constant-dollar sales per man-hour (S/H) was analyzed as the product of average transaction size (A) and the number of transactions per man-hour (N/H), whose reciprocal measures the quantity of service per transaction. The demand for service can be described by the equation,

$$H/N = I^a P^b$$

[13] Gross margin by store-type was computed from IRS, *Sourcebook*, 1957, and payroll was computed on the basis of data from the Census of Business, 1958. Payroll includes wages of proprietors estimated as equal to average earnings of full-time employees.

where H/N is an index, I and P are indexes of income and of relative price, and a and b are the elasticities. The index of average family disposable income in constant dollars in 1963 on base 1929 is 162, and the index of the relative price of retail service is estimated at 225, as we have seen. Now $a = 1$, and $b = -1$. The equation yields an estimate of 72.9 for the index of service per transaction, H/N. The effect of the change in service per transaction on sales per man-hour can be estimated from the reciprocal, N/H, which represents transactions per man-hour, and whose index is 137. Thus the growth in sales per man-hour due to income and price changes was 37 per cent, which is equivalent to an average annual rate of change of .93 per cent.

When we add this estimate to that of the effect of the growth of average transaction size after allowing for the concomitant change in service per transaction, which we estimated at .78 per cent per year, we obtain an estimate of the change in sales per man-hour due to the decline in service per dollar of sales. The sum of the two rates of change is 1.71 per cent.

This estimate of the change in sales per man-hour resulting from the decline in service per dollar of sales is less than the preceding one, which was based on the unadjusted average transaction size, the gross margin, and the price of retail service. Perhaps the adjustment for the increase in service per transaction associated with the growth of average transaction size is excessive, or the estimated price elasticity of demand is lower than it should be. The fact that the previous estimate exceeds the present one indicates that -1 is a conservative estimate of the price elasticity of demand for service per transaction. Both approaches, however, depend crucially on two estimates which may be high: the index of average transaction size and the price index of retail service.

CONCLUSION

Table 7 presents the estimates of the sources of change in sales per man-hour. The contribution of transaction size is corrected for the relation with service, and the estimated contribution of service per transaction is based on the demand equation. Substituting the other estimates, we would show for average transaction size 2.04 per cent and for service per transaction .33 per cent. These figures result in an

TABLE 7

Average Annual Rate of Growth of Margin-Weighted Constant-Dollar Sales Per Man-Hour in Retail Trade Between 1929 and 1963 Compared to Contributions of Components
(per cent)

Increased quality of labor	−.63
Increased quantity of capital	.20
Increased utilization of capacity	.16
Increased utilization of economies of scale	.06
Increased average transaction size [a]	.78
Reduced service per transaction [b]	.93
Total	1.50
Margin-weighted constant-dollar sales per man-hour	1.73
Residual	.23

[a] After adjustment for increase in service per transaction associated with the growth of transaction size independent of the effect of income on the demand for service.
[b] Estimated on the basis of the growth of income and the rise in price of service.

estimate of the effect of service per dollar of sales of 2.37 per cent compared to 1.71 per cent using the alternative approach.

I do not wish to claim that either estimate of the effect of the change in service per dollar of sales is accurate. As I have said earlier, the estimates are offered as evidence that this component of the growth of sales per man-hour has been important.

The estimates suggest that technological progress has been an unimportant factor. We need not see that the components of the growth of sales per man-hour shown in Table 7 nearly exhaust the total in order to arrive at this conclusion. It is implicit in the estimate of the large relative price increase of retail service. The assumption that technological progress has been the principal factor in the growth of sales per man-hour which underlies the Commerce measure of output, appears to be wrong.

The self-service revolution thus appears to have been a result of the increase in the relative price of retail service. Productivity, defined as the ratio of the quantity of service per unit of all factors, in retail trade apparently increased much less than the average output per

unit of all factors in the economy as a whole. The consequences were that retail service became much more expensive relatively and consumers reduced their consumption by patronizing those stores which introduced self-service.

The strength of the hypothesis based on the influence of price is seen in its ability to explain geographic differentials in sales per worker as well as the change over time. The cross-section regression equations revealed that in SMSA's where wages were high sales per worker also were high. Hall, Winsten and Knapp observed that sales per worker in the U.S. were about double that in the United Kingdom, and the difference was not limited to food stores where greater automobile usage may be a factor in the high U.S. ratio.[14] The hypothesis, moreover, is consistent with the general observation that labor-intensive goods and services are plentiful in countries where wages are low. The change in sales per worker in retail trade is part of a general pattern in which price has a key role.

Productivity has grown at very different rates in different industries, and price changes have varied accordingly. The price indexes of some commodities in 1963 showed a decline since 1935; e.g., refrigerators, 88, and electricity, 95. At the other extreme were domestic service, 453, and haircuts, 399. Retail service is among those commodities whose price rose relatively because of a lag in productivity growth, and the result was a decline in the consumption of retail service per transaction. Productivity growth is not equal among industries, and the consequence over any long period may be significant changes in consumption patterns. Part of the increase in sales per worker in retail trade appears to represent a change in consumption caused by relatively slow productivity growth.

The other major contributor, the growth of transaction size, is directly due to the rise of the level of income. The findings thus challenge the representation of retailing in the United States as more efficient than in other countries. High sales per man-hour in the United States are the result of a high wage level which has increased average transaction size and raised the price of retail service.

[14] Margaret Hall, John Knapp and Christopher Winsten, *Distribution in Great Britain and North America: A Study in Structure and Productivity*, London, 1961, p. 17.

DISCUSSION

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What is the output of retail trade and what is the price of that output? Is this industry slow in productivity advance, as frequently claimed (though without the benefit of a measure of output)? Schwartzman, who addresses himself to such problems, uses constant-dollar sales per man-hour as his starting point. Sales per man-hour increased by 1.73 per cent per year between 1929 and 1963. This figure is affected by three major elements. One is the quantity of cooperating factors and the intensity of their use; another is technical change; and the third is the quantity of service per dollar of sales. Schwartzman shows that taking the first set of influences into account increases this figure to 1.94. The increase in quantity of capital per man-hour reduces this figure by .20 per cent per year, and the combined effect of the more intense use of capacity and of economies of scale reduces the figure by an additional .22 per cent. However, the absolute decline in the quality of labor used (as measured by the age, sex, and educational characteristics of the labor force employed) at the rate of .63 per cent per year more than offset the effect of the other factors.

The presence of this 1.94 per cent can be attributed either to productivity improvement or to a decline in service per dollar of sales. The latter can occur due to an increase in relative price or due to a fall in demand caused by increased transaction size. Schwartzman argues that these two factors were dominant, and that technical advance played an insignificant role. He attributes .78 per cent per year to change in transaction size and .93 per cent to reduction in service per transaction due to its increased price after accounting for the income effect. While the effects due to factor substitution, to the intensity of factor utilization, and to labor quality are very convincingly demonstrated, it is harder to accept at face value Schwartzman's explanation of the fall in the quantity of service per dollar of sales.

Since transaction size is correlated with income, Schwartzman's argument leads us to expect that prices would be lower in stores serving

high-income groups than in those serving low-income groups. A casual observation suggests that the reverse is the case. It is probably true that costs fall with transaction size, but apparently this is more than compensated by an increased demand for other services such as speedy check-out, etc. A direct piece of evidence on the increase in quantity of service with transaction size is provided by B. M. Clark in his dissertation on waiting time in shoe stores.[1] He shows a strong negative relation between average price for shoes in a given store and the waiting time required to obtain service. This brings up the general question of incorporating the saving in consumer time as an integral component of retail service (in accord with Becker's argument on the allocation of time).

The observed deterioration in the quality of labor in retail services poses another problem. The substitution occurred in spite of a change in relative prices in the same direction—the relative premium to high-quality labor declined. So it is very hard to escape the conclusion that there was some shift in the production function or, alternatively, that the type of service demanded when income is rising can be economically provided by low-quality labor.[2] Again, casual observation suggests that the second employee at the grocery counter, engaged in wrapping and packaging, is typically an untrained person, frequently a high school boy. The service reduces customers' time at the counter and, more importantly, the time spent in queuing up—such saving being more valuable the higher the earnings of the customer.

In terms of Schwartzman's paper, then, the critical issue is that of the estimated price and income effects. These effects over the period considered are evaluated by an attempt to estimate price and income elasticities cross-sectionally, and to apply the results to the time series. This attempt, which in principle looks very attractive, is not successful because the estimation equation does not appear to provide correct answers to the necessary questions. To demonstrate the difficulties in-

[1] Bruce M. Clark, "The Economics of Waiting Time as a Variable in Retail Competition," unpublished Ph.D. dissertation, University of Washington, 1963.

[2] The second possibility implies that stores serving high-income customers will use a lower quality of labor as compared with stores serving low-income customers. Comparisons of such stores can be profitably used to shed light on this issue as well as on the relation between services and transaction size.

volved with the estimation procedure, it is useful to write the dependent variable, sales per person, as

$$\text{sales per person} \equiv \frac{\text{total \$ expense}}{\text{\# of persons}}$$

$$\equiv \underset{(1)}{\frac{\text{expenses on raw materials}}{\text{\# of persons}}} + \underset{(2)}{\frac{\text{expenses on capital}}{\text{\# of persons}}} + \underset{(3)}{w}.$$

Notice that (2) and (3) comprise the value added per person, representing the inverse of the amount of the retail services per dollar of sales. The two major independent variables are average family income and the wage rate (which is used to infer the price elasticity). We will attempt to compare the desired results with those one may expect from the specific equation used.

THE EFFECT OF INCOME

Desired quantity: the income elasticity for services per dollar of sales. If we have the income elasticities for service and for materials, the difference between the two will give us the desired results.

Actual results: From (1), relative income elasticity between materials and labor is obtained; from (2), relative income elasticity between capital and labor is obtained; (3) should be zero. The sum of (1) and (2) is (materials + capital) relative to labor rather than, and distinct from the desired results of, materials relative to (capital + labor). The two will be the same only if the income elasticity of capital relative to both materials and labor is zero!

THE EFFECT OF PRICE

Desired quantity: the price elasticity of services per dollar of sales. What is the percentage change in (capital + labor) per dollar of sales due to 1 per cent change in the price of (capital + labor)?

Actual results: The independent variable is w, the wage rate. Let us assume it is exogenous. From (1) we obtain the change in materials per person due to change in wages. The inverse of this is change in persons per dollar of sales due to change in wages. From the inverse of (2) we get the change in labor per unit of capital due to change in wages; (3) is 1 by definition.

If the price of capital varies in the actual sample proportionately with wages, (2) will be zero, and (1) will give us the desired estimate. Of course, we still have to subtract 1 from the actual estimate due to (3). If the production function is Cobb-Douglas, the expected size of (1) is +1 (assuming that the price of capital is uncorrelated with w). So to obtain the price effect it is necessary to account for the substitution between capital and labor.

In addition to income and the wage rate, several other variables are considered. It is not clear what one can say a priori on the effect of any of them. It should be noticed, however, that the income variable should account directly for the change in transaction size, and the independent variable of sales per family, itself dependent on income, is an inappropriate proxy for transaction size. In any case, if such additional variables are relevant, their effect should be accounted for in the time series.

In absence of directly observable output units, the difficulties of evaluating the related problems of price, quantity, and productivity in retail trade are immense. The use of a concept such as "gross sales per person employed" as the central empirical unit is very dangerous; traps are abundant. Schwartzman, on the whole, does an excellent job of evading these traps and of squeezing a large number of useful results from the publicly available information as well as from information virtually created by him for this study. Many of the results that may appear arbitrary in this summary paper are well documented in the monograph-size manuscript from which they are derived. Even the part which is criticized here contains many valid and imaginative ingredients necessary to break the value series into its price and quantity components.

REPLY BY SCHWARTZMAN

Barzel challenges my conclusion that the increase in transaction size which was associated with the growth of income resulted in a reduction in the quantity of service per dollar of sales. He refers to Clark's study which found an inverse relation between average price of shoes and waiting time among shoe stores. This does not contradict my re-

sults, for it only implies a positive relation between transaction size and the amount of service per transaction. Moreover, my estimate of the change in service per dollar of sales takes into account the increase in service per transaction resulting from the increased demand associated with the growth of income. I suggest only that the increase in transaction size has been sufficiently large for the quantity of service per dollar of sales to decline despite the concomitant rise in income.

I am not as certain as Barzel that the skill differential in earnings fell between 1929 and 1963. In any case, the change was small. The fall in the average quality of labor can be interpreted as part of the decline in service per transaction rather than as a reflection of a shift in the production function. The reduction in service per transaction did not take the form only of a decline in the number of man-hours per transaction; apparently the elasticity of substitution between the quantity and the quality of labor is positive. What seems to have happened is that the part of retail service which was eliminated was the provision of advice and information which required a relatively high level of skill. The more routine tasks of providing change and wrapping parcels were retained.

Barzel criticizes my model for the estimation of the income and price elasticities of the demand for service. He errs when he suggests that I am estimating the income elasticity of demand for service per dollar of sales. The desired quantity is the income elasticity of demand for service per transaction. This correction does not affect the remainder of his comment, but it is well to keep in mind the actual problem. Barzel develops some of the properties of the estimating equation. I agree that my estimate of the income elasticity is correct only if the income elasticity of capital relative to materials and labor is zero. But there is no basis for assuming any other value; the bias presumably is small.

My estimate of the price elasticity is a range, partly because of the possibility of substitution between capital and labor. The limits are given by the assumptions of zero elasticity of substitution and infinite elasticity. The first assumption yields the upper-limit estimate, and the second assumption yields the lower-limit estimate. I selected a value close to the midpoint of the range.

The coefficient of the income variable may be picking up some of

the effect of transaction size; I agree that sales per family may be a poor proxy for transaction size. The resulting error will lead to an overstatement of the income elasticity of the demand for service per transaction. The bias results in exaggerating the estimated increase in the demand for service due to the rise in income, and it thus results in reducing the estimate of the decline in service per transaction. The validity of the major conclusion that the growth of sales per man-hour is largely accounted for by the growth in transaction size and by the decline in service per transaction is unaffected.