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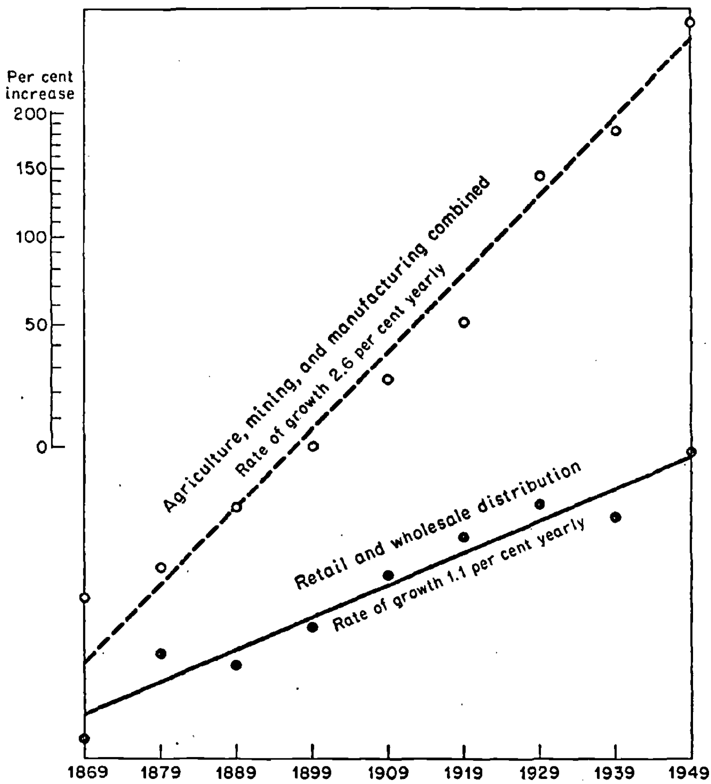
CHAPTER 3

Productivity and Its Measurement

DATA already assembled allow us to compute indexes of output per person engaged and output per man-hour. This is done for distribution, and for the commodity-producing industries by way of contrast, in Table 12. Here it is seen that output per person engaged in the commodity-producing industries rose nearly fivefold, and in distribu-

Chart 2

OUTPUT PER MAN-HOUR, ACTUAL AND COMPUTED TRENDS, 1869–1949



Source: Table 12.

Table 12

OUTPUT, OUTPUT PER MAN, AND OUTPUT PER MAN-HOUR IN COMMODITY PRODUCTION AND DISTRIBUTION, 1869–1949

(*1899 = 100*)

	1869	*1879*	*1889*	1899	1909	1919	1929	1939	1949
Output (Table 10):									
Commodity output	31	46	71	100	143	186	281	290	443
Net output of distribution	22	44	66	100	147	191	310	311	469
Net output, production and distribution combined	28	45	69	100	144	187	290	296	450
Output per person engaged (Tables 6 and 10):									
Commodity industries	63	68	83	100	123	142	224	236	338
Distribution	70	93	89	100	108	115	125	106	120
Production and distribution combined	60	70	82	100	122	139	207	206	278
Output per man-hour (Tables 6 and 10):									
Commodity industries	61	67	82	100	125	151	243	282	402
Distribution	69	92	88	100	118	134	150	144	178
Production and distribution combined	59	69	82	100	125	149	224	248	339

tion increased about 80 per cent, between 1869 and 1949. Because hours fell more sharply in merchandising than in commodity production, if the figures are placed on a man-hour basis, the contrast, though still marked, is less dramatic. Thus output per man-hour multiplied six times in the commodity industries, about two and a half times in trade. On the basis of these figures it would seem that man-hour productivity increased somewhat more than twice as fast in the physical production of commodities as it did in their distribution.

Owing to the uncertainty attaching to figures for individual census dates, and in order to get a summary view, it is again convenient to express the changes by means of average annual percentage rates of growth (Table 13 and Chart 2). The slower rise of man-hour output in distribution than in production is once more seen. To this backwardness must be attributed a large part of the growth in numbers in distribution during our period, from fewer than 100 to more than 300 for each thousand engaged in production.

Table 13

OUTPUT, OUTPUT PER MAN, AND OUTPUT PER MAN-HOUR IN COMMODITY PRODUCTION AND DISTRIBUTION, 1869–1949

(per cent)

	Mean Annual Rate of Change [a]		
	1869–1909	*1909–1949*	*1869–1949*
Output:			
Commodity production	+3.8	+2.7	+3.1
Distribution	+4.5	+2.8	+3.3
Output per person engaged:			
Commodity production	+1.8	+2.6	+2.3
Distribution	+0.9	+0.1	+0.5
Output per man-hour:			
Commodity production	+1.9	+3.0	+2.6
Distribution	+1.1	+0.9	+1.0

[a] Obtained by fitting exponential curves by least squares (Glover's method) to data in previous tables. If the Marshall-Edgeworth formula is used in computing the net output of distribution (see note i to Table 10 above), the mean annual percentage rate of change in output per man-hour in distribution reads as follows:

1869–1909	*1909–1949*	*1869–1949*
+1.3	+0.6	+0.9

The figures in Table 13 suggest that productivity in the commodity industries rose more rapidly in the period since 1909 than in the forty years prior to that date. A similar acceleration does not seem to have occurred in merchandising. Indeed output per person engaged in distribution rose much less rapidly in the second than in the first half of the period. However, this retardation appears to have resulted from the sharp cut in hours of work, for output per man-hour in merchandising increased about as rapidly after 1909 as before.

The contrast between distribution and production is further illustrated in Table 14. Relatively speaking, distribution exhibits a rapid growth of output, persons engaged, and man-hours, but a slow growth of output per person engaged and of output per man-hour.

Table 14

PRODUCTIVITY IN COMMODITY PRODUCTION AND DISTRIBUTION, 1869–1949 [a]

(per cent)

	Mean Annual Rate of Change				
	Output	Persons Engaged	Man-Hours	Output per Person Engaged	Output per Man-Hour
Agriculture	+1.7	+0.1	+0.1	+1.9	+1.9
Mining	+3.4	+1.6	+1.4	+2.3	+2.6
Manufacturing	+3.7	+2.1	+1.6	+1.7	+2.3
Whence three commodity-producing industries	+3.1	+1.0	+0.7	+2.3	+2.6
Distribution	+3.3	+2.9	+2.3	+0.5	+1.0
Whence commodity production and distribution combined	+3.2	+1.3	+1.0	+2.0	+2.3

[a] Obtained by fitting exponential curves by least squares (Glover's method) to data in previous tables.

The more rapid rise in agriculture of output per person engaged (and per man-hour) than of output, despite the positive rate of change in persons engaged (and man-hours), is anomalous. The reason is that a curve with only one constant does not furnish a good fit for persons engaged (and man-hours) in agriculture, a series that rises until 1909 and thereafter declines (Table 1).

To obtain productivity quotients for combinations of industries, we first combined output, then persons engaged (or man-hours), and hence derived output per person engaged (or per man-hour) for the combination. The procedure allows shifts from industries with low output per person (measured by value of product at the base date, 1899) to industries with high output per person (or shifts in the opposite direction) to influence the result. In the present instance the shift from agriculture to manufacturing has such an effect. Agriculture, mining, and manufacturing can also be combined by weighting output per person (or per man-hour) by persons or man-hours, so eliminating the effects of the shifts mentioned. If this is done, mean annual percentage rates of growth are lowered slightly:

	Output per Person Engaged	*Output per Man-Hour*
Three commodity-producing industries	+1.9	+2.1
Commodity production and distribution combined	+1.8	+1.9

If, in combining industries, 1939 is used instead of 1899 as the weight base, growth rates for the three commodity industries undergo no further change. But in combining production and distribution, the relative weight of distribution is increased, and the mean annual percentage rates of growth for commodity production and distribution combined are lowered still further to +1.5 for output per person and +1.8 for output per man-hour.

The growth rates for commodity production and distribution combined lie between those for production and those for distribution. They vary slightly with the choice of weight base used, as explained in the note to Table 14. But as rough orders of magnitude they survive alternative methods of calculation. The figure in the last row and last column of the table, 2 per cent per annum cumulative, may be taken as the most comprehensive measure we at present possess of the growth of output per man-hour in the United States economy during the period that has elapsed since the Civil War. However, the figure quoted—2 per cent yearly—probably overstates the rate of growth of productivity in the economy as a whole. For we may guess that—as in distribution—output per man-hour rose only slowly in the unmeasured sectors of the economy, especially in personal and professional service and government. Could we include these sectors, the over-all rate of growth in output per man-hour probably would fall well below 2 per cent yearly.

Productivity and Employment

The factors responsible for the burgeoning of employment in merchandising can naturally be classified in many different ways. Consider, for example, the following identity, in which numbers engaged,

$$n = q \cdot \frac{1}{h} \cdot \frac{nh}{q},$$

where q refers to output and h to hours worked per week. Here employment is expressed as the product of three factors: (1) output, (2) the reciprocal of hours worked, and (3) man-hours per unit of output. We have already estimated each of these quantities for distribution and for the commodity industries. It is easy, therefore, to illustrate the above formula for each sector of the economy and for the ratio between them, and this is done in terms of average annual percentage rates of change in Table 15. The following conclusions emerge.

For distribution and for the commodity industries, if each is considered separately, the growth in labor force can be fully accounted for by the rise in output. That is to say, in each case the annual average rate of growth in output is larger than the corresponding increase in numbers engaged. With respect to the differential between the two industrial segments, however, the situation is otherwise. Here the relative change in output (0.2 per cent yearly) was far smaller than the shift in labor force (1.9 per cent) in favor of distribution. In fact the differential in output (0.2 per cent yearly), together with the differential in hours worked per week (0.3 per cent), accounts for about one-quarter of the relative shift in numbers engaged (1.9

per cent). The remaining portion of the shift of the labor force away from production and into distribution is evidently accounted for by the differential in man-hours per unit of output—the much slower rise in output per man-hour in distribution than in the commodity-producing industries.

Table 15

THE DECOMPOSITION OF RATES OF GROWTH OF THE LABOR FORCE, 1869–1949 [a]

(per cent)

	Average Annual Rate of Change		
	Distribution	Commodity Production	Ratio of Distribution to Production
Number of persons engaged (n)	+2.9	+1.0	+1.9
Equals			
Output (q)	+3.3	+3.1	+0.2
Together with			
Reciprocal of weekly hours ($1/h$)	+0.5	+0.3	+0.3
Together with			
Man-hours per unit of output (nh/q)	−1.0	−2.6	+1.5

[a] See previous tables. Growth rates were obtained by fitting exponential curves by least squares (Glover's method).

Reliability of Productivity Measures

The broad outline traced above is sharp enough to survive any doubts we may have about such matters as the coverage of particular censuses or the methods chosen for weighting or combining indexes. The rise of man-hour output in distribution, and the fact that this rise lagged behind the corresponding rise in commodity production—these broad conclusions are not in question. Yet in justification of the actual quantitative measures offered here, some further remarks are called for. In particular, the comparability of the output and employment data for distribution needs to be considered.

At the end of the preceding chapter it was suggested that our index for the net output of distribution may be subject to some downward bias, owing to our inability completely to measure quality improvements that may have occurred in distributors' services. However, reasons were given for thinking that this bias is not likely to be large.

There remains the question of bias in our measures of labor input. We have already noticed in Chapter 1 that the occupation data measure persons attached to the industry rather than the number actually working at any given date, still less the number of man-years of employment. It might be thought that numbers engaged (Table 1, Chapter 1) must exceed labor input measured as man-years or full-time employment. Yet, as explained in Appendix A, the tendency of the occupation count to understate numbers in trade makes this unlikely. In recent censuses, numbers engaged have fallen short of full-time employment.

The bias, if any, in the rate of growth disclosed by the occupation data over a period as long as eight decades is far harder to conjecture. For other reasons, however, we may expect our series to have some downward bias. In the occupation count, persons employed in bars and restaurants are tabulated in the service category rather than in retail trade; and some at least of those working for manufacturers' sales branches are reported in manufacturing and mechanical industries rather than in wholesale trade. We may be sure that both categories grew faster than did numbers in distribution as a whole. Other workers probably reported elsewhere than in distribution are craftsmen and repairmen of different kinds; but upward or downward bias on this account is a small matter.[1]

These considerations point to a downward bias in the labor force figures for trade. Our data on hours are shaky enough and may be biased in many ways. We have tried to measure actual hours (Table 5, Chapter 1), i.e. total man-hours divided by the kind of labor-force figure that the occupation census reports. A possible upward bias in the hours trend should be mentioned. We have assumed that part-time working had about the same importance at the beginning as at the end of the period, but it may well have been less important in early years.

We may answer the question as to the comparability of output and employment by saying that both measures appear to be biased in a downward direction—output because of the unmeasured increase in services, employment because of the neglect of bars, restaurants, and factory sales branches. To some extent, at least, these biases must cancel out insofar as our productivity quotient is concerned.

So much for distribution itself. Our measures of differential productivity in distribution and commodity production (Table 15, last column) are in a sense residual estimates, subject to errors in both sectors of the economy. However, the biases we can identify in merchandising are repeated in commodity production. For example, measures of output are biased downward, because of neglect of quality changes, in manufacturing and mining, as in merchandising. Hence in comparing distribution and commodity production, as in

[1] A comparison of numbers reported in the occupation counts for 1930, 1940, and 1950 with numbers employed from the censuses of distribution for 1929, 1939, and 1948 respectively is included in Appendix A.

Table 15; some at least of the errors may be expected to offset each other.

Growth of Productivity and the Cost of Distribution

We have seen that output per man-hour rose somewhat more than twice as fast in commodity production as in commodity distribution. This means that, other things equal, costs of physical production declined more than twice as fast, or rose less than half as quickly, as did costs of distribution. A consequence to be expected, in the absence of offsetting changes, is that gross distributive margins should increase percentagewise, i.e. that as the years pass, more cents out of the consumer's dollar should be absorbed in distribution and fewer in production. Data in Part Two of this study indicate that a modest rise in distribution's percentage share of the retail selling price did in fact occur over the years.

This does not imply that distribution is becoming less efficient. A full account of what the industry did with its resources would require a consideration of other factors besides labor. But even in terms of labor productivity, we know the contrary to be the case: output per man-hour increased. The rise in distribution cost as a percentage of retail prices is a reflection rather of the tendency for productivity to rise more rapidly in other industries—agriculture, mining, and manufacturing—than in distribution. Obviously, a quantitative accounting is desirable that would reconcile the differential movement in our measures of output per man-hour with the observed rise in distribution cost. Such an accounting, by approaching the same problem from opposite sides, would strengthen our confidence both in the productivity measures and in our measures of distribution cost. Actually, the logical connection between productivity change and change in margins is rather complex, and from the statistical standpoint not all the links in the chain are readily forged.

The analysis starts from the concept of value added. Familiar in the field of manufacturing as the difference between value of product and cost of materials, the concept is a perfectly general one and can be applied to any enterprise or industrial segment. For distribution, value added clearly means the difference between sales and cost of goods sold, i.e. the gross distributive spread or margin.[2]

Suppose that for any industrial segment, value added in current dollars,

$$v = \frac{nhp}{r},$$

[2] The margin includes some items, e.g. the costs of packaging materials, fuel, and power, which are not included in value added. We neglect this point.

where n and h are respectively numbers engaged and hours worked, as before; p measures average hourly earnings, of self-employed as well as hired labor; and r is the ratio of nhp to v, i.e. of labor cost to value added. Whence our productivity measure, man-hours per unit of output, can be rewritten

$$\frac{nh}{q} = v \cdot \frac{r}{qp},$$

where q refers to output. This formula can be applied separately to distribution and to commodity production, or we can think of each symbol as measuring the ratio of the quantity's magnitude in distribution to its magnitude in production. In that case we use a capital letter; N, for instance, is the ratio of numbers in distribution to numbers in production. In fact, the latter is the form the calculation takes, for we can estimate V much more reliably as the ratio of value added in distribution to value added in production than as value added, v, in either taken separately.

This formula should enable us to estimate the ratio of the productivity change in distribution to the productivity change in production, provided that we can obtain similar ratios for Q, V, R, and P. It will be observed that what we are really proposing is to make a fresh estimate of man-hours by deflating labor cost, that we obtain labor cost from value added, and that value added comes in turn from our study of distributive margins. The same estimate of output is used as before, but here we need only the ratio of the outputs of distribution and of commodity production; it is to be supposed that this ratio is more accurate than the output of either segment. In the following calculation no use is made of figures for employment, labor force, or hours worked. The calculation, therefore, can be viewed in part as a test of the worth of the estimates of these quantities.

From the margin study we have the ratio of value added by distribution to value (in producers' prices plus freight) of the input into the distribution system. Let us call this the "markup ratio," M. It increased from 0.486 in 1869 (Table 20) to 0.597 in 1948 (Table 23, both tables in Chapter 5) at a mean annual rate of 0.3 per cent.

Next let

$$S = \frac{\text{value of input into the distribution system}}{\text{value added in commodity-producing industries}}.$$

For our three commodity-producing industries taken collectively, we can neglect materials consumed and regard value added as equivalent to value of output. It can therefore be seen that the ratio S may be taken as the fraction of commodity output which passes through the distribution system, or the ratio of input into distribution to commodity output. If we call the value of S in 1899 unity, it grew from $^{24}/_{31}$, or 0.77, in 1869 to $^{493}/_{443}$, or 1.11 in 1949 (Table 10, Chapter 2), or at a mean annual rate of 0.2 per cent.

Now the product of M and S clearly is V. Consequently

$$V = MS$$

grew at an average annual rate of 0.5 per cent.

Of the other quantities that we need, q increased 3.1 per cent yearly for commodity output and 3.3 per cent yearly for the net output of distribution (Table 15), so that Q, the ratio of the latter to the former, rose at an average annual rate of 0.2 per cent. Also, average hourly earnings, p, in dollars, rose from 0.119 in 1869 to 0.454 in 1939 for commodity production, and from 0.141 in 1869 to 0.536 in 1939 for distribution (Appendix Table A-2), so that P, the ratio of the latter to the former, was 1.18 in both years and exhibits no trend.

Finally, r, the ratio of labor cost to value added, declined moderately in commodity production and rose sharply in distribution, so that according to one calculation, R, the ratio of the latter to the former, rose from 0.40 in 1869 to 1.32 in 1939 (Appendix Table A-3) or at an average annual rate of 1.7 per cent. An alternative computation puts the growth of R at 1.4 per cent yearly.

Combining these results, we find that our estimate of relative productivity,

$$\frac{NH}{Q} = \frac{VR}{QP},$$

rose at an average annual rate lying between 1.7 and 2.0 per cent. This result is in terms of man-hours per unit of output; the ratio declined less rapidly in distribution than in production by the indicated differential. Put otherwise, output per man-hour increased more rapidly in production than it did in distribution, the differential being again as indicated.

The results are summarized in Table 16. The differential movements V and Q offset each other, and P has a negligible influence on the result. But the reported rate of change in R, as already mentioned, is large and positive. This means that the share of labor income in value added rose more rapidly, or declined less rapidly, in distribution than in production.

How should such a differential trend be interpreted? It certainly seems in accord with rough common sense to suppose that capital per worker increased more rapidly in factories than in retail stores.

Table 16

ESTIMATES OF THE DIFFERENTIAL IN PRODUCTIVITY, 1869–1949 [a]

(*per cent*)

	Symbol	*Average Annual Rate of Change in Ratio*
Ratio of:		
$\frac{\text{Gross distributive margin}}{\text{Cost of goods sold}}$	M	+0.3
$\frac{\text{Finished goods sold through retail stores}}{\text{Commodity output}}$	S	+0.2
$\frac{\text{Value added in distribution}}{\text{Value added in production}}$	$V = MS$	+0.5
$\frac{\text{Net output of distribution}}{\text{Commodity output}}$	Q	+0.2
$\frac{\text{Hourly earnings in distribution}}{\text{Hourly earnings in commodity production}}$	P	0
$\frac{\text{Labor income} \div \text{value added in distribution}}{\text{Labor income} \div \text{value added in production}}$	R	+1.4 to 1.7
Whence indirect estimate of differential in productivity; ratio of:		
$\frac{\text{Man-hours} \div \text{output in distribution}}{\text{Man-hours} \div \text{output in production}}$	$\frac{VR}{QP}$	+1.7 to 2.0
Direct estimate of productivity differential previously reported (Table 15)	$\frac{NH}{Q}$	+1.5

[a] For derivation and sources see text. Only five observations on R can be made: 1880, 1890, 1900, 1912, and 1922 (see Appendix A). Hence no attempt has been made to obtain similar results for the first and second halves of the period considered separately.

The most cursory survey of technological change in distribution suggests that it has been far slower than in manufacturing. On the other hand, the concentration of retailing in areas where land values have risen sharply with increased urbanization would work in the other direction, tending to increase rents and lower labor income as a fraction of value added in distribution. (This contrary tendency is not reflected in our measure of R, which is based on real estate improvements and equipment; its rate of change may be overstated on this account.) Some of commodity production's growth of capital per worker, and hence of the decline in its labor-income–value-added ratio, may be associated with the decline of agriculture relative to manufacturing. At any rate, real estate improvements and equipment, in 1922 for instance, were about twice as high in manufacturing as in agriculture per person engaged.

This result supports the finding of the earlier sections of this chapter that output per man-hour increased far less rapidly in distribution than in commodity production during the period since the Civil War. In fact, if we take the average annual increment in output per man-hour reported for commodity production by the direct method (2½ per cent), and deduct the differential obtained in this chapter by the indirect method (1¾ to 2 per cent), we get an average annual increment in output per man-hour of ½ to ¾ of 1 per cent for distribution—instead of more than 1 per cent reported by the direct method. Alternatively, if the increment in labor productivity is taken as 1 per cent in distribution (Table 13), the results of this section imply an annual average increment in output per man-hour of 2¾ to 3 per cent in commodity production. But the value obtained for R is so speculative that the results of measuring the productivity differential by the indirect method (Table 16) are almost certainly inferior to those already reached directly (Table 13). So far as concerns the trends in labor productivity in our two sectors (production and distribution), the findings of this section may best be said to offer general confirmation, rather than any opportunity for detailed modification, of the results already obtained by the direct method.

If the results of direct comparisons of output and employment are to be accepted in preference to those obtained by the indirect method of this section, that is to say, if the differential change VR/QP in Table 16 is too large, where does the error lie? We may observe first that the evidence from these various other sources offers no confirmation of the existence of any rise over time in the gross distributive margin. For the change in R is more than sufficient to explain the whole of the differential in productivity, as measured by the direct comparison of output and employment. Indeed, the results of the direct comparison would be compatible with an actual *decline* in margins had such a decline been reported by the study described in Part Two. Yet we believe that the rise in the gross distributive margin, although moderate, is significant in a statistical sense and well established by independent evidence. Moreover, it can be confirmed from other sources, such as the behavior of retail versus wholesale prices.

Various other differentials reported in Table 16 may of course be at fault, but the exceedingly rough character of the estimate for R suggests that the major source of trouble lies at this point. All the evidence suggests that R is positive, for otherwise no reconciliation is possible of this section's results with those obtained earlier in the chapter by the direct method. All the evidence suggests, that is to say, that the ratio of labor income to value added rose more rapidly, or fell less rapidly, in distribution than in commodity production. Since, however, the estimate of *R*'s actual size does indeed appear to be the weakest link in the chain, we may conclude that it is considerably overstated by the entry, obtained from the trend in real estate improvements plus equipment, in Table 16. Its value would appear to be in the neighborhood of 1 per cent per annum.

Interpretation of Results

Let us return to our main theme. Over the period 1869–1949, output per man-hour in merchandising increased substantially—about 1 per cent yearly on the average. This growth of productivity was far slower than in the commodity-producing industries—agriculture, mining, and manufacturing. What explanation can we offer?

In each of the commodity-producing segments a close connection exists between the growth of man-hour output on the one hand and the occurrence of technological change on the other.[3] These changes can be documented and classified. In manufacturing, for instance, improvements of organization, mechanization, and changes in layout are common types of technological advance. In addition, and closely associated with technological change, increase of scale may be mentioned. The large role played by these developments, separately and in conjunction, in raising labor productivity in commodity production prompts the question whether or not technological changes or growth in scale, or both, can be identified in distribution.

The most dramatic development during our period probably was the coming of self-service in food markets and restaurants. The census does not collect statistics for self-service stores separately, but it does distinguish between chains and independents. In 1939, chain food stores probably were predominantly self-service, independents mainly without self-service. In addition, chains operate on a larger scale, both in central organization and as measured by sales per store. Therefore, we should expect man-hour output in chains to average higher than in independents, both because of self-service and because of scale of operation. A comparison shows that in 1939, independent food stores had average sales per person (employees plus active proprietors) of $7,400; chain food stores, $12,400. Though not an accurate measure, these figures plainly reflect dif-

[3] See Solomon Fabricant, *Employment in Manufacturing, 1899–1939: An Analysis of its Relation to the Volume of Production,* National Bureau of Economic Research, 1942, pp. 73–82; Harold Barger and Hans H. Landsberg, *American Agriculture, 1899–1939: A Study of Output, Employment and Productivity,* NBER, 1942, Chap. 5; Harold Barger and Sam H. Schurr, *The Mining Industries, 1899–1939; A Study of Output, Employment and Productivity,* NBER, 1944, Parts II and III.

ferences of man-hour output. Such differences also are reflected by gross margins.[4] As noted in the previous chapter, self-service may be charged with an unmeasured downward bias in output (through lessened service), yet we scarcely should conclude this downward bias wipes out the influence of self-service in raising man-hour output.

The influence of scale of operation may be roughly assessed by the following table for 1939, which covers all stores in the United States: [5]

Number of Employees per Store	*Sales per Person: Employees plus Active Proprietors*
0	$4,900
1	5,600
2	6,400
3	6,900
4–5	7,200
6–7	7,600
8–9	7,900
10–19	7,800
20–99	7,600
100 and over	6,700

Judged by this test, productivity declines with increasing size after a modest size is reached. One may doubt the influence of mere growth in size in raising productivity in distribution since 1869. In any case the difficulty of measuring the growth in store size over the years makes a test impossible.

Self-service, on the other hand, and centrally organized chains were both unknown in 1869. We may conclude that both developments boosted man-hour productivity in distribution during the period under study. Self-service, especially, must be responsible for a significant part of the 1 per cent yearly rise in man-hour output reported during 1909–1949.

So far as concerns the interpretation of the rise in productivity reported by us, it is perhaps unfortunate that much of what can be said about technology affords a qualification, rather than an explanation, of our figures. For instance, the transfer of the packaging function backward toward the manufacturer [6] cut employment in distribution—and also net output. However, the shift is scarcely reflected in our index for the net output of distribution. Consequently the shift suggests that our measures overstate the rise in productivity, but does nothing to explain such rise as actually occurred.

[4] See Chapter 6 below.

[5] *Census of Business, 1939,* Vol. I, *Retail Trade,* Part I, Table 6H.

[6] See above, Chapter 2.

Again, many recent advances in technology contribute greatly to the quality of service rendered by merchants to their customers. Perishable products are kept under refrigeration. Customers' comfort is enhanced by escalators or air-conditioning. Such changes boosted the net output of distribution and raised productivity, but in a manner that eludes measurement. These and similar developments suggest that our measures understate the rise in productivity but do not help to explain the rise (1 per cent yearly) that we actually report.

Yet we can also list changes that did not affect the scope or quality of service in such elusive ways but did increase the amount of service the individual clerk could perform. Self-service certainly, and centralized management in chains probably, belong in this list. Cash registers were introduced early in our period, and fought a long and successful battle with the cash railway and other clumsier devices. Computing scales began to be common about 1900.[7] In department stores and other large establishments, the general progress of office machinery and methods undoubtedly made a significant contribution.[8]

Something needs to be said in this connection about the decline of the wholesaler. While we have made estimates of the sales (and hence could derive measures for the output) of wholesalers, we cannot show separately the employment in the two branches of distribution prior to 1929. Hence we cannot compute productivity changes for the two segments separately. However, the relative decline of wholesaling is well established. To some small extent it may be true that the task once performed by wholesalers actually has disappeared. Improvements in communication may sometimes make local warehousing less important or enable the retailer to go directly to the manufacturer where previously it was not worth his while to do so. But a cursory examination of the buying and warehousing habits of the larger retail units—especially chains and department stores—makes it plain that a large part of the "decline of wholesaling" is simply the obverse of the assumption of wholesaling functions by retailers. In some cases the change may have increased efficiency. But it also has been reflected in a rise in department and specialty store and even of chain store margins.[9] It does not seem likely that, over the field as a whole, the decline in wholesaling has had a significant effect upon man-hour output in distribution.

[7] The earliest reference to a computing scale, noted by us, was an advertisement in the *Butchers' Advocate* for November 26, 1892.

[8] As late as 1919 a large New York dry goods store was being advised to substitute loose-leaf ledgers for "antiquated bound ledgers" still in use at that time.

[9] See Chapter 6 below.

From this brief survey the reader will gather that the list of technological advances in distribution is relatively brief. No individual developments occurred that rank with the coming of gasoline power in agriculture, mechanical loading in mines, or the electrification of factories. One is indeed left with a feeling of surprise that man-hour output in distribution rose as rapidly as it did.

Summary

According to the best available estimate, output per man-hour in distribution (wholesaling and retailing combined) rose 1.0 per cent yearly over the period 1869 to 1949. This rise shows no evidence of retardation. This result compares with average annual increases in man-hour output of 1.9 per cent for agriculture, 2.6 per cent for mining, and 2.3 per cent for manufacturing. The less rapid rise in distribution is confirmed by the relative sparsity of technological innovations when comparison is made with the other industries mentioned.

PART TWO

The History of Distribution Cost