

1 SUMMARY INDICATORS

Transportation makes economic activity possible by enabling the production of goods and services—for instance, in carrying the raw materials needed to manufacture goods. Transportation also serves as a major economic activity itself. Households, businesses, and the government directly consume transportation goods (e.g., vehicles and motor fuel) and services (e.g., public transit and commercial airline transportation) to meet their travel needs. This chapter shows transportation’s relationship to the economy, while Chapter 2 measures the indirect and direct contribution of transportation to the economy.

Transportation Services Index

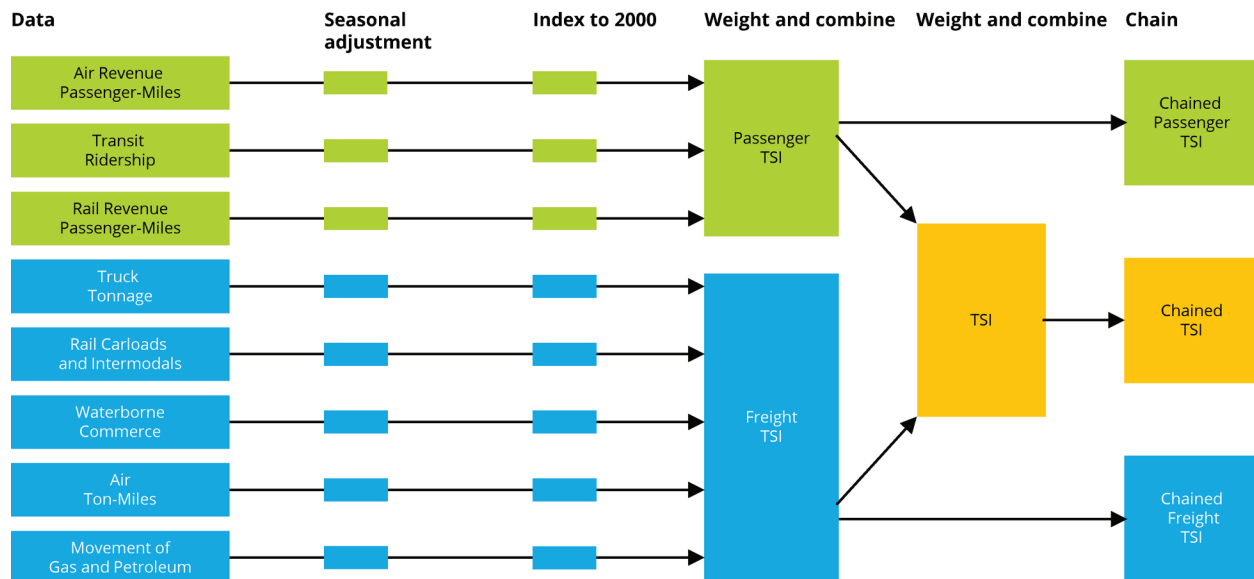
Transportation activities have a strong relationship to the economy. The Bureau of Transportation Statistics (BTS) developed the Transportation Services Index (TSI) to measure the volume of freight and passenger transportation services provided monthly by the *for-hire transportation sector* in the United States (box 1-1). For-hire transportation consists of the services provided by transportation firms to industries and the public on a fee basis. Airlines, railroads, transit agencies, common carrier trucking companies, and pipelines are examples of for-hire transportation. Other types of transportation are discussed in Chapter 2.

Box 1-1: Transportation Services Index

The Bureau of Transportation Statistics’ (BTS) Transportation Services Index (TSI) measures the volume of freight and passengers moved. BTS produces three indexes: a freight index, a passenger index, and a combined index. The indexes incorporate monthly data from multiple for-hire transportation modes. Each index shows the month-to-month change in for-hire transportation services. Monthly data on each mode of transportation is seasonally adjusted, then combined into the three indexes. The passenger index is a weighted average of data for passenger aviation, transit, and passenger rail. The freight index is a weighted average of data for trucking, freight rail, waterborne, pipeline, and air freight. The combined index is a weighted average of all these modes. These indexes serve both as multimodal monthly measures of the state of transportation and as indicators of the U.S. economic future.

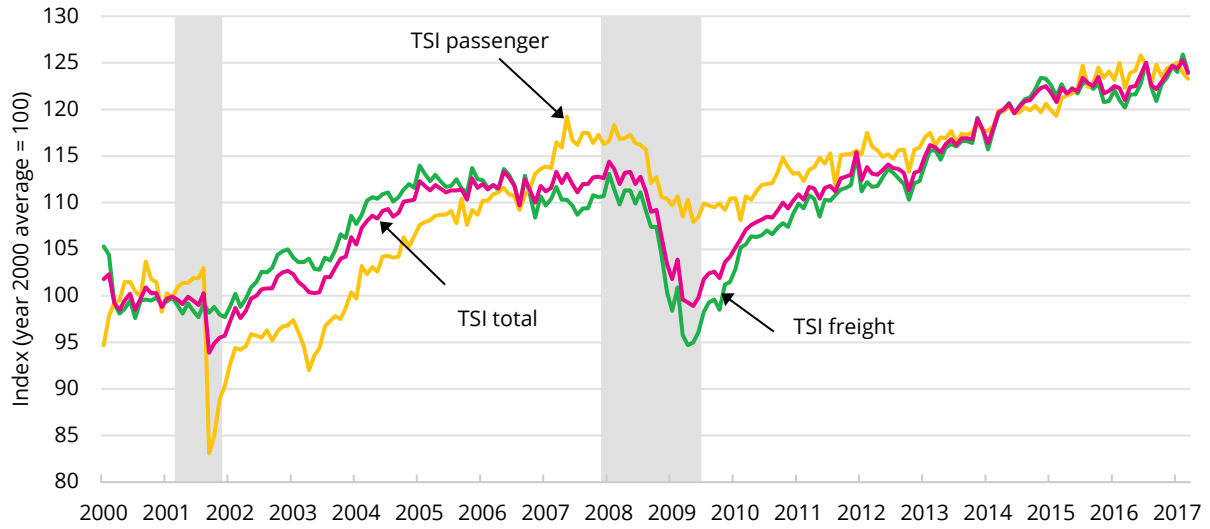
Source: U.S. Department of Transportation, Bureau of Transportation Statistics, 2017.

Figure 1-1 shows the steps used to create the TSI, from collecting raw data, through seasonally adjusting and indexing the data, to combining them into summary chained indexes (box 1-2). The green boxes in figure 1-1 highlight the data input and process for the passenger TSI, and the blue boxes highlight the data input and process for the freight TSI. The two indexes are then appropriately weighted to create the combined TSI.

Figure 1-1: Transportation Services Index (TSI) Production Process

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index, available at www.transtats.bts.gov/OSEA/TSI.

Figure 1-2 illustrates trends in the TSI from January 2000 to March 2017. Overall, the combined TSI increased by 21.7 percent, the freight TSI increased by 17.8 percent, and the passenger TSI increased by 30.2 percent. However, all three measures declined in the wake of the September 2001 terrorist attacks. The passenger TSI dropped sharply—19.3 percent from August 2001 to September 2001 due to significant declines in passenger air travel. The indexes also decreased sharply during the Great Recession from December 2007 to June 2009. The combined TSI decreased by 11.4 percent, the passenger TSI decreased by 6.7 percent, and the freight TSI decreased by 13.2 percent. All three indexes have since recovered to pre-recession levels.

Figure 1-2: Transportation Services Index (TSI), January 2000 to March 2017

Note: Shaded areas indicate economic recessions.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index, available at www.transtats.bts.gov/OSEA/TSI.

Box 1-2: Chained Indexing

Many economic measures use a fixed base year to allow comparisons over time. However, the measures are highly sensitive to the base year chosen, and choosing a new base year can change the measure's history dramatically. In the past, when government economists changed the base year for calculating GDP, the revised growth calculations sparked many debates about the true state of the economy. At the same time, these measures become less accurate the further one moves away from the base year. In other words, keeping the base year fixed introduces a new problem.

One method to address these issues is chained indexing, a technique that uses values from the current year and the fixed year to calculate values. For the Transportation Services Index, the Bureau of Transportation Statistics uses the Fisher Ideal Index formula to chain the data. Technical details are available at go.usa.gov/xNpGK.

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

TSI and the Economy

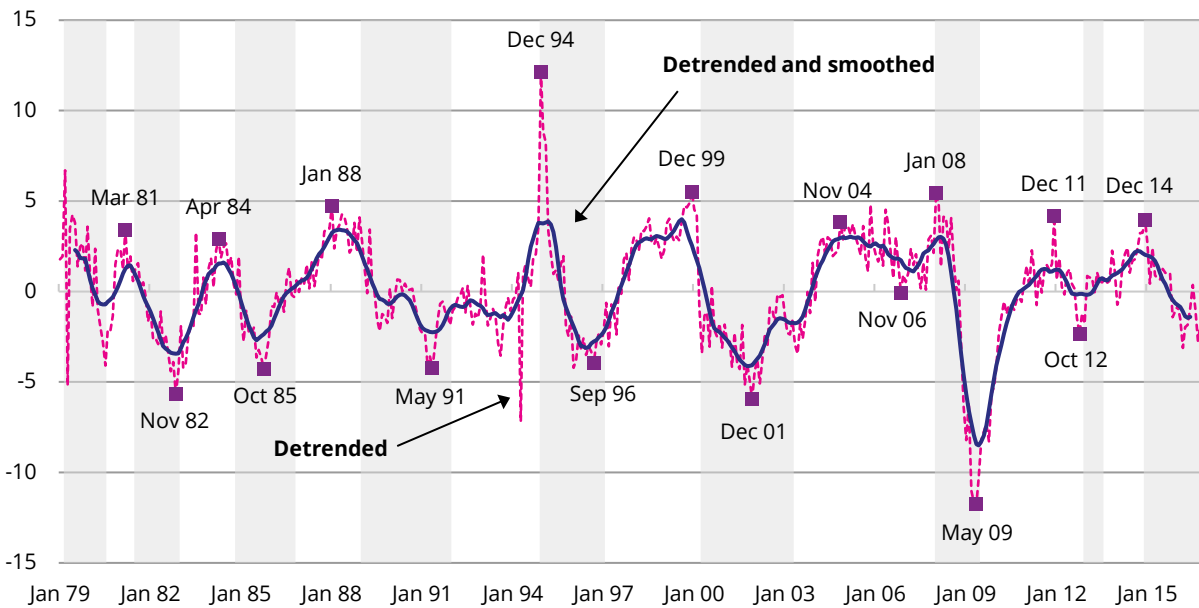
BTS research shows that changes in the TSI occur before changes in the economy, making the TSI a potentially useful economic indicator.¹ Figure 1-3 illustrates the relationship between the freight TSI and the national economy from January 1979 to December 2016. The dashed blue line shows the freight TSI detrended to remove long-term changes. The red line shows the freight TSI detrended and smoothed to eliminate month-to-month volatility as well. The shaded areas represent *economic slowdowns*, or periods when economic growth slows below normal rates and unemployment tends to rise as a result of the slowdown. The peaks and troughs show that the freight TSI usually peaks before a growth slowdown begins and hits a trough before a growth slowdown ends (box 1-3).

Two economic accelerations followed the Great Recession: the first from June 2009 to December 2012, and the second from July 2013 to December 2014. BTS research shows that the freight TSI led both accelerations; however, the relationship between the freight TSI and growth cycles changed somewhat.² The freight TSI reached a peak in December 2011 and turned downward. This occurred 12 months before the economic deceleration that began in December 2012. The freight TSI turned a second time before December 2012, hitting a trough in October 2012 and turning upward. Historically, the freight TSI has not hit a trough and turned upwards before the onset of an economic deceleration. The economic deceleration begun in December 2012 ended in July 2013. The freight TSI peaked in December 2014 and turned downwards at the same time as the growth cycle.

¹ See U.S. Department of Transportation, Bureau of Transportation Statistics, "TSI and the Economy Revisited," December 2014, available at go.usa.gov/xnEP3.

² See U.S. Department of Transportation, Bureau of Transportation Statistics, "Long Term Growth in Freight Transportation Services: Methods and Findings," December 2017, available at go.usa.gov/xnPst.

Figure 1-3: Freight Transportation Services Index and the Economic Growth Cycle, January 1979 to December 2016



Notes: Shaded areas indicate decelerations in the economy (growth cycles). Detrending and smoothing refer to statistical procedures that make it easier to observe changes in upturns and downturns of the data. Detrending removes the long-term growth trend and smoothing eliminates month-to-month volatility.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index, available at www.transtats.bts.gov/OSEA/TSI.

Box 1-3: Expansions, Recessions, and Growth Cycles

In an economic expansion, the economy is growing in real terms, as shown by increases in statistics like employment, industrial production, sales, and personal incomes. In a recession, the economy is contracting, as shown by decreases in those statistics. In the United States, the National Bureau of Economic Research (NBER) determines the official dates for expansions and recessions, which together make up business cycles. A business cycle has four phases: an expansion, a peak, a recession, and a trough. An expansion is measured from the trough (or bottom) of the previous business cycle to the peak of the current cycle, while recession is measured from the peak to the trough.

Growth cycles occur within a business cycle, and represent the cyclical changes in the economy that are evident once the long-term trend and seasonality have been removed. Growth cycles therefore highlight accelerations and decelerations in the economy.

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

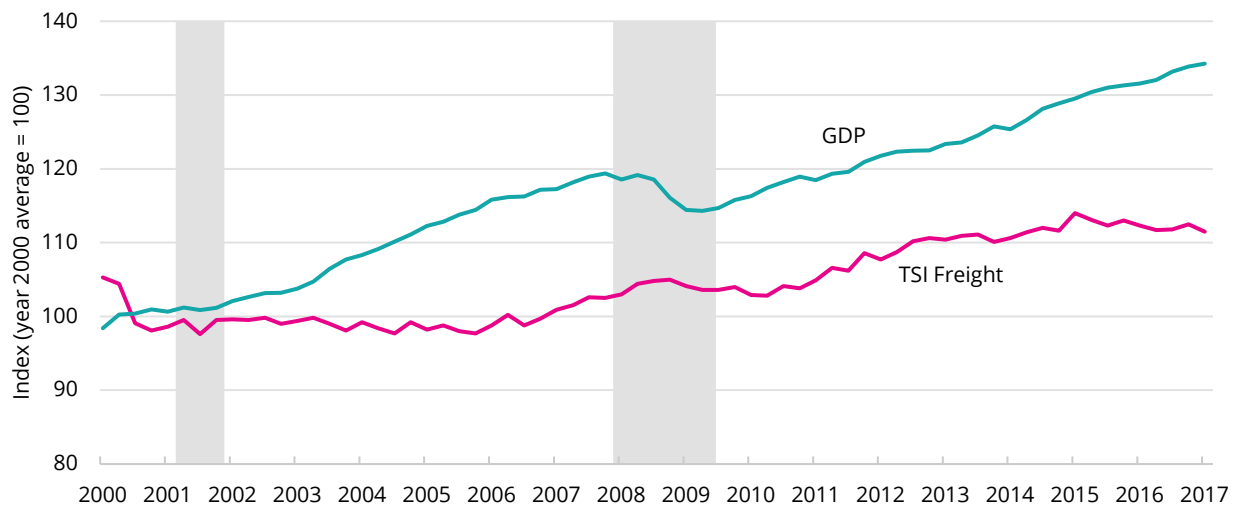
TSI and Other Economic Indicators

To understand the relationships between transportation and the rest of the economy, one can compare trends in the TSI with trends in other economic measures. The economic measures are presented as indexes for comparability with the TSI.

Gross Domestic Product (GDP)

Gross Domestic Product (GDP) is the broadest measure of the economy. The U.S. GDP includes the monetary value of all goods and services produced within the United States. Between the first quarters of 2000 and 2017, real GDP increased 36.4 percent, and the freight TSI increased by 21.1 percent (figure 1-4). This growth hides the extended period of decline during the recession. From the fourth quarter of 2007 to the second quarter of 2009, GDP decreased 4.2 percent, and the freight TSI decreased 13.9 percent. Both measures have since recovered to pre-recession levels. GDP includes many sectors besides transportation, so the magnitude of changes in GDP and the TSI cannot be directly compared.

Figure 1-4: Quarterly Gross Domestic Product and Freight Transportation Services Index (seasonally adjusted), Q12000 to Q1 2017



Note: Shaded areas indicate economic recessions.

Sources: **GDP:** U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts, table 1.1.6, available at www.bea.gov/iTable/index_nipa.cfm. **Freight TSI:** U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index, available at www.transtats.bts.gov/OSEA/TSI.

Industrial Production and Manufacturers' Shipments

Industrial production and manufacturers' shipments are major sources of demand for freight transportation services (box 1-4). When these shipments declined during the 2007 to 2009 recession, the freight TSI declined as well. From December 2007 to June 2009, industrial production declined by 17.3 percent, and manufacturers' shipments declined by 21.6 percent (figure 1-5). After the recession, industrial production increased by 18.3 percent and manufacturers' shipments increased by 29.9 percent. However, manufacturers' shipments recently declined 10.1 percent from September 2014 to February 2016.

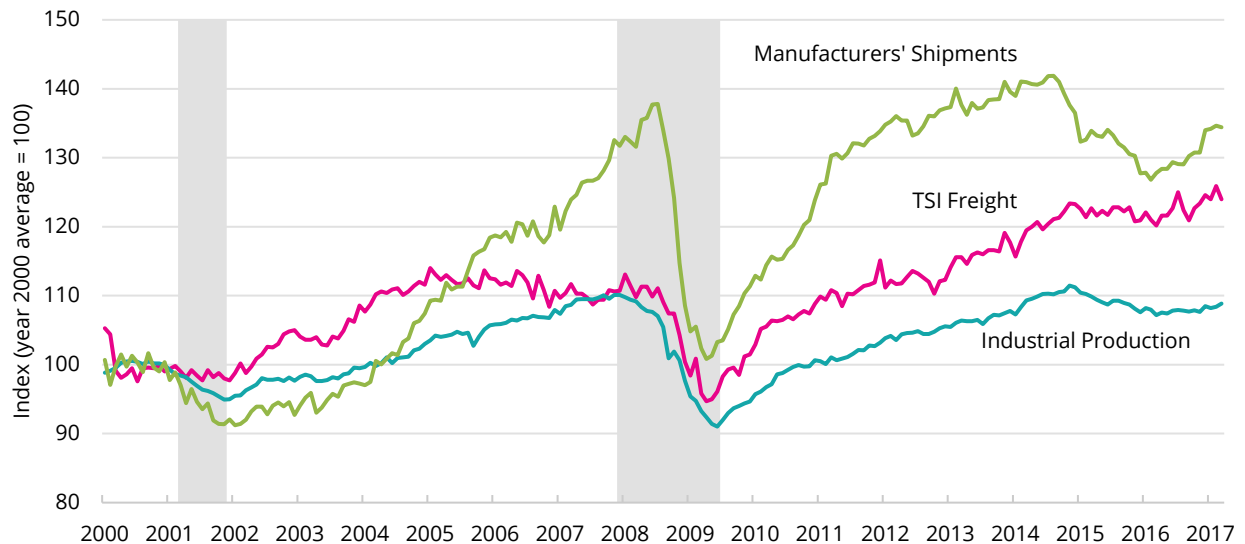
Box 1-4: Industrial Production and Manufacturers' Shipments Data

Data on industrial production come from the Industrial Production Index, published monthly by the Federal Reserve Board. It measures real output in the U.S. industrial sector, which includes manufacturing, mining, and electric and gas utilities.

Data on manufacturers' shipments come from the Census Bureau's Manufacturers' Shipments, Inventories, and Orders (M3) survey. This survey provides monthly data on economic conditions in the domestic manufacturing sector, and measures the dollar value of products sold by manufacturing establishments and is based on net selling values after discounts and allowances are excluded. Freight charges and excise taxes are excluded.

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

Figure 1-5: Monthly Industrial Production, Manufacturers' Shipments, and Freight TSI (seasonally adjusted), January 2000 to March 2017



Note: Shaded areas indicate economic recessions.

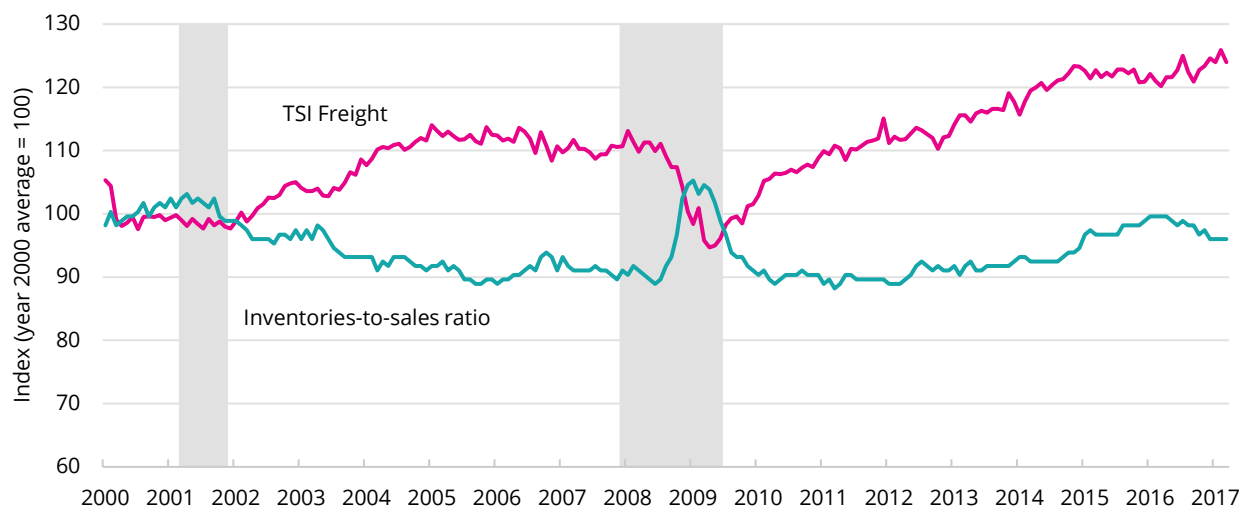
Sources: Industrial Production: Board of Governors of the Federal Reserve System, Industrial Production Index, available at www.federalreserve.gov/releases/g17/current. **Manufacturers' Shipments:** U.S. Bureau of the Census, Value of Manufacturers' Shipments for All Manufacturing Industries, available at www.census.gov/manufacturing/m3. **Freight TSI:** U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index, available at www.transtats.bts.gov/OSEA/TSI.

Inventories-to-Sales Ratio

When businesses keep greater amounts of inventory on hand, they use less freight transportation. One measure of inventory on hand is the *inventories-to-sales ratio*, or the value of goods on shelves and warehouses divided by monthly sales. A ratio of 2.5, for example, would indicate that a business has enough goods to cover sales for 2.5 months. When the inventories-to-sales ratio increases, the freight TSI tends to decrease at the same time or soon after. Conversely, when businesses move greater amounts of inventory and inventories to sales ratio falls, the freight TSI tends to increase.

The U.S. Census Bureau produces a national inventories-to-sales ratio for businesses in the United States. This ratio has generally declined as businesses adopt just-in-time delivery and learn to manage their inventory more efficiently. From January 2000 to June 2008, the inventories-to-sales ratio declined by about 9.4 percent (figure 1-6). During the recession, however, the ratio rose 18.4 percent from June 2008 to January 2009, while the freight TSI declined 10.5 percent. From January 2009 to March 2017, the inventories-to-sales ratio declined 8.8 percent, and the freight TSI increased 26.0 percent.

Figure 1-6: Monthly Freight Transportation Services Index and Inventory to Retail Sales Ratio (seasonally adjusted), January 2000 to March 2017



Notes: The inventories-to-sales ratio is indexed to the year 2000 for ease of comparison with the TSI. Shaded areas indicate economic recessions.

Sources: Inventories-to-Sales Ratio: U.S. Bureau of the Census, Manufacturing and Trade Inventories and Sales, available at www.census.gov/mtis. **Freight TSI:** U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Services Index, available at www.transtats.bts.gov/OSEA/TSI.

Seasonally Adjusted Transportation Data

The monthly data used to create the TSI are highly seasonal, reflecting trends such as stores increasing inventory for the holiday season and households taking vacations in the summer. Seasonal trends make it difficult to observe underlying long-term changes in the data, as well as monthly shifts and short-term trends, which are best viewed using seasonally adjusted data (box 1-5).

Box 1-5: Seasonal Adjustment

Seasonal adjustment is the process of estimating and removing seasonal movement. Seasonal adjustment decomposes a time series into a seasonal part and an irregular part. The goal is to remove changes in the data happening at the same time and with the same magnitude and direction every year. Controlling these predictable influences allows measurement of real monthly changes, short- and long-term patterns of growth, or decline and turning points.

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

To portray real changes in the TSI, BTS seasonally adjusts, indexes, and weights the data based on economic value added for all transportation modes including truck tonnage, rail freight carloads, rail freight intermodal, pipeline, natural gas, U.S. waterway tonnage, passenger air transportation, rail passenger-miles, and public transit ridership.³ Figures 1-7 and 1-8 show the seasonally adjusted modal data included in the freight and the passenger TSI as indexes.

Seasonally Adjusted Freight Transportation

Rail intermodal grew the fastest among the freight modes in the TSI, rising 50.6 percent from June 2009 (the end of the economic recession) to December 2016 (figure 1-7). Competitive pricing, track upgrades, and investment in rail intermodal terminals and other infrastructure contributed to the rapid growth of rail intermodal traffic.⁴ Trucking grew the second fastest at 37.8 percent, followed by pipeline at 29.6 percent, waterborne at 23.2 percent, and air freight at 21.7 percent. Rail intermodal, trucking, and pipeline all have grown steadily since June 2009, while air freight and waterborne show little growth after initial recovery. Rail carloads declined 0.8 percent from June 2008 to December 2016. Data from the Association of American Railroads suggest that the decline in rail carload shipments is due to reductions in coal shipments.⁵ The total coal shipped by Class I

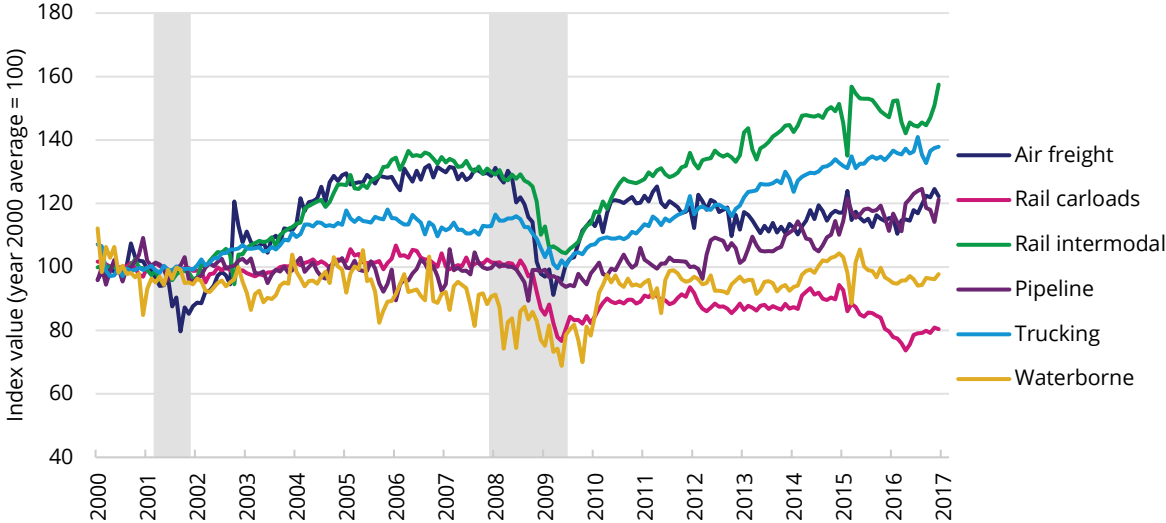
³ Value added is defined as industry gross output less purchased materials and purchased services. This is a measure of the size of an industry sector used by economists. Value added for all industries sums to Gross Domestic Product.

⁴ See "Railroad Intermodal Keeps America Moving," May 2016, available at www.aar.org/BackgroundPapers/Rail%20Intermodal.pdf.

⁵ See "Railroads and Coal," July 2016, available at www.aar.org/BackgroundPapers/Railroads%20and%20Coal.pdf.

railroads peaked in 2008 at 878.6 million tons, dropped to 787.6 million tons in 2009, and continued to fall to 491.7 million tons in 2016.⁶

Figure 1-7: Modal Data (seasonally adjusted), Included in Freight Transportation Services Index, January 2000 to March 2017



Note: Shaded areas indicate economic recessions. Pipeline is a weighted average of petroleum pipeline and natural gas movement.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, seasonally adjusted transportation data, available at www.transtats.bts.gov/osea/seasonaladjustment.

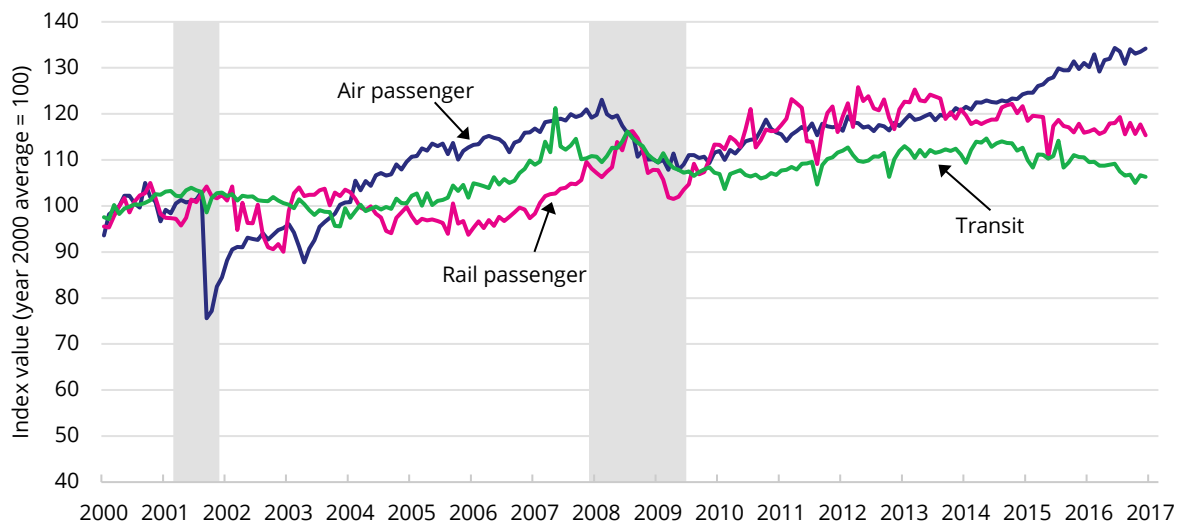
Seasonally Adjusted Passenger Transportation

Among the passenger modes included in the TSI, seasonally adjusted air passenger-miles increased the most, at 40.5 percent, from January 2000 to March 2017 (figure 1-8). Air passenger-miles reached their lowest point in September 2001 following the September 11, 2001 terrorist attacks, but have increased by 73.9 percent since that point.

⁶ See Class I Railroad Statistics, May 2009, 2010, and 2017, available at www.aar.org/Documents/Railroad-Statistics.pdf.

Seasonally adjusted rail passenger-miles have increased by 20.7 percent since January 2000. They reached their highest level in April 2012 and since have declined 8.3 percent (figure 1-8). Seasonally adjusted transit ridership has increased by 10.1 percent since January 2000. Transit ridership fell after reaching a peak in July 2008 and then began to grow after February 2010. Transit ridership did not recover to the July 2008 high point before beginning a steady decline once again in late 2014 through the present (figure 1-8).

Figure 1-8: Modal Data (seasonally adjusted), Included in Passenger Transportation Services Index, January 2000 to March 2017



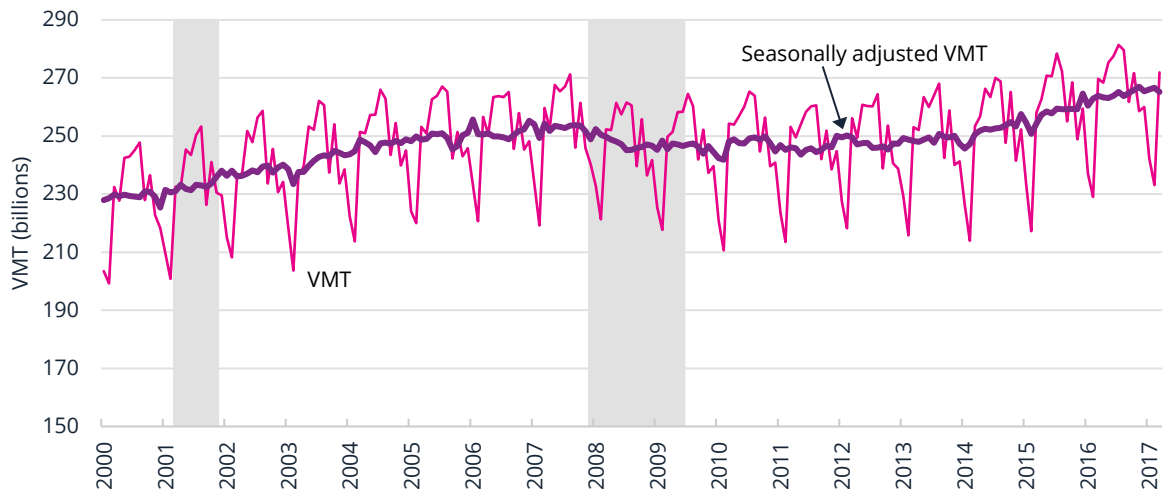
Note: Shaded areas indicate economic recessions.

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, seasonally adjusted transportation data, available at www.transtats.bts.gov/osea/seasonaladjustment.

Seasonally Adjusted Highway Vehicle-Miles Traveled

While the TSI measures for-hire transportation services, BTS also seasonally adjusts data for highway vehicle-miles traveled (VMT) to show trends in travel volumes. Seasonally adjusted VMT has grown by 16.3 percent since January 2000 (figure 1-9). VMT remained stable after a marginal decline at the onset of the recession and then began to steadily rise in early 2014. VMT grew 7.9 percent from January 2014 to March 2017.

Figure 1-9: Highway Vehicle-Miles Traveled (VMT), 2000 to 2017



Note: Shaded areas indicate economic recessions.

Sources: **Unadjusted VMT:** U.S. Department of Transportation, Federal Highway Administration, Traffic Volumes and Trends, available at www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm. **Seasonally-adjusted VMT:** U.S. Department of Transportation, Bureau of Transportation Statistics, seasonally adjusted transportation data, available at www.transtats.bts.gov/osea/seasonaladjustment.