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Output, Employment, and Productivity

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Trends in Employment and Productivity

Employment in all commercial transportation agencies grew from under 1 million in 1889 to 2½ million during the 1920's, fell below 2 million in 1939, and rose again to over 2 million in 1946 (Table 11). The employment figures given here for 1939 differ rather sharply from the Occupation Census figures for 1940 in Table 1: conjectural reasons for these differences are mentioned in the notes to Table 11. The data for employment come from various sources and are intended to measure full-time equivalent workers, i.e., man-years. Their reliability is uneven, figures for highways and waterways being especially uncertain. However, the total reflects with fair accuracy the draft of these industries upon the labor force.

From the employment figures of Table 11, in conjunction with the output figures of Table 5, we can estimate changes in labor productivity. Accordingly the movement of output per employee is recorded in Table 12. It will be seen that over the fifty-year period productivity almost tripled. In the transportation industries the average rise in output per employee from 1889 to 1939 lay between 2.1 and 2.2 percent annually.[1] The average annual rate of increase appears to have been larger in transportation than in any other major industrial division — except mining, when mining is taken to include oil and gas wells (Table 13). For manufacturing and agriculture, and for mining other than oil and gas wells, productivity increased less rapidly than in transportation.

The relatively rapid rise in output per worker in the transportation industries as a whole invites comment from several distinct

[1] Between 1889 and 1946 output per worker quadrupled, rising 2.5 percent annually; but 1946 conditions were perhaps not representative.

Table 11

EMPLOYMENT IN THE TRANSPORTATION INDUSTRIES, 1889-1946[a]
Thousand workers

	1889	1920	1929	1939	1946
Steam railroads[b]	749	2,076	1,694	1,007	1,378
Electric railways and city buslines[c]	71	316	280	184	203
Intercity buslines[d]	0	14	45	34	59
Intercity trucking, for-hire[e]	0	50	252	290	443
Pipelines[f]	0	16	25	22	27
Waterways[g]	97	178	126	106	151
Airlines[h]	0	0	2	15	82
TOTAL	917	2,650	2,424	1,658	2,343

[a] This table attempts to build up an employment series for transportation as a whole comparable with the output series already given. The data are intended to represent man-years, or equivalent full-time workers, but in this they only partly succeed. Most employment counts exaggerate the number of man-years: they give the peak payroll, the total number of individuals engaged at any time, or the average number employed during the active period of the year only. For instance estimates of employment in trucking often start from truck registrations, in waterways from the number of jobs to be filled in every vessel that sailed at any time during the year. Such counts plainly over-state the number of man-years of employment in the industry. For steam railroads in 1920 and later years and for other industries in 1929 and later years, averages of twelve monthly counts have been used, or the figures have been adjusted to a man-year basis in other ways. 1920 figures for industries other than steam railroads are substantially based on single counts and have not been adjusted to a man-year basis. However, the level of traffic in 1920 was so high, and periods of inactivity so brief, that the required adjustment would be slight and probably not exceed errors of estimation. Figures for 1889 (fiscal 1890 in the case of railroads) also rest on single counts: this too was a period of active business, and it may be that the adjustment necessary to convert the figures shown to a man-year basis would be small.
[b] Class I, II, and III line haul roads.
[c] 1889, electric railways, Census. 1920, electric railways, American Transit Association; local busline employment estimated at 7,000 on basis of number of buses. 1929, 1939 and 1946, full-time equivalent employees, National Income Table 24 (*Survey of Current Business,* July 1947, Supplement, and July 1948).
[d] 1920, based on number of buses. 1929 and 1939, full-time equivalent employees, unpublished tabulation by National Income Division of U. S. Bureau of Foreign and Domestic Commerce. 1946 extrapolation based on number of buses (see *Bus Facts,* annual publication of National Association of Motor Bus Operators).
[e] 1920, see Appendix F. 1929, 1939 and 1946, full-time equivalent employees, National Income Table 24.
[f] 1920, based on figure for 1921 in ICC Statement 4280 'Statistics of Oil Pipe Lines, 1921-1941' (Oct. 1942). 1929, 1939 and 1946, full-time equivalent employees, National Income Table 24.
[g] Vessel employees only. See Appendix Table H-7.
[h] See Appendix Table I-1.

viewpoints. First, how much confidence do we have that the result is genuine, and not due to some optical illusion or statistical quirk? To a minor extent the expansion of output reflects a shift of passenger traffic from agencies with low to agencies with high revenue per passenger or per passenger-mile, and of freight traffic from agencies with low to agencies with high revenue per ton-mile. Yet this factor is quite unimportant, for if the effects of such shifts of traffic between agencies are eliminated,[2] 1939 output on an 1889 base becomes 530 instead of 540 as reported in Table 12.

Table 12

ALL TRANSPORTATION: OUTPUT, EMPLOYMENT, AND
PRODUCTIVITY, 1889-1946
1889 : 100

	1889	1920	1929	1939	1946
Output (Table 5)	100	560	600	540	1,040
Number of workers (Table 11)	100	290	260	180	260
Output per worker	100	190	230	300	400

Again, our use of the 1889 Census of Waterways may have under-stated local traffic on rivers and canals, but in that case a corre-sponding undercount of employees would apparently prevent any bias from this cause in the productivity index. Finally, it is true that employment figures for intercity buslines and intercity truck-ing are very uncertain. To be on the safe side, let us double them. For 1939 this would raise the employment index in Table 12 to around 230 and cut output per worker from 290 to 240. Even so, the average annual increase in output per worker (Table 13) for transportation would be reduced only from 2.2 to 1.8 percent, the figure for manufacturing. To balance the hypothetical upward bias just mentioned, a definite downward bias must be pointed out. The output of local transportation (streetcars and buslines) is perforce measured by number of passengers. But as cities have grown and urban transportation networks have been expanded

[2] To eliminate the influence of such shifts, passengers (for electric railways and city buslines), passenger-miles (elsewhere), and freight ton-miles were respectively summed over all agencies. The three totals were then weighted by aggregate passenger revenue in 1939 on electric railways and city buslines, passenger revenue elsewhere, and freight revenue, respectively.

the average journey has undoubtedly lengthened. Could we report the output of buses and streetcars on a passenger-mile basis, our output and productivity indexes for transportation as a whole would rise more rapidly than they do.

So much for possibilities of error in the measurement of output. Yet suppose that output, although correctly measured, has shifted from low to high productivity agencies? 'High productivity' in this context denotes a high value of product per worker, product being valued in some constant set of prices. It need not denote

Table 13

AVERAGE ANNUAL RATES OF CHANGE IN OUTPUT PER WORKER IN TRANSPORTATION AND OTHER INDUSTRIES

	Period Covered	Average Annual % Increase
Transportation[a]	1889-1939	2.2
Manufacturing[b]	1899-1939	1.8
Mining, including oil and gas wells[c]	1902-1939	2.8
Mining, excluding oil and gas wells[c]	1902-1939	1.6
Agriculture[d]	1890-1940	1.6

[a] See Table 12. Based on a comparison of 1939 with 1889.
[b] Fabricant, *Employment in Manufacturing*, p. 10.
[c] Barger and Schurr, *The Mining Industries,* Table 11.
[d] Barger and Landsberg, *American Agriculture,* Table 39.

greater efficiency of individuals working under comparable conditions. It may reflect more capital per worker in one industry than in another, or a larger consumption of materials, or a stronger bargaining position in marketing the transportation service produced.

To what extent can shifts of this sort be held responsible for the relatively rapid rise reported for output per worker in transportation as a whole? To test this question, per worker product, measured in 1939 prices, was computed for the five divisions of transportation shown in Table 14.

We may notice, first, that the two industries with higher-than-average productivity (in the above sense) appear to be waterways and pipelines. Although the growth in pipeline traffic has been rapid, the percentage share in total traffic neither of pipelines nor

of waterways increased sufficiently to offer a ready explanation of the relatively high annual increment in the productivity of total transportation. In fact highways, toward which notoriously the largest diversion of traffic from older agencies occurred, has actually had a lower-than-average product per worker.

Table 14

PRODUCT (IN 1939 PRICES) PER WORKER IN THE TRANSPORTATION INDUSTRIES[a]
Thousand dollars

	1889	1920	1929	1939	1946
Steam railroads	1.3	2.4	3.0	3.7	5.1
Highways[b]	2.0	2.6	2.3	3.8	4.9
Pipelines	....	1.9	5.4	8.5	11.7
Waterways	1.3	5.1	7.0	7.2	10.0
Airlines	....	....	1.0	3.9	5.5
MEAN	1.4	2.6	3.0	4.0	5.4

[a] Computed from Tables 3, 4, 5, 8, 11, and 37.
[b] Electric railways, city and intercity buslines, and for-hire intercity trucking.

The matter may be further tested as follows. If we take the per worker product, measured in 1939 prices, for steam railroads, highways and waterways, weighted by the number of workers in each industry in 1889, we find that the average change in output per worker between 1889 and 1939 is the same as that reported for all transportation in Table 12, i.e., a rise from 100 to 300, or about 2.2 percent yearly. In other words, shifts in the relative share of traffic, including the advent of high-productivity pipelines and low-productivity airlines, approximately offset each other, so far as concerns the level of output per worker in transportation as a whole. On the other hand, if the same calculation is performed, using per worker product in 1939 prices, and also 1939 (instead of 1889) employment to weight the quotients, the average change in productivity for railroads, highways, and waterways works out (on an 1889 base) at 260 for 1939 (instead of 300).[3] The lower figure is due to the heavier weight given to

[3] Further calculations, for instance valuing product in 1889 prices, cannot be made for lack of data.

highways whose per worker product rose less rapidly than that of railroads or waterways. On this showing productivity would still have risen — in the absence of shifts in relative shares of traffic — more than 1.9 percent per annum.

A critique of the statistical basis for the estimate of 2.2 percent per annum as the average rate of growth of productivity in transportation is therefore reassuring. This high rate of growth can scarcely be due to faulty estimates of output or employment. Nor can it be explained to an appreciable degree, either by shifts from low- to high-value forms of output, or by shifts from low- to high-productivity industries. To an unknown but probably not very large degree it may reflect the reduction in railroad employment consequent upon the cessation of new construction, and possibly undermaintenance of existing railroad equipment (see Chapter 4). We may conclude that most of the reported rise in productivity reflects a real increase — real in the sense that it does not depend upon the weighting system used to combine the outputs of different agencies.
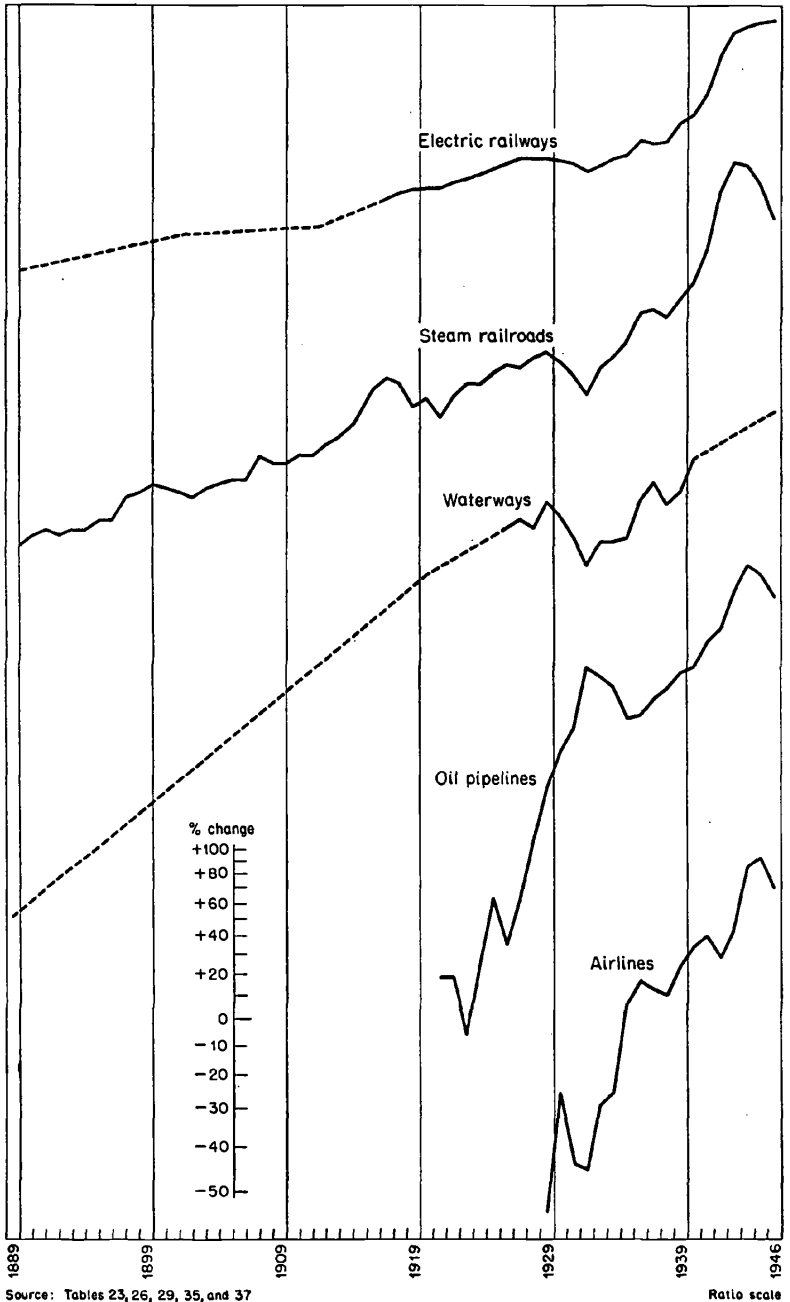
In contrast to output, to judge from the few observations recorded in Table 12, output per worker grew without retardation during our period. Average annual growth rates were 2.1 percent during 1889-1920 and 1920-29, 2.7 percent during 1929-39, and 4.2 percent during 1939-46. Unusually intensive utilization of equipment raised productivity in 1946.

The relatively more rapid rise of output per worker in transportation than elsewhere offers a partial explanation of its declining share of national income and employment, reported in Chapter 1. In part, at least since 1920, transportation output seems to have lagged — especially through diversion to the automobile and the private truck. Yet advances in productivity, more rapid than in other sectors of the economy, probably helped to cut transportation's percentage shares of the labor force and of national income.

INDIVIDUAL INDUSTRIES

It would be pleasant to offer indexes of output per employee, not only for the five groups shown in Table 14, but also for different

Chart 9
OUTPUT PER WORKER

Electric railways

Steam railroads

Waterways

Oil pipelines

% change
+100
+80
+60
+40
+20
0
−10
−20
−30
−40
−50

Airlines

1889   1899   1909   1919   1929   1939   1946

Source: Tables 23, 26, 29, 35, and 37   Ratio scale

types of highway transportation and different kinds of waterway. Unfortunately the data do not allow any more detailed analysis than that sketched. For instance, employment figures for buslines and trucking have been inserted in Table 11 to complete the totals, but they do not inspire sufficient confidence to enable us to offer separate productivity indexes for those industries. Obviously the discussion of trends in employment and productivity must be confined to the few industries for which adequate data exist. Accordingly Part Two deals only with steam railroads, electric railways, pipelines, waterways and — for a few recent years — airlines. In addition, some aspects of the motor trucking industry (for which productivity trends can only be guessed at) are treated in Appendix F.

Trends in output per worker for the five industries for which the ratio can be computed are brought together in Chart 9. Electric railways had the slowest growth of productivity. Young at the opening of our period, at its close the industry had passed its peak and all but disappeared. Somewhat larger gains in output per worker were recorded by steam railroads and waterways, old industries still vigorous. The sharpest rises in productivity were reserved for the two still youthful forms of carriage — oil pipelines and airlines. If we discard electric railways as anomalous in behavior, these results roughly confirm Fabricant's observation for manufacturing, i.e., that the sharpest gains in output per worker tend to be recorded by the most youthful, or at least the fastest growing, industries.[4] The individual trends will be discussed and interpreted in the chapters that follow.

[4] *Employment in Manufacturing,* Chapter 4.