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Productivity Growth In Transportation

In the 1990s, labor productivity growth in railroads, local trucking, and pipelines surpassed labor productivity gains in the overall economy. Meanwhile multifactor productivity (see Box A) gains for rail, spurred by improvements in capital inputs and the organization of service delivery, far outstripped those in the private business sector.

Labor Productivity[1]

In recent years, several transportation modes had considerably higher labor productivity increases than the U.S. business sector. According to the data shown in Figure 1, labor productivity of the U.S. business sector (measured in real output per employee) increased from 1990 to 2000 at an annual rate of 2.1%. By comparison, labor productivity in local trucking grew by 5.2% per year while railroad transportation grew by 5.1%. In petroleum pipelines, labor productivity increased by 3.3% per annum.

- **From 1990 to 2000, labor productivity rose in all transportation modes, but only exceeded the productivity growth rate for the overall economy in three – railroads, local trucking, and pipelines.**
- **From 1990 to 1999, rail transportation experienced a substantially higher growth of multifactor productivity than did the private business sector.**
- **Increases in multifactor productivity in rail transportation have been affected by improvements in capital inputs (e.g., equipment investments) and changes in the organization of service delivery.**

On the other hand, labor productivity in air transportation increased by 1.8% per annum; in "trucking except local" it grew by 1.7% per annum; and for bus carriers it increased by 1.5% per annum.

The basic factors that affect labor productivity in the transportation industries, as well as in others, are increased use of capital in production—which increases the amount of capital (i.e., equipment) per worker—and technical progress. "Technical progress" is a general term that includes improvements in the organization of the production process, in the quality of the inputs, and in the information technology used in production.

These two basic factors—increased capital in production and technical progress—are responsible for labor productivity increases in rail transportation. Higher output (in ton-miles) has resulted from more frequent and heavier loads moving longer distances. Labor input is down because of crew downsizing and because mergers have allowed a decrease in interchanges between railroads, which means fewer employees are needed. An index on "employee hours" for railroad shows a steady decline from 1990 to 2000 (from 91.0 to 71.6).[2] Moreover, other data show significant decreases in employment in "railroad brake, signal, and switch operators" from 1990 to 2000.[3]

Increases in labor productivity of "local trucking without storage" were positively affected by the increasing use of computer technology (hardware and software) – such as optimal routing and load matching.[4]

Increases in labor productivity for petroleum pipelines likely resulted from increasing pipeline sizes and the

[1] Labor productivity is measured by the Bureau of Labor Statistics (BLS) as output per employee-hour, for industries under the Standard Industrial Classification (SIC) system. That output is gauged by quality-adjusted ton-miles and passenger-miles for rail and air transportation; by quality-adjusted ton-miles for trucking and pipelines; and by passenger-miles for buses. "Quality-adjusted" refers to differences in service and handling—for example, the difference between flying first class and coach or the differences in the handling requirements of fragile versus durable commodities. A "ton-mile" is the movement of 1 ton the distance of 1 mile. Ton-miles are calculated by multiplying the weight in tons of each shipment transported by the miles hauled. "Passenger-miles" are the number of passengers carried in a vehicle or aircraft multiplied by the number of miles traveled. BLS data on labor productivity are not presently available for water transportation.

[2] BLS website, Office of Productivity and Technology, http://www.bls.gov/lpc/.

[3] BTS, *National Transportation Statistics, 2002,* p. 232.

[4] Personal communication with the American Trucking Associations.

Box A—The Importance of Productivity

Productivity increases translate to lower cost per unit, which typically results in lower prices for consumers—particularly when there is industry competition. Thus, productivity increases improve the standard of living as lower prices allow consumers to purchase more per dollar of income—with other factors remaining constant. Productivity increases can also mean higher profits for the transportation companies and higher labor compensation. There are two main measures of transportation productivity—labor productivity (single-factor) and multifactor productivity.

Such measures are critical to assessing how effectively we are enhancing the performance of our transportation system.

Single-factor v. Multifactor Productivity[1]

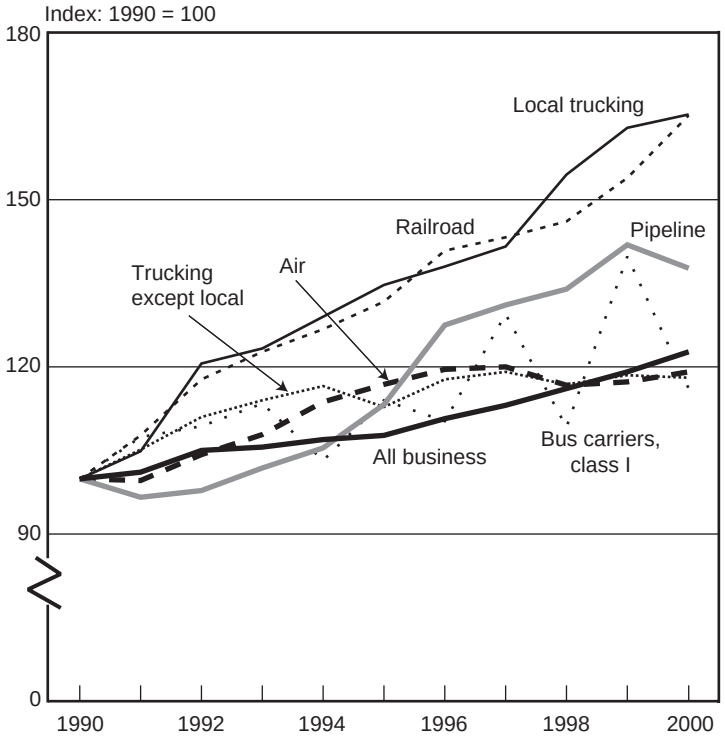
The ratio of output to the most critical input is the most basic measure of productivity. In car manufacturing, for example, productivity can be measured as the ratio of cars produced (the output) to the number of hours worked (the input). This type of productivity measure is known as labor productivity—the most commonly used single-factor measure of productivity. In agriculture, a productivity measure might be the ratio of bushels of wheat (the output) to acres planted (the input). This single-factor measure is know as land productivity. In single-factor productivity measures, other inputs, such as capital or fertilizer used, are not considered.

However, such single-factor-based measurements are limiting because in industries there are often several productive factors of near equal importance, and the relative importance of these inputs may shift over time. For example, if the labor force shrinks, the relative importance of skilled labor to other inputs may become critical.

Multifactor productivity sidesteps this problem because the combined productivity of all inputs are measured. Simply put, multifactor productivity is the productivity of all inputs, where the weights used to estimate the contribution of each input to output are their shares in the total cost of production.

[1] Adapted from David T. Owyong, Productivity Growth: Theory and Measurement, *APO Productivity Journal,* http://www.apo-tokyo.org/productivity/016_prod.htm as of July 29, 2003.

Figure 1. Transportation Labor Productivity by Mode: 1990–2000



SOURCE: **All except noted:** U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, "Industry Productivity Database," available at http://www.bls.gov, as of February 2003.
Bus carriers and Pipeline: Personal communication with U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology.

length of the haul.[5] These factors affect economies of scale (as output increases faster than inputs, cost per unit of output drops).

The relatively slow growth of labor productivity in air transportation was likely affected by diminishing returns from factors that in the past positively influenced air transportation labor productivity, such as the introduction of larger and faster aircraft, computerized passenger reservation systems, and the hub-and-spoke flight network.

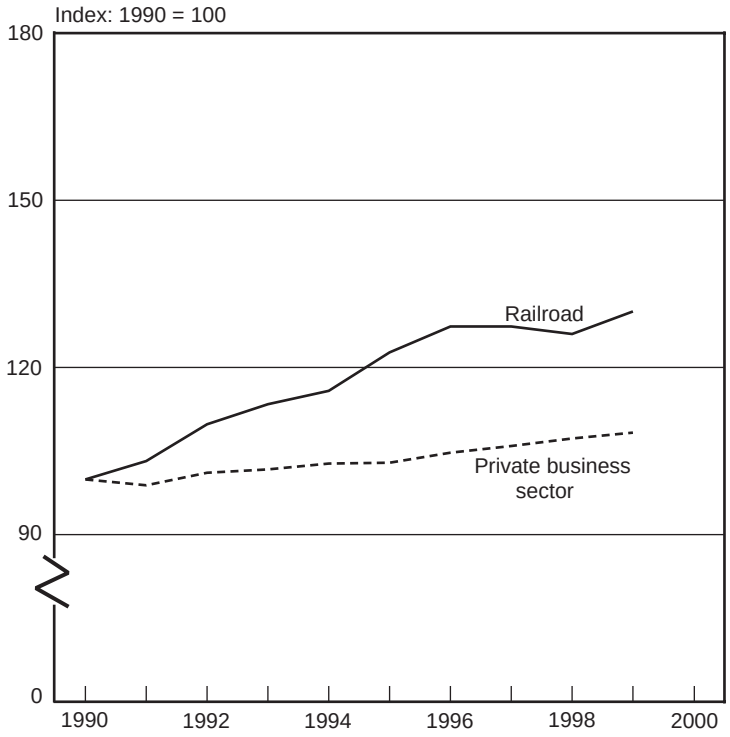
Multifactor Productivity

The only data presently available on multifactor productivity, from BLS under the SIC system, for the transportation sector relate to rail transportation. These data indicate that from 1990 to 1999 rail transportation experienced a substantially higher growth of multifactor productivity than did the private business sector (see Figure 2). Multifactor productivity in rail transportation increased at an annual average growth rate of 3.0%, while the private business sector increased at an annual rate of 0.9%. Thus, the rail industry has contributed positively and substantially to increases in multifactor productivity in the private business sector and, hence, to the U.S. economy over this period.

Technical Progress Spurs Growth in Rail Transportation

Increases in rail transportation multifactor productivity can be traced to technical progress, such as improved capital inputs and technological changes in the form of improved methods of service delivery. Improved technol-

Figure 2. Multifactor Productivity: 1990–2000



SOURCE: **All except noted:** U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, "Industry Productivity Database," available at http://www.bls.gov, as of February 2003.
Bus carriers and Pipeline: Personal communication with U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology.

[5] Association of Oil Pipelines/AOPL, *Pipeline Monthly,* Vol. I, No. 7, Dec. 18, 2001.

ogy for locomotives, freight cars, and track and structures have increased reliability and reduced maintenance needs. Reduced maintenance translates into less downtime for equipment and, consequently, increased output and productivity. Moreover, information technology, through computers, improved operational efficiency. Industry restructuring, including mergers, permitted a more efficient use of labor and rail traffic moving over longer distances without interruptions. The consolidation of railroad companies has likely resulted in more efficient use of equipment and lines.[6]

Freight railroads also are making more efficient use of fuel. This is a form of productivity increase and can result in higher output with a given amount of fuel and, thus, lower transportation costs. To make their operations more fuel-efficient, railroads have been moving longer distances between interchanges, buying more fuel-efficient locomotives, using innovative equipment (e.g., aluminum freight cars and lightweight double-stack container cars), and reducing locomotive idling time. Data show that the number of "Btu per ton-mile" for Class I freight railroads decreased from 420 Btu in 1990 to 352 Btu in 2000.[7]

Currently, work is being carried out at the Bureau of Transportation Statistics to estimate multifactor productivity for several additional transportation industries/subsectors. This includes the development of data on publicly owned capital stock for airports, waterways, and transit.

The results of estimating multifactor productivity for transportation subsectors should clarify the extent to which increases in transportation outputs have occurred because of changes or increases in inputs (labor, capital, intermediate inputs) or because of increases in the productivity of those inputs (e.g., due to changes in the organization of the industry or improvements in the inputs). Also, this research should provide information on the relative importance of transportation in increasing multifactor productivity in the U.S. economy, and thus estimate an important contribution of transportation to economic growth.

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[6] "Railroads," *U.S. Industry and Trade Outlook 2000,* U.S. Department of Commerce, and The McGraw-Hill Companies, Inc.
[7] U.S. Department of Energy, *Transportation Energy Data Book,* Edition 22, Oak Ridge National Laboratory, September 2002, Table 2.15, p. 2-20.