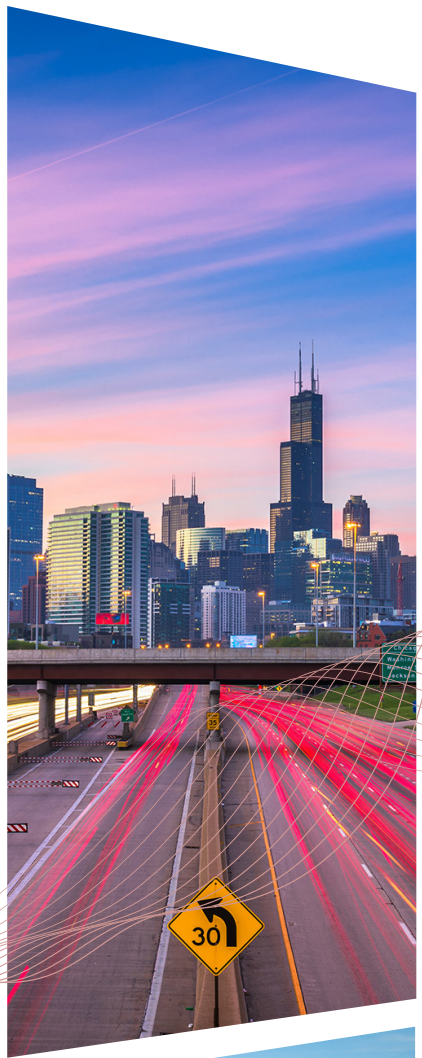
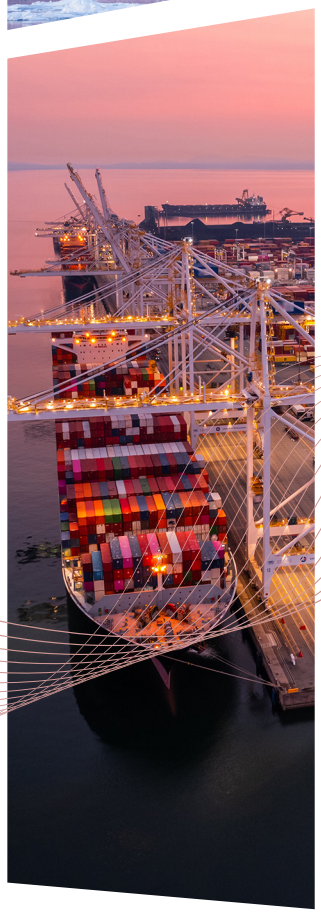
TRANSPORTATION STATISTICS

ANNUAL REPORT 2024

30th Anniversary









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TRANSPORTATION STATISTICS ANNUAL REPORT 2024

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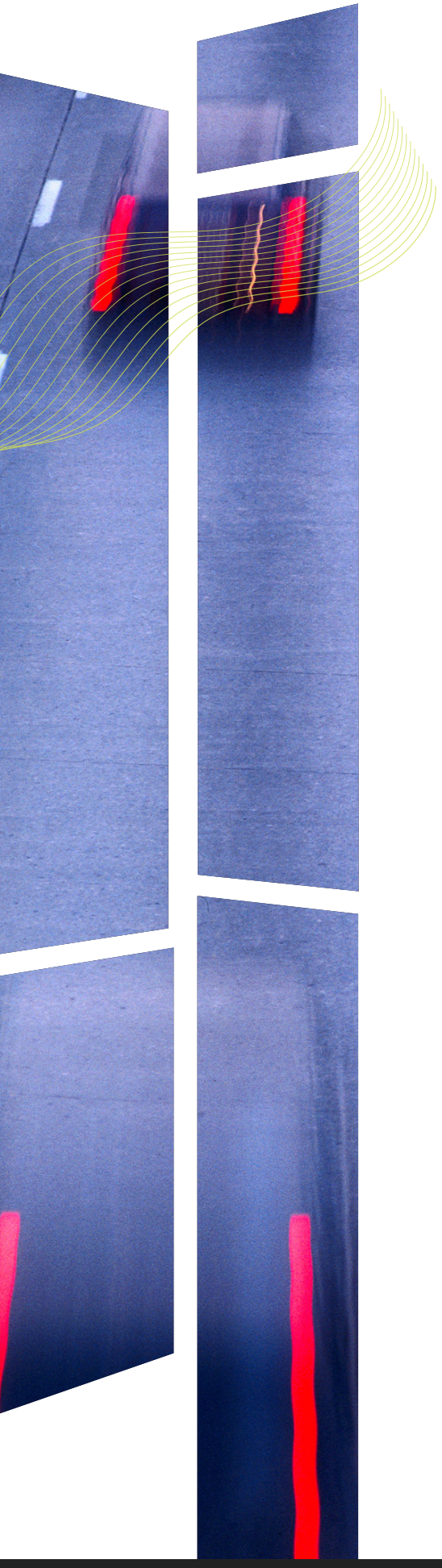

INTRODUCTION

Transportation is fundamental to the vibrancy of the Nation and facilitates economic prosperity and quality of life. It enables people to engage in productive pursuits and experience the social interactions that take full advantage of geographic specialization and diffusion. An efficient and resilient transportation system and its seamless operation underpin the overall efficiency and resilience of the entire economy.

Recognizing the importance of transportation and the importance of objective statistics for transportation decision-making, Congress requires the Director of the Bureau of Transportation Statistics (BTS) of the U.S. Department of Transportation (USDOT) to provide the *Transportation Statistics Annual Report* (TSAR) each year to Congress and the President.[1] BTS published the first TSAR in 1994.

The first TSAR covered the same topics as the current edition in a slightly different order and without the benefit of many major statistical products. For example, freight statistics were based on data from carriers and trade associations rather than the comprehensive, public statistical information in today's Freight Analysis Framework. Economic statistics lacked the complete enumeration of transportation's role in the economy provided by today's Transportation Satellite Account. The environmental section discussed transportation noise in general without today's National Transportation Noise Map. The State of Transportation Statistics chapter included extensive discussions of transportation in the Decennial Census, economic classification, the forthcoming Commodity Flow Survey, and the need for a large survey of long-distance travel.

While TSARs in the last 3 decades have followed a similar format, three editions were much shorter than the traditional format. The 20th-anniversary edition focused on a look back and a look ahead in *Two Decades of Change in Transportation: Reflections from Transportation Statistics Annual Reports: 1994-2014*. The 2019 edition focused on the effects of recent legislation on the state of transportation statistics. The 2021 edition focused on the effects of the COVID-19 pandemic on transportation. All editions of the TSAR can be downloaded from the National Transportation Library,[2] a major part of BTS that was not anticipated in the first edition of the annual report.

This 30th-anniversary edition of TSAR documents how the transportation system has changed through economic booms, a major recession, and the shock of a pandemic. This report is organized into 7 chapters on the State of the System, Passenger Travel and Equity, Freight and Supply Chains, Transportation Economics, Transportation Safety, Energy and Sustainability, and the State of Transportation Statistics. The concluding chapter provides specific information required in the mandate for this report.[1]

BTS welcomes comments on TSAR and the Bureau's other products. Comments, questions, and requests for printed copies should be sent to bts@dot.gov or the Bureau of Transportation Statistics, U.S. Department of Transportation, 1200 New Jersey Avenue SE, Washington DC, 20590.

Previous editions of the TSAR are available at www.bts.gov/tsar.

1 Title 49 U.S.C. § 6312, Transportation Statistics Annual Report. Available at https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title49-section6312&num=0&edition=prelim.

2 USDOT. n.d. National Transportation Library, Transportation Statistics Annual Report Series. Available at https://rosap.ntl.bts.gov/gsearch?ref=docDetails&related_series=Transportation%20Statistics%20Annual%20Report%20%28TSAR%29.

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CHAPTER 3

FREIGHT AND SUPPLY CHAIN

03

Efficient U.S. freight transportation is essential to the country's economic strength, directly impacting industries' abilities to access materials, ship products, and manage logistics operations. Freight movement underpins the supply chain, from procurement and production to delivery. The transportation and logistics industry forms the connective tissue, providing critical links between suppliers, manufacturers, and end customers.

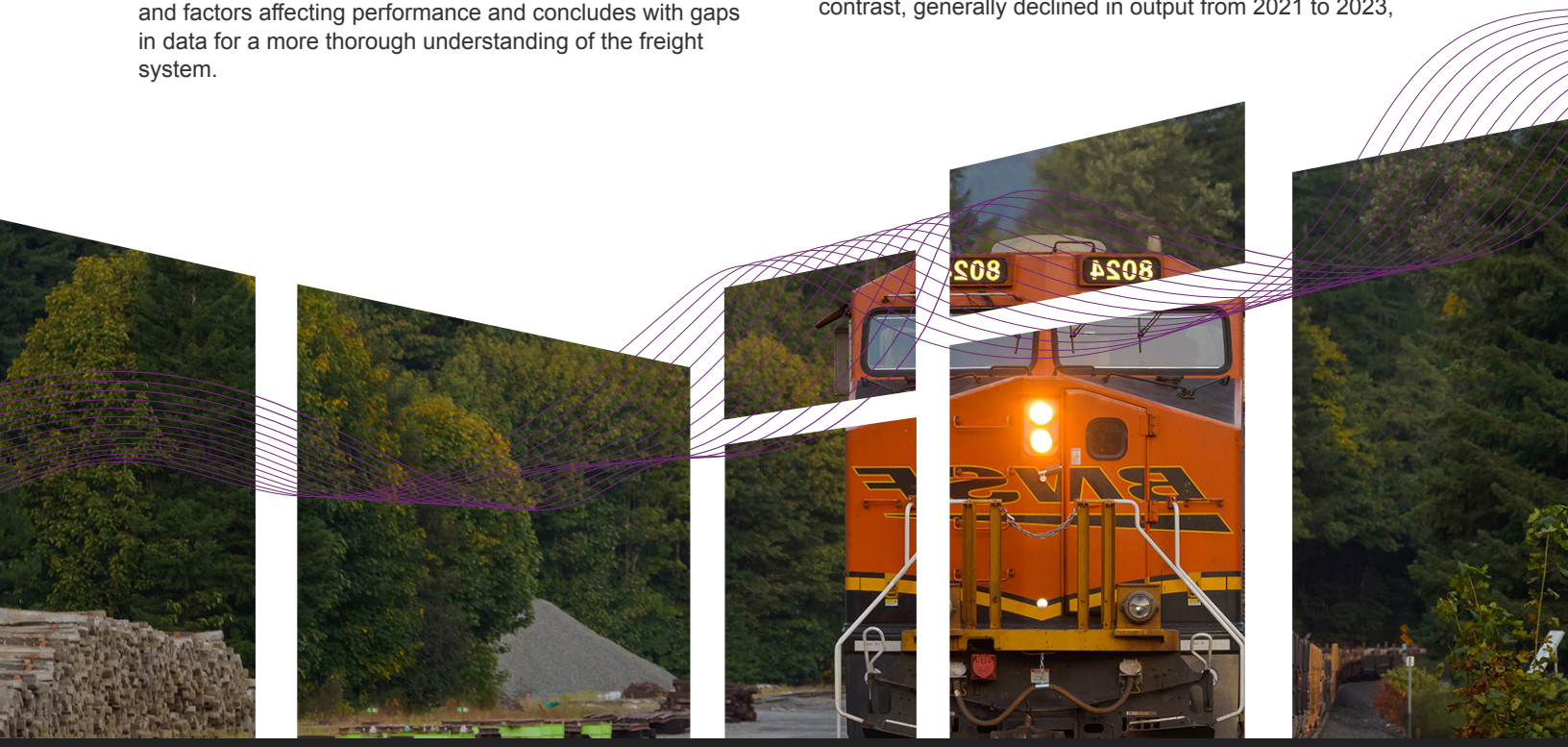
Recent global events have highlighted the freight sector's role in economic resilience. The COVID-19 pandemic triggered supply chain disruptions. This event was followed by shifts in international trade flows that were influenced by geopolitical factors, such as the Russia–Ukraine conflict, and environmental challenges, including droughts in major waterway regions. Additionally, labor challenges and shifting trade dynamics with key partners—particularly China and Mexico—have underscored the sector's vulnerabilities and the pressing need for adaptable infrastructure and logistics strategies.

This chapter examines the factors contributing to the demand for freight movement followed by the volumes of freight by commodity and mode moved domestically and between the United States and its trading partners. The chapter then presents selected performance measures and factors affecting performance and concludes with gaps in data for a more thorough understanding of the freight system.

Factors Affecting U.S. Freight Transportation Demand

Freight transportation demand is closely linked to domestic industrial output and international trade activities. As illustrated in Table 3-1, the gross output of industries that are heavily reliant on freight transportation has exhibited notable shifts over recent years. Manufacturing remains the sector most dependent on the U.S. freight system, accounting for approximately 39.4 percent of the total output among the eight most freight-dependent industries.

Manufacturing; retail trade; construction; mining; and agriculture, forestry, fishing, and hunting all experienced output growth from 2022 to 2023, with retail trade achieving an all-time high from 2017 to 2023. Wholesale trade, in contrast, generally declined in output from 2021 to 2023,



HIGHLIGHTS

The U.S. freight system accommodated around 5,465 billion ton-miles in 2023, with trucking dominating short-haul distances below 100 miles (75 percent of ton-miles) and rail taking the lead on distances from 1,000–2,000 miles (37.8 percent of ton-miles), emphasizing the importance of modal efficiency across varying distances.

By tonnage, natural gas and other fossil products led all U.S. domestic commodities in 2023, comprising 23.3 percent of total volume among the top 10 commodities, with most transported by pipelines.

In 2023, U.S.–Mexico trade totaled $798 billion, a 2.4 percent increase from 2022, making Mexico the top U.S. trade partner for the first time, surpassing U.S.–Canada trade, which declined by 2.5 percent to $772.9 billion. Meanwhile, U.S.–China trade experienced a significant decline of 16.8 percent, from $690.3 billion in 2022 to $574.7 billion, highlighting shifting trade dynamics.

Pipelines continued to dominate in U.S.–Canada trade, carrying 45 percent of the total freight weight, while vessel transport led in U.S.–Mexico trade with a 60 percent share of the total freight weight.

Emerging issues for the freight sector include concerns over potential overcapacity in the liner shipping industry, ongoing vessel diversions around the Suez Canal due to the Middle East conflict, and increased foreign direct investment in Mexico, driving up cross-border freight demand.

Significant data gaps remain in freight transportation analysis, including real-time metrics on port congestion, truck turn times, and capacity utilization, as well as data on shipment routing, first- and last-mile freight movements, and shipping costs. Addressing these gaps is critical for improving system efficiency, enhancing resilience, and achieving sustainability goals.

The gross output of U.S. industries reliant on freight transportation reached significant levels in 2023, with manufacturing alone accounting for 39.4 percent of the total output among the most freight-dependent sectors.

Electronics, valued at $1.86 trillion, topped the list of high-value U.S. commodities transported in 2023, with Truck and Multiple Modes and Mail options as the primary modes, reflecting the high demand for efficient logistics in high-value, low-weight goods.

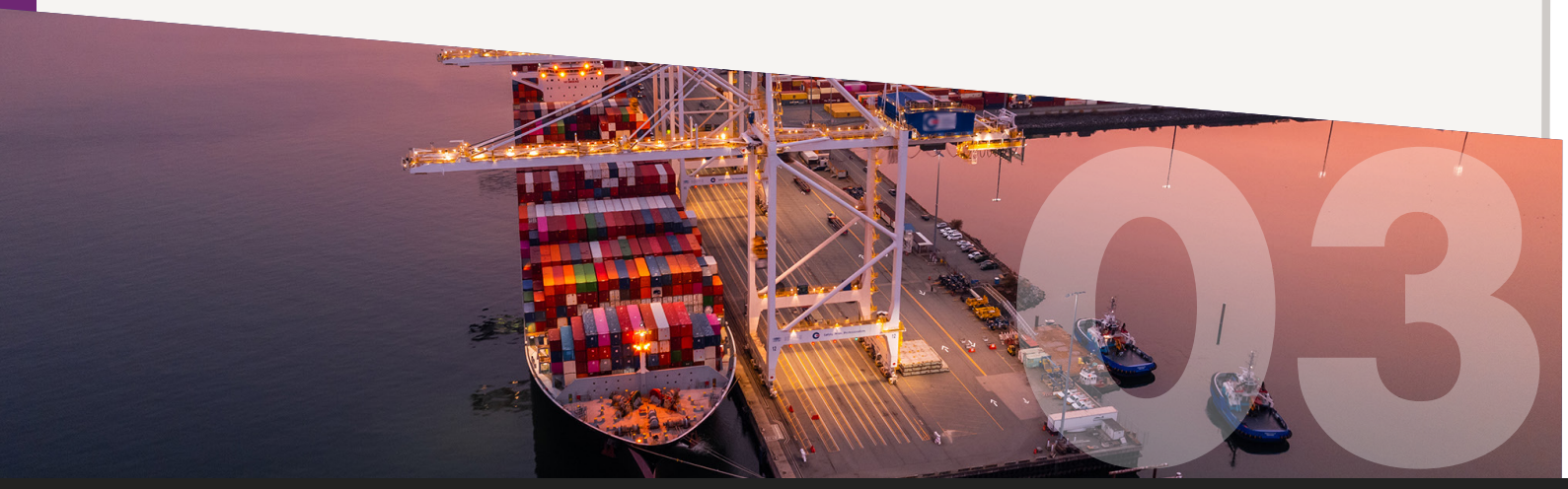
Containerized Asian imports at East Coast ports surpassed those of the West Coast for the second consecutive year in 2023, with East Coast ports handling 63.8 billion kilograms of containerized Asian imports compared to the West Coast's 55.0 billion kilograms.

The Liner Shipping Connectivity Index ranked the Port of New York and New Jersey highest among U.S. ports in 2023. The port reached a score of 517, up from 506 in 2022, while West Coast ports like Los Angeles and Long Beach experienced declines in connectivity scores to 276 and 233, respectively.

Average truck speeds within 5 miles of the Ports of Los Angeles and Long Beach were consistently higher than those at the Port of New York and New Jersey from 2019 to 2023, with speeds peaking at 20.96 mph in 2023 at Los Angeles/Long Beach compared to 18.95 mph at New York/New Jersey, reflecting operational improvements and smoother traffic flows.

The total value of U.S. foreign trade reached approximately $5.1 trillion in 2023, representing a slight decline from 2022 but underscoring the continued importance of international trade in the U.S. economy.

Highlights Continued ⟫



HIGHLIGHTS CONTINUED

The U.S. freight transportation system moved 20.1 billion tons of goods valued at about $18.7 trillion in 2023. Trucking remained the dominant mode, transporting 64.5 percent of the total freight weight and 72.5 percent of the total value.

Vessel dwell time at the top 25 U.S. ports decreased to an average of 28.5 hours in the first half of 2023, down from the peak of 35.5 hours in 2022, indicating a recovery in port efficiency after COVID-19 disruptions.

East Coast ports have consistently gained share in U.S.–Asian containerized trade over the past decade, with total volumes surpassing those of West Coast ports in 2023. East Coast ports handled a combined 102.2 billion kilograms of containerized imports and exports, compared to 86.3 billion kilograms for West Coast ports.

Pipelines transported 4 billion tons of freight in 2023, accounting for 20 percent of the total weight moved, underscoring the heavy reliance on this mode for energy-related freight and its critical role in supporting bulk transport logistics.

with 2023's output being lower than that of the pre-COVID-19 year of 2019. Additionally, while transportation and warehousing shows a decline in output from 2022 to 2023, it still reached its second-highest output between 2017 and 2023, surpassing pre-COVID-19 peaks between 2017 and 2019, along with utilities.

In 2023, the United States' northern and southern neighbors, Canada and Mexico, remained pivotal trade partners (Figure 3-1). The total freight exchanged between the United States and Canada reached $773 billion, marking a 3.0 percent decrease from 2022's peak of $796.7 billion. Meanwhile, trade with Mexico rose by 2.8 percent, with freight flows totaling $798 billion in 2023. In stark contrast, trade with China saw a substantial decline, dropping by nearly 16.8 percent from $690.4 billion in 2022 to $574.7 billion in 2023.

Between 2021 and 2023, the U.S. trade landscape shifted significantly, particularly in its relationships with China and Mexico. U.S.–China trade saw a marked decrease over this period, with the total value falling from a 2022 peak of $690.3 billion to $574.7 billion in 2023—a 16.7 percent drop. This trend signals changing dynamics between the two largest economies. Canada and Mexico both surpassed China as the United States' top trade partners during this period. Canada was the leading partner in 2021 and 2022, but Mexico overtook that position in 2023, with China remaining in third place throughout these years.

Trends in Total Freight Movements

In 2023, the U.S. freight transportation system handled approximately 20.1 billion tons of goods valued at around $18.7 trillion (in 2017 dollars). This extensive system is supported by capital assets valued at $8 trillion in 2022, including critical infrastructure, such as ports, highways, rail systems, airports, and pipelines. The asset value in 2022 represents an increase of $143.3 billion from the previous year [BTS 2023a].

The data from 2023 show that, while freight weight experienced a slight growth of 196 million tons compared to 2019 (Table 3-2), the last pre-COVID-19 year, the overall freight value saw a minor decline of $250 billion (Table 3-3, reported in constant 2017 dollars). Notably, the "Air (air and truck)" category exhibited stability in freight weight, remaining unchanged at 7 million tons, though its value decreased by $11 billion. Similarly, the Multiple Modes and Mail category recorded a modest decline of 9 million tons in freight weight between 2019 and 2023, accompanied by a slight drop in value.

Additionally, certain modes like pipeline transportation saw increases in both freight weight and value, with pipeline freight tonnage rising by 117 million tons and its value increasing by $38 billion in constant 2017 dollars compared to 2023. These shifts reflect the dynamic nature of the U.S. freight transportation system and highlight areas where growth and decline have occurred, though changes in value can also reflect fluctuations in commodity prices, such as the volatility often seen in energy markets.

Trucking continued to dominate as the principal mode of freight transportation in 2023, moving 13.0 billion tons of cargo valued at more than $13.6 trillion. This accounted for 64.5 percent of the total freight weight and 72.5 percent of the total value. Trucking's freight volume remained significantly higher than that of rail, the third-ranked mode, by approximately 8.1 times. Pipelines played a crucial role as well, transporting 4.0 billion tons in 2023, representing about 20 percent of total freight tons, emphasizing the importance

Table 3-1 Gross Output of Freight System–Dependent Industry Sectors: 2017–2023 (Billions of 2017 Chained Dollars)

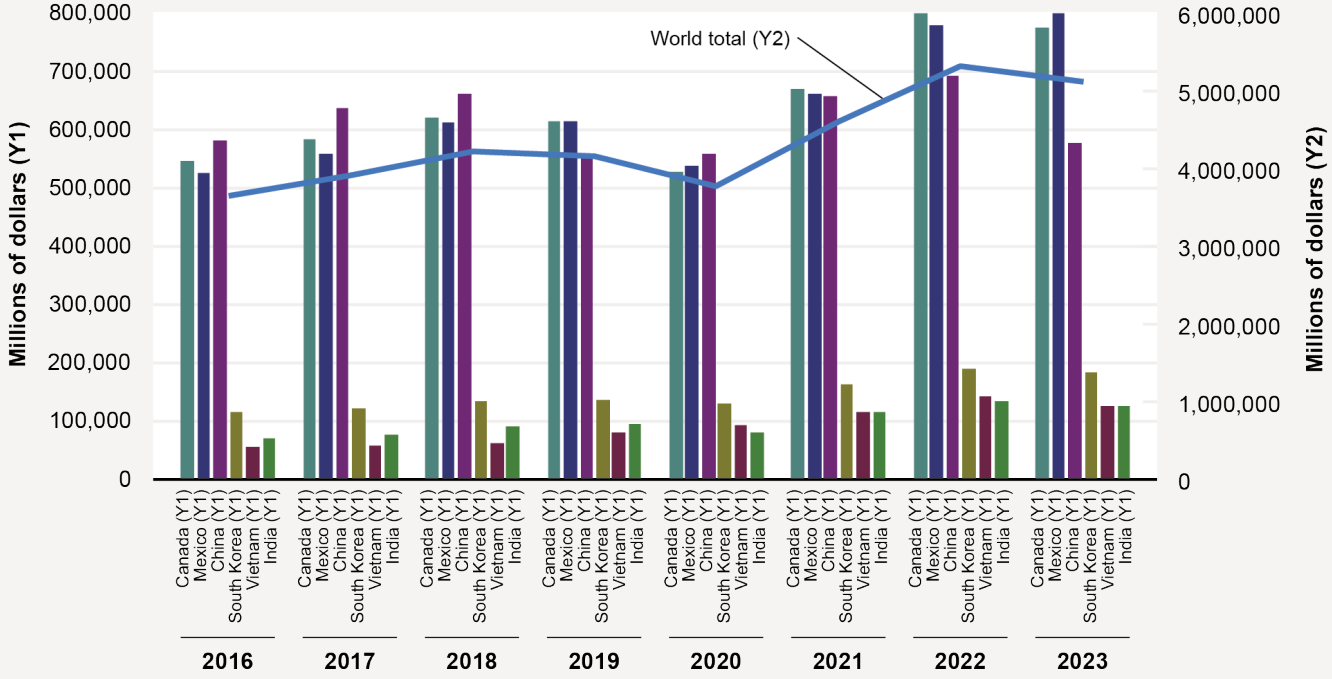
Industry sector*	2017	2018	2019	2020	2021	2022	2023
TOTAL	**13,768.1**	**14,181.9**	**14,165.9**	**13,446.8**	**14,177.3**	**14,231.4**	**14,301.3**
Agriculture, forestry, fishing, and hunting	448.9	447.2	440.1	454.5	454.8	434.8	444.5
Mining	462.8	536.2	568.2	471.8	501.7	531.9	539.8
Utilities	474.1	496.4	492.9	481.5	492.5	507.1	501.5
Construction	1,578.0	1,601.3	1,614.9	1,643.6	1,669.3	1,564.3	1,610.5
Manufacturing	5,676.6	5,786.4	5,724.7	5,335.3	5,498.2	5,541.9	5,629.0
Wholesale trade	2,053.9	2,115.5	2,089.1	1,986.7	2,203.5	2,198.7	2,068.5
Retail trade	1,846.9	1,914.6	1,932.0	1,931.2	2,089.5	2,092.2	2,163.4
Transportation and warehousing	1,226.9	1,284.3	1,304.0	1,142.2	1,267.8	1,360.5	1,344.1

Source: Bureau of Economic Analysis, Gross Output by Industry (billions of 2017 chain dollars), available at https://apps.bea.gov/iTable/?reqid=150&step=2 as of July 2024.

Note: Chain dollars adjust for inflation over time allowing for equitable comparisons among dollar amounts. Transportation and Warehousing includes warehousing and storage, water, truck, and pipeline transportation only; rail and air transportation are excluded due to a mix of freight and passenger output. Transit and ground transportation and other transportation and support activities are also excluded due to their focus on passenger transportation.

* Industry sectors include those highly dependent on transportation and warehousing.

Figure 3-1 U.S. Trade Growth With Selected 6 of Top 10 Trading Partners: 2016–2023 (Current Dollars)



Source: Bureau of Census, U.S. Department of Commerce, "U.S. International Trade in Goods and Services: 2023, Annual Revision," Exhibit 13, available at https://www.census.gov/foreign-trade/Press-Release/ft900/final_2023.pdf as of August 2024.

Table 3-2 Freight Weight in Millions of Tons by Mode: 2019 and 2023

	2019				2023			
Mode	TOTAL	Domestic	Exports[1]	Imports[1]	TOTAL	Domestic	Exports[1]	Imports[1]
TOTAL	**19,930**	**17,825**	**1,139**	**968**	**20,126**	**17,867**	**1,218**	**1,041**
Truck	12,852	11,941	468	443	12,975	12,015	462	497
Rail	1,599	1,160	267	172	1,598	1,113	317	169
Water	819	657	112	51	797	644	110	43
Air (air and truck)	7	2	3	2	7	2	3	2
Multiple modes and mail	653	538	63	52	645	526	61	57
Pipeline	3904	3,437	221	247	4,021	3,490	259	272
Other and unknown	96	89	5	2	84	77	6	1

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, as of August 2024.

Note: Numbers may not add to totals due to rounding. Data in this table are not comparable to similar data in previous years because of updates to the Freight Analysis Framework. All truck, rail, water, and pipeline movements that involve more than one mode, including exports and imports that change mode at international gateways, are included in Multiple Modes and Mail to avoid double counting. As a consequence, rail and water totals in this table are less than other published sources.

[1] Data do not include imports and exports that pass through the United States from a foreign origin to a foreign destination by any mode.

Table 3-3 Freight Noninflation Adjusted Value in Billions of 2017 Dollars by Mode: 2019 and 2023

	2019				2023			
Mode	TOTAL	Domestic	Exports[1]	Imports[1]	TOTAL	Domestic	Exports[1]	Imports[1]
TOTAL	**18,945**	**15,126**	**1,575**	**2,243**	**18,695**	**14,877**	**1,535**	**2,283**
Truck	13,809	11,294	985	1,530	13,562	11,036	945	1,582
Rail	584	226	138	220	577	223	135	219
Water	268	182	47	39	256	178	44	35
Air (air and truck)	611	150	237	223	600	153	228	219
Multiple modes and mail	2,582	2,343	78	161	2,573	2,352	66	155
Pipeline	1,061	929	73	59	1,099	934	98	67
Other and unknown	30	2	17	11	28	2	19	7

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, as of August 2024.

Note: Numbers may not add to totals due to rounding. Data in this table are not comparable to similar data in previous years because of updates to the Freight Analysis Framework. All truck, rail, water, and pipeline movements that involve more than one mode, including exports and imports that change mode at international gateways, are included in Multiple Modes and Mail to avoid double counting. As a consequence, rail and water totals in this table are less than other published sources.

[1] Data do not include imports and exports that pass through the United States from a foreign origin to a foreign destination by any mode.

of energy-related flows within U.S. freight movements. Trucking's substantial share in both freight weight and value underscores its critical role in the U.S. freight system. Despite changes in overall trends, trucking remains the primary mode of freight transportation.

Distance of Freight Movement and Modes of Transportation Used

In 2023, the U.S. freight transportation system not only handled approximately 20.1 billion tons of goods valued at around $18.7 trillion but also facilitated the movement of these goods over vast distances, totaling 5,465 billion ton-miles [BTS, FHWA n.d.].

Figure 3-2 presents value, tonnage, and ton-miles for freight shipments by distances. Shares of value, tonnage, and ton-miles by mode are also presented by distance bands. Trucks maintained a prominent role across all distances, especially dominant in shorter ranges, accounting for 75 percent of ton-miles for distances less than 100 miles, which aligns with their flexibility and capacity for quick delivery. For mid-range distances of 100 to 499 miles, the importance of rail and pipelines became more pronounced, with pipelines playing a significant role between 250 and 499 miles, handling 33.6 percent of the ton-miles and more than 34.1 percent of the total value moved in this range. This highlights their efficiency in transporting bulk commodities such as oil and gas where continuous movement over moderate distances is critical.

As distances increased further in 2023, rail took the lead in moving ton-miles, particularly in distances from 1,000–2,000 miles, accounting for 37.8 percent of ton-miles and a substantial portion of the value. This emphasizes rail's capacity for efficient long-haul transport, suitable for heavy and bulk commodities that benefit from the economies of scale offered by rail transportation. At the longest distances—more than 2,000 miles—Multiple Modes and Mail emerged as vital for the longest hauls, managing nearly one-third of the ton-miles and demonstrating a significant share of the total freight value. This diversity in modal use underlines the complexity and integration required for transcontinental and international logistics, catering to logistics of high-value, multifaceted goods that require careful handling over considerable distances.

Leading Commodities in U.S. Freight

In 2023, the U.S. freight transportation system handled a significant volume of commodities, as detailed in Table 3-4 and Table 3-5 and illustrated in Figure 3-3 and Figure 3-4, which outline the top 10 domestic commodities ranked by both weight and transportation mode, as well as by value and mode. These commodities collectively accounted for nearly 13.5 billion tons, representing approximately 67.0 percent of all domestic commodity weight, predominantly falling within the bulk freight category.

Table 3-4 Top 10 Commodities by Weight and Share: 2023

Commodities by weight	Thousands of tons
Natural gas and other fossil products	3,135,356
Gravel	2,075,021
Gasoline	1,439,329
Cereal grains	1,343,053
Nonmetal mineral products	1,199,802
Crude petroleum	1,166,626
Fuel oils	960,839
Other agriculture prods.	741,396
Natural sands	709,856
Waste/scrap	709,294
TOTAL, Top 10	**13,480,570**
TOTAL of all commodities	**20,240,154**
Top 10 share of TOTAL	**66.6%**

Source: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, September 2024.

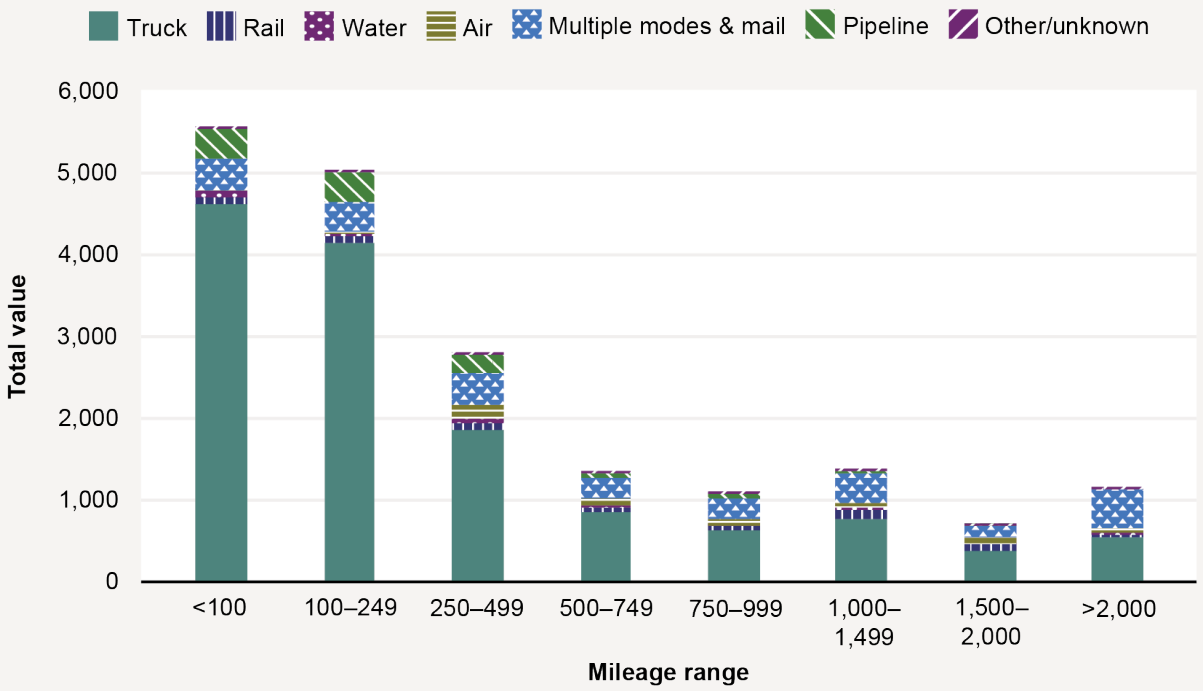
Table 3-5 Top 10 Commodities by Value: 2023

Commodities by value	Billions of 2017 dollars
Electronics	1,860,933
Motorized vehicles	1,604,890
Mixed freight	1,522,017
Pharmaceuticals	1,469,259
Machinery	1,176,483
Plastics/rubber	784,441
Miscellaneous manufacturing products	772,471
Gasoline	771,114
Natural gas and other fossil products	748,872
Other foodstuffs	740,277
TOTAL, top 10	**11,450,757**
TOTAL of all commodities	**18,733,941**
Top 10 share of TOTAL	**61.1%**

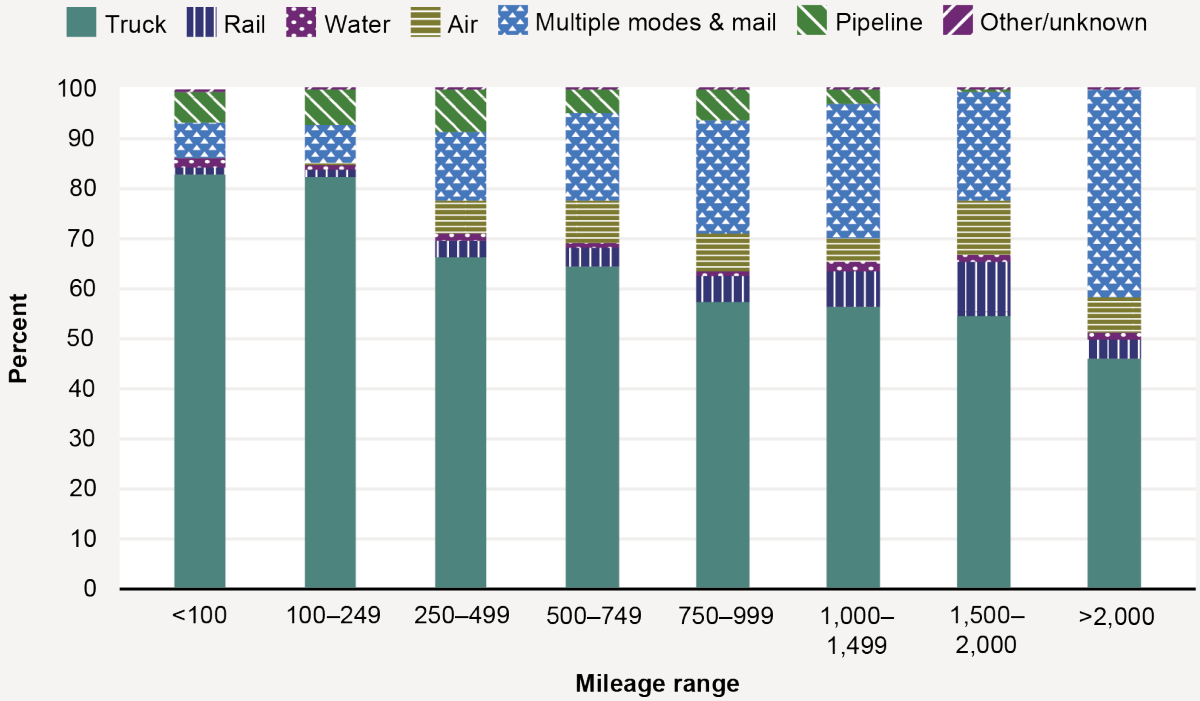
Source: U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, September 2024.

Figure 3-2 Value, Tonnage, and Ton-Miles by Distance Traveled: 2023

A. Total Value by Distance



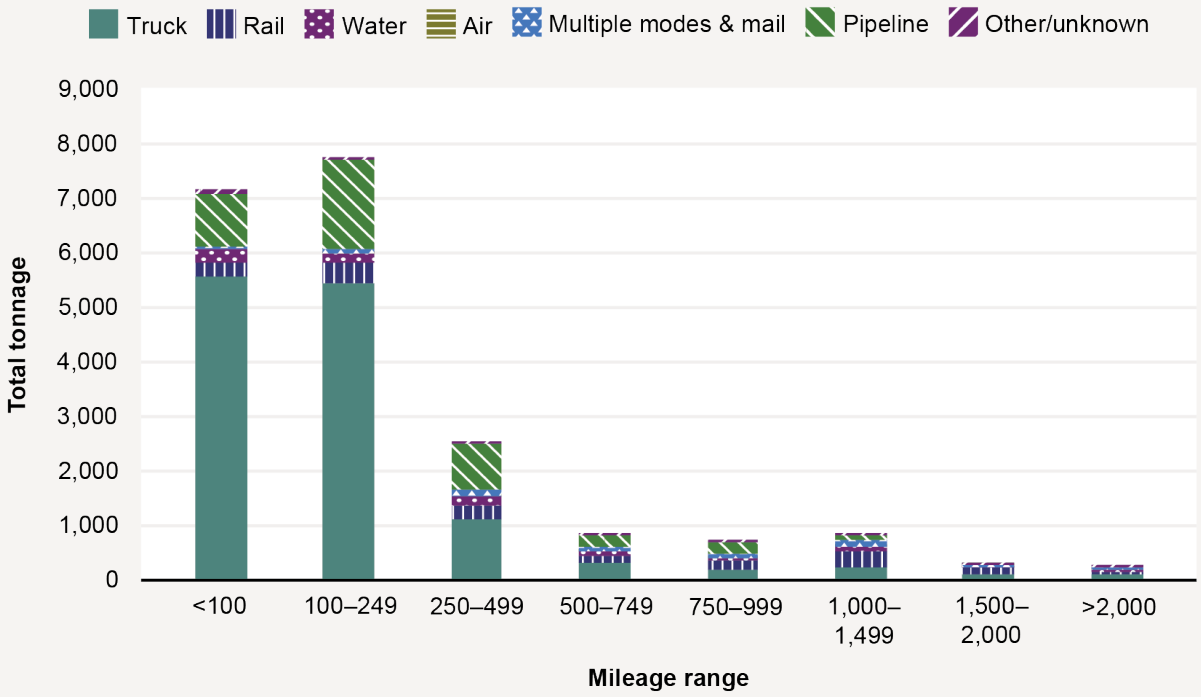
B. Mode Share of Value by Distance



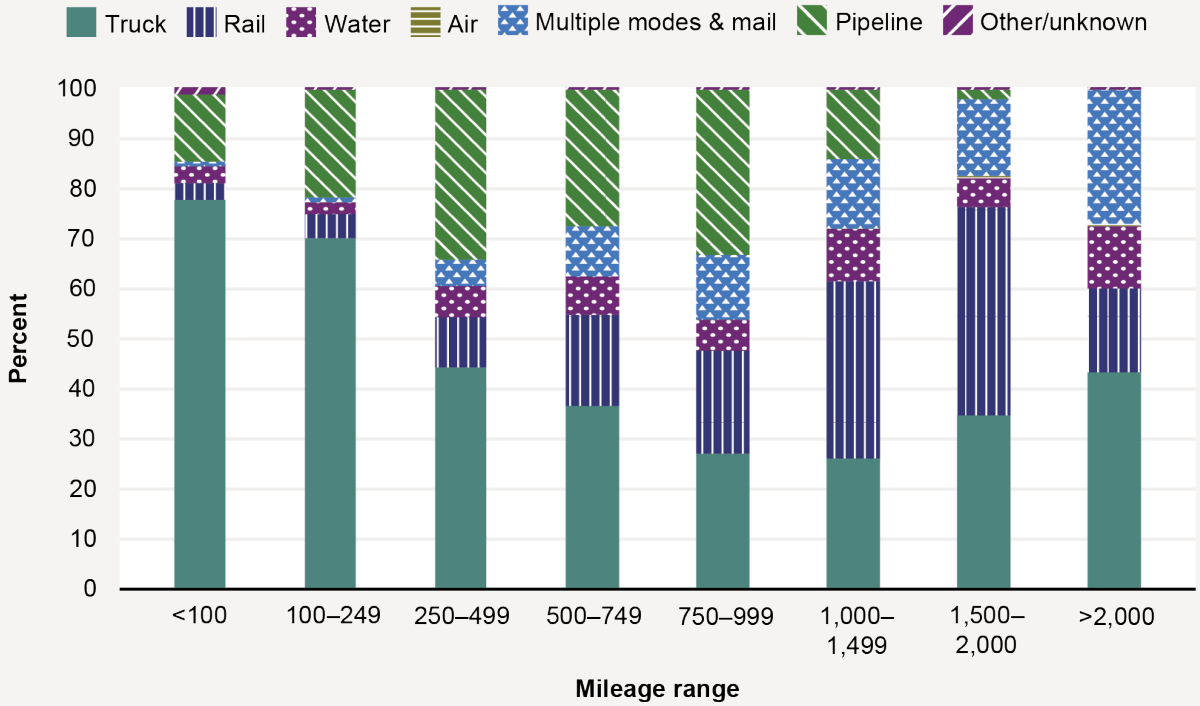
Source: U.S. Department of Transportation, Bureau of Transportation Statistics, and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, as of July 2024.

FIGURE 3-2 Continued

C. Total Tonnage by Distance



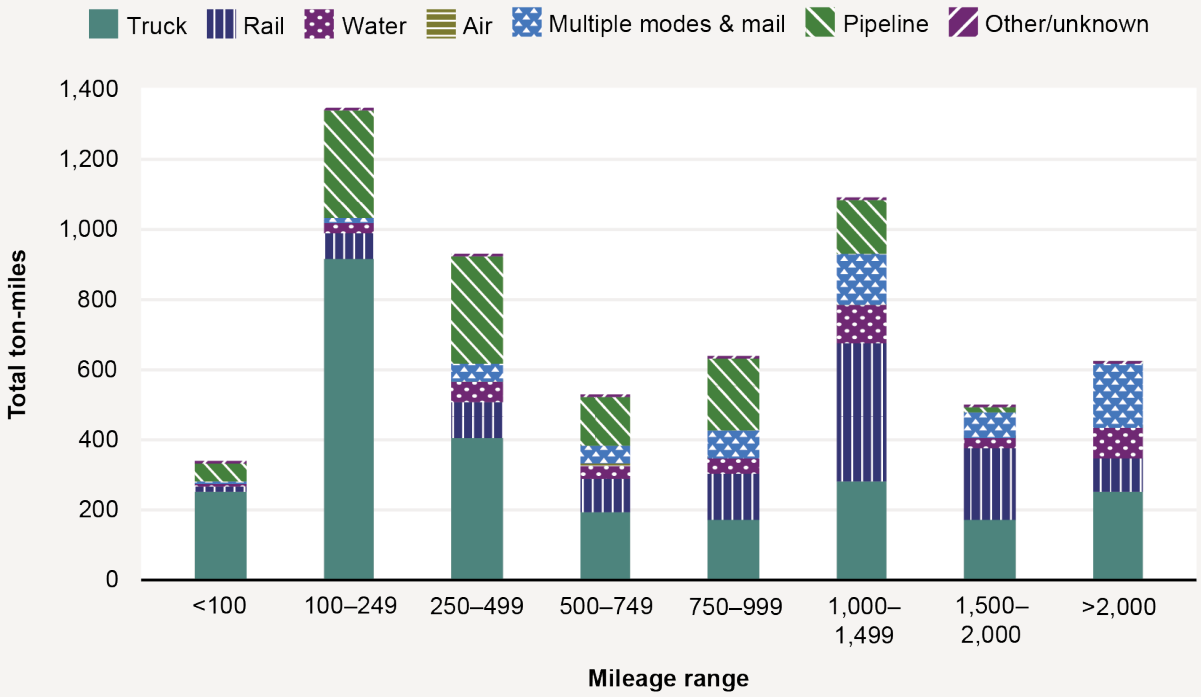
D. Mode Share of Tonnage by Distance



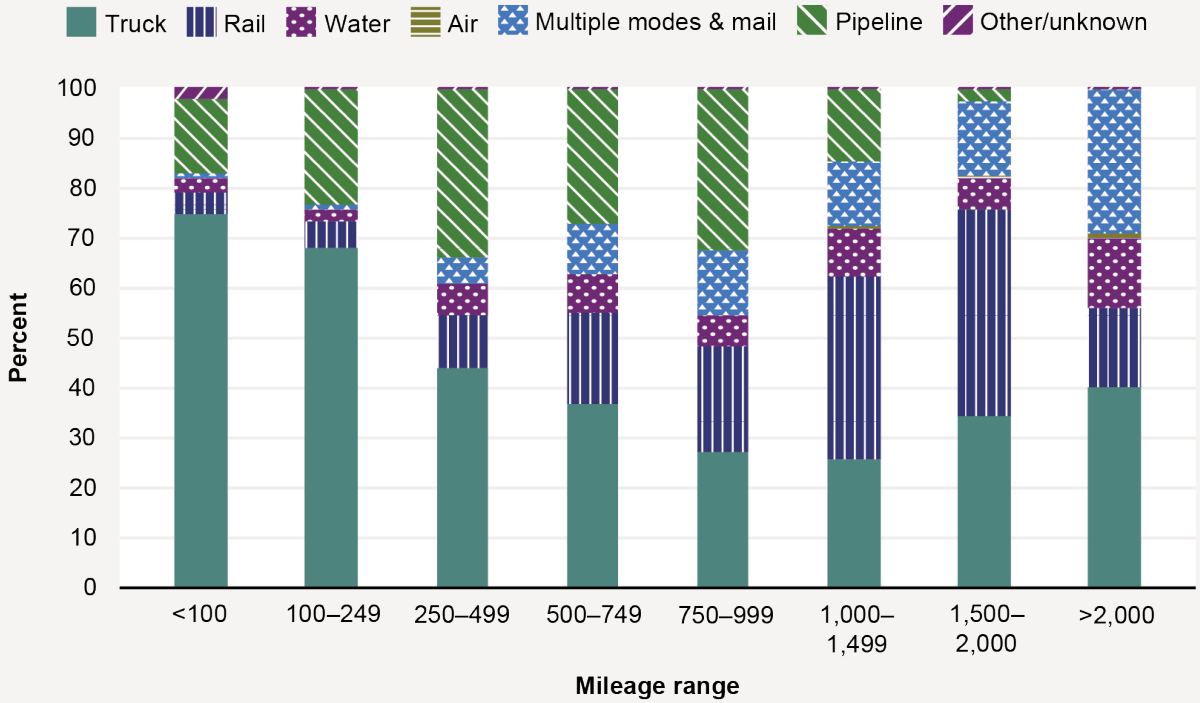
Source: U.S. Department of Transportation, Bureau of Transportation Statistics, and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, as of July 2024.

FIGURE 3-2 Continued

E. Total Ton-Miles by Distance

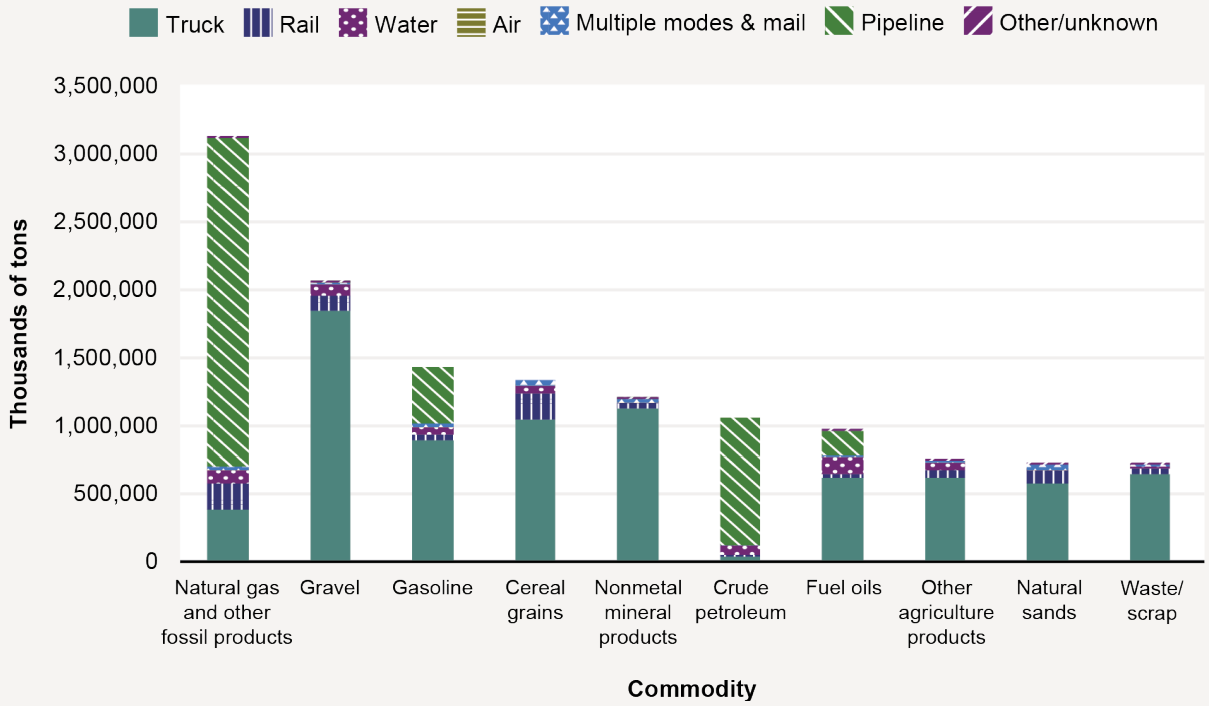


F. Mode Share of Ton-Miles by Distance



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, as of July 2024.

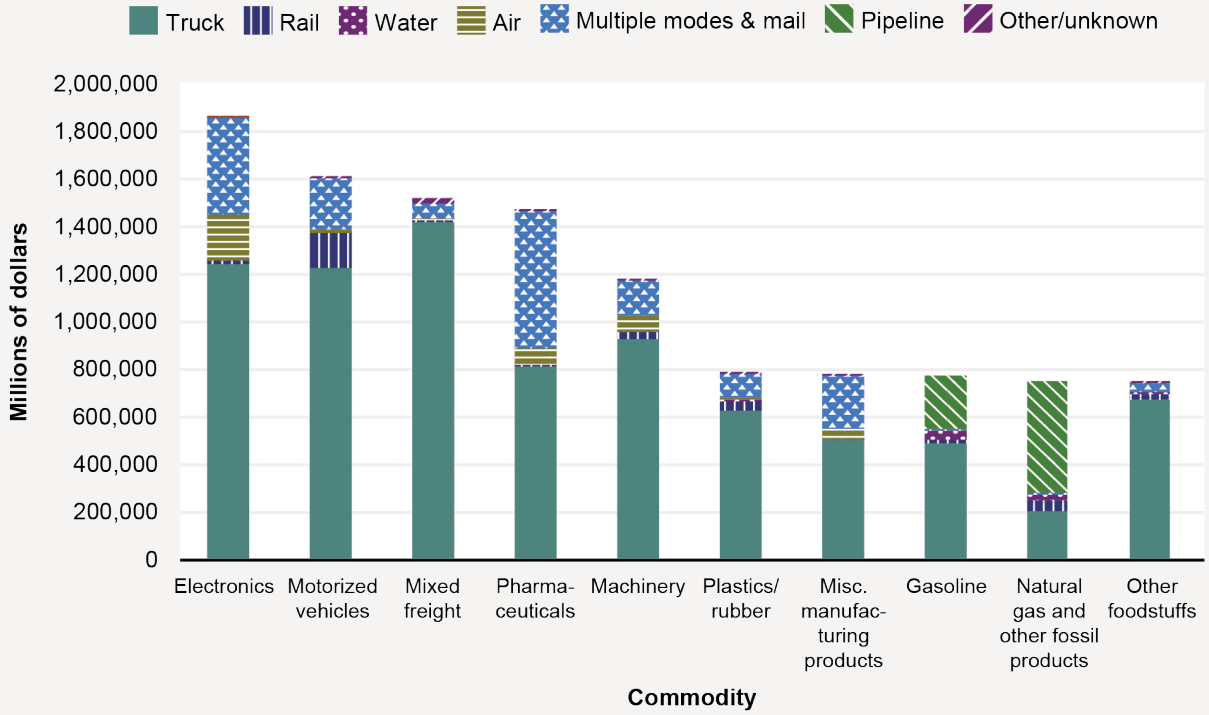
Figure 3-3 Tonnage of Top 10 Commodities by Transportation Mode: 2023



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, July 2024.

Note: Air includes truck-air.

Figure 3-4 Value of Top 10 Commodities by Transportation Mode: 2023



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, and Federal Highway Administration, Freight Analysis Framework, version 5.6.1, July 2024.

Note: Air includes truck-air.

The perspective of value presents a contrasting picture, where high-value commodities like electronics and pharmaceuticals dominated. Electronics led the list with a total value of approximately $1.86 trillion, with significant portions transported by trucks and the Multiple Modes and Mail category, highlighting the high-value, low-weight nature of electronics compared to bulk commodities. Motorized vehicles and mixed freight also contributed significantly to the total value of U.S. freight, with trucks transporting the majority of these goods, underscoring the importance of road transport in the distribution of manufactured goods. The pharmaceutical sector, known for its high-value products, primarily relies on trucks and the category for transport, much like other high-value goods like electronics. Interestingly, pharmaceuticals show the highest use of Multiple Modes and Mail among the top-10 commodities, perhaps reflecting the shipping and handling processes required to maintain product integrity across various exchanges in the pharmaceutical supply chain. This complexity contributes to its high placement in value terms.

International Freight

The nominal value of international import and export freight reached an estimated $5.1 trillion in 2023 (as detailed in Table 3-6), a decline of $200.2 billion from 2022. Although international freight accounts for approximately 27.3 percent of the total U.S. freight value—estimated at $18.7 trillion in 2023—this share belies the crucial role that international freight plays in the U.S. economy. The logistics activities concentrated in the Nation's maritime ports, land borders, and airports, particularly in regions like Los Angeles and Long Beach, underscore the strategic importance of international trade.

Table 3-6 provides a breakdown of U.S. international freight flows by geography and transportation mode in terms of freight value. Vessel transport continues to dominate trade with Asia, with the value of goods moved by vessels amounting to $1.11 trillion in 2023. Though this figure represents a decline of about $110.4 billion from the previous year, Table 3-6 shows the continuing dominance of maritime transport serving U.S. trade. First, vessel freight flows serving the U.S.–Asian trades represent 52.4 percent of all vessel freight flows between the United States and global markets. Second, vessel transport represents 60.6 percent of the value of freight flows between the United States and Asia.

Air transport shows a 27.4 percent share of all modes serving U.S. international trade. This contrasts sharply with air transport's share of 34.6 percent for U.S.–Asia trade, though there was a decline in U.S.–Asia trade transported by air of $75.8 billion from 2022 to 2023. Despite this decrease, the total value of U.S.–Asia air freight reached $633.1 million in 2023 still underscores the ongoing importance of air transport for time-sensitive and high-value goods, even as maritime transport gains a larger share of the market.

For trade with Europe, a more balanced distribution between air and vessel transport is observed. The value of goods transported by air reached $599.6 billion in 2023, while vessel transport accounted for $540.9 billion in the same year. This balance underscores the competitive dynamics between air and maritime transport in U.S.–Europe trade, with air transport holding a slight edge in market share.

Trade with Canada and Mexico, the United States' largest trading partners by land, continues to be dominated by truck transport, which carried $435.7 billion worth of goods

Table 3-6 Value of U.S.–International Freight Flows by Geography and Transportation Mode: 2023 (Millions of 2017 Dollars)

	Mode						
Geography	**Truck**	**Rail**	**Pipeline**	**Air**	**Vessel**	**Other**	**TOTAL**
TOTAL	**996,352**	**209,224**	**112,563**	**1,399,452**	**2,117,239**	**265,204**	**5,100,034**
Canada	435,702	113,860	105,197	35,577	34,901	48,702	**773,939**
Mexico	560,650	95,364	7,366	21,563	91,414	22,477	**798,834**
Asia	—	—	—	633,134	1,109,398	89,444	**1,831,977**
Europe	—	—	—	599,573	540,917	81,799	**1,222,289**
Other	—	—	—	109,605	340,609	22,782	**472,996**

Source: Truck, Rail, and Pipeline: U.S. Department of Transportation, Bureau of Transportation Statistics, TransBorder Freight Data, available at www.bts.gov/transborder; Air, Vessel, and Other: U.S. Department of Commerce, Census Bureau, USA Trade Online, https://usatrade.census.gov/ as of August 2024.

Note: Transportation mode in this table represents the mode by which freight arrived to or departed from the United States. Therefore, truck, rail, and pipeline are only available for U.S. freight flows with Canada and Mexico.

— Not applicable.

to Canada and $560.7 billion to Mexico in 2023. Rail and pipeline modes also play significant roles, particularly in trade with Canada, where they accounted for a combined $219.1 billion in freight value. These modes are essential for the movement of bulk commodities and energy products, which are key components of trade with Canada.

Table 3-7 provides a breakdown of U.S. international freight flows by geography and transportation mode in terms of tonnage. The total tonnage of U.S. international freight reached approximately 1.29 billion tons in 2023. This represents the physical volume of goods moved across various transportation modes between the United States and its trading partners. Although tonnage provides an alternative metric to value for understanding trade, certain modes, such as pipelines and vessels, transport much heavier cargo compared to others, like air transport. This weight disparity reflects the composition of goods moved internationally, where merchandise goods and bulk commodities such as petroleum and agricultural products often dominate.

Vessel transport dominates U.S.–Asia trade, with 290.9 million tons of goods moved by vessels in 2023. This represents the largest share of tonnage among all regions and modes, reflecting Asia's extensive involvement in U.S. imports and exports. Similarly, vessel transport between the United States and Europe accounted for 177.3 million tons, emphasizing the continued importance of maritime transport for transatlantic trade.

In North America, land-based modes, particularly trucks, rail, and pipelines, play a dominant role in trade with Canada and Mexico. In 2023, truck transport accounted for 63.2 million tons and 61.2 million tons of freight to Canada and Mexico, respectively. Additionally, pipelines moved significant volumes, particularly in U.S.–Canada trade, where 201.4 million tons of goods were transported by this mode, largely reflecting energy product flows. Mexico, by contrast, saw the movement of just 259,000 tons via pipeline, with most goods transported by truck and vessel. Figure 3-5 summarizes the modal shares.

Figure 3-6 highlights the prominence of the Nation's top 25 gateways in 2022, where 17 out of these gateways handled more imports than exports. Los Angeles, CA, emerged as the leading gateway, processing a substantial $310.7 billion in combined export and import freight value. Of this, imports amounted to $282.2 billion, positioning Los Angeles well ahead of second-ranked Laredo, TX, by $107.1 billion. However, Los Angeles trailed behind Laredo in exports by $83.7 billion.

At the land border, Laredo, TX, held the top position as the leading land gateway, managing international freight valued at $287.3 billion, which reflects the significant trade volumes between the United States and Mexico. Although ranked fifth overall, Houston, TX, was the Nation's primary export gateway with an impressive $133.0 billion in exports, followed closely by John F. Kennedy International Airport with $117.5 billion in exports.

The Port of Los Angeles stood out as the premier maritime gateway, with a total freight throughput of $310.7 billion in exports and imports. Notably, the port also secured the top spot for imports among the top 25 gateways, handling $282.2 billion in imports, surpassing the Houston gateway by a significant margin of $173.8 billion.

Table 3-7 Weight of U.S.–International Freight Flows by Geography and Transportation Mode: 2023 (Thousands of Short Tons)

	Mode						
Geography	**Truck**	**Rail**	**Pipeline**	**Air**	**Vessel**	**Other**	**TOTAL**
TOTAL	**124,478**	**100,873**	**201,700**	**4,315**	**853,200**	**9,310**	**1,293,877**
Canada	63,229	82,047	201,440	242	92,710	8,532	**448,200**
Mexico	61,249	18,826	259	135	122,124	777	**203,372**
Asia	—	—	—	1,807	290,901	—	**292,709**
Europe	—	—	—	1,371	177,253	—	**178,624**
Other	—	—	—	760	170,211	—	**170,971**

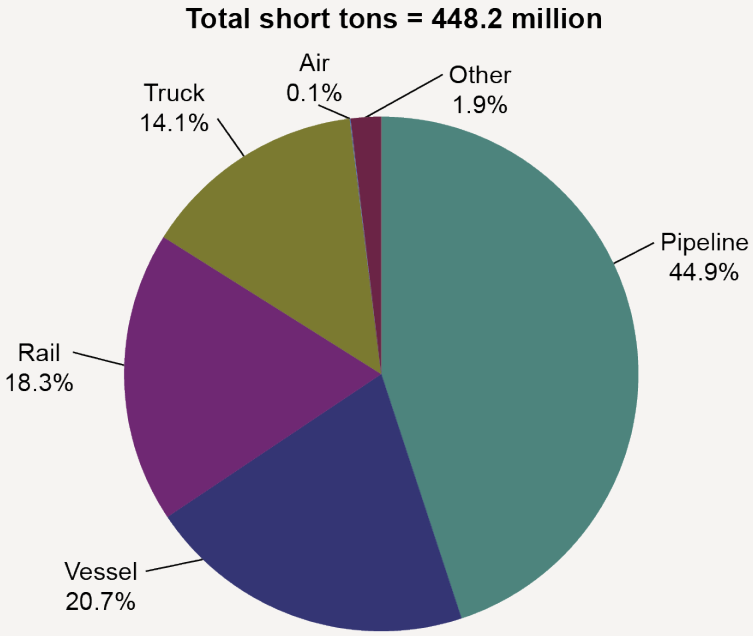
Source: Truck, Rail, and Pipeline: U.S. Department of Transportation, Bureau of Transportation Statistics, TransBorder Freight Data, available at www.bts.gov/transborder; Air, Vessel, and Other: U.S. Department of Commerce, Census Bureau, USA Trade Online, https://usatrade.census.gov/ as of August 2024.

Note: Transportation mode in this table represents the mode by which freight arrived to or departed from the United States. Therefore, truck, rail, and pipeline are only available for U.S. freight flows with Canada and Mexico.

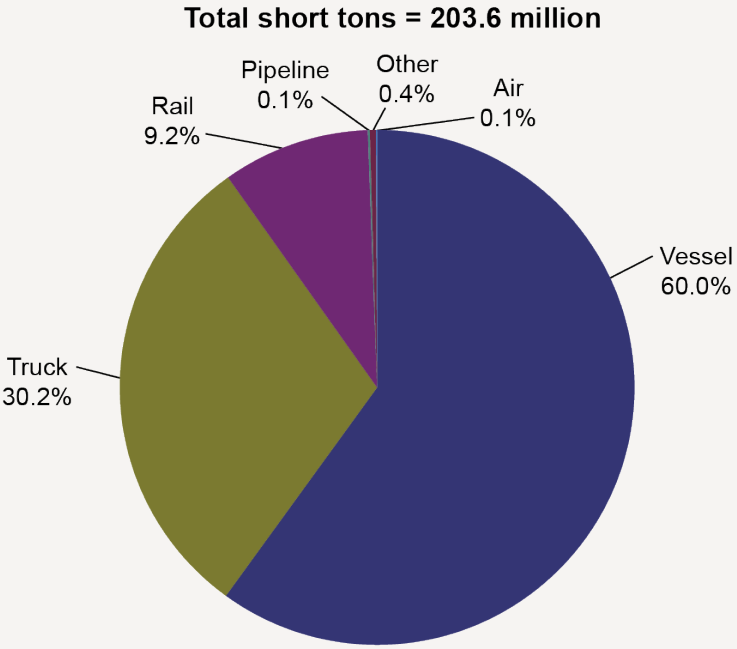
— Not applicable.

Figure 3-5 Modal Shares of U.S. Trade With Canada and Mexico: 2023

A. U.S.–Canada Trade in Short Tons



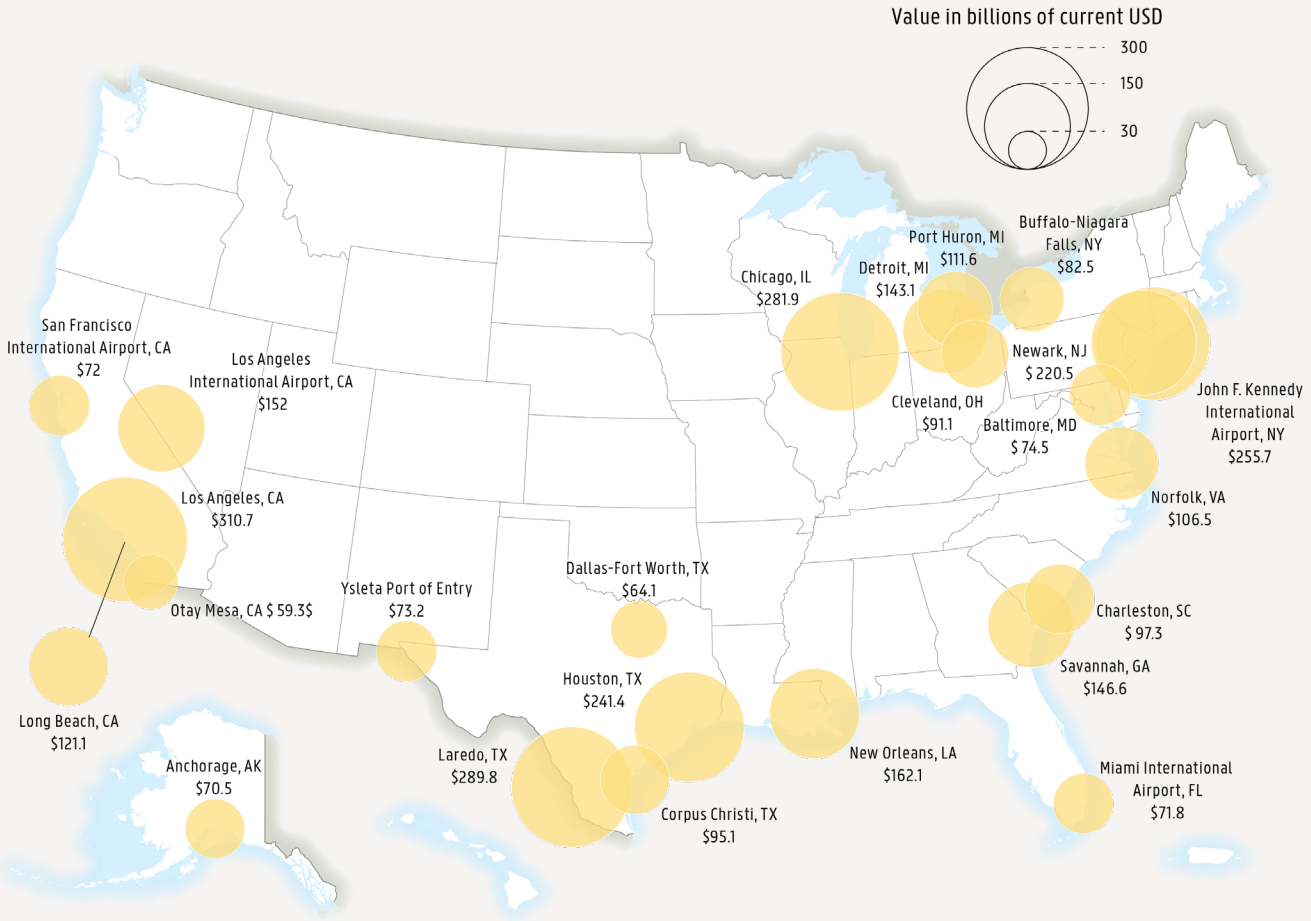
B. U.S.–Mexico Trade in Short Tons



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transborder Freight Data, available at https://data.bts.gov/stories/s/myhq-rm6q as of August 2024.

Note: Other includes imports into free-trade zones, mail, and unknown.

Figure 3-6 Top 25 U.S. International Freight Gateways by Freight Value: 2022



Source: U.S. Department of Commerce, U.S. Census Bureau, Foreign Trade Division, USA Trade Online, available at https://ustrade.census.gov as of November 2024. Land: U.S. Department of Transportation, Bureau of Transportation Statistics, North American Transborder Freight Data, available at https://www.bts.gov/transborder as of November 2024. Water: U.S. Department of Commerce, U.S. Census Bureau, Foreign Trade Division, USA Trade Online, available at https://usatrade.census.gov as of November 2024.

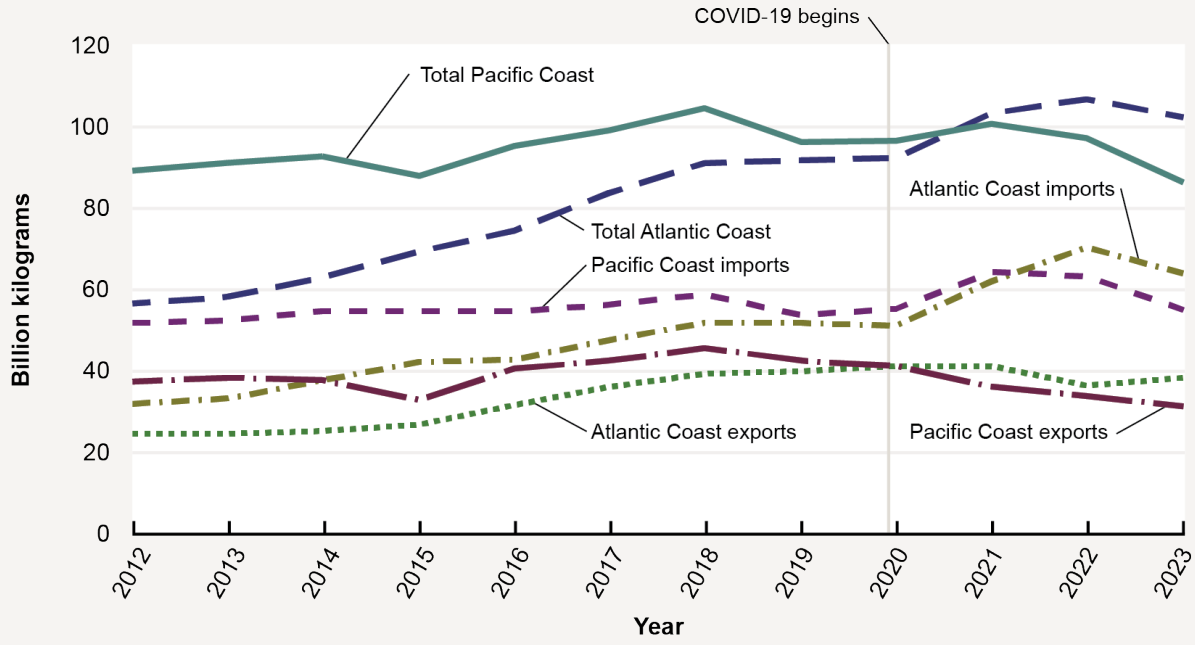
Shifts in Containerized Freight

The logistics landscape within the United States has experienced a significant transformation, particularly in the movement of containerized freight from Asian countries to the East Coast of the United States. Earlier editions of this report were the first to observe the marked shift of U.S.–Asian trade containers to U.S. East Coast ports.

In 2023, U.S. East Coast ports continued to capitalize on these developments, demonstrating an increasing capability to handle Asian imports and exports. According to Figure 3-7, East Coast ports handled 63.8 billion kilograms of imports and 38.4 billion kilograms of exports, totaling 102.2 billion kilograms. Despite a slight decrease from 2022, these figures underscore the ongoing preference for East Coast ports over their West Coast counterparts, which managed 55.0 billion kilograms of imports and 31.3 billion kilograms of exports, totaling 86.3 billion kilograms in the same year.

This trend marks a significant redirection of the traditional supply chain routes, with East Coast ports increasingly surpassing West Coast ports, which historically served as the primary gateways for imported Asian containerized cargoes. In 2022, East Coast ports had already begun to lead with 70.2 billion kilograms of imports compared to the West Coast's 63.2 billion kilograms—a gap that persisted into 2023. This shift, as shown in Figure 3-7, is not merely incremental but indicative of a larger strategic realignment in U.S. maritime logistics.

Figure 3-7 U.S. East Coast and West Coast Asian Containerized Freight Volumes: 2012–2023



Source: U.S. Department of Commerce, Census Bureau, Economic Indicators Division, accessible at http://usatrade.census.gov as of August 2024.

The data further illustrate how this strategic realignment has unfolded. The compound annual growth rates (CAGRs) between 2012 and 2023 highlight a long-term shift: East Coast ports exhibited a CAGR of 5.5 percent, while West Coast ports declined at −0.3 percent. Postpandemic growth rates show an even more pronounced disparity, with East Coast ports growing at 3.4 percent annually and West Coast ports contracting at −3.6 percent. This clear divergence in growth rates underscores the increasing role of East Coast ports in handling containerized freight from Asia. The shift is also reflected in the export volumes, where East Coast ports are increasingly dominant. The comparative export volumes and the broader dynamics indicate a significant strategic realignment in U.S. maritime logistics, influenced by global changes in shipping routes and port capabilities.

The United Nations Conference on Trade and Development's Liner Shipping Connectivity Index (LSCI) provides additional evidence of this strategic shift. The Port of New York and New Jersey led all U.S. ports with the highest connectivity score in 2023, increasing from 506 in 2022 to 517 in 2023 (Figure 3-8). This improvement reflects the port's growing integration into global shipping networks and its pivotal role in handling a larger share of containerized imports. Ports like Savannah and Norfolk also improved their LSCI scores, further demonstrating the strengthening position of East Coast ports.

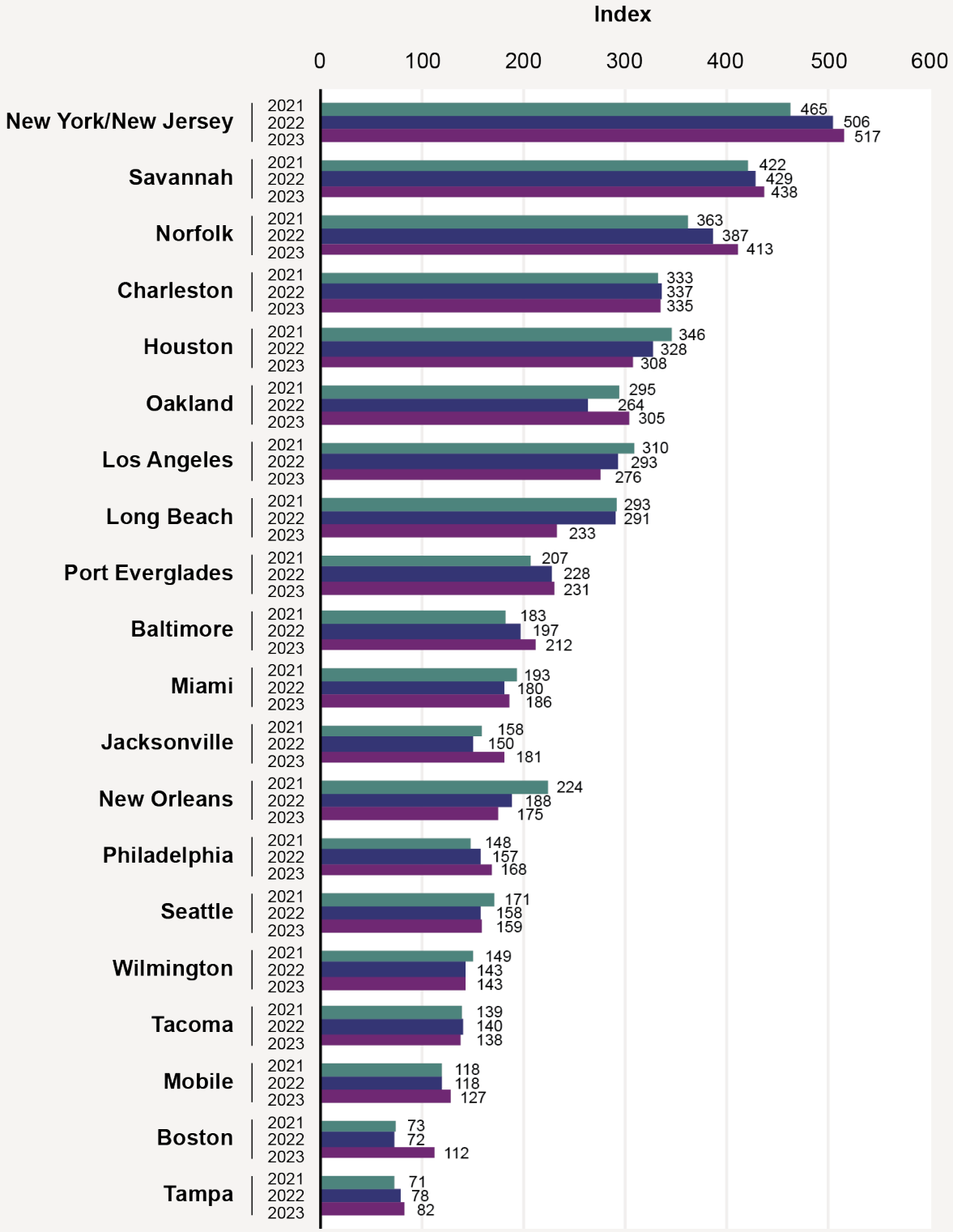
The United Nations Conference on Trade and Development's Liner Shipping Connectivity Index (LSCI), developed in 2004, serves as a critical gauge for assessing the connectivity of global shipping networks among countries and ports. High scores on this index indicate superior connectivity, offering ports competitive advantages in providing diverse and efficient shipping options.

In 2023, as shown in the latest LSCI data from Figure 3-8, reveals that the Port of New York and New Jersey continued to lead with the highest connectivity score among U.S. ports, marking an increase to 517 from 506 in 2022. This progression underscores its robust integration into global shipping networks and its pivotal role in managing an expanding share of containerized imports.

Following the Port of New York and New Jersey, the Ports of Savannah and Norfolk also exhibited growth in their LSCI scores, reflecting enhancements in their connectivity. Savannah's score increased from 429 to 438, and Norfolk's score improved from 387 to 413. These gains demonstrate ongoing developments in their infrastructure and service offerings that bolster their positions in the shipping industry.

Overall, the 2023 LSCI data illustrate a continuing realignment within the U.S. maritime sector, with East and

Figure 3-8 U.S. Top 20 LSCI Ports: 2021–2023



Source: United Nations Conference on Trade and Development (UNCTAD), LSCI, 2024, available at https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=170026 as of July 2024.

Notes: UNCTAD changed its scoring system to better reflect the relationship between trade and transport costs and maritime connectivity. The new system was implemented in 2024 and applied to UNCTAD data back to 2006. Refer to https://unctad.org/news/new-context-calls-changing-how-we-measure-maritime-connectivity for more details.

Gulf Coast ports increasingly enhancing their connectivity to meet the demands of global shipping lines and their customers. This strategic shift suggests a responsive adaptation to the evolving landscape of international trade and logistics, positioning these ports as critical hubs in the global supply chain.

Freight Transportation Performance

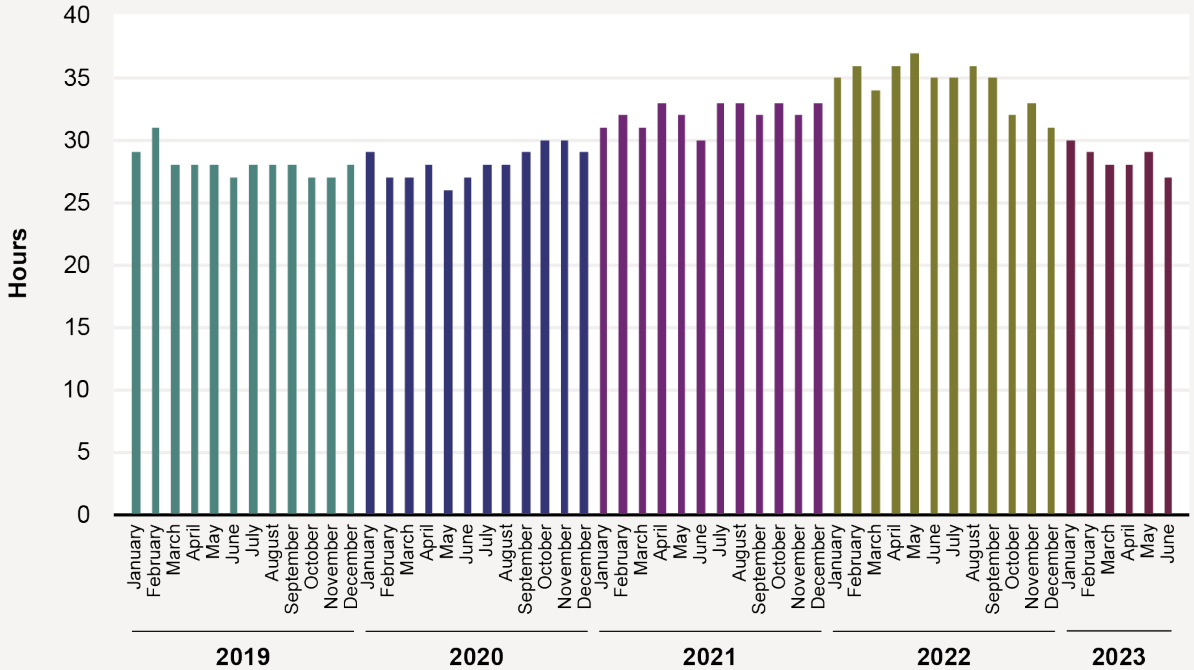
The United States' freight transportation infrastructure is an intricate network consisting of multiple nodes and links, each susceptible to becoming choke points that may hinder overall system efficiency. The COVID-19 pandemic underscored the vulnerability of these supply chain choke points. Monitoring the flow of marine containers through this network offers a clear lens on supply chain efficiency. This flow involves several stages, including transit via ships, trucks, trains, and barges, and passes through critical points, such as marine terminals, customs, border posts, free zones, and distribution centers. In port areas, the movement is particularly complex as container ships maneuver from the entrance buoy to the berths, where containers are handled, stored, and processed. Recent disruptions have significantly strained these components of the network, with some critical areas being monitored by the Bureau of Transportation Statistics (BTS), which employs various indicators to measure freight performance.

Container Port Performance

In the realm of port operations, a suite of performance indicators is important for assessing the efficiency of marine terminal operations. One such critical metric is the container vessel dwell time, which is calculated using the Automatic Identification System (AIS). This system identifies, tracks, and records the speed, direction, and location of vessels, pinpointing which port or terminal a vessel is visiting. BTS utilizes AIS data to monitor the time vessels spend at the berth—known as container-vessel dwell time.

Figure 3-9 tracks the average dwell time for the top 25 U.S. container ports, providing insights from January 2019 to June 2023. Over these years, the average dwell time experienced fluctuations, largely influenced by various factors including

Figure 3-9 Average Container Vessel Dwell Time for Top 25 U.S. Container Ports: 2019–June 2023



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, calculated using AIS data from the U.S. Coast Guard's Nationwide Automatic Identification System (NAIS) archive, processed by the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, through the AIS Analysis Package (AISAP) software application, as of August 2024.

Note: Vessel calls of less than 4 hours or more than 120 hours were excluded as representing calls either too short for significant cargo handling or too long for normal operations. The Top 25 container ports are based on 2018, 2019, and 2020 port rankings published by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

the vessel's size, measured in twenty-foot equivalent units (TEUs), and the call size, which refers to the container volume loaded or discharged per vessel.

In 2019, average dwell times hovered around 28 hours, with minor variations throughout the year, peaking at 31 hours in February and reaching a low of 27 hours in June. The trend continued in 2020 and 2021, with times slightly increasing to an average of 33 hours by the end of 2021, reflecting the strains imposed by COVID-19-related demands on supply chains.

By the first half of 2022, the average dwell time had climbed to 35.5 hours, marking a noticeable increase due to the ongoing global logistics challenges. This was followed by a reduction in dwell time for the first half of 2023, beginning the year at 30 hours in January and decreasing to 27 hours by June, reaching an average of 28.5 hours in the first half of 2023, suggesting some recovery and optimization in port operations.

The data from Figure 3-9 indicates a gradual adaptation and response to the heightened demands and challenges faced during the pandemic, with average dwell times showing a trend toward stabilization in 2023. This metric serves as a crucial indicator of the efficiency and capacity of U.S. ports to handle international trade and logistics challenges.

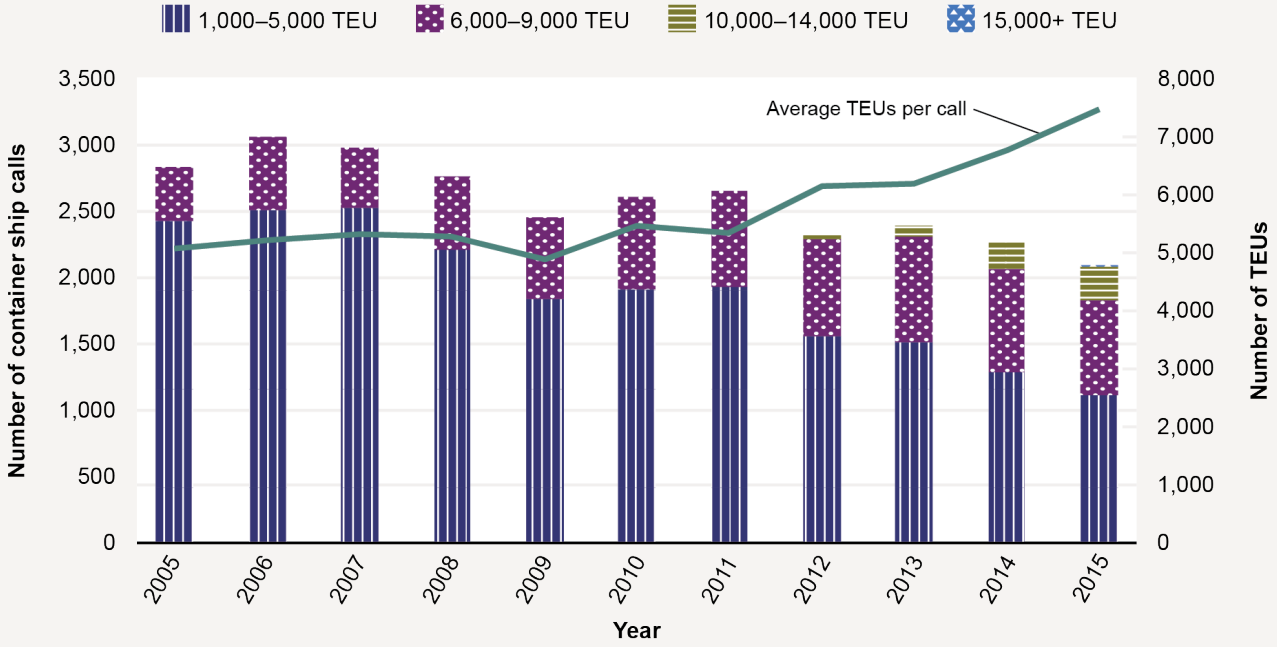
Vessel Size, Efficiency, and Productivity

The relationship between the size of container vessels and operational efficiency at ports is illustrated by historical data from the Ports of Los Angeles and Long Beach. Between 2005 and 2015, these ports demonstrated significant trends in vessel size categories and the corresponding average container throughput per call, as depicted in Figure 3-10.

During this period, there was a noticeable decrease in the total number of ship calls, from 2,817 in 2005 to 2,069 in 2015, indicating a trend toward fewer but larger capacity vessel visits. Concurrently, the average container volume per ship call significantly increased, rising from 5,039 TEUs per call in 2005 to 7,420 TEUs per call in 2015. This trend reflects a shift in operational strategies toward accommodating larger vessels capable of carrying more containers.

Notably, the composition of vessel sizes calling at these ports evolved dramatically. In 2005, the majority of vessels fell into

Figure 3-10 Vessel Size and Call Trends and Average Container Throughput per Call, Ports of Los Angeles and Long Beach: 2005–2015



Source: Vessel call data and size category from San Pedro Bay Ports Clean Air Action Plan, Bay Wide Ocean-Going Vessel International Maritime Organization Tier Forecast 2015–2050, July 2017, p. 3; TEU volume data from the Port of Los Angeles, Annual Container Statistics, available at https://www.portoflosangeles.org/business/statistics/container-statistics and Port of Long Beach, TEUs Archive: 1995 to Present by Year, available at https://polb.com/business/port-statistics#yearly-teus; data at both ports available as of October 2023.

TEU = twenty-foot equivalent unit.

smaller size categories (1,000–5,000 TEU), but by 2015, there was a significant presence of much larger vessels (10,000–14,000 TEU and 15,000+ TEU). The data show that, while ships in the 1,000–5,000 TEU range accounted for 2,409 calls in 2005, this number drastically dropped to 1,103 by 2015. In contrast, vessels larger than 10,000 TEUs, which were nearly nonexistent in 2005, made up to 256 calls in 2015, with the introduction of the 15,000+ TEU category marking a significant milestone in the capabilities of the ports.

This shift toward larger vessels has facilitated increased efficiency in port operations, as larger vessels mean more cargo moved per operation, reducing the relative cost and time per TEU handled. Although the data series ends in 2015, the principle that larger vessels achieve higher productivity due to economies of scale continues to hold true. As discussed below, this led to the World Bank reporting port performance relative to vessel size category. This factor remains a key component of contemporary port strategy, ensuring that the insights drawn from historical data remain relevant and actionable for understanding current and future port operations performance.

U.S. Top 25 Container Ports

Figure 3-11 shows the top 25 U.S. container ports ranked by TEUs for 2022, highlighting the leading positions of the Ports of Los Angeles, Long Beach, and New York and New Jersey. These ports, pivotal in importing activities, emphasize their strategic roles in global shipping. The Port of New York and New Jersey, for instance, handled about 5.4 million TEUs in imports, closely followed by Ports of Los Angeles and Long Beach, showing a significant focus on accommodating large-scale international trade.

Interestingly, the Port of New Orleans stands out for its unique trade balance, handling more exports than imports, which might indicate a specialized market focus. Conversely, the Port of Honolulu serves as a crucial hub for domestic containers, showing its role in supporting interisland transport within Hawaii.

Additionally, the Port of Savannah and the Port of Houston have emerged as significant players, with Savannah processing over 3 million TEUs and Houston more than 2 million TEUs while also showcasing a strong balance between imports and exports. Ports like Tacoma and Jacksonville highlight substantial portions of domestic TEUs, pointing to their strategic roles in facilitating regional trade and distribution networks within the United States. Meanwhile, the Port of Seattle and the Port of Oakland further demonstrate the West Coast's capacity to handle significant volumes, reinforcing its crucial position in trans-Pacific maritime trade.

U.S. Top 10 Container Port Performance Insights

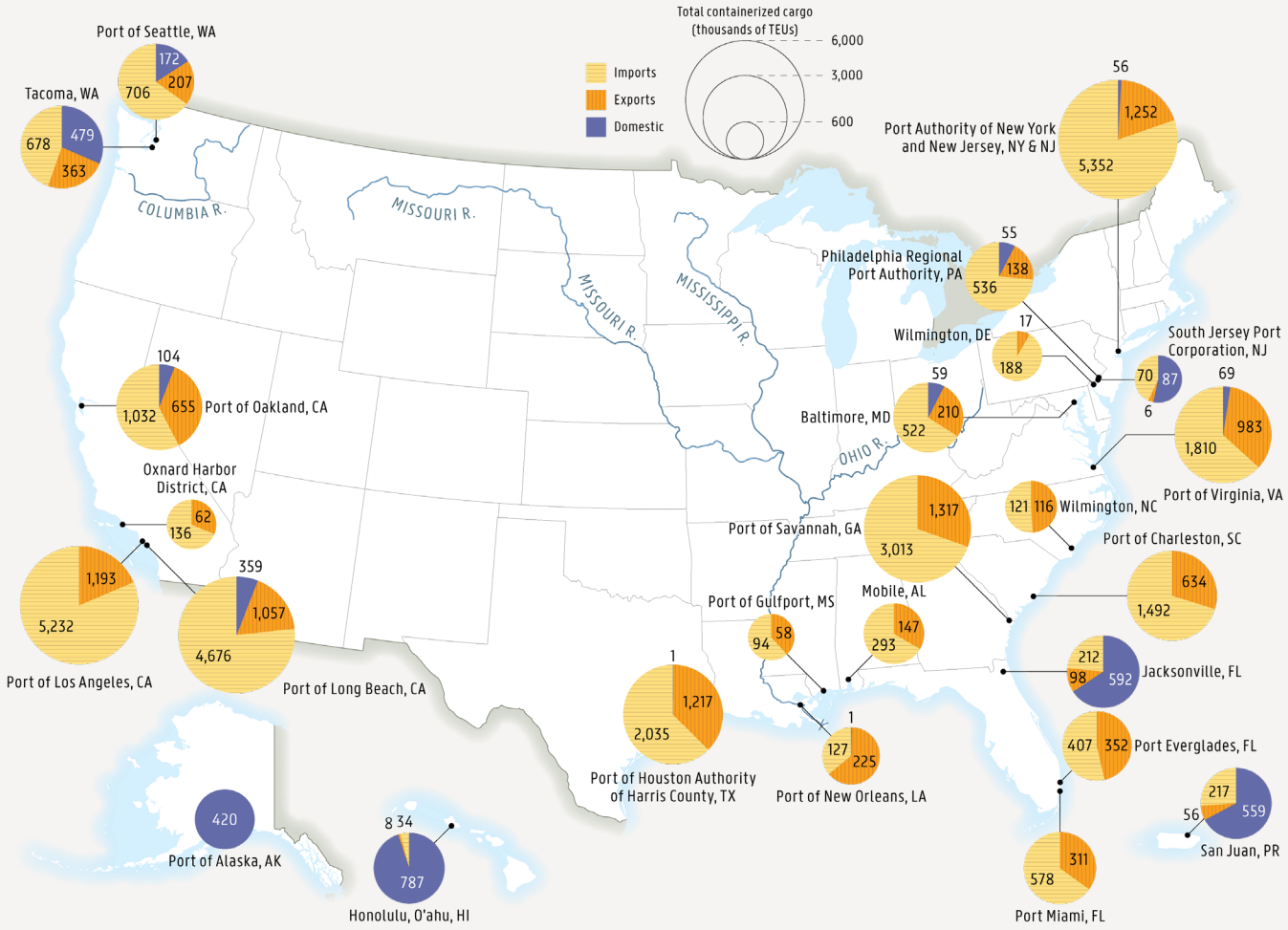
Table 3-8 presents the latest assessment by the World Bank of the top 10 U.S. container ports, highlighting their global rankings based on performance indicators like vessel waiting time, transit time from the entrance buoy to the berth, and berth time. The data provide a nuanced picture of how each port has adapted to changes in shipping dynamics, particularly concerning the management of vessels of varying sizes.

In 2023, the World Bank expanded its evaluation to include 405 container ports, up from 350 in the previous year, offering a broader context for understanding U.S. port performance. Despite this increase in competition, the performance of U.S. ports has shown varied trends. Notably, the Port of New York and New Jersey showed significant improvement, jumping from 309th in 2022 to 99th in 2023. This port performed exceptionally well across different vessel size categories, particularly in managing larger vessels (>13,500 TEU), where it ranked 82nd.

Conversely, other major ports like Los Angeles and Long Beach have declined in the World Bank's performance rankings, with Los Angeles moving from 337th in 2022 to 378th in 2023, and Long Beach from 348th to 376th. Both ports struggled particularly with smaller vessel categories (<1,500 TEU) and saw their best performance in handling the largest vessel categories of 8,501–13,500 TEUs and >13,500 TEUs; Long Beach ranked 92nd in the former category while Los Angeles and Long Beach ranked 103rd and 101st in the latter size category, respectively. The discrepancy across vessel size categories highlights the challenges faced by these ports in balancing efficiency across different vessel sizes, influenced by the challenge in accommodating smaller vessels as the larger vessels take greater berth space over longer periods of time.

The Port of New York and New Jersey performed best among the top-10 ports in the >13,500-TEU category, ranking 82nd worldwide while also ranking best (79th) among the top-10 container ports in the 5,001–8,500 size category. At 86th, Charleston ranked the highest top-10 port in the 8,501–13,500 and 49th in the largest vessel-size category. The performance in these vessel-size categories contributed to the port's dramatic improvement to 60th place in 2023 from 341st in 2022, marking Charleston as 2023's best top-10 performer overall. The Port of Virginia, once the top performer in 2021 ranked at 23rd worldwide, experienced a significant drop to 306th place in 2023 from its 49th rank in 2022, demonstrating the volatility of port-performance metrics under evolving global trade conditions.

Figure 3-11 U.S. Top Container Ports Based on TEUs: 2022



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Loaded TEU by Port, Top 25 Ports by Loaded TEU Quantity, 2022, available at https://data.bts.gov/stories/s/Container-TEU/x3fb-aeda as of August 2024.
TEU = twenty-foot equivalent unit.

The rankings underscore the complexity of port operations, where performance is not uniform across different vessel sizes. Ports generally perform better in handling larger vessels, likely due to improved berth productivity in handling them. However, the challenge remains for ports to enhance their efficiency across all vessel sizes, particularly as they adapt to the shifting demands of global shipping and the pressures of larger vessel calls.

This data illustrates that while some U.S. ports have improved their global standing, others face ongoing challenges. The discrepancies in performance across different vessel size categories highlight the need for continued focus on port infrastructure and technology to ensure that all types of vessels can be accommodated efficiently, maintaining the competitiveness of U.S. ports on the global stage.

Rail and Truck Performance

The average rail terminal dwell time for all railroads in 2023 was 21.7 hours, an increase of 0.7 hours from 2022. Dwell time, an essential performance metric, indicates the average duration a freight car remains within a rail terminal's boundaries. This measure starts with the train's arrival, customer release, or interchange receipt and concludes with its departure, the customer receiving the car, or its transfer to another railway.

Throughout Figure 3-12's reporting period, the rail operators demonstrated varying trends in dwell times. Notably, Norfolk Southern (NS), Burlington Northern and Santa Fe Railway (BNSF), and Chessie System and Seaboard Coast Line Railroad (CSX) experienced peak dwell times around the

Table 3-8 World Bank Container Port Performance Index Rankings of Top 10 U.S. Container Ports: 2021–2023

Port	Overall rank 2021	Overall rank 2022	Overall rank 2023	2023 rank by vessel size ranges by TEU capacity				
				<1,500	1,501–5,000	5,001–8,500	8,501–13,500	>13,500
Los Angeles	370	337	378	—	274	168	163	103
Long Beach	348	328	376	214	304	214	92	101
NY/NJ	251	309	99	180	140	79	94	82
Savannah	367	350	398	255	288	184	174	112
Houston	119	338	327	120	192	171	162	—
Virginia	23	49	306	—	184	149	132	85
Oakland	359	345	396	254	248	190	172	111
Charleston	130	341	60	122	102	91	86	49
Tacoma	345	327	402	—	—	224	176	113
Seattle	336	293	356	—	259	166	155	91

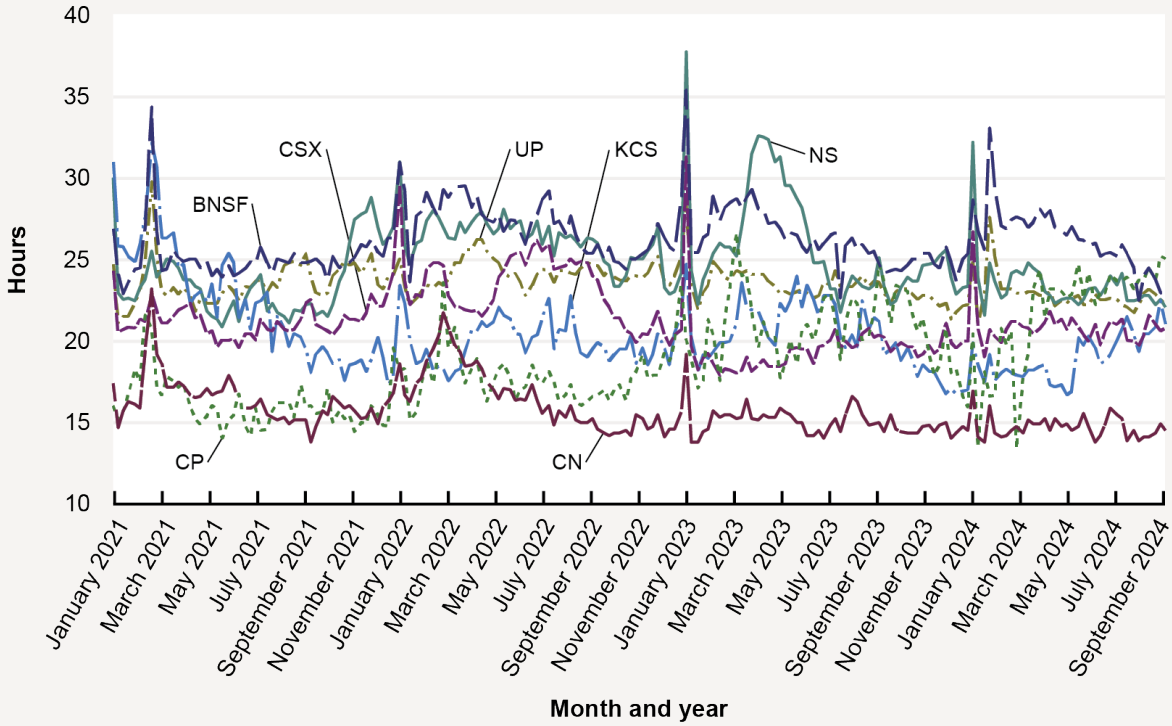
Source: World Bank, Container Port Performance Index 2023, available at https://openknowledge.worldbank.org/entities/publication/87d77e6d-6b7b-4bbe-b292-ae0f3b4827e8 as of July 2024.

Note: The higher the number for the ranking, the poorer the performance.

— Data do not exist.

TEU = twenty-foot equivalent unit.

Figure 3-12 Average Rail Terminal Dwell Time in Hours: January 2021–August 2024



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Freight Indicators, available at https://www.bts.gov/freight-indicators as of August 2024.

UP = Union Pacific; NS = Norfolk Southern; KCS = Kansas City Southern Railway Company; CSX = Chessie System and Seaboard Coast Line Railroad; CP = Canadian Pacific; CN = Canadian National Railway; BNSF = Burlington Northern and Santa Fe Railway.

end of December 2022, with recorded times of 37.5, 35.2, and 31.2 hours, respectively. Other significant observations include the Kansas City Southern Railway Company (KCS), Union Pacific (UP), and Canadian National Railway (CN) marking their highest dwell times in February 2021, with KCS reaching 32.1 hours, UP peaking at 29.7 hours, and CN at 23.3 hours. Canadian Pacific (CP) recorded its highest dwell time in March 2023 at 26.7 hours, while UP noted a significant dwell time of 29.7 in February 2021.

Table 3-9 details the average system-wide annual dwell times for major U.S. railroad systems from 2020 to 2023, capturing shifts in the performance metrics across different regional rail networks. These data provide insights into the operational dynamics of railroads and their efficiency in freight handling over the 4-year period.

Across the western railroads, BNSF and UP showed a general stability in dwell times with minor fluctuations. BNSF recorded a slight decrease from 27.3 hours in 2022 to 26.2 hours in 2023, indicating an improvement in terminal operations. UP also demonstrated a reduction in dwell time from 24.4 hours in 2022 to 23.4 hours in 2023, reflecting an improvement to their operations.

The central railroads presented a mixed response, with CP showing a significant increase in dwell times, rising from 18.2 hours in 2022 to 20.9 hours in 2023, which could indicate operational challenges or increased freight volumes. Conversely, CN saw a decrease in dwell time in 2023, improving to 15.4 hours from 16.9 hours in 2022. KCS maintained relatively stable dwell times around 20 hours over the years.

Eastern railroads experienced more substantial variations with both CSX and NS reporting decreases in dwell times in 2023 compared to the previous year. CSX improved from 23.4 hours in 2022 to 19.7 hours in 2023 while NS decreased from 26.4 hours in 2022 to 25.7 hours in 2023.

The trend of dwell times across these railroads suggests that geographic location and operational strategies significantly influence railroad performance. Notably, the eastern railroads have historically faced higher dwell times, possibly due to denser network configurations and higher freight traffic, particularly with the shift of some of the container trade to the U.S. East Coast. The improvements in 2023 may indicate effective adaptations to these challenges.

The performance of these railroads over the period also highlights the interconnected nature of rail operations with broader logistical trends, including shifts in shipping patterns and port activities. As U.S. ports have experienced increased congestion due to higher cargo volumes, particularly on the East Coast, rail operators have had to adjust their operations to handle the growing demand.

Table 3-10 reveals the progression of average truck speeds within 5 miles of two significant U.S. ports, highlighting variations that suggest differences in congestion levels and operational efficiencies. Over the 5 year period from 2019 to 2023, the Ports of Los Angeles and Long Beach consistently exhibited higher average speeds compared to the Port of New York and New Jersey, pointing to smoother traffic flows, less traffic congestion, and potentially more efficient cargo handling operations at Los Angeles/Long Beach.

From 2019 to 2023, both the Ports of Los Angeles and Long Beach and the Port of New York and New Jersey displayed a trend of generally increasing truck speeds, with a peak sometimes occurring in the second quarter each year, possibly reflecting seasonal adjustments in port operations

Table 3-9 Average Railroad System-Wide Annual Dwell Time Hours: 2020–2023

		Average dwell times (hours)			
Location	**Railroad System**	**2020**	**2021**	**2022**	**2023**
Western railroads	BNSF	26.6	25.2	27.3	26.2
	UP	22.9	23.7	24.4	23.4
Central railroads	CP	15.3	16.5	18.2	20.9
	CN	17.1	16.7	16.9	15.4
	KCS	20.3	22.5	20.3	20.4
Eastern railroads	CSX	18.3	21.5	23.4	19.7
	NS	18.8	23.8	26.4	25.7

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Freight Indicators, available at https://www.bts.gov/freight-indicators as of July 2024.

BNSF = Burlington Northern and Santa Fe Railway; UP = Union Pacific; CP = Canadian Pacific; CN = Canadian National Railway; KCS = Kansas City Southern Railway Company; CSX = Chessie System and Seaboard Coast Line Railroad; NS = Norfolk Southern.

and cargo handling. However, the data for 2023 show a noticeable dip in average speeds for the Port of New York and New Jersey in all quarters, which are lower than its 5-year averages for three of four quarters, ending the year with an average speed of 18.95 mph—the lowest in the 5 years. This reduction may indicate rising congestion or operational challenges that have emerged over the year partly as a result of the shift of Asian-related container trades to the U.S. East Coast from the U.S. West Coast.

Conversely, the Ports of Los Angeles and Long Beach not only maintained but slightly increased average speeds across the years, culminating in a higher average of 20.96 mph in 2023. This consistent performance underscores ongoing improvements and possibly better traffic management strategies at Los Angeles/Long Beach compared to New York/New Jersey. The quarter-by-quarter analysis further supports this, showing Los Angeles/Long Beach with a stable or increasing trend in speeds, particularly in the third and fourth quarters, reflecting effective responses to operational demands.

The differences in average speeds between the ports are significant, especially when considering the higher volume of containers typically handled at these locations. The consistent higher speeds at the Ports of Los Angeles and Long Beach compared to the Port of New York and New Jersey could be reflective of the broader infrastructure and operational adaptations that have been implemented, possibly in response to the shifting dynamics of global trade routes and the increasing size of vessels being accommodated.

Disruptions to Supply Chains From Drought and Geopolitical Conflicts

Weather significantly impacts supply chains by disrupting production, particularly in agriculture, and affecting the operation of transportation systems. Waterborne commerce is especially highly vulnerable to disruptions from droughts and extreme weather events. Localized disruptions can also have substantial impacts on trade and supply chains, as illustrated by the recent Francis Scott Key Bridge incident in Baltimore (Box 3-A), which highlights the cascading effects of infrastructure failures on freight flows.

The Mississippi River system remains a crucial artery for transporting goods across the 12 states bordering the Upper Mississippi River system and Louisiana. As reported in the *Transportation Statistics Annual Report 2023*, this vital river faced significant challenges in 2023 due to severe drought conditions, particularly during the summer and early fall [BTS 2023b]. Low water levels severely restricted barge shipments, impacted agricultural outputs, and even threatened drinking

Table 3-10 Average Truck Speed in the Port of New York/New Jersey and the Ports of Los Angeles/Long Beach: 2019–2023

Port	Year	Average speed by quarter				Average annual speed
		1st	2nd	3rd	4th	
New York/ New Jersey	2019	18.14	17.80	17.86	17.76	17.89
	2020	18.59	20.31	19.42	19.17	19.37
	2021	19.99	19.96	19.74	19.33	19.75
	2022	19.90	19.33	19.60	19.00	19.46
	2023	19.70	19.20	18.67	18.23	18.95
	2019–2023 average speed by quarter	19.26	19.32	19.06	18.70	—
Los Angeles/ Long Beach	2019	19.45	19.63	19.39	19.12	17.89
	2020	19.61	20.43	19.88	20.07	19.37
	2021	20.87	20.65	20.28	20.38	19.75
	2022	20.59	20.73	21.03	20.87	19.46
	2023	20.83	20.97	21.13	20.90	20.96
	2019–2023 average speed by quarter	20.27	20.48	20.34	20.27	—

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Freight Indicators, available at https://www.bts.gov/freight-indicators as of September 2024.

— Not applicable.

BOX 3-A

PORT OF BALTIMORE DISRUPTION: IMPACT OF THE KEY BRIDGE COLLAPSE

The collapse of the Francis Scott Key Bridge on March 26, 2024, has had a profound impact on the Port of Baltimore, one of the Nation's top 20 ports by tonnage and container volume. The incident, caused by a 947-foot containership losing power and striking the bridge's supporting pier, resulted in the bridge's partial collapse and a temporary shutdown of the shipping channel into Baltimore Harbor.

Key facts regarding the bridge's collapse include the following:

- **Port activity:** The Port of Baltimore is a critical hub for dry bulk, motorized vehicle trade, and containerized goods. It ranks 15th in container throughput among U.S. ports and is sixth among U.S. ports on the Shipping Line Connectivity Index.
- **Disrupted traffic:** On March 27, vessel tracking data identified 11 ships—including bulk carriers, general cargo ships, a tanker, and the container ship DALI—stranded in the harbor behind the collapsed bridge. Beyond the bridge, 12 vessels waited at anchorage, further intensifying delays.
- **Cruise ship operations:** Two cruise ships, including one with over 2,000 passengers, were diverted, requiring complex logistics to reunite passengers with vehicles parked at the port terminal.
- **Traffic and safety concerns:** The bridge collapse diverted 34,000 daily vehicles to alternate routes through the congested Fort McHenry and Harbor Tunnels. Hazardous cargo trucks have been diverted around the opposite side of the Baltimore Beltway (I-695). These shifts increased traffic volumes by 18 percent on these routes and exposed over 100,000 residents to greater risk along longer, peak-congested pathways.

Economic and operational implications of the collapse include the following:

- **Supply chain impact:** The temporary closure of the shipping channel disrupted the Port's role in international trade, with an estimated weekly supply chain cost of $1.7 billion during the shutdown.
- **Bridge and port recovery:** While the shipping channel reopened in June 2024, allowing vessel movements to resume, the bridge remains out of service as reconstruction planning progresses.

The incident underscores the vulnerability of critical infrastructure and highlights the cascading impacts disruptions can have on freight, passenger operations, and regional traffic networks.

water supplies in areas such as Louisiana, Mississippi, and Texas.

In 2024, however, the Mississippi River system saw some improvement from the harsh drought conditions of the previous year. Early in the year, river levels returned to near-average, and the risk of spring flooding was below average [NASA, MRIS 2024]. By mid-2024, the Midwest region experienced minimal drought with only 4 percent of the area in moderate to severe drought. These improvements allowed for more reliable barge operations along the river. However, extreme heat and below-normal rainfall in late summer led to the re-expansion of drought conditions, particularly in parts of Ohio and Kentucky [NOAA, NISID 2024]. This underscores the Mississippi River system's continued vulnerability to drought, highlighting the need for regular and frequent rainfall to prevent further issues.

Drought conditions have also significantly impacted the Panama Canal, a critical maritime passageway where 68.6 percent of its freight is tied to U.S. imports and exports, as shown in Table 3-11.

The canal has faced ongoing challenges due to drought, although there have been some improvements compared to 2023. The impacts of low water levels, reduced vessel drafts, and delayed transits underscore the canal's vulnerability to environmental challenges, as detailed in Box 3-B.

In early 2024, the Panama Canal authorities were still forced to impose strict limits on vessel traffic due to critically low water levels. These restrictions caused significant disruptions in global shipping, leading to global supply chain impacts worldwide. By mid-2024, however, as water levels began to normalize, the Panama Canal Authority eased some of these

restrictions, allowing for an increase in vessel drafts and daily transits (Figure 3-13).

Efforts to mitigate the impacts of future droughts include the Panama Canal's investment in expanding its water reservoirs and improving water management practices. These measures aim to ensure the canal's continued accommodation of larger vessels and maintain reliable operations even during dry periods. Additionally, the Panama Canal has implemented water conservation practices, including recycling water from the locks, which has led to increased salinity in Lake Gatún—a critical water source for the canal and local communities [Millard, McDonald, Roston 2024].

During the peak of the 2023 drought, the Panama Canal's daily transits were restricted to as few as 24 vessels, a sharp reduction from its typical capacity of handling around 34 to 38 vessels per day; at its maximum sustainable capacity, the canal could accommodate up to 38–40 vessels daily [Labrut 2023]. The restrictions during the drought significantly reduced this number, causing notable disruptions in global shipping.

In response to recent rains in 2024, the canal has been able to ease these restrictions, now accommodating up to the near-normal 36 vessels per day—marking a significant improvement from the height of the drought [The Maritime Executive 2024a]. Nevertheless, the canal's continued vulnerability to fluctuating water levels underscores the

Table 3-11 Panama Canal Cargo Volumes by Principal U.S. Vessel Trade Routes: Fiscal Year 2023

Vessel trade route	Long tons (thousands)
East Coast U.S.–Asia	121,143
East Coast U.S.–West Coast South America	36,620
East Coast U.S.–West Coast Central America	20,610
U.S. Intercoastal, including Alaska and Hawaii	1,929
Europe–West Coast U.S.	5,116
East Coast U.S.–Oceania	3,601
East Coast South America–West Coast U.S.	583
East Coast Central America–West Coast U.S.	433
West Indies–West Coast U.S.	1351
East Coast U.S.–West Coast Canada	621
East Coast U.S.–Pacific World	3,990
TOTAL U.S. vessel trade routes	**195,997**
TOTAL Panama Canal transits tonnage	**285,771**
Percent U.S. transit trade tons	**68.6%**

Source: Statistics and Models Administration, Panama Canal Authority (PCA), available at https://pancanal.com/wp-content/uploads/2023/11/00-Panama-Canal-Traffic-Along-Principal-Trade-Routes.pdf, as of September 2024.

BOX 3-B

PANAMA CANAL DROUGHT DISRUPTIONS

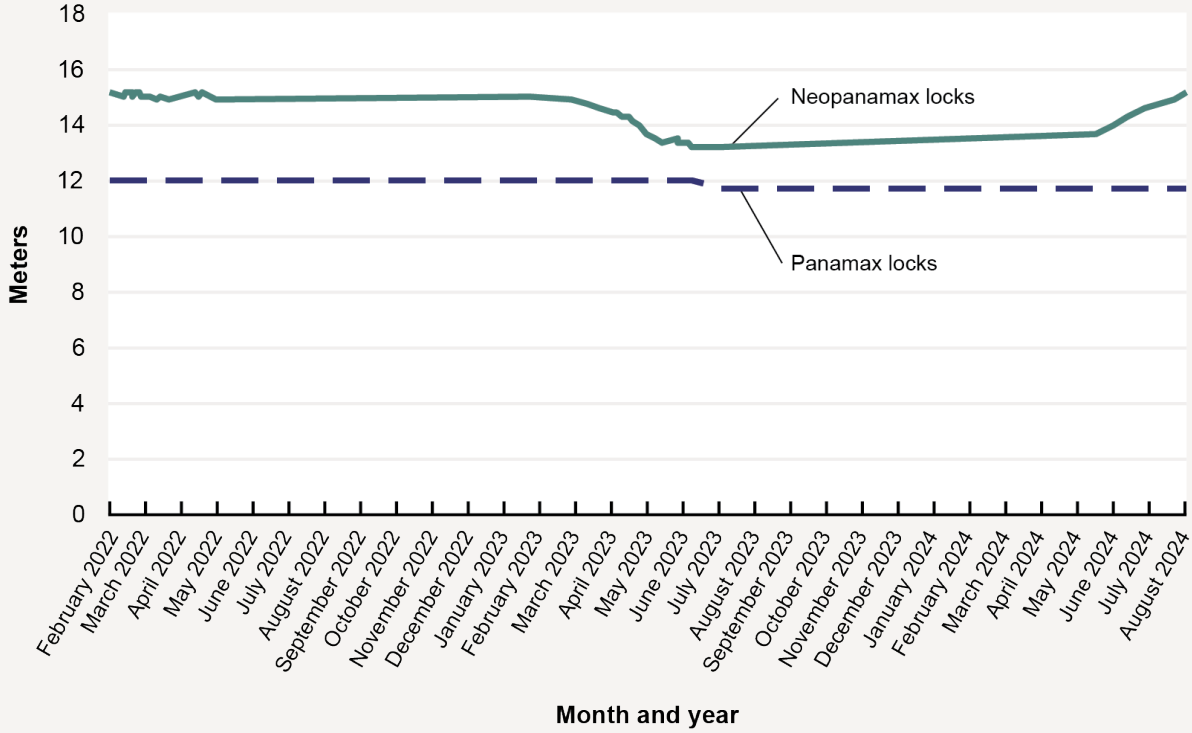
The Panama Canal, a vital artery for global trade and U.S. freight transportation, faced significant operational challenges in 2023 and early 2024 due to severe drought conditions. Gatun Lake, a key water source for the canal's lock operations, experienced water levels well below seasonal norms, forcing the Panama Canal Authority (PCA) to implement strict draft restrictions and limit the number of vessel transits.

Draft restrictions reduced the maximum allowable draft for Neopanamax vessels from the usual 50 feet to 44 feet, requiring ships to reduce cargo loads to meet the new limits. These measures contributed to a 10 percent decline in cargo throughput during the last quarter of fiscal year 2023 compared to the same period in fiscal year 2022. Furthermore, wait times for vessels without reserved transit slots increased significantly, with some ships waiting days or even weeks to transit the canal.

To manage transit delays, some carriers resorted to alternative strategies, including unloading containers onto rail for cross-isthmus transport, participating in PCA auction systems for priority transits, or rerouting ships via the Cape Horn or Suez Canal. These adjustments not only increased shipping costs and transit times but also underscored the canal's vulnerability to water resource challenges.

In response to these disruptions, the PCA has intensified investments in water conservation and management, including reservoir expansions and advanced recycling measures. While such efforts aim to mitigate future drought impacts, the events of 2023–2024 highlight the critical importance of sustainable water management for maintaining the canal's operational reliability.

Figure 3-13 Vessel Draft Restrictions on the Panama Canal by Locks: February 2022–August 2024



Source: Panama Canal Authority, Advisory to Shipping, 2022, 2023, and 2024, available at https://pancanal.com/en/maritime-services/advisory-to-shipping/ as of August 2024.

Note: Panamax and Neopanamax refer to the maximum vessel size that each lock can handle. Panamax vessels typically have maximum dimensions of approximately 965 feet (294.13 meters) in length, 106 feet (32.31 meters) in width, and a draft (the submerged depth of the ship) of about 39.5 feet (12 meters). For container ships, these dimensions will allow vessels of about 4,500–5,000 TEU capacity. Ships that exceed these dimensions transit through the Neopanamax locks. Neopanamax vessels have lengths of up to 1,200 feet (366 meters), widths of up to 160 feet (49 meters), and drafts generally within the range of generally between 39.5+ feet (12+ meters) to 50 feet (15.2 meters).

TEU = twenty-foot equivalent unit.

importance of ongoing water management and conservation efforts to sustain its critical role in global maritime trade.

Since October 2023, global events have further complicated supply chain dynamics, particularly with the onset of the Hamas–Israeli conflict. The conflict has led to significant vessel diversions, with many shipping companies rerouting their vessels away from the Red Sea route through the Suez Canal to the longer route around the Cape of Good Hope. This shift has resulted in a 43 percent drop in Suez Canal transits and a 60 percent increase in traffic around the Cape from the previous year, leading to longer transit times and higher operational costs for shipping companies and re-routings of U.S.–Asian trades to the trans-Pacific routes [Simon 2024].

The financial impact of these changes is evident in the rising global container freight rates. Before the conflict, the global average freight rate for a forty-foot container was around $1,479 in September 2023; by July 4, 2024, rates continued to rise, reaching an average of $5,868 per forty-foot container, the highest global average ever recorded [Statista 2024]. These increased costs and extended transit times have particularly impacted the availability and pricing of goods, further straining global supply chains.

Emerging Issues

Excess Liner Shipping Capacity

The container shipping industry is navigating a period of potential overcapacity, driven by a wave of new vessel orders initiated during the pandemic's peak, a time when container shipping companies enjoyed record profits due to surging demand and high freight rates. This trend is evident in the extensive orderbook, which amounts to about 28 percent

of the current global container fleet's capacity, with notable deliveries expected through 2025—approximately 2.45 million TEUs, for example, were expected to be added in 2023 and another 2.74 million TEUs in 2024, each representing nearly 10 percent of the current fleet's capacity [Miller 2022]. Such rapid expansion in capacity poses a risk, particularly if global trade growth fails to keep pace, which could drive down freight rates and profitability.

Key players in the container shipping industry are particularly active in fleet expansion. Major operators like MSC, ONE, and Evergreen have aggressive order books, adding over 30 percent of their existing capacity (Table 3-12). MSC leads the market with a fleet of 867 ships totaling 6.19 million TEUs, with 31.2 percent of this capacity in newbuilds. Evergreen also has a substantial 36.5 percent of its capacity on order, followed by ONE at 31.5 percent, while the average of the top 10 shipping line orderbook is 20 percent of available capacity. This investment in new vessels reflects not only the industry's bullish outlook but also its shift toward more fuel-efficient, environmentally compliant vessels, anticipating stricter emissions regulations.

However, this level of fleet expansion raises concerns about potential oversupply, especially as newbuild prices have surged by 53 percent since 2020 due to high demand for shipyard slots. Historically, similar capacity expansions have resulted in periods of oversupply, as in the 2010s, when excessive capacity led to prolonged rate depressions [The Maritime Executive 2024b]. The current Red Sea disruption has temporarily mitigated some of the overcapacity, as carriers redeploy excess capacity to serve Asia-Europe trades sailing around the Cape of Good Hope. However, this redeployment involves already idle capacity and does not reduce the long-term risk. Once the Red Sea situation stabilizes and the orderbook capacity is deployed, these vessels will likely exacerbate the oversupply problem. If demand for container shipping does not grow in tandem with this capacity increase, freight rates could face downward pressure, negatively impacting carrier revenues and profitability.

For the United States, this overcapacity poses specific challenges. Lower freight rates due to excess capacity could initially benefit U.S. importers with reduced shipping costs, potentially lowering consumer prices for imported goods. However, the financial strain on carriers may lead to cost-cutting measures that could impact service reliability, especially on less profitable routes. This could affect smaller U.S. ports and regional trade routes, where service frequency and options might be reduced if carriers focus on consolidating high-demand routes to maintain profitability.

Vessel Diversions from Middle East Conflict

The ongoing Israel–Hamas conflict has had a profound impact on shipping through the Suez Canal, with a precipitous decline in vessel transits, from 2,286 in October 2023 to 998 transits in June 2024 (Figure 3-14). Heightened risks of attacks in the Red Sea have prompted shipping companies to reroute container ships around the Cape of Good Hope. This diversion, while avoiding security risks, extends transit times by about 10 days on Asia–Europe routes, leading to higher operational costs, increased fuel consumption, and delays in delivery schedules. Consequently, freight rates and insurance

Table 3-12 Liner Shipping Capacity and Orderbook in TEUs of Top 10 Shipping Lines

	TOTAL		Owned		Chartered		Orderbook		
Operator	TEU	Ships	TEU	Ships	TEU	Ships	TEU	Ships	Percent of chartered and owned capacity
MSC	6,191,591	867	3,221,745	575	2,969,846	292	1,930,530	131	31.2
Maersk	4,393,446	713	2,541,002	333	1,852,444	380	491,164	35	11.2
CMA CGM	3,800,171	650	2,080,726	289	1,719,445	361	1,034,473	73	27.2
COSCO	3,292,106	507	1,946,646	195	1,345,460	312	918,963	58	27.9
Hapaq-Lloyd	2,273,765	296	1,320,466	128	953,299	168	176,126	12	7.7
ONE	1,941,587	247	783,644	92	1,157,943	155	611,708	47	31.5
Evergreen	1,726,419	221	1,100,963	138	625,456	83	629,877	56	36.5
HMM	881,593	79	729,806	54	151,787	25	109,653	12	12.4
Zim	760,449	129	65,700	12	694,749	117	36,515	5	4.8
Yang Ming	695,799	93	300,354	57	395,445	36	77,500	5	11.1

Source: Alphaliner Top 100, available at https://alphaliner.axsmarine.com/PublicTop100/ as of October 29, 2024.
TEU = twenty-foot equivalent unit.

premiums for these longer routes have risen, reflecting the elevated risks and added expenses.

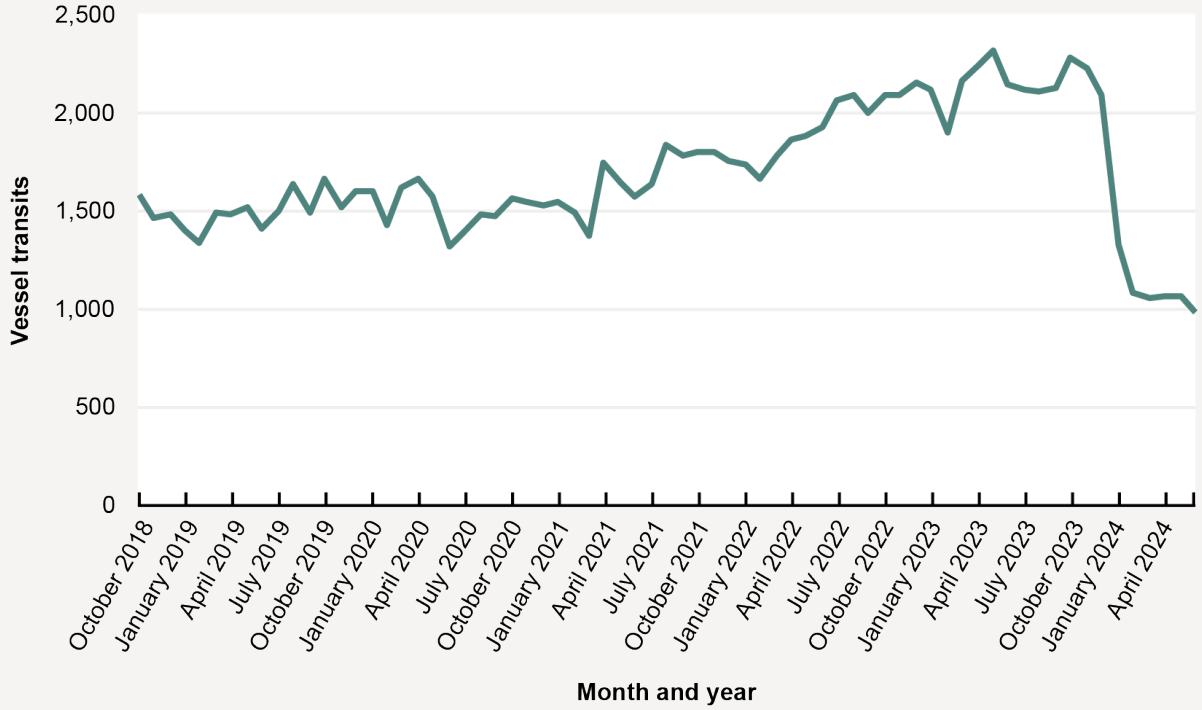
Shipping companies have responded by adding extra vessels to maintain service frequencies, increasing logistics costs further. These reroutings have significant downstream implications for U.S. importers and exporters reliant on the Suez Canal for timely shipments, impacting inventory management and raising costs for U.S. businesses. Moreover, the extended transit times and increased fuel use present challenges to sustainability efforts in the shipping industry, counteracting emissions reduction initiatives.

As the situation unfolds, carriers serving the Asia–Europe and Asia–U.S. markets might re-evaluate their route strategies, particularly for services to the U.S. East Coast via the Suez Canal. This reevaluation could lead to a shift of capacity from Asia–U.S. East Coast routes to trans-Pacific routes, where carriers avoid the Suez Canal and rely on U.S. West Coast ports as entry points. While this could bring short-term benefits to U.S. West Coast importers due to increased shipping line capacity and potentially stabilized rates, it may also introduce complications for East Coast-oriented customers.

For East Coast customers, the shift to trans-Pacific routes increases demand for intermodal and trucking services to transport goods cross-country from West Coast ports to certain U.S. East Coast port markets, which may result in higher shipping costs and longer delivery times. Increased demand for rail and truck transport across the country could further strain U.S. inland logistics networks, creating potential bottlenecks and higher rates for cross-country deliveries.

The increased cargo volumes at U.S. West Coast ports also carry the risk of renewed congestion. Ports like Los Angeles, Long Beach, and Seattle–Tacoma have limited capacity, and an influx of diverted shipments could strain existing resources, especially during peak seasons. However, West Coast ports are better prepared now than they were during the pandemic peak, having made significant infrastructure improvements and operational adjustments to handle higher volumes. Ports and logistics providers would likely need to closely coordinate to manage these increased volumes effectively and mitigate the risk of congestion, but the improved preparedness could help manage the influx more smoothly.

Figure 3-14 Suez Canal Vessel Transits: October 2018–June 2024



Source: UNCTAD, "Navigating Troubled Waters: Impact to Global Trade of Disruption of Shipping Routes in the Red Sea, Black Sea and Panama Canal," UNCTAD Rapid Assessment, February 2024, available at https://unctad.org/publication/navigating-troubled-waters-impact-global-trade-disruption-shipping-routes-red-sea-black#anchor_download; and UN Office for the Coordination of Humanitarian Affairs (OCHA)/ Humanitarian Data Exchange (HDX), "Red Sea crisis: Suez Canal traffic impacts," Panama and Suez Canal Transits dataset, available at https://data.humdata.org/dataset/the-red-sea-suez-canal-traffic.

Foreign Direct Investment

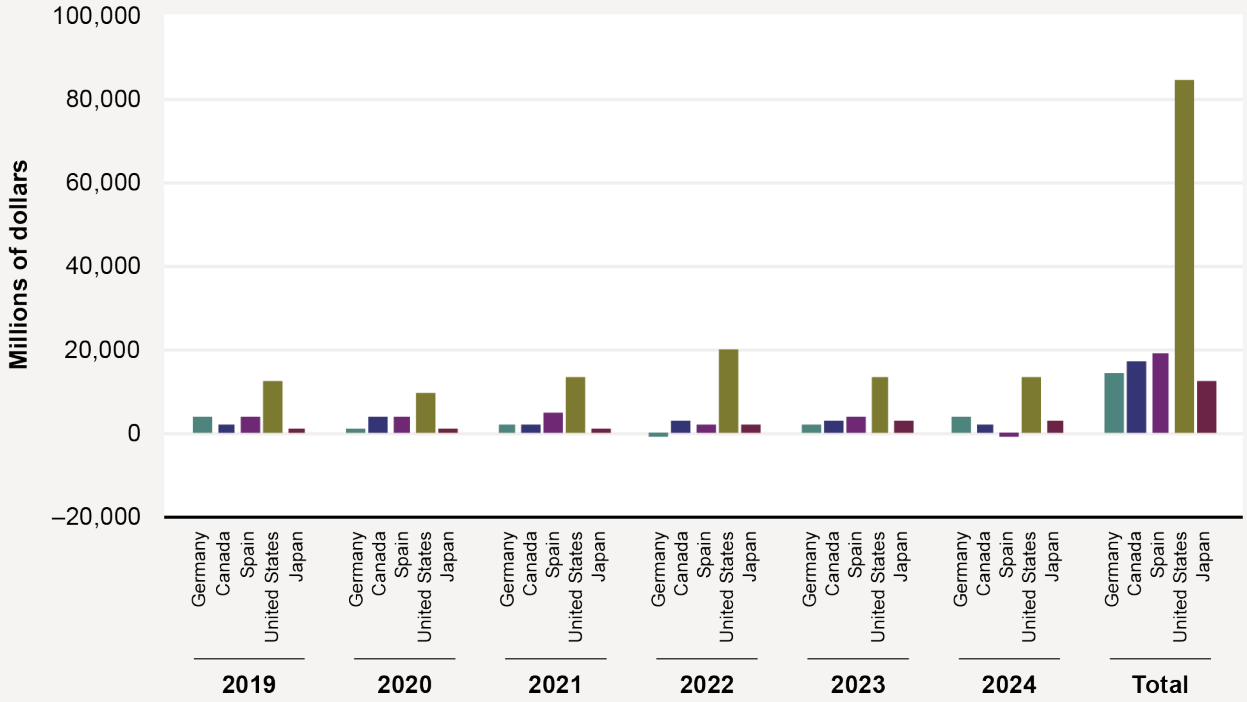
As Figure 3-15 shows, the data on foreign direct investment (FDI) in Mexico from 2019 to the first two-quarters of 2024 highlights the country's strategic emergence as a manufacturing and trade hub within North America, particularly for the top five investing countries—Germany, Canada, Spain, the United States, and Japan. The United States stands out with consistently high investment levels, peaking at $20.2 billion in 2022, and accumulating over $83 billion across the period. Further, the first two quarters of U.S. FDI in Mexico match the total U.S. FDI of 2023. This sustained inflow reflects a shift by U.S. companies toward reshoring production to Mexico to leverage proximity, reduced logistics costs and supply chain risks, and favorable trade terms under the United States–Canada–Mexico Agreement (i.e., the USMCA). Additionally, Mexico's lower labor costs provide U.S. companies with an economically viable way to keep production costs competitive, balancing cost efficiency with supply chain resilience.

For other major economies, including Canada, Germany, Spain, and Japan, the FDI data suggests that Mexico is also a preferred base for accessing the U.S. market. Canada's steady investment reflects its continued focus on Mexico's manufacturing sectors as cost-effective export points to the United States, while Germany and Spain, despite some fluctuations, collectively contributed over $33 billion between 2019 and 2024. Japan's growing investment, especially in recent years, underscores a commitment to high-tech manufacturing and automotive production targeting North American markets.

Annual FDI fluctuations reveal specific dynamics. The spike in U.S. investment in 2022 likely aligns with reshoring efforts as companies seek to mitigate supply chain risks, capitalize on tariff benefits, and reduce transit times to the U.S. market. Concurrently, the increased Canadian and German investments from 2020 to 2023 reflect strategic moves to leverage Mexico's cost advantages in North American trade. Spain's negative FDI in early 2024 may indicate capital adjustments or profit repatriations, though its overall investment remains substantial.

These FDI trends have profound implications for cross-border transportation, especially by truck, given the dominance of

Figure 3-15 Top Five FDI Countries in Mexico: 2019–2023 and First Two Quarters of 2024



Source: Gobierno de México, "Información Estadística de la Inversión Extranjera Directa," Información estadística general de flujos de IED hacia México desde 1999, available at https://www.datos.gob.mx/busca/dataset/informacion-estadistica-de-la-inversion-extranjera-directa as of October 28, 2024.

FDI = foreign direct investment.

land transport between the United States and Mexico. As manufacturing activities increase in Mexico to serve U.S. and broader North American markets, cross-border trucking demand will likely surge. This will put added pressure on infrastructure at key border crossings, such as those in Laredo, TX, and Nogales, AZ, as well as on highways and inspection facilities.

Data Gaps

The growing complexities in freight transportation require a more robust and comprehensive dataset to analyze system performance and respond to emerging challenges. The most recent developments—such as shifting supply chains, advancements in e-commerce, and efforts to address port congestion—highlight the critical need for more granular and timely freight transportation data.

Shipment Routing Data

Existing data sources focus mainly on collecting information on the origins and destinations of shipments. However, there is a critical gap regarding the distribution or routing of goods between origin and destination. For example, many shipments use multiple modes, such as containerized shipments that use truck–rail intermodal, which requires moving vehicles from truck to train, typically at an intermodal yard. Additionally, even when goods transport uses only one mode, carriers may transfer goods between trucks at less-than-truckload terminals, or from one train to another train at a rail classification yard. Existing sources do not reveal these details of shipment paths. This gap limits the ability of stakeholders to evaluate the impacts of potential facility disruptions and assess overall freight system performance. Data on shipment routes and transfer points would give freight operators insight into benefits of their operational improvements, and allow them to understand impacts of these facilities on system resilience.

Ports: Performance and Utilization Data

A critical gap persists in the availability of real-time data related to freight system performance, particularly at the port level. Although the massive pandemic-related port bottlenecks are over, disruptions (either realized or potential) continue to occur. Therefore, these data gaps are as important for preparedness as they were in 2021–2022. A comprehensive analysis of freight transportation requires more granular data points that capture port activity, such as the following:

- **Vessel waiting time:** Measuring the time container vessels wait for an available berth, categorized by vessel type and size, is essential for monitoring port congestion and for vessel operators to optimize vessel calls.
- **Truck turn time:** Understanding how long trucks spend entering and exiting a terminal, accounting for factors like empty hauls, double hauls, and whether containers are full or empty, is key to improving terminal performance. Double hauls—where trucks drop off and pick up containers in a single trip—can significantly reduce truck trips, lowering both operational costs and emissions.
- **Truck queue time:** The time trucks spend waiting to reach the gate impacts both operational efficiency and environmental outcomes. Reducing these wait times improves throughput and reduces fuel consumption and emissions.

Tracking these performance metrics helps identify inefficiencies and the underlying causes of delays, providing the foundation for solutions that can enhance port performance and reduce emissions. By collecting data on vessel waiting times, truck turn times, and truck queue times, ports and marine terminals can better evaluate the environmental benefits of their operational improvements.

Additionally, data on underutilized port assets is essential for planning for available capacity during disruptions. Developing a dataset that identifies the TEU capacity of all U.S. ports capable of handling sea-going container vessels would enable stakeholders to quickly identify excess capacity and strategically deploy resources during periods of congestion or unforeseen disruptions. Such data would provide a valuable tool for managing port and terminal performance, ensuring that available capacity is fully leveraged when disruptions occur.

Other Logistics Nodes: Capacity and Infrastructure Utilization Data

Supply chain performance metrics require more comprehensive data collection to effectively manage capacity and infrastructure utilization. This gap encompasses both transportation-specific facilities and storage and distribution facilities. Transportation facilities, such as intermodal yards and less-than-truckload terminals, are critical to freight system performance, as are warehouses and distribution centers. While data on their locations are available, information on their capacity and utilization remains scarce. Such data is essential for understanding system congestion, resilience, and the potential benefits of improvements to these facilities.

For instance, warehouse capacity utilization is a critical measure—ideally, utilization should not exceed 85 percent to prevent bottlenecks. Comprehensive data on warehouse capacity availability and utilization, the capacity and utilization of other logistics nodes, as well as chassis and vehicle availability and truck queue and waiting time data at distribution centers, can help industry stakeholders anticipate and mitigate bottlenecks and congestion-related risks.

First-Mile and Last-Mile Freight Movements

Freight transportation analysis has increasingly emphasized the "last mile" of deliveries, particularly as e-commerce has introduced new challenges for freight transportation infrastructure. The rise of e-commerce has led to a growing frequency of smaller delivery vehicles, such as vans and light trucks, sharing road space with larger freight trucks. This increased road congestion is particularly notable in urban areas and impacts the efficiency of freight truck movements, causing delays in transporting goods to and from ports. Delivery vehicles frequently stopping in residential and commercial areas contribute to traffic bottlenecks, which create additional challenges for larger freight trucks.

However, a critical data gap exists in understanding e-commerce shipments that originate directly from retail stores rather than warehouses. Many retailers, such as PetSmart, Ulta, Target, and Walmart, now offer shipping and delivery services from their stores. This trend introduces additional complexities in freight logistics and creates challenges in quantifying the scale and impact of these shipments, as no authoritative data source currently tracks these operations. Efforts to address this gap, such as ongoing work from the Commodity Flow Survey (CFS), are essential for providing a clearer picture of e-commerce freight dynamics.

It is also important to consider the "first mile" of freight movements, particularly in agricultural regions during harvest seasons. Trucks transporting agricultural products to grain elevators and terminals often face significant congestion with bottlenecks forming at these collection points. Similar to marine terminals, agricultural sites can experience long truck queues and extended truck turn times, leading to increased emissions from idling vehicles and inefficiencies in the supply chain.

The focus on first-mile operations, alongside last-mile challenges, highlights the need for data collection across both ends of the freight transportation spectrum. Key data points—such as truck queuing time and truck turn time—should be gathered not only at marine terminals but also at agricultural sites and distribution centers to monitor congestion and improve operational efficiency. Reducing congestion and optimizing truck movements in both the first and last mile can lead to emissions reductions and enhance overall supply chain performance.

Moreover, data related to delivery density, missed deliveries, and the utilization of alternative delivery methods (e.g., cargo bikes or delivery lockers in the case of e-commerce) will help improve the efficiency of last-mile logistics. By broadening the focus to include the first mile, especially in rural and agricultural contexts, stakeholders can take a more comprehensive approach to optimizing freight movements and reducing the environmental impact of inefficiencies across the entire freight system.

Shipping Freight Cost

While BTS has made significant strides in providing cost indicators for specific freight routes, a more extensive dataset is still needed to capture freight costs across the supply chain. These costs include not just freight rates, but also tariffs and fees from shipping lines, ports, airports, trucking companies, and distribution centers.

Detailed freight cost data are crucial for stakeholders to monitor cost trends, understand the impact of market disruptions, and make informed decisions regarding freight planning. More expansive cost data would also support policy decisions aimed at improving the competitiveness and sustainability of U.S. transportation networks.

Similarly, companies have monetized the value of time and hence incorporate time and reliability as additional factors for route planning and delivery. Data relative to delivery time and the extent to which delivery schedules are met fills out a more holistic view of freight system performance from a company's perspective.

Conclusion: Addressing Data Gaps for a Resilient Freight System

The ongoing evolution of global trade, domestic production, and e-commerce highlights the urgent need for more granular and real-time data across the U.S. freight transportation network. Access to accurate, timely data is critical for improving the resilience of the freight system, optimizing both operational efficiency and environmental performance.

Crucial data gaps remain in the areas of port congestion, vessel and truck waiting times, and infrastructure utilization. Addressing these gaps is essential for improving port and terminal performance, reducing emissions, and ensuring efficient use of resources during periods of disruption or high demand. Additionally, as sustainability-linked loans become more widely adopted, tracking environmental performance data at the port and terminal level will allow operators to achieve emissions reduction targets and access more favorable loan terms.

The need for a better understanding of the e-commerce impacts on transportation is clear. Urban, suburban, and even rural streets and roads are being used by different vehicles in different ways. E-commerce has facilitated the limited introduction of sidewalk robots and may do the same for aerial drones. Transportation planners need to determine how to cope with these changes or even whether coping is necessary.

Equally important is the need to collect and analyze data on the first and last mile of freight movements. While e-commerce has brought renewed focus to last-mile logistics, the first mile, particularly in agricultural contexts, also presents significant challenges related to congestion

and emissions. Understanding the dynamics of freight movements at both ends of the supply chain will allow for a more comprehensive approach to reducing inefficiencies, optimizing truck operations, and mitigating the environmental impacts of freight transportation.

Moreover, shipping freight costs, delivery time, and reliability metrics are critical components for monitoring cost trends, route optimization, and overall system performance from a company's perspective. Expanding these datasets will not only empower stakeholders to make better decisions, but also support policy efforts aimed at enhancing the competitiveness and sustainability of the transportation sector.

Ultimately, these diverse aspects of data collection—port performance, shipping costs, and delivery metrics—tie together into a cohesive strategy for improving the freight transportation network. By gathering and analyzing more detailed data on port performance, supply chain capacity, and first- and last-mile movements, stakeholders will be better equipped to navigate the challenges of a rapidly changing marketplace, ensuring that the U.S. transportation system remains competitive, responsive, and environmentally responsible.

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