5 TRANSPORTATION PRODUCTIVITY

This chapter highlights trends in transportation productivity by exploring three measures of productivity: labor productivity; multifactor productivity; and revenue per passenger-mile or freight ton-mile. The chapter also uses productivity measures to illustrate how the transportation sector has contributed to economic growth in the United States.

What is Productivity?

In the general sense, "productivity" refers to the rate at which workers produce goods or complete work. *Economic productivity* has a more precise definition: it is the ratio of total output to the inputs used in the production process. Inputs may include capital, labor, energy, materials, and services. Productivity increases when a business produces the same output using fewer (or lower-cost) inputs. The business may then choose to produce more output, lower prices, invest in the business, or return income to shareholders.

Productivity may increase for several reasons. For example, new technology or training classes may help workers produce more goods in the same amount of time or with the same amount of resources. Likewise, policy changes may allow firms to operate more efficiently.

Productivity growth increases national income and improves the standard of living. One classic example is the Ford Motor Company's Model T automobile, produced in the early 1900s. Ford greatly increased productivity by using interchangeable parts and a moving assembly line. Ford chose to use the increased productivity to sell the Model T for a lower price than competing vehicles. As a result, more people could afford an automobile.

Increases in productivity may not lead to lower prices for consumers or increases in output. For example, demand for a business' products may decline despite an increase in productivity, which in turn may make the business unable to profitably increase output and lower its prices. Productivity increases achieved through automation may also lead to worker layoffs and overall reductions in employment. In other words, productivity growth is necessary but not sufficient for increases in total economic activity and economic well-being.

Productivity Measurements

Productivity measures provide answers to important questions about the transportation sector—for example, how efficiently transportation providers move people and goods, and whether the value of their services has grown more rapidly than the costs of the inputs they use. There are two main measures of transportation productivity: *labor (single-factor) productivity* and *multifactor productivity*. Labor productivity measures the output per unit of labor input, while multifactor productivity measures the output per unit as a weighted average of multiple factors, such as fuel, equipment, and materials. While multifactor productivity is a more comprehensive measure of economic performance, labor productivity is easier to measure and continues to have a broad appeal.

In the United States, the Bureau of Labor Statistics (BLS) produces labor and multifactor productivity measures for industries and sectors as defined by the North American Industry Classification System (NAICS) (box 5-1). These measures show industry and sector changes in inputs, outputs, and productivity.

Box 5-1: BLS Productivity Programs

The Bureau of Labor Statistics (BLS) produces productivity statistics through its Major Sector Productivity (MSP) Program and its Industry Productivity Studies (IPS). The MSP program generally produces productivity measures at the North American Industry Classification (NAICS) sector (2-digit) and subsector (3-digit) level, while IPS publishes productivity statistics at the 4-digit NAICS industry level. Sometimes a 3-digit subsector is the same as a 4-digit industry in the NAICS system, and as a result, both MSP and IPS produce measures for the same NAICS industry. However, these measures will not be the same due to methodological differences between the two programs. The largest difference is in the measurement of output. The MSP program takes an aggregate approach and uses real gross output (less the portion consumed in the same industry) obtained from BLS. IPS takes a micro-level approach and uses deflated sales, values, or physical quantities for output.

BLS also produces statistics for private business and private non-farm business as a whole and uses *value-added output* as a measure of output. Value-added output is gross output less all purchased intermediate inputs. Productivity statistics based on real gross output, as for 3-digit and 4-digit NAICS industries in the MSP program, tend to be preferred because they show the impact of changes in the quality of nonlabor inputs. BLS' productivity statistics presented in this chapter are from the MSP program.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, 2017.

The Bureau of Economic Analysis (BEA) also produces labor and multifactor productivity measures in the BEA/BLS Integrated Industry-Level Production Accounts (box 5-2). The Integrated Accounts take the BLS measures a step further by measuring the contribution of labor, capital, and other factors of production to the economy by industry.

Box 5-2: BEA/BLS Integrated Industry-Level Production Accounts

The Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS) collaborate to produce industry-level production accounts for the United States. To produce the accounts, BEA and BLS combine data on industry-level outputs and intermediate inputs from BEA's GDP by industry accounts with data on capital inputs and labor hours from the BLS Productivity Programs. The integrated accounts show the contribution of labor, capital, and multifactor productivity to economic growth. For more information, please see "A Prototype BEA/BLS Industry-Level Production Account for the United States," available at www.bls.gov/mfp/bea_bls_industry_product_account.pdf.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, 2017.

Labor Productivity

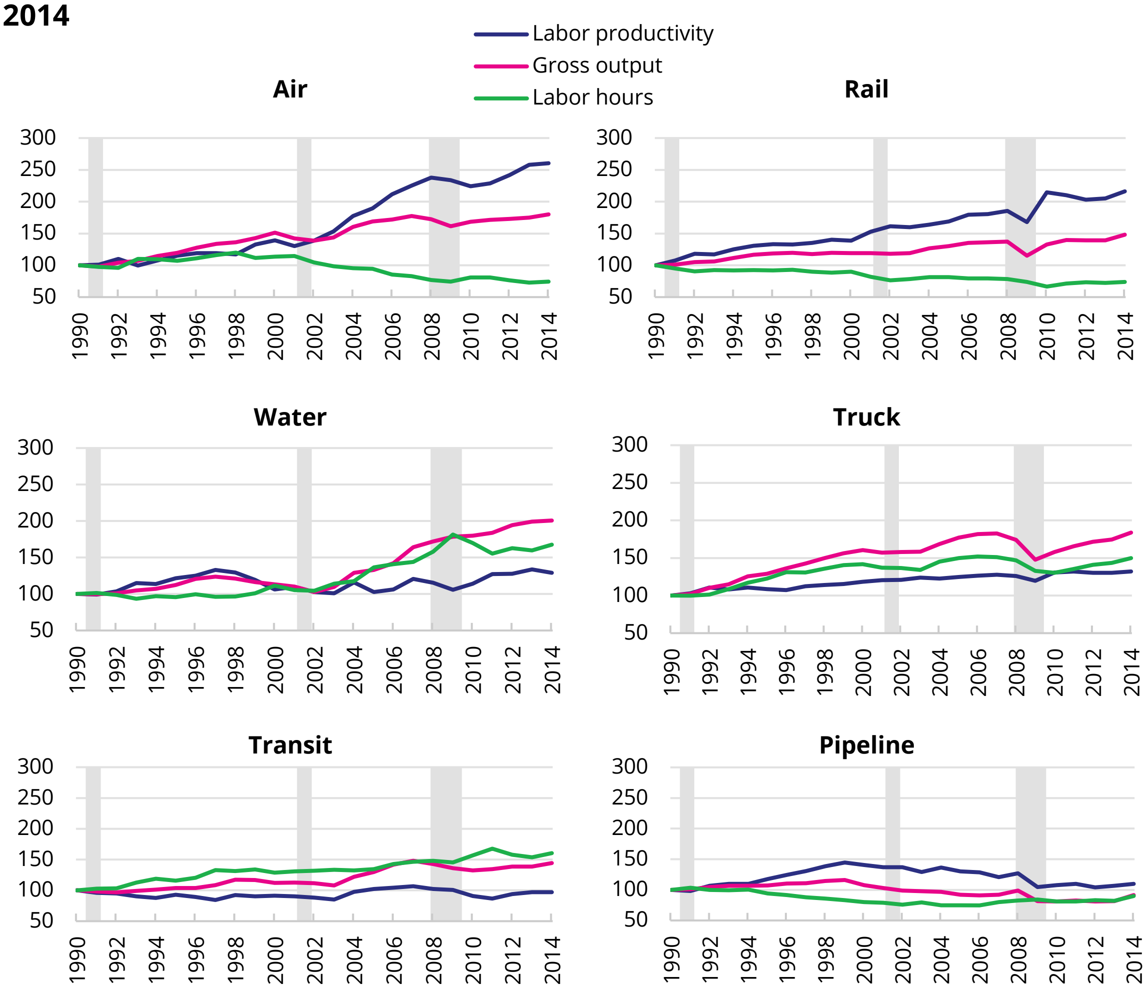
BLS produces the official labor productivity measures for the UNITED STATES To measure *labor productivity*, BLS measures outputs by industry and divides the output by paid labor hours. When an industry has multiple products or services, the outputs are weighted by value. BLS indexes the ratios to a common base year to allow for comparisons over time. BLS measures show industry responses to regulations and policies, changes in labor costs, and competitive pressures; the measures also enable comparisons across industries.

Figure 5-1 illustrates changes in labor productivity for selected transportation sectors from 1990 to 2014. Air transportation experienced the largest increase in labor productivity among all transportation modes, growing 160.5 percent from 1990 to 2014. Air transportation's labor productivity grew most notably between 2001 and 2008. The gains during this period come from legacy carriers adopting aggressive labor-saving initiatives and from large output gains among low-cost carriers.[1] Rail transportation experienced the second largest gains in labor productivity, increasing by 116.3 percent. These gains are the result of labor-saving technologies automating operational and administrative tasks.[2] Labor-saving initiatives in air and rail resulted in a decline in labor hours with continued

[1] See Russell, Matthew. "Economic productivity in the air transportation industry: multifactor and labor productivity trends, 1990–2014," *Monthly Labor Review*, U.S. Department of Labor, Bureau of Labor Statistics, March 2017. Available at www.bls.gov/opub/mlr/2017/article/economic-productivity-in-the-air-transportation-industry.htm as of May 2017.
[2] See Kriem, Youseff. The Productivity of the U.S. Freight Rail Industry 1979-2009. U.S. Transportation Productivity Study, Massachusetts Institute of Technology, available at transportation.mit.edu/sites/default/files/documents/MIT_Rail_Freight_Report.pdf as of June 2017.

growth in output over the 1990 to 2014 period. During the same period, smaller labor productivity increases occurred in truck (32.1 percent) and water (28.9 percent) transportation. Labor productivity in pipeline transportation grew 9.5 percent despite declining from 2000 through 2014. Labor productivity in transit transportation declined 3.0 percent due to the total amount of hours required to produce output (labor hours) rising faster than output.

Figure 5-1: Labor Productivity Indexes for Selected Transportation Sectors, 1990 to 2014



Notes: Data in these graphs are not comparable to data in previous editions due to a change in the data used. Shaded areas indicate economic recessions. Labor hours is the total number of number of hours worked by all workers in a sector to produce gross output. Gross output is the total value of goods and services produced by the sector. Gross output includes the value of the goods and services used to produce the sector output. Labor productivity measures a sector's output per unit of labor input.

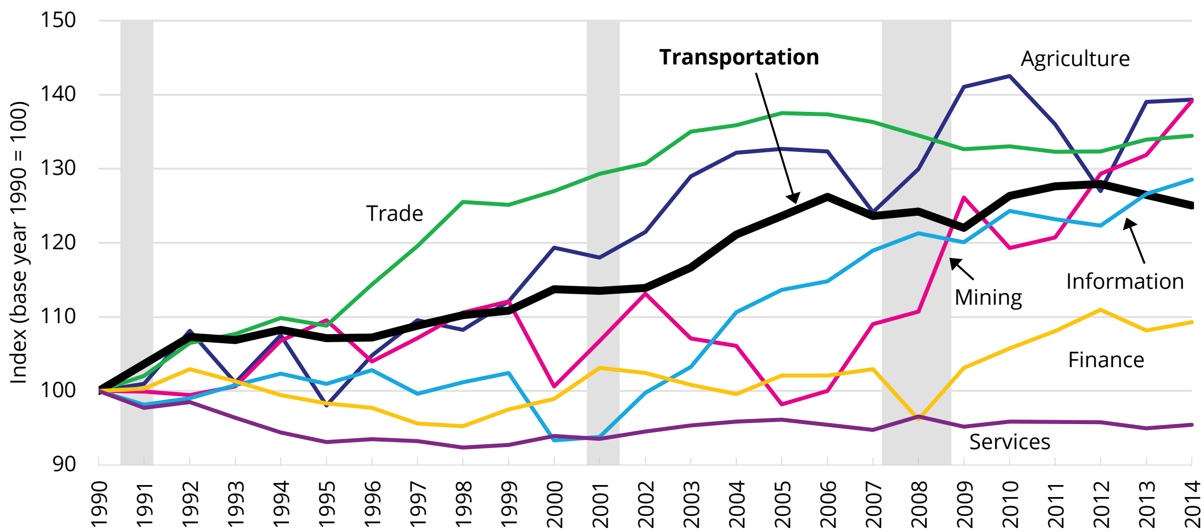
Source: U.S. Department of Labor, Bureau of Labor Statistics, Major Sector Productivity, available at www.bls.gov.

Multifactor Productivity

To measure *multifactor productivity (MFP)*, BLS divides output by a weighted set of inputs, including capital (e.g., equipment), labor, energy (e.g., fuel), materials, and purchased services. MFP measures the change in output relative to the change in inputs used to produce that output. Changes in multifactor productivity reflect the combined effects of factors, such as new technologies, new regulations, or organizational changes, after accounting for changes in inputs.

From 1990 to 2014, MFP for the transportation sector grew, at 25.0 percent, more modestly than all other sectors except the finance and service sector (figure 5-2). MFP gains in the transportation sector reflect an 81.5 percent increase in output and a 45.2 percent increase in combined inputs (figure 5-3). Capital services grew by 44.6 percent and labor input, which is the combined effect of hours worked and labor composition, grew 44.4 percent. Intermediate inputs grew by 46.4 percent.

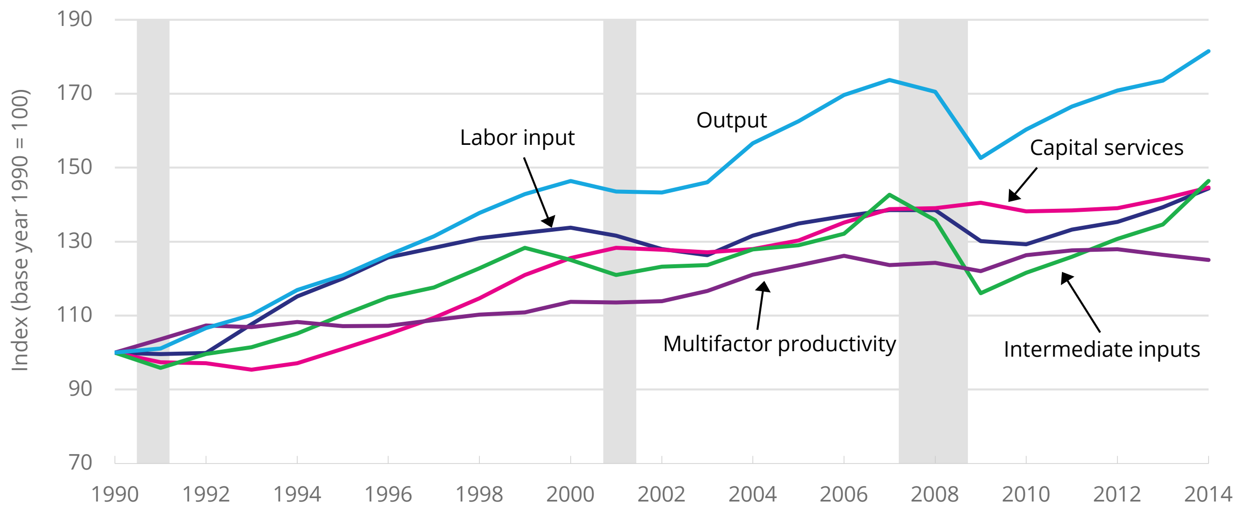
Figure 5-2: Multifactor Productivity Indexes for Selected Sectors, 1990 to 2014



Notes: Finance includes finance and insurance and real estate rental and leasing. The service sector includes professional and business services; education and health services; leisure and hospitality; and other services (NAICS 54–81). Shaded areas indicated economic recessions.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Major Sector Productivity, available at www.bls.gov.

Figure 5-3: Productivity of the Transportation Sector, 1990 to 2014



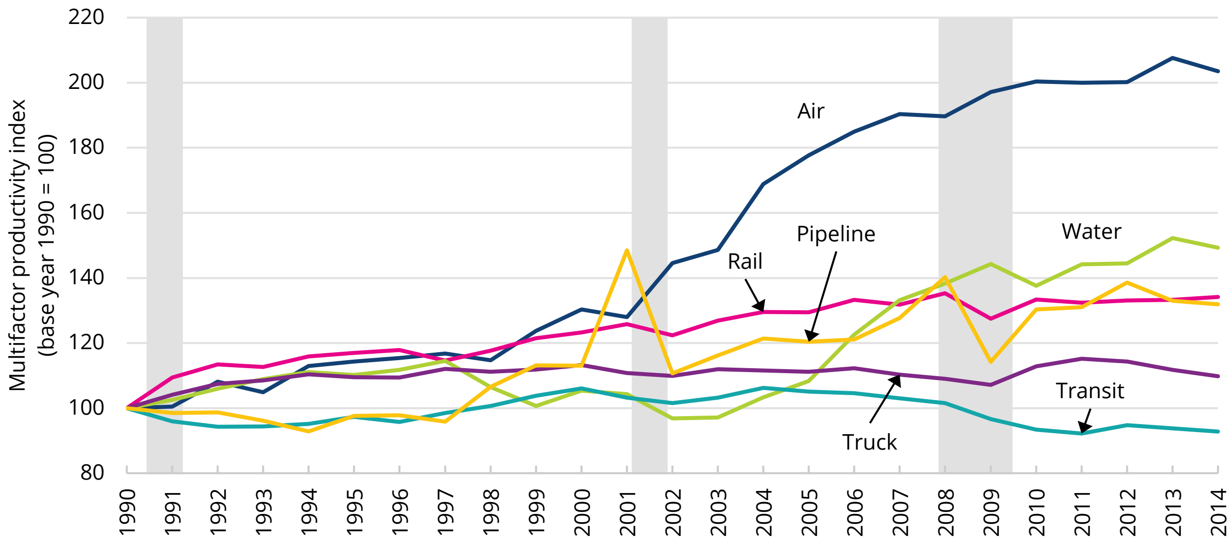
Note: Shaded areas indicate economic recessions.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Major Sector Productivity, available at www.bls.gov.

From 1990 through 2014, air transportation had the largest increase in MFP, growing at 103.5 percent (figure 5-4). The gain in air transportation reflects an 80.1 increase in output and an 11.5 percent decline in combined inputs. Combined inputs fell, despite an increase in capital services, because of declines in labor inputs and intermediate inputs. The increase in capital services and the decline in labor follow from the air transportation sector adopting labor-saving technologies, such as self-service kiosks.

Water transportation experienced the second largest increase in MFP, growing 49.3 percent from 1990 to 2014, despite declining 15.2 percent from 1997 to 2003. The MFP of rail transportation grew steadily over the entire period but more slowly, increasing 34.2 percent. MFP in pipeline transportation had a smaller increase of 31.9 percent over the same period and showed more year-to-year variation than other modes. Truck transportation's MFP grew marginally at 9.8 percent, while the transit sector experienced a decline of 7.2 percent.

Figure 5-4: Multifactor Productivity Indexes for Selected Transportation Sectors, 1990 to 2014



Note: Shaded areas indicate economic recessions.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Major Sector Productivity, available at www.bls.gov.

Sources of Economic Growth

The BEA/BLS Integrated Production Accounts show the contribution of labor, capital, and MFP to economic growth. Based on the accounts, transportation's contribution has been smaller than other sectors. Between 2003 and 2007, transportation, with an average annual growth rate of 0.14 percent, contributed significantly less than the manufacturing, service, and finance, which all had average annual growth rates in excess of 0.50 percent (table 5-1). Almost all sectors, including transportation, experienced negative growth during the 2007 to 2009 economic recession. Since 2009, transportation has contributed positively to economic growth. However, transportation's average annual contribution to economic growth from 2009 to 2014 (the latest available year) is below its pre-recession level at 0.06 percent.

Table 5-1: Sources of Economic Growth (average annual growth rate), 2003 to 2014

Industry	2003–2007	2007–2009 (Recession)	2009–2014
All	2.73%	-1.56%	1.79%
Finance	0.58%	0.03%	0.31%
Services	0.56%	-0.12%	0.59%
Manufacturing	0.51%	-0.66%	0.20%
Information	0.32%	0.03%	0.14%
Government	0.28%	0.17%	0.07%
Trade	0.28%	-0.61%	0.26%
Transportation	**0.14%**	**-0.11%**	**0.06%**
Mining	0.07%	0.17%	0.11%
Utilities	0.02%	-0.05%	0.02%
Agriculture	0.00%	0.09%	0.02%
Construction	-0.03%	-0.48%	0.01%

Notes: Finance includes finance and insurance and real estate rental and leasing. The service sector includes professional and business services; education and health services; leisure and hospitality; and other services (NAICS 54-81).

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Integrated Industry-Level Productivity Account, available at www.bea.gov.

Per-Mile Revenue Measures

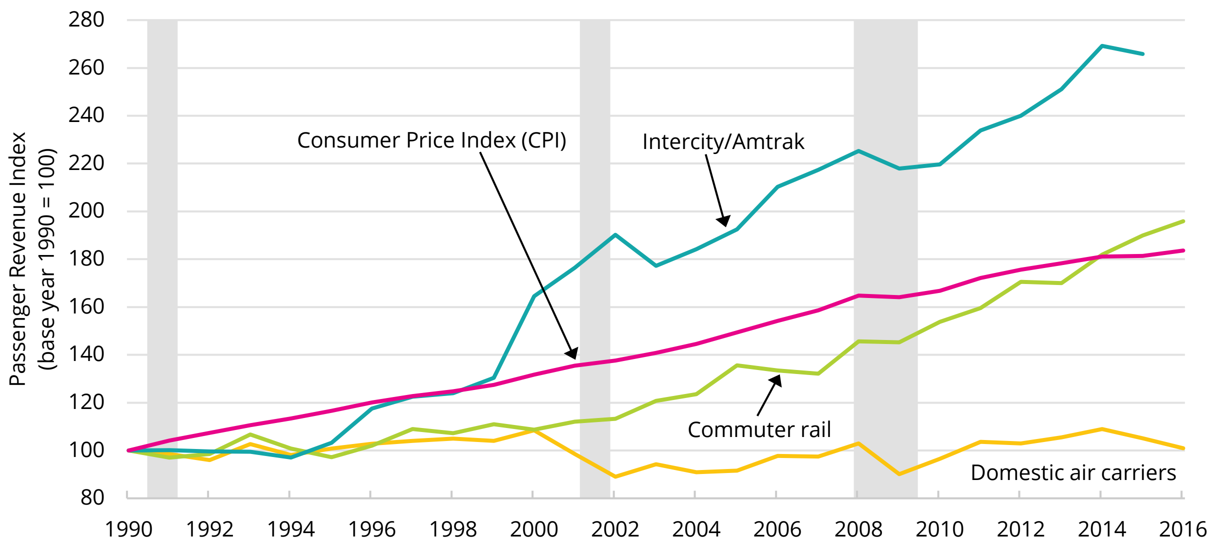
Another way to look at transportation productivity is to examine what users pay for transportation. This can be seen as an economic measure of the value of transportation. For for-hire passenger transportation, the unit of output is passenger-miles. The measure of what travelers pay is *average revenue per passenger-mile*. For for-hire freight transportation, the unit of output is ton-miles. The measure of what freight shippers pay is *average freight revenue per ton-mile*. For modes where users do not typically pay per use, like driving a personal vehicle, complete data are difficult to obtain.

Revenue per Passenger-Mile

While nominal revenue per passenger-mile has increased since 1990, only Amtrak/intercity rail and commuter rail experienced real (inflation-adjusted) passenger revenue growth. Figure 5-5 shows nominal changes in revenue per passenger-mile relative to the Consumer Price Index (CPI) for three industries: domestic air carriers, commuter rail, and Amtrak/intercity rail. Amtrak/intercity rail experienced the largest growth in revenue per passenger-mile, increasing 165.8 percent between 1990 and 2015 (latest available year), and commuter rail increased 95.9 percent between 1990 and 2016. Both Amtrak/intercity rail and commuter rail experienced steady growth. In contrast, domestic air carrier revenue per passenger-mile fell after the September 2001 terrorist attacks, began to rise after reaching a low in 2002, and then fell again during the Great Recession (December 2007 to June 2009) to its 2002 level in 2009. Between 2009 and 2014, domestic air carrier revenue per passenger-mile rose 21.0 percent but then fell 7.3 percent between 2014 and 2016.

The increases in revenue per passenger-mile are partly due to an increase in the overall price of goods and services. The CPI, which measures overall changes in prices, increased by 83.6 percent from 1990 to 2016, indicating that Amtrak/intercity rail and commuter rail were the only industries with real increasing revenue per passenger-mile during the period. Domestic air carriers, meanwhile, suffered a decrease in real revenue per passenger-mile.

Figure 5-5: Average Passenger Revenue per Passenger-Mile Indices, 1990 to 2016



Notes: Domestic air carrier revenue includes baggage fees and reservation change fees. Shaded areas indicate economic recessions.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, table 3-20, available at www.bts.gov.

Domestic Air Carrier Revenues

Two developments have affected domestic air carrier revenues from 1990 to the present. First, average inflation-adjusted domestic air fares declined 22.0 percent between the fourth quarter of 1995 and the fourth quarter of 2016.[3] As a result, fares have accounted for a lower percentage of operating revenues. In the 1990s, domestic air carriers received slightly below 90 percent of their revenues from passenger fares. In the 2000s, however, the percentage declined from 88.9 percent in 2000 to 73.7 percent in 2009, and has remained near the same percentage since then. Second, airlines began increasing baggage fees and reservation change fees in 2008. In 2016, passenger airlines collected $3.3 billion from baggage fees and $1.9 billion from reservation change fees; these fees accounted for 2.6 and 1.5 percent of total operating revenue, respectively.

Freight Revenue per Ton-Mile

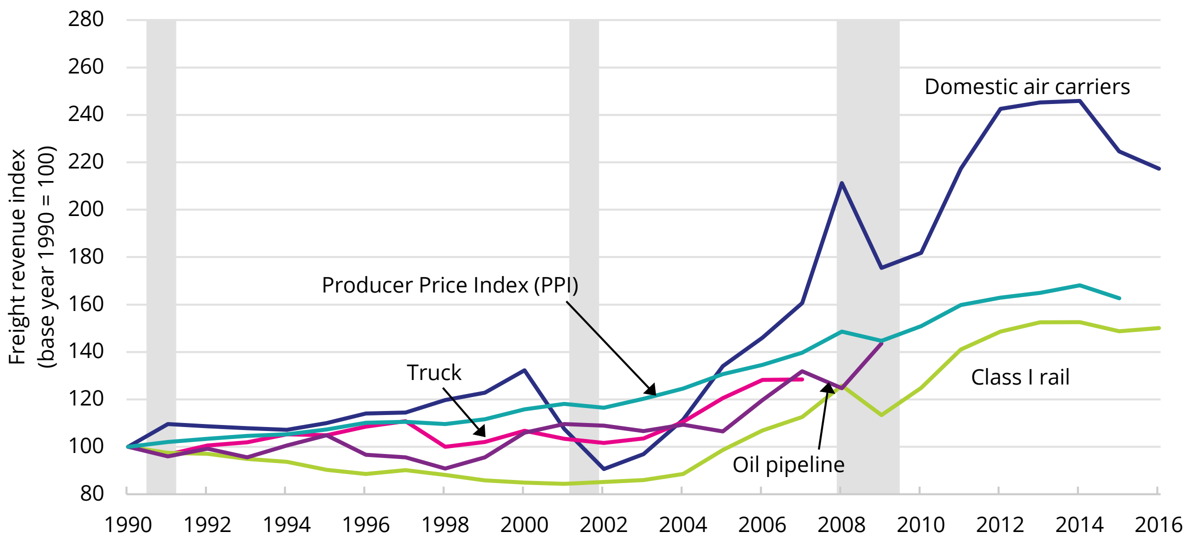
Figure 5-6 shows the average freight revenue per ton-mile for air, truck, rail, and pipeline compared to the Producer Price Index (PPI). Data for pipelines after 2009 and for trucks after 2007 are unavailable. The PPI measures overall changes in the selling prices received by transportation service providers for their services.

Nominal freight revenue per ton-mile increased for all freight modes; however, revenue increases exceeded producer price increases only for domestic air. Domestic air carriers experienced the largest increase in revenue per ton-mile, increasing 117.3 percent from 1990 to 2016. The largest gains in air revenue per ton-mile occurred between 2002 and 2014, despite a slight decline during the 2007 to 2009 recession. Air revenue per ton-mile remained virtually unchanged between 2012 and 2014 and declined in 2015 and 2016 from its 2014 level. Class I railroads, defined as line-haul freight railroads with annual operating revenues of $457.91 million or more as of 2015,[4] experienced a smaller increase in revenue per ton-mile of 50.1 percent in the same period due to an initial decline. Rail revenue per ton-mile declined 15.6 percent from 1990 to 2001 but then grew 77.9 percent from 2001 to 2016 with only a slight decline during the 2007 to 2009 recession and in 2015. Oil pipelines experienced an increase of 43.6 percent from 1990 to 2009, and trucks experienced the smallest increase of 28.4 percent from 1990 to 2007.

[3] For more information on domestic air carrier revenues, please see the BTS airline financial data press releases at www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/press_releases/airline_financial_data.html.

[4] See "Class I Railroad Statistics", Association of American Railroads, May 2017, available at www.aar.org/Documents/Railroad-Statistics.pdf as of June 2017.

Figure 5-6: Average Freight Revenue per Ton-Mile Indices, 1990 to 2016



Note: Shaded areas indicate economic recessions.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics*, table 3-21, available at www.bts.gov.