

CHAPTER Df

Transportation

Editor: Louis P. Cain

TRANSPORTATION

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Transportation refers to systems for carrying persons and goods from one place to another. It includes routes such as roadways, waterways, railways, airways, and pipelines. It also includes the means of conveyance such as carts, carriages, wagons, bicycles, automobiles, trucks, railroad engines and cars, ferries, barges, sailing ships, steamers, airplanes, and pipes.

Transportation systems have a direct impact on many aspects of a country's economy and society. This is because individuals, regions, and countries can increase their incomes by specializing in the production of those goods and services that they produce relatively efficiently, and then trading these with others. By reducing the costs of making those trades, transportation systems encourage this specialization and thereby promote the growth of income and wealth. Because of its large size and the diversity of its resources, the United States developed the potential to increase wealth through specialization and trade earlier than most countries. The legal structure of the United States also encouraged this specialization. The U.S. Constitution forbade states from establishing tariffs or other barriers to trade with other states and delegated to the federal government the power to regulate commerce among the states and with foreign nations. As a consequence of these clauses, trade barriers between the former colonies were removed, and the United States established a common, national set of tariff schedules with other countries. The Constitution thus created the framework for the various states to become a "common market" or free trade zone.

Technological advances also led to improvements in transportation. Notable inventions were the steam engine, internal combustion engine, and aircraft, as well as developments in the engineering of bridges and roadways. Much of the technology involved in transportation was invented and developed in the United States, and this makes American transportation history especially interesting.

Transportation is part of the infrastructure of the United States, that is, the underlying, basic structures such as transportation and communications systems, water and power lines, and public institutions such as post offices and schools that are considered vital to the functioning of an economy and society. Where people work and where they live, where goods are produced and where they are sold, are all determined in part by the transportation infrastructure.

Acknowledgments

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One key to effective transportation systems is integration. It is far less costly to cross a river by bridge than to unload a wagon or train, board a boat, and then reload the goods before returning to an overland route. Integrated transportation systems are expensive, and, as a consequence, the transportation system of the United States was developed – by both private and governmental enterprises and in some cases by hybrid government–private enterprises. The subject of one of the earliest Constitutional debates was the Gallatin Report and concerned the role of the federal government in what were called "internal improvements." It was believed that the sheer size of the investment required for these improvements was too great for private entrepreneurs acting alone and that governments should ease this constraint. Two mechanisms were identified. Governments could make direct financial contributions to the development of transportation systems, or they could issue long-term bonds to help pay for construction.¹ In addition, governments became involved by issuing corporate charters to transportation companies. In the early years of this country, such charters implied a special relationship with the government. In granting corporate charters, political leaders could give transportation companies the right to contract loans, levy tolls, and even, in some cases, print money to support transportation enterprises. Government action is also necessary to secure right-of-way for railroads and highways, in many cases using the power of eminent domain to force the sale of private property. Consequently, state and local governments became vitally involved in the development of the U.S. transportation system almost from the beginning. The federal government, in spite of the suggestions of the Gallatin Report, did not become involved in a systematic and continuous way until the late nineteenth century.

Another consequence of the large size of integrated transportation systems was the challenges they presented to management. Business historian Alfred D. Chandler Jr. called the railroad companies, together with their associated telegraph companies, "the first modern business enterprises."

They were the first to require a large number of full-time managers to coordinate, control, and evaluate the activities of a number of widely scattered operating units. For this reason, they provided the most relevant administrative models for enterprises in the production and distribution of goods and services when such enterprises began to build, on the basis of the new transportation and communication network, their own geographically extended, multiunit business empires. (Chandler 1977, p. 79)

The early history of transportation in the United States and its impact on the larger economy is a complex and fascinating story

¹ Goodrich (1960), Chapter 1. The original scholarship on this point was done by Callender (1902).

that has been told in many important historical works, some of which are cited here. This essay examines the major modes of transportation sequentially, focusing on the available quantitative historical evidence that illustrates their growth and development (see Table Df-A).

Highways, Wagons, and Motor Vehicles

In colonial America, most “highways” were little more than earthen paths that turned to mud in rainy weather. This made overland transportation slow, costly, and undependable. Overland transportation

TABLE Df-A Important events, legislation, and judicial decisions relating to transportation: 1787–1996

1787	A steamboat built by John Fitch is given a successful trial.
1794	The Lancaster Turnpike between Philadelphia and Lancaster is completed.
1804	Richard Trevithick of England invents the steam locomotive.
1806	Construction begins on the National Road (now U.S. Highway 40) that extends west from Cumberland (later, Baltimore), Maryland, and reaches Vandalia, Illinois, in 1837.
1807	Robert Fulton introduces the first commercially successful steamboat.
1808	Secretary of the Treasury Albert Gallatin delivers to Congress his report on internal improvements.
1811	First steamboat trip from Pittsburgh to New Orleans is completed.
1817	The Pittsburgh Pike is completed.
1818	Erie Canal construction begins with funding from New York State (a year earlier President James Madison had vetoed a bill providing federal funding).
1819	The <i>Savannah</i> becomes the first steam-powered vessel to cross the Atlantic Ocean, but it uses its engines during only 85 hours of a 27.5-day trip; the balance is under sail.
1821	Trade with Santa Fe begins.
1825	Construction begins on the Baltimore and Ohio Railroad.
1825	The Erie Canal between Buffalo and Albany is completed.
1825	The Schuylkill Navigation between Philadelphia and Port Carbon, Pennsylvania, a system of canals and slack water, is opened.
1825	The Stockton and Darlington Railway, built in England by George Stephenson, offers the first regularly scheduled steam-powered railway service.
1826	The Granite Railroad, actually a tramway, is completed in Quincy, Massachusetts.
1830	Peter Cooper builds the first steam locomotive in the United States.
1830	The Baltimore and Ohio Railroad begins passenger service.
1831	The South Carolina Canal and Railroad Company begins the first regularly scheduled steam-powered railway service in the United States.
1839	Charles Goodyear successfully vulcanizes rubber.
1843	A substantial flow of migration to Oregon begins.
1844	The first U.S. plank road is constructed in New York State.
1845	The <i>Rainbow</i> , the first clipper ship, is constructed in New York.
1847	The Mormon migration from Illinois to Utah begins.
1851	The Illinois Central Railroad is chartered and given a federal land grant to subsidize construction.
1853	Elisha Otis introduces the elevator.
1859	The first oil well is drilled near Titusville, Pennsylvania.
1860	The <i>Pony Express</i> is in operation from St. Joseph, Missouri, to San Francisco.
1869	The first transcontinental railway line across the United States is completed at Promontory Point, Utah.
1872	George Pullman introduces his sleeper coach.
1876	Gustavus Swift successfully ships meat from Chicago to Boston in a refrigerated car.
1876	Refrigerated ships permit the export of beef from Argentina.
1877	<i>Munn v. Illinois</i> establishes the right of states to regulate private property in the public interest.
1883	The Brooklyn Bridge is opened.
1883	Railroads introduce standard time zones.
1886	Railroads adopt standard gauge.
1886	<i>Wabash v. Illinois</i> establishes that states cannot regulate private property in interstate commerce.
1887	The Interstate Commerce Act creates the Interstate Commerce Commission, the first federal regulatory body.
1888	The first U.S. electric trolley line is opened in Richmond, Virginia.
1893	Charles and Frank Duryea create the first American gasoline-powered automobile.
1897	Francis and Freelon Stanley introduce their steam-powered automobile.
1897	Rudolf Diesel of Germany successfully demonstrates the engine that bears his name.
1897	The first subway opens in Boston, Massachusetts.
1901	Hay–Paunce Treaty authorizes the United States to build a canal across the Central America isthmus.
1903	Wilbur and Orville Wright make the first successful airplane flight using a petrol engine.
1906	Cunard of Great Britain introduces the <i>Lusitania</i> and the <i>Mauretania</i> , the first giant passenger ships.
1908	Henry Ford introduces the first Model T.

TABLE Df-A Important events, legislation, and judicial decisions relating to transportation : 1787–1996 *Continued*

1911	First transcontinental flight takes place.
1913	Ford introduces the moving assembly line in Highland Park, Michigan.
1914	The first scheduled airline service begins across Tampa Bay between St. Petersburg and Tampa, but lasts only a few months.
1914	The Panama Canal is completed.
1916	The Federal Aid Roads Act creates a national road network.
1918	The U.S. government uses army pilots to initiate the first permanent airmail service.
1920	The first transcontinental airmail service begins.
1927	Charles Lindbergh makes the first nonstop transatlantic flight.
1932	The Boeing 247, the first modern airliner, is introduced.
1936	The DC-3, which will carry the majority of the U.S. air trade over the next decade, is introduced.
1937	Limited-access “superhighways” are introduced.
1954	The St. Lawrence Seaway Act is passed.
1956	The United States creates the Interstate Highway System.
1957	Russia launches the <i>Sputnik</i> satellite.
1958	The National Aeronautics and Space Administration (NASA) is created.
1959	A Soviet probe hits the moon.
1959	The Boeing 707, the first jet airliner, is introduced.
1959	The <i>Savannah</i> , the first nuclear-powered merchant ship, is introduced.
1959	The St. Lawrence Seaway is opened.
1961	Alan Shepherd becomes the first American in space.
1965	Ralph Nader publishes <i>Unsafe at Any Speed</i> .
1966	The U.S. Department of Transportation is created as a cabinet-level department.
1966	The National Traffic and Motor Vehicle Safety Act is passed.
1969	The United States lands a man on the moon.
1970	The Boeing 747, the first jumbo jet airliner, is introduced.
1970	The Environmental Protection Agency is created.
1970	The first volume of <i>National Transportation Statistics</i> is published.
1970	The nationally owned Consolidated Rail Corporation (Conrail) is created.
1971	The National Rail Passenger Corporation (Amtrak) is created.
1976	The Concorde, the first supersonic airplane carrying passengers, is introduced by Air France and British Airways.
1977	The U.S. Department of Energy is created.
1978	The deregulation of airlines, railroads, and motor carriers begins.
1982	First commercial space launches.
1991	The Intermodal Surface Transportation Efficiency Act (ISTEA) creates the U.S. Bureau of Transportation Statistics (BTS).
1996	Congress abolishes the Interstate Commerce Commission and assigns its remaining functions to the Department of Transportation.

was subordinate to water, with roads built to facilitate connections with rivers, bays, and the ocean. This transportation system tended to facilitate communications between England and her American colonies while frustrating linkages among the colonies.

After the War of Independence, the new U.S. government sought to encourage interactions among the former colonies through the development of a national transportation system. In 1806, Congress approved a route and appointed a committee to plan the details of the National Road. But this federal initiative was an exception. The work of building the nation's highways was largely the result of private, state, and joint private–state initiatives.²

The first intercity highways were “turnpikes,” toll roads that charged fees to travelers. Turnpikes offered more dependable road surfaces than the “common” or free highways. They were paved in

stone, gravel, and later with wooden plank. The hope of investors was that these improved roads would attract sufficient traffic to cover construction costs and return a profit. In the South, state governments took the lead. Oversight on these public turnpikes was the responsibility of public trustees and local road commissioners. In the North, private companies and some mixed private–public enterprises organized turnpike building projects. The most famous of these roads was the Lancaster Turnpike, constructed by the Philadelphia and Lancaster Turnpike Company, chartered in 1792. By 1800, there were seventy-two private turnpike companies in the Northern states; a decade later there were literally thousands. State–private ventures also flourished. In Pennsylvania, for example, public funds had been invested in fifty-six different construction companies by 1825.³ Table Df25–26 demonstrates the growth in turnpike mileage and expenditures in New England, the Middle Atlantic states, and Maryland during their period of rapid development between 1810 and 1830. Development of turnpikes

² When it was first proposed in 1806, the National Road was to extend from Cumberland (now Baltimore), Maryland, to St. Louis, Missouri. The first section, called the Cumberland Road, extended to Wheeling, Virginia (now West Virginia), and was opened in 1818. At this point, the project was turned over to the states. When it was completed in 1833, the National Road extended to Vandalia, Illinois, and was the most ambitious road-building project of its time. See Jordan (1948).

³ Most of the funds invested in turnpikes were private. Even in Pennsylvania, which had the most direct state government investment, the amount of public money was only 30 percent of the estimated total, a much smaller percentage than states would later invest in antebellum canal and railroad construction.

was slower in the South than in the North, partly because of the presence of rivers that penetrated the interior, providing alternative transportation routes, and also because of an absence of cities that concentrate travelers' routes. In the West, where there were few prepared roadbeds; routes such as the Oregon Trail and the Santa Fe Trail simply crossed the land following identifiable landmarks (see Table Df27–33). What turnpikes there were in the West were located adjacent to population centers, such as Chicago.

The typical turnpike company was a small enterprise that operated a relatively short length of road. Thus, several companies would serve a long-distance route, each charging a toll on its section. The profitability of these companies was often poor. Albert Fishlow estimated average profit rates of only 3 to 4 percent, well below the rate of return on alternative investments (Fishlow 1972). Part of the explanation for the low rate of return had to do with governmental regulation of the fee structures and activities of the turnpike companies. Turnpikes required substantial investments relative to other business opportunities at the time. To assemble the required capital, turnpike companies were organized as chartered corporations, and this made them subject to government regulation. Public officials regulated the tolls charged and restricted company activities to road operations. Regulations made tolls per ton-mile relatively low for the transportation of heavy loads over long distances and relatively high for the transportation of light loads over short distances. Because there were many more short journeys involving light loads and because travelers on such routes had the alternative of using "common" (free) roads, the toll structure worked against the turnpike companies. They did not attract the volume of traffic they might have, and their revenue consequently was lower than it might have been.

After about 1830, highways in the United States were eclipsed by canals and railroads as the dynamic component of the transportation infrastructure. But with the development and diffusion of the automobile, highways returned to prominence. Commercial production of automobiles began in the late 1890s and developed very quickly (Flink 1970). By 1900, when statistics on automobile ownership were first collected and compiled, the nation could claim 8,000 registered vehicles. During the next ten years the number rose to 458,000 (see Table Df339–342).

The growth and development of the automobile industry in this era had an enormous impact on American social and economic institutions. James J. Flink summarizes some of these consequences:

With the introduction of the moving-belt assembly line and the \$5-day in 1913–14, Henry Ford created a new class of semiskilled industrial worker and set a new standard of remuneration for manual labor. At General Motors under Alfred P. Sloan, the decentralized, multidivisional structure of the modern industrial corporation, modern management techniques, and consumer installment credit as we know it were pioneered in the 1920s. Applied to the manufacture of many other items, these innovations have called the tune and set the tempo of modern American life. . . . Since the 1920s the automobile industry has also been the lifeblood of the oil industry, one of the chief customers of the steel industry, and the biggest consumer of many other industrial products, including plate glass, rubber, and lacquers. Construction of streets and highways remains one of the largest items of governmental expenditure in the United States. The motorcar has also been responsible both for a continuing suburban real estate boom and for the rise of many new types

of small businesses, such as service stations and tourist accommodations.⁴

As early as the 1890s, the growing ranks of automobile owners joined with bicyclists to petition their elected officials for improved roads. Strong "good roads" planks were adopted into the state platforms of the two most popular political parties of the day (see Flink 1975, p. 8).

Systematic data on state and local highway finance were collected and published beginning in 1890 and are presented in Table Df305–317. These data can be used as a proxy for the pace and pattern of highway construction until data on surfaced mileage become available starting with 1904 (see Table Df184–186). Both tables indicate a rapid rate of growth in highway construction in the decades surrounding the turn of the twentieth century. By 1910, state spending on highways exceeded that of local governments, and all Eastern states had established highway departments. By this time, the streets and highways in most cities and towns were paved.

The continuing growth in automobile ownership began to generate demand for intercity connections and then a cross-country system of highways. The first proposal for a transcontinental highway to link New York and San Francisco was developed by a group of private citizens who solicited donations and enlisted the energies of towns along the way. Named the Lincoln Highway in an effort to bolster public support, organizers charted a route similar to that of present-day Interstate 80 and began construction (see Hokanson 1988).

The federal government also became involved in highway development (see Seely 1987). In 1893, it established the Office of Road Inquiry, an advisory center for road information, within the Department of Agriculture.⁵ Congress appropriated funds for a federal program of rural highway construction in 1912 and passed the Federal–State Road Act, which provided federal subsidies to states for highway construction, in 1916. In 1921, it designated a portion of the federal highway subsidies for interstate and inter-county road construction. One of the requirements of the Federal-Aid Road Act of 1921 was that highways funded by the federal government be integrated into a nationwide system of roads. Many states along the path of the Lincoln Highway used these federal funds to complete the transcontinental link. Integration of the nation's highway system led to the abandonment of "named" highways such as the Lincoln Highway and the adoption of a national interstate highway numbering scheme. By 1925, the numbered-route system of intercity roads was in place. Route 1 was the north–south road along the Atlantic Coast advocated in the Gallatin Report; the National Road, an east–west route, became Route 40. The famous Route 66, linking Chicago and Los Angeles, was inaugurated in 1926. Route 101 was the north–south route on the West Coast.

In the 1930s with the onset of the Great Depression, the federal government initiated road-building projects as a method of alleviating unemployment. Herbert Hoover established the Reconstruction Finance Corporation, which was authorized to build public highways. Franklin Roosevelt allocated federal money for a large number of emergency public works, especially highways. It has

⁴ Flink (1970), pp. 2–3. See also Cochran (1957), p. 44.

⁵ The Office of Road Inquiry evolved into the Bureau of Public Roads twelve years later. Between 1939 and 1949, this Bureau was called the Public Roads Administration. Later it was renamed the Federal Highway Administration, and its functions were transferred to the Department of Transportation in 1967.

been estimated that between a third and a half of the labor force hired by federal relief projects during the Depression worked on building highways. The scale of governmental expenditures on this road-building was unprecedented (Hughes 1991). The Works Progress Administration itself constructed 572,000 miles of intercity road, 67,000 miles of city streets, and 78,000 bridges (Seely 1993, p. 32). An important milestone was the construction of a section of Route 30 in Nebraska in 1935, which completed the first paved transcontinental highway.

The states were also active in highway construction. Several noted the advantage of limited-access highways in facilitating high-speed travel and reducing accidents. Thus, they fell back on eighteenth-century precedent and constructed toll roads. The first of these was the Pennsylvania Turnpike, construction of which began in 1937. The roadway used the road bed and tunnels from the old New York Central railroad line built by Cornelius Vanderbilt in the nineteenth century. The turnpike entered service in 1940 and exhibited new concepts of superhighway design. It also demonstrated that revenue bonds could finance toll road construction in the twentieth century. Planners predicted that 1.3 million vehicles would use the turnpike each year, but early actual usage was 2.4 million vehicles; sometimes as many as 10,000 vehicles per day were recorded. The Pennsylvania Turnpike was an excellent example of public-private partnerships. Toll collections allowed the construction bonds to be retired early and reissued for capital improvements to the road. Following the success of the Pennsylvania Turnpike, other states began plans to build their own toll roads after the war, including Ohio, Indiana, Illinois, New York, and New Jersey.

During the Second World War, both highway construction and automobile production were suspended in order to direct resources to the war effort; but with the return of peace, automobile sales soared, and the fraction of households owning one or more automobiles rose from just over half in 1948 to almost three quarters just ten years later (see Table Df330–338). The prosperity of the postwar years, and particularly automobile-based suburbanization, further increased the demand for new roads. In 1952, Congress authorized funding of a national limited-access Interstate System. The 1956 Interstate Highway Act, with a preamble citing national defense concerns, authorized an additional 42,500-mile system of limited-access, high-speed roadways (Rose 1979). Although the actual roadway construction was undertaken by the states, the federal government paid 90 percent of the total costs. Data on the financing of the highway system can be found in Tables Df225–329.

With the creation of the U.S. Department of Transportation (USDOT) in 1966, and with the passing of the Urban Mass Transportation Act two years later, the United States entered what Bruce Seely terms the “golden age of infrastructure development” (Seely 1993, p. 35). The Federal-Aid Highway Act of 1970 created the federal-aid urban system and increased the federal government’s share for non-interstate projects to 70 percent. In 1991, Congress passed the Inter-modal Surface Transportation Efficiency Act (ISTEA). The ISTEA restructured the federal-aid highway system and created the Bureau of Transportation Statistics.

As early as 1939, private automobiles accounted for almost 90 percent of domestic intercity passenger traffic, as shown in Figure Df-B. The exigencies of World War II diverted much of this traffic to the rails and buses, but automobiles resumed their importance immediately after the war’s end. Since the mid-1960s,

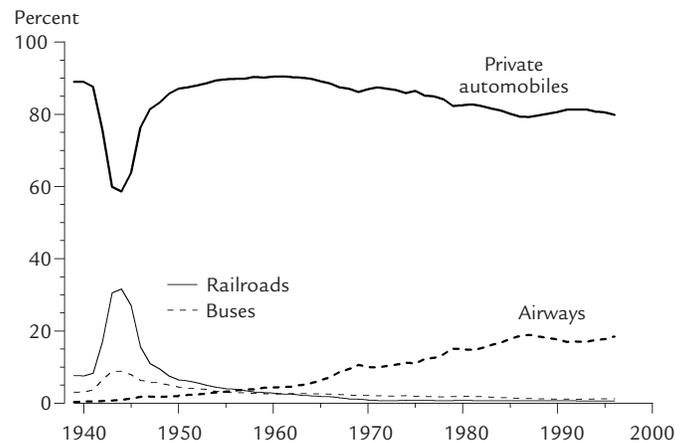


FIGURE Df-B Domestic intercity passenger traffic – percentage of total, by type of transportation: 1939–1996

Sources
Series Df44–47.

Documentation
Percentages are based on the measurement of traffic in terms of passenger-miles.

private automobiles have lost ground relative to air transport as a means of intercity travel.

Highway safety was a public concern from the beginning of the automobile era. Data compilation on highway fatalities began in 1900 (see Table Df413–417). Although the number of traffic fatalities has increased enormously over time, the overall safety of automobile travel has improved. Measured in terms of millions of miles of annual vehicle travel, traffic fatalities fell from thirty-six to fewer than two over the course of the century. Despite the improvements in safety, the relative death rate attributable to automobile travel continued to increase into the 1940s as automobile travel became more extensive and medical advances reduced death rates from other causes. In the 1960s, there was a strong public reaction to highway fatalities. This prompted the legislation of a variety of vehicular safety features such as seatbelts and, later, airbags. Since 1970, motor vehicle death rates have been falling in the population as a whole, even among young drivers (see Figure Df-C).

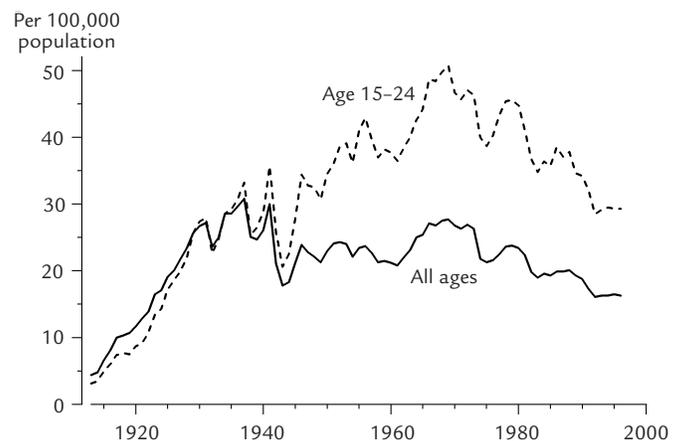


FIGURE Df-C Motor vehicle death rates, by age: 1913–1996

Sources
Series Df465 and Df468.

Highway construction also facilitated the development of trucking as a means of transporting freight. As trucking developed, it was both complementary to and competitive with the railroad. The Railway Express Company emerged as the national firm that delivered what the railroad brought to town. With highway improvement (including bridges and tunnels) and technological developments in tires, brakes, and lights, the truck emerged in the 1920s as more than a replacement for the local horse and wagon. United Parcel Service, which began as a messenger service in Seattle in 1907, grew to become one of the important long-distance carriers of light freight by truck.

In the early 1930s, roughly two thirds of all trucking firms owned but a single vehicle (90 percent owned one or two), and these firms covered relatively short distances. A few consolidations emerged during the Depression, but both they and the railroads faced rate competition from the many small independent firms fighting for survival. This instability led the industry toward political solutions through trade associations and state laws. As William Childs notes, "Since it affected so much of the economy, motor trucking was bound to elicit collective attempts to control its development. The real issue was not whether the new technology should be controlled, but how and by whom" (Childs 1985, p. 48).

During the 1930s, the U.S. Supreme Court and the Interstate Commerce Commission (ICC) began to regulate the trucking industry. The Court clarified issues concerning truck regulation, while the ICC designed and promoted a structure in which trucking could be regulated. The attempt of the trucking industry to develop a National Recovery Act (NRA) code contributed to the creation of the American Trucking Association, which quickly became the agency through which the industry attempted to influence legislation to its advantage. The code was a failure as there was no efficient enforcement mechanism, and competitive rate-cutting continued in a still growing industry. Out of these pieces emerged the Motor Carrier Act of 1935, which contained the cartel features the NRA code lacked. Rates were to be regulated, as were safety, accounting procedures, mergers, and consolidations. Federal regulation, the ICC in particular, shaped the growth of the trucking industry in the twentieth century.

Although some consideration was given to coordinating the different transport modes, integration came about haphazardly and infrequently. Trucks began taking high-valued freight from the railroads in the mid-1920s, and, by 1940, they carried a large proportion of total freight. Just before World War II, trucking accounted for approximately 10 percent of domestic intercity freight traffic. This fell to just over 5 percent during the war, but it quickly recovered and began to grow steadily to where it was just under 30 percent in 1996 (see Table Df48–58 and Figure Df-D). Successful integration came to truck–rail transportation only in the final decades of the twentieth century. While "piggy back" service (truck trailers hauled on railroad flat cars) began expanding in the 1950s, the ground transportation component remained relatively inefficient until the 1980s. Federal policy contributed to the lack of efficient integration, but so did poor railroad management. Efficiency increased dramatically in the 1980s as a result of investment from the railroads. The trucking industry was prodded by competition to change the way they organized their work as, by this time, firms such as United Parcel and Federal Express were using airplanes to move light freight quickly across the country. Complete integration, however, is not feasible; it is limited by the

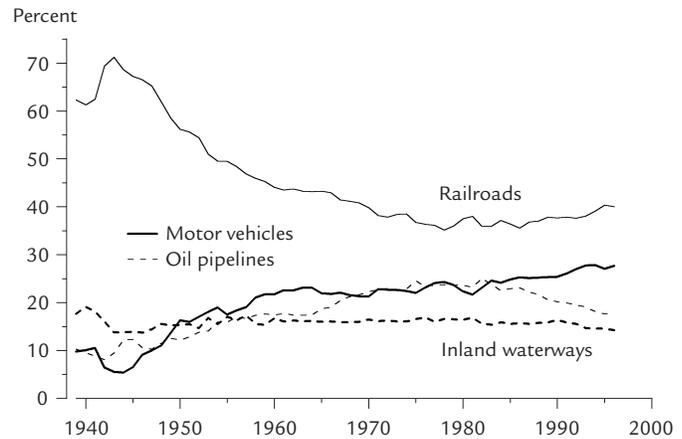


FIGURE Df-D Domestic intercity freight traffic – percentage of total, by type of transportation: 1939–1996

Sources

Series Df54–57.

Documentation

Percentages are based on the measurement of traffic in terms of ton-miles.

technology. For example, with respect to household goods transportation, "piggy back" does not work well because the goods are more likely to become damaged on the rail haul than on the highway haul.

Water

Transportation over water was preferred in the years before the Civil War. Natural waterways such as rivers, lakes, and coastal routes were heavily used. Where natural waterways were absent, an elaborate system of canals was developed to link important commercial centers. As early as 1808, the Gallatin Report proposed that canals be cut through Cape Cod, between the Raritan and Delaware rivers, between Delaware Bay and Chesapeake Bay, and between the Chesapeake and Albemarle sounds. In addition, the Report suggested major east–west links: a northern link from the Hudson River to Lake Champlain, and from the Mohawk River to Lake Ontario and Lake Erie (Goodrich 1960, pp. 27–48).

The major era of American canal building commenced at the end of the War of 1812 and lasted until the Panic of 1837. The construction of canals, like the construction of Northern turnpikes, was undertaken by combinations of private and public enterprises. Of the total funds invested in canals before the Civil War, about three quarters came from state and local governments (Goodrich, Cranmer, et al. 1961, p. 215). Trends can be seen in Jerome Cranmer's data on investments in canals between 1815 and 1860, which are reported in Table Df684–689. Few entirely private canals were constructed. Economically, the most important canal was the 363-mile Erie Canal. The New York legislature hoped to receive federal aid for this project, but President Madison vetoed the funding bill in 1817. A month later, urged by Governor DeWitt Clinton, New York's legislature passed the necessary laws to build the canal with state resources and without federal help. Funding for this enterprise came from earmarked taxes, from borrowing on state credit, and from tolls that were collected when sections of the canal were opened. The initial public offering of Erie Canal bonds was in small denominations. These bonds were purchased mainly by

New Yorkers, with one New York City savings bank holding 30 percent of the outstanding debt in 1821.⁶

The Erie Canal opened in 1825 and was an immediate success; within ten years, cumulative toll collections exceeded construction costs. Those who shipped on the canal, within and through New York State, found their dollar costs fell in excess of 75 percent and their time costs fell by almost 67 percent. The Erie Canal had political implications as well. By providing a direct link between New York and the Northwest Territory, it strengthened the commercial advantage of the Northern relative to the Southern states. Prior to the construction of the Erie Canal, the Southern states had had the advantage of ease of access to the Ohio River and its tributaries. The completion of the Erie Canal helped shift the axis of Midwestern commerce from north–south to east–west. Further, with the help of the Erie Canal, New York City grew to become the largest port and largest city in the country. The ton-mile rates on the canal are reported in Table Df679–680; the tonnage moved on the Erie and other New York State canals appears in Table Df696–697.

The success of the Erie Canal prompted other states to initiate similar projects, but none of these were as financially remunerative for their investors. In Pennsylvania, for example, Philadelphia was already linked to the Susquehanna River by the Union Canal at the time of the Erie's completion. In 1826, the Pennsylvania legislature voted to build the Main Line Canal to connect the Susquehanna River with Pittsburgh, on the Allegheny and Monongahela rivers in the western part of the state. This proved to be a very complicated and expensive project because the canal had to cross the Appalachian Mountains. The Main Line Canal required 174 locks compared with 84 on the Erie and at its highest point was 2,200 feet above sea level compared with 650 feet for the Erie. The Main Line involved transfers of cargo from canal barges to surface transport (later to rail links) at several points. These breaks in transport put the Main Line at a competitive disadvantage with the Erie. When the 359-mile Main Line was completed in 1835, it was hailed as a technological and engineering wonder but earned only a 3 percent rate of return on investment and was finally sold to the Pennsylvania Railroad in 1857 (Rubin 1961). The Chesapeake and Ohio and the James River and Kanawha canals in Virginia were also financial disappointments for investors (Taylor 1951, pp. 42–5).

States of the Old Northwest⁷ were also active in canal building even though their canals faced competition from railroads almost immediately on completion. Indiana built the longest waterway, the 450-mile Wabash and Erie Canal, from Evansville, Indiana, on the Ohio River to Toledo, Ohio, on Lake Erie. It was finished in the 1850s and almost immediately abandoned. Prior to Illinois's becoming a state, its northern border was extended by approximately 60 miles to ensure that a planned canal would be contained entirely within the state boundaries. A few years later, the state received a federal land grant to support construction of the Illinois and Michigan Canal, linking Lake Michigan at Chicago to the Illinois River at LaSalle. The canal opened in 1848, the same year as the first railroad train departed and the first telegraph message

arrived in the city. Despite this inauspicious beginning, the canal ultimately broke even financially, although its more important role in Chicago's history was that of an open sewer (see Cain 1978).

It has been suggested that the most important long-run consequence of canals in the United States was their encouragement of the development of manufacturing in the nation's hinterland. Although this manufacturing was largely involved in the processing of agricultural products, it made for a more even pattern of industrial development than would have been the case in the United States in the canals' absence.

The appearance of the railroad marked the end of the canal era. Railroads were much faster and more dependable (for example, ice halted canal transport in the winter months). These features attracted customers away from canals despite the railroads' higher freight rates.

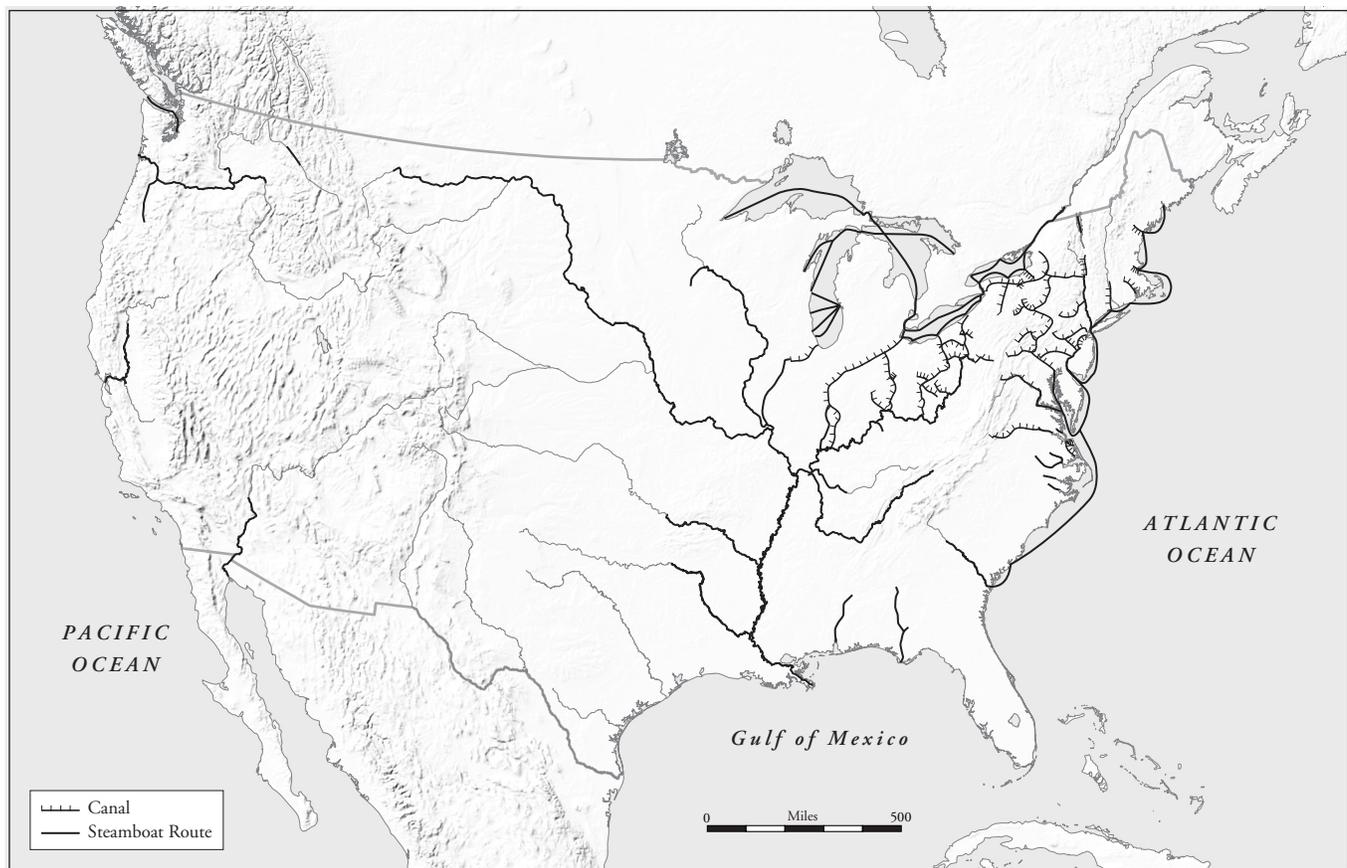
The development of the steamboat was also important to economic growth before the Civil War. Robert Fulton's steam-powered *Clermont* traveled upstream on the Hudson River from New York City to Albany in 1807. By 1811, the steamboat was widely used. Before the advent of the steamboat, passengers and freight traveled downstream on these waterways using flatboats and keelboats. But without power, these vessels were unable to navigate upstream against the current. The steam-driven paddle wheeler was a major advance that improved speed and lowered cost in both directions. Upstream improvements were most dramatic and helped bring manufacturing products to the interior of the country. Improved downstream speed facilitated farmers' shipment of their crops to market (see Table Df641–650). Tables Df651–678 provide comparative data on travel times and freight rates in the two directions.

Steamboats proved particularly important in the West, where the Missouri, Ohio, and Mississippi rivers drain half the continental United States. Erik Haites, James Mak, and Gary Walton did the research that currently shapes our understanding of the river steamboat fleet and its tonnage on the Western rivers in the antebellum period. By the end of the 1850s, a fleet of some 800 steamboats with an average working life of 5.5 years serviced the interior rivers of the United States. Steamboats significantly reduced transit and turnaround times (see Tables Df632–638 and Df667–678). Douglass North's data on the general pattern of inland freight rates are presented in Table Df17–21. Freight rates for steamboats fell by 90 percent upstream in real terms between 1815 and 1860 and by nearly 40 percent downstream (see Table Df651–658). Vessels built in the 1850s were far more efficient than those built in earlier periods. Mak and Walton found that per-unit productivity increased by a factor of nearly nine from 1815 to 1860 (see Table Df639–640) (Mak and Walton 1972, p. 637). Map Df-E shows the extent of the canal system in 1860.

Transatlantic travel continued to be dominated by sailing ships through the mid-nineteenth century. In 1818, the Black Ball line began scheduled service between New York and London. Even before the Erie Canal was completed, this connection began the process of making New York City the dominant American transatlantic port. Over the remainder of the antebellum period the size and efficiency of sailing ships increased dramatically. The average sailing ship of the 1820s was approximately 300 tons. By the Civil War era, the average was more than three times as large. This was the era of the clipper ship that ruled ocean shipping from the early 1830s to the 1860s. Clippers were not the largest ships, but they were the fastest. For this reason, they were favored by passengers and shippers of high-value freight.

⁶ With the success of the canal, other large investors and foreign buyers entered the canal bond market. By 1829, foreigners held half of the canal debt. See Olmstead (1972).

⁷ The Old Northwest refers to a historical region in the north-central United States, control of which was a major issue in the War of 1812 with Britain. The area was later split into the present-day states of Ohio, Indiana, Illinois, Michigan, Wisconsin, and part of Minnesota.



MAP Df-E Canal and steamboat routes: 1860

Sources

National Geographic Society, *Historical Atlas of the United States* (National Geographic Society, 1993), p. 188. Underlying data are from H. A. Burr, *Mitchell's New National Map Exhibiting the U.S.* (Library of Congress, Geography and Map Division, 1858); *Distrunell's American and European Railway and Steamship Guide* (J. Distrunell, 1853); *The Great Lakes, or Inland Seas of America* (J. Distrunell, 1863); and Louis C. Hunter, *Steamboats on the Western Rivers: An Economic and Technological History* (Octagon Books, 1969). Also see Carter Goodrich, editor, *Canals and American Economic Development* (Columbia University Press, 1961), pp. 184–5.

Data on the number of ships constructed, tonnage, and the region in which construction took place are shown in Tables Df612–616, Df618–625, Df681–683, and Df698–702. These data reveal a rapid growth in the construction of wooden sailing vessels beginning in the 1840s and extending through the 1850s, with the maximum number produced in 1855. Productivity grew rapidly and the cost of transatlantic travel fell markedly throughout the first half of the nineteenth century. Douglass North's indices of this ocean-going shipping productivity and costs can be found in Table Df626–631, while George Rogers Taylor's estimates of cotton freight rates on the New York and New Orleans routes to Europe appear in Tables Df692–695.⁸

Even though steam-powered vessels became important on inland routes at a relatively early date, they did not come to dominate transatlantic travel until after the Civil War. In terms of construction, the number of ocean-going steam vessels did not surpass sail-powered ships until the 1880s. The locus of production was in New England throughout the nineteenth century, but it shifted to the Middle Atlantic and Gulf regions in the twentieth century (see

Tables Df618–625 and Df698–702). Tonnage on the Northern lakes and Western rivers became important after the Civil War and remained so until World War I (see Table Df703–707). Iron, coal, and grain were the important commodities that were shipped on inland waterways in this era (see Tables Df703–707 and Df716–721).

Steam eventually supplanted sail as a means of powering even ocean-going vessels. Two major innovations were crucial. The adoption of the screw propeller in place of the paddle wheel reduced fuel consumption and increased speed. The development of riveting techniques enabled engineers to produce iron-hull ships that proved to be stronger and longer lasting than wood (for data on the construction of American merchant vessels by type, see Table Df612–616). Both innovations were British, and, by the outbreak of the Civil War, British steamships were making considerable inroads against American sailing ships for transatlantic travel. In the 1820s, the American merchant marine carried more than 93 percent of America's imports and 87 percent of its exports in wooden sailing ships. By the decade of the 1850s, the American merchant marine share had fallen to 71 and 70 percent, respectively.

The Civil War accelerated the decline of the U.S. merchant marine, as shown in Figure Df-F. Virtually all antebellum U.S. international trade was conducted by shipping companies based in

⁸ For a description of the American shipbuilding industry, see Goldenberg (1976) and McGowan (1980).

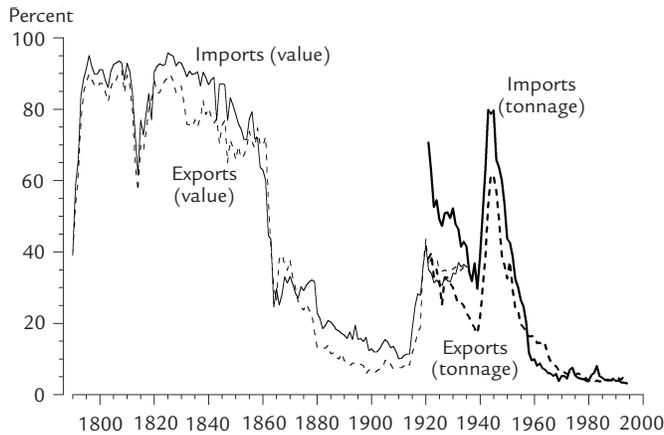


FIGURE Df-F Waterborne imports and exports – percentage carried by U.S. vessels: 1790–1994

Sources

Computed from series Df606–607, Df609–610, Df736–737, and Df739–740.

New England; the Southern states had only a minimal commercial fleet. At the onset of the war, the Confederacy obtained from Great Britain a number of fast sailing ships that it used to successfully raid these Union merchant ships. A large number of Union ships were burned at sea, and an estimated 110,000 tons of Northern shipping was destroyed. Even more damaging to the American merchant marine was its loss of business to foreign fleets. The Southern raids pushed up insurance rates on Northern ships so high that shipping became unprofitable. Many ship owners were forced to sell their vessels to foreigners, while others transferred their allegiance and reregistered their ships under foreign flags. In total, over 800,000 tons of American shipping was reregistered in neutral countries; after the war, none of those ships were allowed to return to the U.S. registry (Gibson and Donovan 2000, pp. 67–9). Series Df590 shows the reduction in the size of the U.S. merchant marine during this period, while Table Df606–611 shows the reduction in the U.S. merchant marine's share of the value of U.S. waterborne exports and imports.

American merchant marine losses continued after the Civil War. By 1910, the American share of U.S. waterborne exports and imports had fallen to only 10 and 7.5 percent of the total, respectively. Scholars explain the American decline in terms of a shift in technology combined with a quirk in the American regulatory system. Wood was plentiful and inexpensive in the United States, whereas iron was relatively inexpensive in Britain. The shift from wooden to iron ships favored the British. The negative impact of the technological shift was reinforced by U.S. laws that restricted the American merchant marine fleet to American-made vessels.⁹ The British also dominated the emerging transatlantic passenger business that catered to European emigrants. The Cunard Line was the most famous of these shipping companies (see Hyde 1975 and Taylor 1971). The same restrictions that crippled American international shipping protected American intercoastal and inland water trade. Despite strenuous competition from the railroad, the shipping industry exhibited modest growth during the second half of the nineteenth century (see series Df591).

⁹ For a lively discussion of these developments, see Chamberlain (1968), volume 1, pp. 39–40.

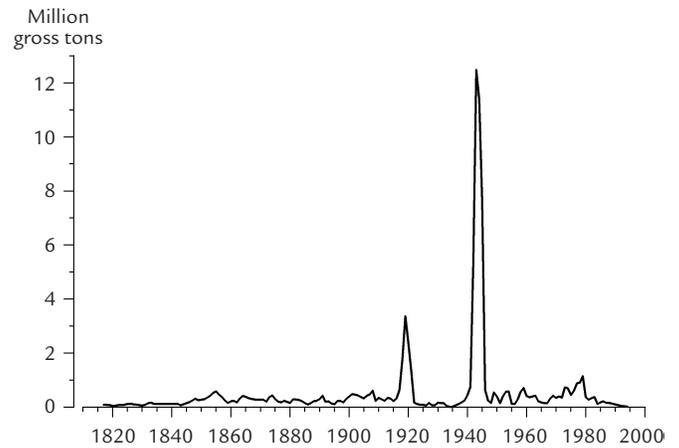


FIGURE Df-G Merchant vessels built: 1817–1994

Sources

1817–1839: computed from series Df681 and Df683. 1840–1916: computed from series Df698 and Df702. Beginning 1917, series Df723.

The First and Second World Wars had a profound effect on the U.S. shipbuilding industry and merchant marine (see Figure Df-G). To protect transatlantic shipping from German submarine attacks and to transport troops and supplies to the theaters of war in Europe, the United States in 1917, shortly after its entry into the First World War, undertook an emergency shipbuilding program under the direction of the Emergency Fleet Corporation (EFC). The EFC, with a budget estimated at twice the value of the entire world merchant marine fleet, established new shipyards and began new construction. Because of the program's late start, the continuation of government-subsidized shipbuilding after the Armistice, and President Woodrow Wilson's restriction of government-built ships to the U.S. merchant marine, the volume of U.S. vessels involved in international trade increased dramatically. The quantitative impact of the wartime shipbuilding program can be seen in series Df579, which records a more than doubling of the tonnage of vessels in the U.S. merchant marine between 1916 and 1922.¹⁰

The enormous quantity of ships produced in the waning days of the First World War had a disastrous effect on the U.S. shipbuilding industry during the 1920s and 1930s. With so many ships afloat, there was little demand for new vessels. Between 1922 and 1928, not a single new ship for world commerce was built in the United States. Many famous and long-lived shipyards went out of business during these years. Political developments following the war favored a return to isolationism and an "America First" focus to federal policy. In response to these political developments and also to the fact that the large fleet of government-owned ships was expensive to maintain and operate, many ships were sold to private companies both in the United States and abroad (Gibson and Donovan, pp. 121–33).

The growing threat of hostilities in Europe in the mid-1930s changed U.S. mercantile policy dramatically. In 1936, Congress passed the Merchant Marine Act, a law that Gibson and Donovan call "a legislative landmark of unrivaled importance in the history

¹⁰ For a detailed discussion of the role of sea power during World War I, the EFC shipbuilding program (including the characteristics of the ships it produced), and public policy toward shipbuilding and the merchant marine in the 1920s, see Gibson and Donovan (2000), pp. 103–21.

of U.S. maritime policy” (Gibson and Donovan, p. 141). The 1936 Merchant Marine Act formally recognized the importance of the maritime industry to the commercial prosperity and military security of the United States. It also acknowledged the need for federal subsidies to keep the industry viable in the face of international competition. Following passage of the legislation, shipbuilding subsidies were established. Government-initiated ship production commenced in 1939. As a carryover from World War I, the United States already had a large fleet. It also had experience with wartime shipbuilding. Nonetheless, the scale of World War II shipbuilding efforts reached unprecedented levels. Quantitative comparisons can be made using Tables Df681–683, Df698–702, and Df722–732. One measure of the human dimension of this effort is contained in the account by Gibson and Donovan of the work of Henry J. Kaiser, a successful industrialist who was drawn into the shipbuilding industry during the war.

Henry J. Kaiser [was] a successful industrialist who had never built a ship before 1941. Unburdened by the limitations of vision and practices of traditional shipbuilding, Kaiser geared up for volume production. His ships were built of prefabricated modules that were then assembled in series construction. Welding, a skill that could be learned in a month, was used extensively for the first time instead of riveting. In the first year and a half, construction time for Liberty ships was reduced from 105 to 14 days; in a much publicized stunt one ship was built and launched in less than 5 days. By the end of the war Kaiser had built one-third of the Maritime Commission’s vessels and had set the standard for all other yards. . . . A country that had constructed only 1 million tons of merchant shipping in 1941 built more than 17 million tons by 1943. By the war’s end in 1945, a workforce of 4 million men and women had built 5,000 ships. . . . The speed with which this was done and the scale of the effort still defy comprehension. When operating at their peak rate of production, America’s shipyards were capable of reproducing the entire world’s prewar commercial tonnage in less than three years. (Gibson and Donovan, pp. 166–7)

This unprecedented shipbuilding effort had consequences far beyond the shipyards as well, affecting the geographic location of the population and the work experience of minority and especially women workers.

At the end of the war, America owned more than 60 percent of the tonnage of the world’s ocean-going vessels. In an effort to help rebuild the war-torn countries of Europe and to stimulate the emerging economies of Latin America, the United States passed the 1946 Merchant Marine Sales Act that facilitated the sale of surplus ships. Following the conclusion of the war, countries of the Far East developed highly productive and competitive shipbuilding industries that soon dominated the international industry. Given this competition and American reluctance to subsidize water transport, the U.S. share of international waterborne commerce fell rapidly. By the end of the twentieth century, it was but a small fraction of the world total.

The shipbuilding frenzy of the Second World War also had a long-lasting effect on coastal and inland shipping. During the war years, the military demand for ships meant that domestic trade was shifted to rail and trucking. After the war, these alternative modes of transportation came to dominate. The shifting importance of water relative to other modes of domestic, intercity freight transportation is displayed in Table Df48–58.

Railroads

No innovation is more emblematic of the drama of nineteenth-century American economic history than the railroad. To earlier historians, the railroad was an empire-builder “opening the country,” built at great risk “ahead of demand.” By decreasing transportation costs, the railroad spurred economic growth. By stimulating the demand for iron and steel, the growth of the railroad helped to reduce unit costs in industries that were important inputs into a variety of industries across the economy. Modern cliometric scholarship on railroads, pioneered by Albert Fishlow and Robert Fogel, suggests that the claims of these early historians were exaggerated (Fogel 1964; Fishlow 1965). At the same time, it does not deny the broader proposition that the railroad had a transformative impact on the American economy in the nineteenth century.

The first railroad in the United States, the Baltimore and Ohio, began operations in 1830, five years after the Stockton and Darlington, the first English railroad. By the beginning of the Civil War, U.S. mileage exceeded that of railroads in the United Kingdom, France, and the German states combined. Fishlow estimated that total investment in railroads up to 1860 was more than five times the amount invested in canals (see Table Df865–873) (Fishlow 1972, p. 496). Government support encouraged this development. It was greatest in the South, where sparse population and competition with river transport reduced private profit possibilities. In New England and the Old Northwest, the governmental contribution was less necessary.

In the 1850s, the federal government, which had previously been reluctant to become involved in internal improvements, found a new and seemingly costless way to aid and encourage railroad development. Rather than provide cash subsidies or guarantee bonds as the states had done to promote canal and then railroad development, the federal government used its vast holdings of lands in the West and offered title and right of way to any company that agreed to build a railroad. When the land was offered, its value was virtually worthless, but if and when a railroad was completed and the land was connected to world markets, land values would rise dramatically. Thus, the land-grant system, like the modern system of stock options, encouraged entrepreneurs with the promise of capital gains.¹¹

In 1851, the federal government made a land grant of 3.75 million acres to finance the building of the Illinois Central Railroad, a north–south route running parallel to the Mississippi River that, unlike the upper portion of that river, would not close in the winter (Gates 1934). Although this was not the first land grant for internal improvements, it was the largest of its time. It was also a sign of things to come; in the next seven years, forty-five railroad companies in ten states received federal land grants (see Table Df890).

Entrepreneurs responded enthusiastically to these incentives, which were sufficiently generous to energize an explosion of railroad construction. Between 1850 and the start of the Civil War in 1860, more than 20,000 miles of track were laid (see Table Df882–885). This period also witnessed rapid developments in the many industries associated with the railroads.

Discovery of gold in California in 1849 following America’s triumph in its war with Mexico created both an economic and a

¹¹ The government profited from this system as well because it kept alternate land sections, which it then sold after railroad construction was completed and land values rose.

military interest in linking the newly acquired and newly rich state of California to the eastern part of the country. At the time, travel from the East Coast to California was a lengthy and dangerous process, whether pursued by wagon or by sail. The advantages and importance of a rail link between the two coasts were obvious.

The planning for a transcontinental railroad, particularly the determination of the site of its eastern terminus, aroused bitter political sectional debates in the years before the Civil War. The ultimate selection of Omaha, Nebraska, was sufficiently west that each eastern railroad could build its own connection to it. After the Civil War, four transcontinental railroads were granted 100 million acres, one tenth of the public domain, to facilitate construction. In total, the federal government granted 131 million acres, and states added an additional 49 million acres, to encourage railroad construction. The objective was to link the two coasts and create a nation that was transcontinental in settlement as well as in territorial claims. Success was achieved in 1869 when the Golden Spike at Promontory Point, Utah, completed the link. For data on public land grants to encourage the construction of railroads, wagon roads, canals, and river improvements, see Tables Cf83–87 and Df890.

After the Civil War, main-track mileage rose until World War I. Fishlow identifies three major construction booms: 1868–1873, 1879–1883, and 1886–1892 (see Table Df882–885 and Figure Df-H). By 1899, railroad tracks crisscrossed the nation. Every major American city had a rail head that was connected to the national system (see Map Df-I). Railroads were the life-blood of the American common market, and the links brought prosperity to the more remote outposts of a large, continental economy.

As railroad track mileage increased in the years after the Civil War, railroad companies grew in size and became complex, multi-state units with thousands of employees. They became America's first "big business" (Chandler 1965). As pioneers of large-scale enterprise, their management problems and methods defined U.S. industrial practice for years. Trading in railway bonds and stock became sufficiently active to lead to the development of organized stock and bond exchanges (see Table Df891–900). The evolution

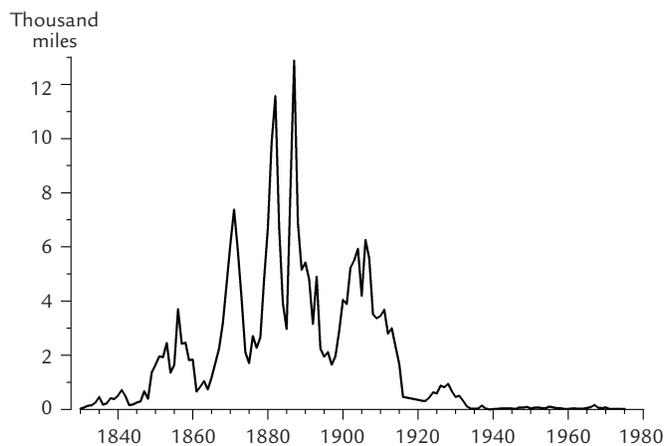


FIGURE Df-H Railroad mileage built: 1830–1975

Sources

1830–1890, series Df884; 1891–1916, series Df885; and beginning 1921, series Df928.

Documentation

See the text for Table Df882–885 for discussion of the use of yearly changes in mileage operated and owned as proxies for mileage built.

of public policy toward all big business was heavily influenced by the nation's experience with the railroads. Railroads' size, rapid economic growth, and power not only excited imaginations and enthusiasm but also led to concerns about excessive concentration of power. In response to these concerns, the federal government established the first business regulatory agency in the country's history, the ICC. Established in 1887, the ICC was charged with the responsibility of regulating rates and overseeing railroad business practices. Railroad rate-setting practices were a main source of the public outcry that spurred the creation of the ICC, particularly what were felt to be high rates on routes with few railroad company competitors and the railroad company practice of giving rebates on transportation expenditures to favored shippers.¹²

There was another railroad construction boom in the first decade of the twentieth century and some construction in the 1920s, but, for the most part, the American rail network was gradually abandoned over the twentieth century. As Table Df927–955 indicates, there was very little new rail construction in the United States after 1920, and in most years the number of miles of rail abandoned was many times the level of new miles constructed. The railroads met with increasing competition for both the freight and passenger portions of their business from automobiles, trucks, and, later, airplanes.¹³

When statistics on the relative importance of various modes of transportation for passenger and freight shipment first became available in 1939, they indicated railways accounted for 62 percent of the volume of intercity freight traffic. Because railroads had accounted for virtually all of this traffic in 1900, this marked a dramatic drop in the railroad's share of this business. Even though this share rose during World War II, the conclusion of the war saw a return of the railroads' long-term losses to trucking and, more recently, to air. Intercity passenger travel was lost even more quickly (see Tables Df38–58, Df956–963, and Df965–979, as well as Figures Df-B and Df-D).

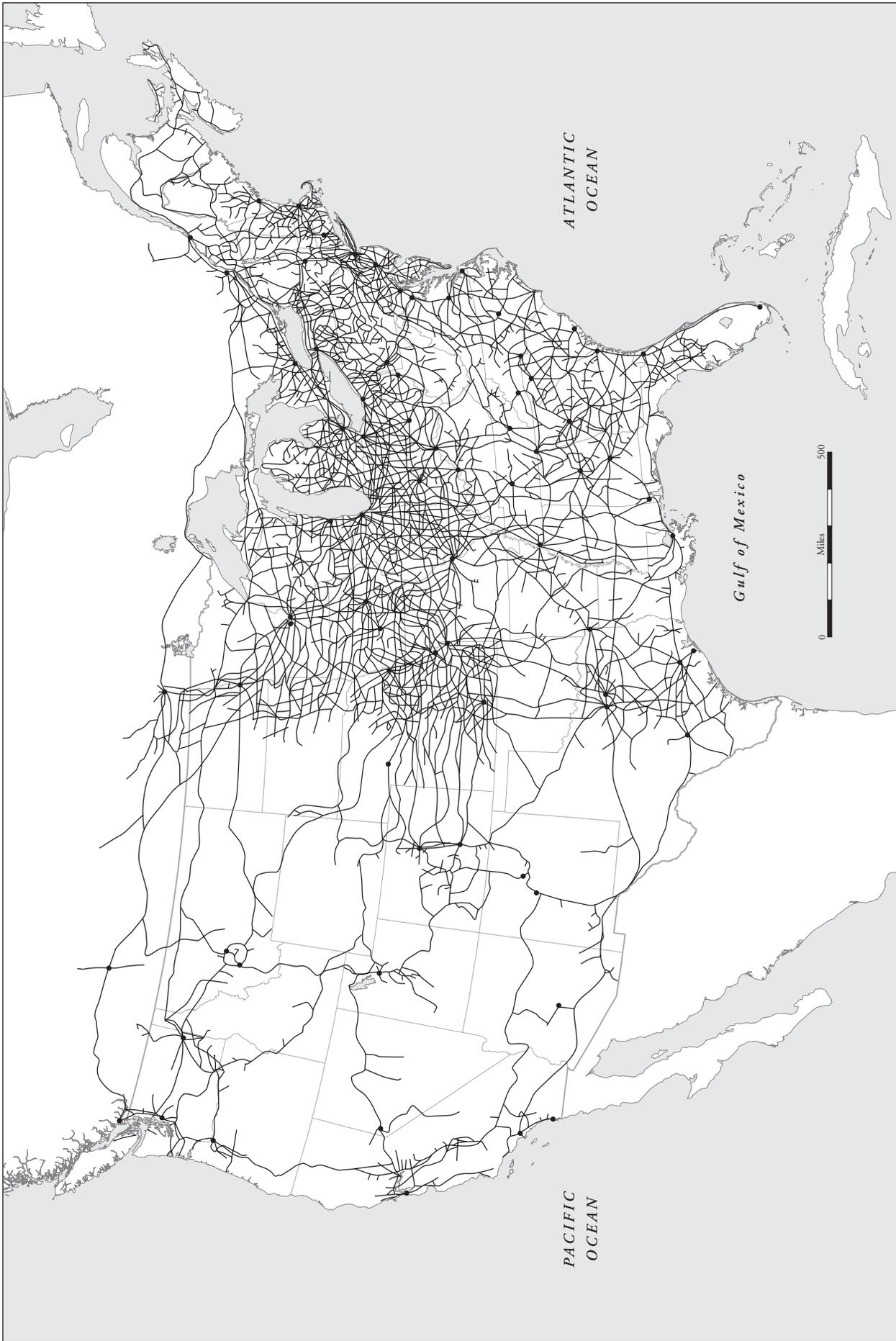
Air

The air transportation industry began in 1903 when Orville and Wilbur Wright made the first sustained flights in a heavier-than-air vehicle near Kitty Hawk, North Carolina. Commercial applications followed quickly. The Wright brothers concentrated their marketing efforts on the U.S. federal government, and their first order came from the Army Signal Corps, which purchased aircraft for military observation. The initial commercial market for aircraft was largely for sport and exhibition.

The first systematic data relevant to air transportation begin in 1913 and document the growth of total airplane production and sales through 1961 (see Table Df1165–1176). These data highlight the shifting importance of the industry's commercial and military customers. The military accounted for an important share of plane sales in most years through 1961, completely dominating sales during wartime. During war years, U.S. aircraft production occurred at record levels.

¹² At the same time, the law and practice of railroad regulation grew out of earlier legal developments; see Hughes (1991).

¹³ Some observers blame the decline of the railroads on the system of regulation that was put in place in the nineteenth century. For examples of different perspectives on this issue, see Caves (1980), Bryant (1988), and Martin (1992).



MAP Df-1 The North American railroad system: 1899

Source

James E. Vance Jr., *The North American Railroad: Its Origin, Evolution, and Geography* (Johns Hopkins University Press, 1995), endpaper in front of book. Underlying data are from *Travelers' Official Railway Guide*, January 1899.

Technological change in the air transportation industry was rapid. The first transcontinental flight was accomplished in 1911, less than eight years after the first flight at Kitty Hawk. A mere three years later, the St. Petersburg–Tampa Airboat Line carried out the first commercial flight when it flew passengers the eighteen miles between those two cities. Beginning in 1920, pilots (including many trained during the First World War) participated in national air races (for example, the Pulitzer and Bendix Trophy Races) that proved a major inducement to progress in design, production, and performance, after the decline in government support for the industry following the conclusion of World War I. By 1928, when the first statistics on the number of scheduled aircraft in air transportation become available, the United States already had 268 aircraft in domestic operations and 57 in international operations (see Tables Df1112–1138).

With the outbreak of World War II, and the likelihood that air power would play an even more significant role than in the First World War, President Franklin D. Roosevelt asked Congress for an appropriation that greatly expanded U.S. airplane production. This appropriation also provided a spur to technological development, such as the helicopter and the jet engine.

The high level of aircraft production during World War II is clearly evident in the data on the number of aircraft produced. The Korean War stimulated an additional round of aircraft production. Unfortunately, the series on total and military aircraft production end in 1961, just before the escalation of the Vietnam conflict (see Table Df1165–1176).

The end of the Second World War also saw an important increase in the development and production of aircraft for civilian use. Series Df1167, which displays total civilian aircraft produced, show a sharp spike immediately after the war. Following the first successful test of a jet transport plane in 1951, civilian aircraft production began a sustained rise through the late 1970s, interrupted only during the Vietnam War era, when the demand for military aircraft competed with production for civilian use.

The rapid growth of airline travel in the post–World War II era is evident in Tables Df1112–1138 and Df1159–1164, which display statistics of U.S. domestic and international scheduled airline operations and international air passenger arrivals and departures. In the post–World War II era, airlines progressively displaced bus and rail as a mode of intercity passenger travel. While the airlines' share of freight transportation is still small, it too has been growing (see Tables Df38–58 and Figure Df-B).

The early and mid-1960s were among the most dramatic in aviation history.¹⁴ The rate of technological change was at an all-time high, both in the airline industry and in the emerging “aerospace” industry, whose growth was spurred by the Cold War “race for space” that began in the late 1950s. See Table Cg236–240 for one measure of the aerospace industry's growth internationally, commercial space launches since 1982.

With the end of the Vietnam War in 1975 and the maturation of commercial aviation, aircraft production declined sharply and remained at a much-reduced level over the subsequent twenty-five years. Observers point to the decline of the NASA space program, an increase in international competition, and damage to the industry as a result of contracting and corruption scandals (Pattillo 1998, p. 317).

Alongside the history of air transportation's growth and technological change, there is a parallel history of government regulation and promotion of commercial air transportation, which began with passage of the Air Commerce Act of 1926. The Bureau of Air Commerce was created to help promote air safety by overseeing the licensing of pilots, checking the airworthiness of aircraft, and establishing and maintaining air traffic control. The positive impact of this regulation can be seen in Table Df1229–1245, which records data on airline safety since 1926.

The Aeronautics Branch of the Commerce Department initiated regular collection of national statistics in 1926. The growth in the number of airports, pilots, and the like can be seen in Table Df1139–1158. The Air Mail Act of 1925 opened an existing, federally operated airmail service to private competition and led to the development of aircraft to carry both passengers and mail. In 1926, the Postmaster General established a competition in which commercial airlines bid on routes for carrying airmail. Many of the famous pilots of the day, including Charles A. Lindbergh, began their aviation careers flying these airmail routes. The airmail contracts were crucial to the early development of passenger service because they guaranteed the airlines a known fee for flying a route, even in the absence of paying passengers and regardless of the volume of mail.

A new structure for airline regulation was initiated in 1934 following charges of collusion in the awarding of airmail contracts. President Franklin D. Roosevelt revoked all existing contracts and sponsored a new airmail act that divided responsibility for civil aviation among three agencies. The Post Office continued to award airmail contracts and set routes, the Interstate Commerce Commission fixed rates and payments, and a reorganized Bureau of Air Commerce (1934) assumed responsibility for establishing airways and creating licensing. The first comprehensive regulation was established in 1938 with the creation of the Civil Aeronautics Administration (CAA). Two years later a separate Civil Aeronautics Board (CAB) was created. In 1958, the Federal Aviation Agency assumed the function of the CAA and the safety functions of the CAB. It operated independently from the Commerce Department. In 1966, this agency was renamed the Federal Aviation Administration (FAA) and moved to the USDOT.

The FAA and the CAB carried out federal promotion and regulation of civil aviation. The FAA's principal activities address many aspects of airline safety, including the operation of air route traffic control centers, airport traffic control towers, and flight service stations. In addition, it became involved in the design, construction, maintenance, and inspection of navigation, traffic control, and communications equipment for the airways, as well as the promotion of air safety. The CAB was also involved in setting interstate routes and regulating fares for the commercial airlines. The responsibility for investigation of aviation accidents, originally held by the CAB, was transferred to the National Transportation Safety Board of the USDOT in 1966.

In 1978, federal regulation of the airline industry was dramatically curtailed when airline deregulation was implemented. The role of the CAB in setting interstate routes and regulating fares was reduced. On January 1, 1985, the CAB was eliminated. Its residual functions were assumed by the USDOT. The FAA continued to perform its functions within that department. Unfortunately, the USDOT does not publish many of the data series that had been reported by the CAB. Thus, one consequence of deregulation was a significant reduction in quantitative evidence on the commercial

¹⁴ Pattillo (1998), p. 261. See also Morrison and Whinston (1995).

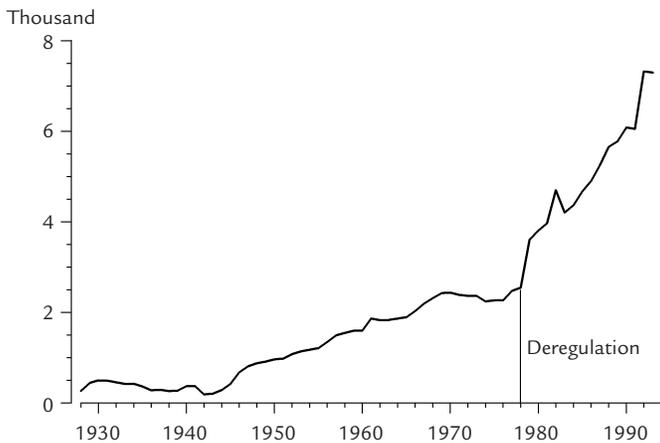


FIGURE Df-J Scheduled domestic aircraft in operation: 1928–1993

Source

Series Df1113.

airline industry. In particular, it has become more difficult to obtain information on airline routes and fares; as a result, the full impact of deregulation on the industry's activity and performance has been difficult to assess.¹⁵

Still, some effects of airline deregulation can be seen in the series on number of airline operators and aircraft in operation in domestic air transportation, shown in Table Df1112–1125 and Figure Df-J, and in the airline financial data presented in Tables Df1177–1228. Deregulation permitted the entry of many new airline companies, which brought a surge in the number of aircraft in operation. This heightened competition led to a much more turbulent financial situation for the industry, with many companies sustaining sizeable losses in the mid-1980s and early 1990s.

Pipelines

Pipelines are most commonly used for natural gas and petroleum products, but they are also used to transport slurry-coal, a thin mixture of fine particles of coal suspended in water. In some places, they are used to move water out of aquifers and to remove sludge from wastewater treatment plants.

Long-distance petroleum pipelines were first built in the United States in the 1870s, not long after Edwin Drake's first oil strike near Titusville, Pennsylvania, in 1859 (see the essay on mining, energy, fisheries, and forestry in Chapter Db). Independent crude-oil producers in the western Pennsylvania oil fields were trying to escape the control of the Standard Oil Trust over railroad rates on oil shipments. They organized themselves into the Tidewater Oil Company and built a pipeline as an alternative transportation mode to the railroad. At first, Standard Oil vigorously fought pipeline development. After the pipelines were built, however, Standard Oil was quick to see the advantages of this new form of transportation. Before pipelines were constructed, the high cost of shipping crude

oil meant that oil was refined in a large number of very small refineries that were located in out-of-the-way fields near the oil wells. Inexpensive pipeline transportation made it profitable to ship crude oil to a small number of very large refineries. This opportunity revolutionized petroleum manufacturing and the organization of the industry.¹⁶

Alfred D. Chandler Jr. emphasized the importance of pipelines in the development of the petroleum industry.

Not only did it greatly reduce shipping costs, but it also provided magnificent storage areas and thus assured a much greater and steadier flow of crude oil into the refineries. The alliance quickly made an investment of more than \$30 million in pipelines, at a time when the Standard Oil Company's total assets were valued at \$3 million. As the new pipelines neared completion, the members of the Standard Oil alliance formed the Standard Oil Trust, which then rationalized the petroleum industry. (Chandler 1990, p. 94)

Oil and natural gas pipeline construction in the United States followed the geography of gas and oil discoveries and the location of refineries. Oil discoveries in Texas, Oklahoma, and Southern California in the 1920s instigated the development of a nationwide system of oil and natural gas pipelines. Table Df1246–1258 gives data on interstate pipelines and points to the substantial volume of pipeline construction in the 1920s. At its peak in the 1970s, pipelines accounted for almost a fourth of U.S. domestic intercity freight traffic (see series Df57 and Figure Df-D).¹⁷ The discovery of oil at Prudhoe Bay on the Alaskan North Slope in 1968 prompted the construction of the Trans-Alaska Pipeline System during the mid-1970s. At the time, it was the largest privately financed construction project in world history. Because this project lay entirely within the state of Alaska, it is not included in the statistics shown in Table Df1246–1258, which refer to interstate pipeline projects only.¹⁸

Appendix: A Note on Data Sources

Because government involvement in the development of the nation's transportation infrastructure took place primarily at the state and local levels, and because of the heavy involvement of private enterprise, statistics on the early period of U.S. transportation history are to be found in the records of literally hundreds of separate local governmental jurisdictions and in those of private companies.

The federal 1880 Census made an effort to survey the extent and development of the nation's transportation system at the time, and the census continued quinquennial surveys of transportation systems through 1982. In 1957, the Census Bureau initiated a *Census of Transportation*.

Henry Varnum Poor, who operated a private credit assessment and reporting agency, began collecting and publishing statistics on selected transportation companies in 1851. His *History of the Railroads and Canals of the United States of America* (1860) is an important source of early data on these transportation modes.

¹⁵ Both agencies published, and the FAA continues to publish, annual operational data on the use of airway facilities; data related to the location of air personnel, aircraft, and airports; the activity volume in the field of non-air carrier (general aviation) flying and aircraft production and registration.

¹⁶ For a contemporary discussion of the implications of pipeline development, see Folger (1968), pp. 209–11.

¹⁷ For a history of petroleum pipelines, see Johnson (1967). On natural gas pipelines, see Castaneda and Smith (1996).

¹⁸ For a discussion of the Trans-Alaskan Pipeline, see Coates (1991).

Not until the formation of the ICC in 1887 did a truly coordinated and comprehensive national effort to collect and publish data on the transportation system begin. The ICC's data collection effort was undertaken to support its regulatory mission. Originally, the ICC had jurisdiction only over the railroads, but over time it came to regulate interstate activities of other transportation companies including those in trucking, passenger buses, freight forwarding, water carrying, oil and gas pipelines, transportation brokering, and express delivery. As these additional modes of transportation came under ICC jurisdiction, their statistics entered the ICC statistical base.

In 1966, the federal government created the USDOT with the mandate for "the development, collection, and dissemination of technological, statistical, economic, and other information relevant to domestic, and international, transportation." This department then conceived and developed a statistical compendium titled *National Transportation Statistics*. The first volume was published in 1970–1971, and it became an annual publication starting in 1978.

Deregulation of the airlines, railroads, and motor carriers between 1978 and 1980 significantly reduced or altogether eliminated data collection programs in the federal transportation regulatory agencies. The annual expenditures of the USDOT shrank dramatically between 1976 and 1986. In 1982, the Census Bureau terminated its quinquennial collection of data on commodity flows and passenger travel. No data on national multimodal commodity flows were collected between 1977 and 1993. The federal government conducted no comprehensive analyses of national transportation between 1979 and 1989. The few remaining data series published by the ICC ended when the ICC went out of existence in 1996 and its few remaining functions were transferred to the USDOT.

The Eno Transportation Foundation (ETF) is a nonprofit organization founded in 1921. Eno's *Transportation in America, Historical Compendium, 1939–1995*, and the annual edition of that volume are important continuations of historical series formerly produced and published by the federal government.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) created the Bureau of Transportation Statistics (BTS). Many of the provisions in the act speak to recapturing past capabilities. How the BTS has responded to the mandates in ISTEA is addressed in its *Transportation Statistics Annual Report*. Further, the BTS has become responsible for the annual *National Transportation Statistics* volume. The BTS is mandated to develop an intermodal transportation data base on commodity and passenger flows, including public and private investment in intermodal transportation facilities and services. To that end, it has developed the Commodity Flow Survey and the American Travel Survey. It compiles locational and connection data on intermodal facilities and services for all modes as part of the National Transportation Atlas Database.

National Transportation Statistics contains a great deal more comparative data than existed in the past. Data since 1960 have been reported on measures such as average freight revenues (see Table Df104–108), the volume of intercity passenger and freight (see Tables Df38–58), length of haul (see Table Df126–133), passenger fares (see Tables Df109–113 and Df148–152), personal consumption expenditures on transportation (see Table Df153–157), and national freight bill as a component of aggregate income (see Table Df114–117).

The new *National Transportation Statistics* data are reported annually for the previous ten years. Earlier data are reported only in five-year increments – those ending in a 5 or 0. One unfortunate consequence of the new format is that, even though series continue to be revised, often as a result of changed definitions, the data are not being revised for the earlier years. Where this has happened in the data presented in the tables shown here, two numbers have been supplied. Researchers are referred to the original sources where this presents problems of comparability.

A second difficulty results from the fact that no attempt has been made to adjust the data in *National Transportation Statistics* for the effect of changes in methods of accounting and reporting; hence, the data for the various years are often only approximately comparable. This is in keeping with the way the data are reported in the source documents. Once again, concerned researchers should consult the original sources.

The best source for quantitative data on highways is the Federal Highway Administration's annual *Highway Statistics*, first published in 1945. This publication and its companion volume, published every ten years, the most recent being *Highway Statistics, Summary to 1995*, are the principal source of data on public roads, the ownership and operation of motor vehicles, and fuel consumption (see Tables Df370–412 and Df473–481). There have been several format changes over the years. For example, in 1985, the Federal Highway Administration stopped requesting that states supply data on county and rural governments separate from that of municipalities. In several cases, these format changes make it impossible to update historical tables in a consistent fashion to the present time.

Data on the motor vehicle and equipment industry and on retail, wholesale, and services aspects of this industry can be found in reports of the *Census of Manufactures*, the *Census of Business*, and the *Annual Survey of Manufactures*. Domestic sales, plus the imports and exports, of passenger cars and trucks are reported in Table Df347–352. Travel data on these vehicles can be found in Tables Df370–412. The Bureau of Public Roads published surveys of highway mileage, revenues, and expenditures that were conducted in 1904, 1909, and 1914.

Data on water traffic and the merchant marine can be found in a number of sources. For the earliest period, 1789–1823, the primary source is the *American State Papers: Class IV, Commerce and Navigation*, volumes 1 and 2. Between 1821 and 1946, there are the various annual issues of *Foreign Commerce and Navigation of the United States*. The *Annual Report of the Commissioner of Navigation* was issued between 1884 and 1923. Both the latter two reports were originally issued by the Register of the Treasury and later by the Treasury Department. They then moved to the Department of Commerce and Labor, which became simply the Department of Commerce.

The Bureau of Customs prepared annual issues of *Merchant Marine Statistics* between 1924 and 1965.¹⁹ These were originally

¹⁹ A number of copying and typesetting errors in the 1936 *Merchant Marine Statistics* report were corrected in the *Historical Statistics of the United States* (1975), Table II, p. 744. The corrections were limited to situations where the exact nature of the discrepancy could be determined beyond reasonable doubt. The text statements, and the correction of errors found in the published tables, are based on reference to the following primary sources: For 1789–1823, see *American State Papers: Class IV, Commerce and Navigation*, volumes 1 and 2 (published in 1834); for 1821–1892, see annual issues of *Commerce and*

prepared by the Department of Commerce as a successor to the statistical section of the *Annual Report of the Commissioner of Navigation*. These statistics were supplemented by records of the U.S. Coast Guard, and the various annual issues of the *Annual Report of the Office of the Chief of Engineers*, Corps of Engineers. Data for “documented merchant vessels” have not reported since the 1970s (see, for example, Table Df822–824). The *Statistical Abstract of the United States*, issued by the Bureau of the Census, also contains historical water-traffic and merchant-marine statistics.

Congressional documents are another source of historical series on the merchant marine, foreign commerce, and related areas. For 1789–1882, a particularly valuable collection of documents was bound together under the title *Decadence of American Shipping and Compulsory Pilotage*. The documents in this collection include: *Foreign Commerce and Decadence of American Shipping*, U.S. House of Representatives Ex. Document number 111, 41st Congress, 2d session; *Causes of the Reduction of American Tonnage and the Decline of Navigation Interest . . .*, U.S. House of Representatives Report number 28, 41st Congress, 2d session; *Foreign Commerce and the Practical Workings of Maritime Reciprocity*, U.S. House of Representatives Ex. Document number 76, 41st Congress, 3d session; *Causes of the Decadence of Our Merchant Marine; Means for Its Restoration and the Extension of Our Foreign Commerce*, U.S. House of Representatives Report number 342, 46th Congress, 3d session; *American Shipping*, U.S. House of Representatives Report number 1827, 47th Congress, 2d session; *American Merchant Marine*, U.S. House of Representatives Report number 363, 48th Congress, 1st session; *Ship-Building and Ship-Owners Interests*, U.S. House of Representatives Report number 750, 48th Congress, 1st session; and reports of lesser interest, U.S. House of Representatives Miscellaneous Document number 37 and Report number 1848, both of the 48th Congress, 1st session.

The publications of the Maritime Commission and its predecessor agencies are another important source of data. *Ocean-Going Merchant Fleets of Principal Maritime Nations, Iron and Steel, Steam and Motor, Vessels of 2,000 Gross Tons and Over*, issued quarterly or semiannually, 1921–1941, provides data for each leading maritime nation on ocean-going merchant vessels of 2,000 gross tons and over, showing number and tonnage of such fleets classified by age, speed, size, boilers, engines, draft, and so forth, by major vessel type. *Employment of American Flag Steam and Motor Merchant Vessels of 1,000 Gross Tons and Over*, issued quarterly, 1923–1941, shows the number and tonnage of such vessels employed in U.S. foreign and domestic trade for seagoing merchant vessels of 1,000 gross tons and over, arranged by major vessel type, ownership (government and private), and area of operation (see Table Df758–821).

The Bureau of the Census (and its predecessor, the Census Office) published the results of five censuses of water transportation, for the years 1880, 1889, 1906, 1916, and 1926.²⁰ Although data

from these sources are not presented here, it is worth noting what is included in these volumes. The 1880 Census was limited to steam vessels; the report includes a detailed history of steam navigation in the United States with a separate discussion and single-year construction statistics by geographic region, from the beginning to 1880.²¹ The report of the shipbuilding census, also taken the same year, includes a detailed technical history of shipbuilding in all aspects, with particular reference to sailing craft. Single-year figures are shown for New England shipbuilding, 1674–1714, classified by type of vessel and place where built.²² The censuses of 1889 and 1906 included all classes of vessels; however, the 1889 Census included fishing vessels for the Pacific Division only, and the 1906 Census excluded fishing vessels. The Censuses of 1916 and 1926 provided data for all U.S. vessels and craft of five tons net register or more, documented and undocumented, whether propelled by machinery or sails, or unrigged, except that certain specified types of vessels were excluded.²³

An early chronicler and critic of the railroads in the nineteenth century was Henry Varnum Poor, editor of the *American Railroad Journal* and later publisher of the *Manual of the Railroads of the United States*. As mentioned earlier, the vast majority of railroad (and canal) data available up to the time of the ICC is attributable to Poor. This includes information on the miles of road that was operated, equipment, passenger and freight service, and property investment, capital, income, and expenses. The ICC republished Poor’s data in 1932 under the title *Railway Statistics Before 1890*. Elmus Wicker conducted a careful review of Poor’s work and advises using these data with caution; anyone using Poor’s data is advised to consult Wicker’s essay.²⁴ The Tenth Census of 1880 also contained data on rail mileage through 1879. Similar data appeared in the Eleventh Census of 1890, but it was not strictly comparable. Beginning in 1893, *Railway Age* collected information similar to that reported in the Tenth Census (see Tables Df874–885, Df888–889, Df891–910, and Df919–926).

Beginning in 1890, the principal sources of the railroad series through the late 1970s are various issues of two annual publications of the ICC: *Statistics of Railways in the United States* for the years prior to 1954 and *Transport Statistics in the United States*, part 1, for 1954–1978 (see Tables Df927–1003 and Df1014–1033).

Beginning in 1911, the ICC classified operating companies on the basis of operating revenues. Those of Class I had annual revenues above \$1,000,000; Class II, above \$100,000; and Class III, below \$100,000. Beginning in 1956, the minimum for Class I was raised to \$3,000,000, and the other two classes were consolidated. Effective January 1965, the classification was changed to the following: Class I, \$5,000,000 or more; and Class II, under \$5,000,000. Companies with revenue falls that would move them into a new, lower, class were not reclassified until the revenue reduction appeared to be permanent. The relative importance of Class I railroads has increased since 1911 because of the growth of traffic and the absorption of small roads in larger systems. The

Navigation of the United States; for 1884–1923, see issues of *Annual Report of the Commissioner of Navigation*; for 1924–1945, see annual issues of *Merchant Marine Statistics*. Although the census reports of 1850 and 1860 contain some statistics relating to water transportation, these statistics apparently were collected by other agencies.

²⁰ For reports of these censuses, see *Tenth Census Reports*, volume 4, *Report on Agencies of Transportation* (1880); *Eleventh Census Reports, Report on Transportation Business*, Part 1, “Transportation by Water”; *Transportation by Water* (1906); *Water Transportation* (1916); and *Water Transportation* (1926).

²¹ See T. C. Purdy, “Report on Steam Navigation in the United States,” *Tenth Census Reports* (1880), volume 4.

²² See Henry Hall, “Report on the Ship-Building Industry of the United States,” *Tenth Census Reports* (1880), volume 8.

²³ See U.S. Bureau of the Census (1929), p. 5.

²⁴ Wicker (1960). George Rogers Taylor in a comment on Wicker in the same volume seconds Wicker’s cautions. Both Fishlow and Fogel, whose work makes use of Poor’s data, were aware of these cautions. It should also be noted that the original ICC publication contained typographical errors.

ratio of operating revenues of Class I line-haul companies to the total revenues of Classes I, II, and III was 96.48 percent in 1911, 97.45 in 1916, 98.07 in 1926, 98.76 in 1941, 99.06 in 1945, and 98.21 in 1969. Since the demise of the ICC, reported data are most consistent with what it reported as Class I railroads.

The vast majority of the freight statistics reported after deregulation are the work of the Association of American Railroads (AAR) and appear in one of that group's publications, particularly in its annual *Railroad Facts*. The AAR has been publishing data almost as long as the ICC. Its data are close, but not identical, to those of the ICC. The AAR does not collect as much data as the ICC did; consequently, some series simply cannot be continued to the present. Tables Df1034–1088 present the AAR data that parallel the old ICC data. In this volume, the tables on railroads that begin in 1960 were constructed to provide some overlap to the ICC data. It should be noted that the series reported in these tables often begin much earlier than 1960. Interested readers are referred to the source volumes.

The AAR no longer collects information on passenger service, as its members now handle freight exclusively. The federal government assumed responsibility for intercity-passenger service through Amtrak in 1970. Passenger service statistics come from Amtrak, and only recently did Amtrak begin publishing data on its operations. Over the past few years, Amtrak has included a ten-year "historical data appendix" as part of its *Annual Report*. Those data are reported in Tables Df1092–1111. Other data series relating to Amtrak are included in *National Transportation Statistics*; a few other series can be found in the *Statistical Abstract of the United States*. In most cases, the underlying source of these published numbers is private correspondence with Amtrak.

Through 1978, the railroads regulated by the ICC were still described legally as "steam railways," yet since 1957 most train and switching operations are performed by diesel locomotives, and some divisions of the railways included were electrified. The ICC also regulated a small (and diminishing) number of railways of the interurban electric type. These are not included in the ICC data reported here. Information on electric railways for the period 1890 through 1937 can be found in Table Df1004–1013.

An important source for information on public transportation is the American Public Transit Association's *Transit Fact Book*. There is some overlap between this source and Amtrak information on urban commuting. Multimode data on public transportation can be found in Tables Df158–183.

The FAA's annual *Statistical Handbook of Aviation* is the source for most of the air statistics presented in this volume.

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