“Public policy tends to treat ports as infrastructure facilities that serve only their surrounding place, rather than as shared assets upon which dozens of metro areas across the country rely.”

# The Great Port Mismatch
## U.S. Goods Trade and International Transportation

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### Summary

The United States traded over $4 trillion worth of international goods in 2014, ranging from raw agriculture to advanced precision instruments. The enormous variety of exports and imports powers American industries, allowing industrial and household consumers to enjoy cost-effective products and exporting producers to access global markets. Even with a transition to a more service-based economy, goods trade still represents a vital component of economic growth.

America’s international ports—the water, air, and surface transportation facilities that handle global goods—are either the first or last place a good touches domestic soil, and therefore they are vital components in trade networks. With towers of containers sitting on docksides, flocks of cargo planes parked at airports, and lines of trucks on both sides of the borders, ports are often the clearest visual evidence of all the goods trade taking place across the country.

While ports are a vital conduit between the international marketplace and domestic producers and consumers, there is an information gap when it comes to ports’ specific role in the country’s trade networks. As a consequence, public policy tends to treat ports as infrastructure facilities that serve only their surrounding place, rather than as shared assets upon which dozens of metro areas across the country rely. This approach fails to take a holistic view of trade infrastructure and limits the coordination of fixed investments and commercial trade policies. To address this deficiency, this report analyzes international goods trade at ports of entry, whether land, air, or sea; it uses data from 2010, the latest year available. The analysis finds that:

- **Ocean vessels and airplanes move over 70 percent of all internationally traded goods into and out of the U.S., a share consistent with transportation’s modal trends over the past two decades.** Trucks, railroads, and pipelines account for the rest.[1] There is a greater degree of modal variety by the commodity traded, with lower-value, higher-weight goods like energy products and agriculture more likely to move by ship and higher-value, lower-weight goods like electronics and precision instruments more likely to move by airplane.
- **The country relies on 25 port complexes—a group of ports within one place—to move 85 percent of all internationally traded goods.** The majority of these port complexes are in large metropolitan areas, ranging from the seaports and airports in Los Angeles, New York, and Houston to single major ports in metro areas like Anchorage, Alaska; Buffalo, N.Y.; and Savannah, Ga. The ports also tend to specialize in moving specific commodities, which affects their average value and determines common trading partners.
- **All port complexes primarily serve customers in other parts of the country, with only 4 percent of their goods either starting or ending in their local market.** Due to commodity specialties and common trading partners, even local economies tend to use other ports more than their local ports. This creates a spatial mismatch between where international transactions occur and the domestic source of that trade.

- **The average international good travels over 1,000 miles within the U.S. to get from a port to its market, underscoring how international trade relies on the domestic freight network.** This includes extensive travel from West Coast ports, but also lengthy average trips for goods starting or ending at East Coast, Gulf Coast, and NAFTA (North American Free Trade Agreement) ports.

This paper uncovers an intense spatial mismatch in the country's international flow of goods: A small group of port complexes handles the vast majority of all trade flows, but those ports primarily serve domestic markets besides their own. In response, federal policies must do a better job recognizing the outsized role of the busiest ports and the benefits the entire country receives from efficient connections to those key assets. Likewise, local leaders must reconsider their ports' role within the local economy and possibilities for logistics growth.

## Background

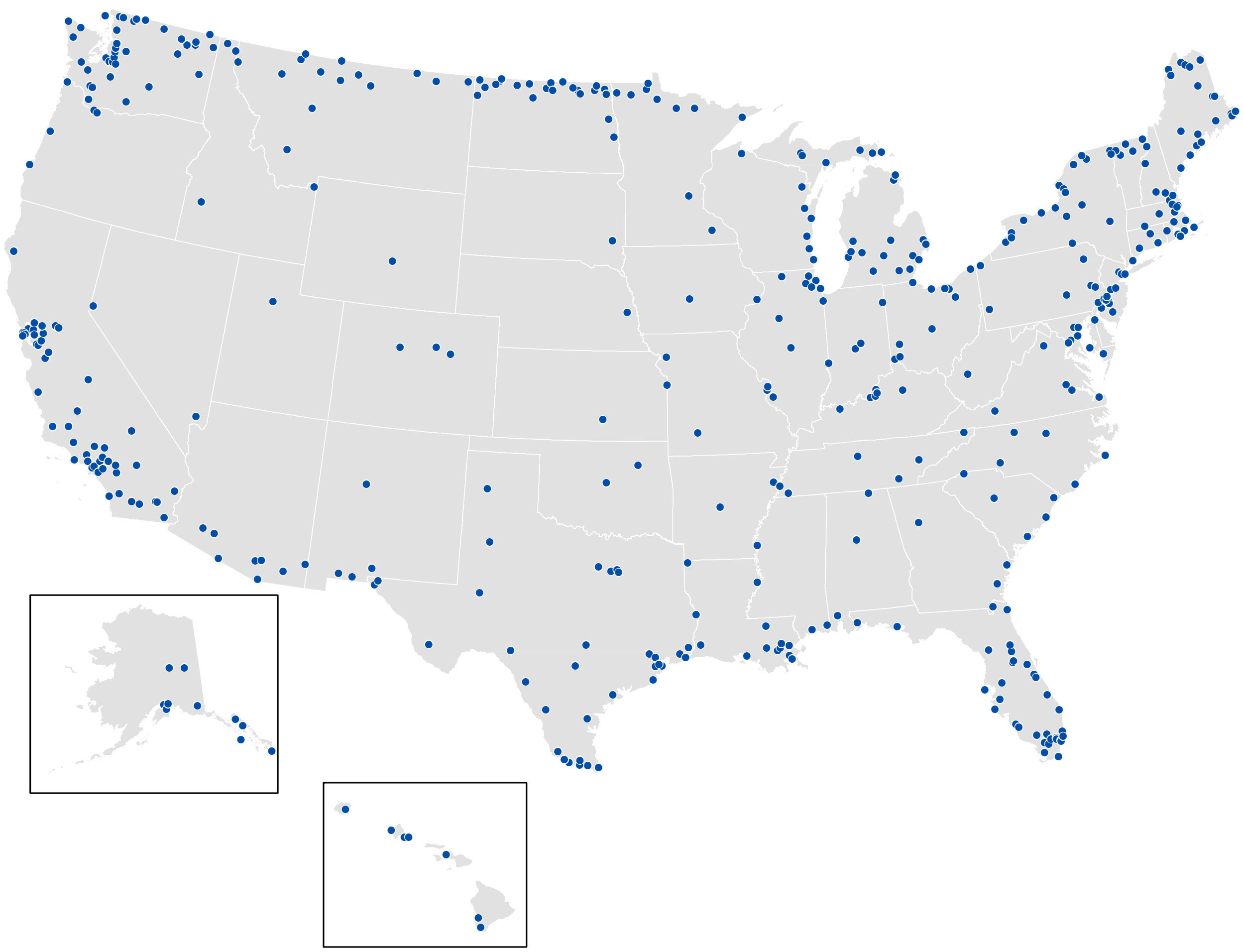
The United States has long been one of the world's preeminent traders, currently ranking second to China in the exchange of physical goods. In 2014 alone, the United States exported and imported $4.0 trillion in goods—exceeding the combined trade of Japan, France, and the United Kingdom.[2]

These high levels of international trade benefit the U.S. economy in several ways. Exporting firms not only pay higher wages, but they also play an outsized role in the ongoing economic recovery.[3] Similarly, by importing foreign products, American producers and consumers can enjoy lower costs for many goods, and producers can inject additional value into domestic supply chains.[4] Ultimately, exports and imports help regions across the U.S. create, manage, and participate in the global value chains that define modern production practices.[5] For example, while many computer products are now assembled in Asia and imported to the U.S., high-value design, manufacturing, and management still takes place in metro areas like San Jose, Calif.; Portland, Ore.; and Austin, Texas.

Maximizing these economic benefits, though, requires an efficient and reliable freight infrastructure network. Various infrastructure facilities, including roads, railroads, and ports, represent the primary physical conduits between the domestic economy and the international marketplace. At the same time, transportation itself has a significant impact on the costs of traded goods. The marginal cost to move goods internationally can determine whether firms conduct trade at all.[6] That means high-functioning infrastructure is more than just a luxury—it's a requirement to maintain competitive exports and low-cost imports.[7]

Among these infrastructure assets, the nation's ports—the physical sites of foreign exchange—act as perhaps the most critical links tying together regional and international economies. From major cargo airports in New York and Miami, to seaports in Los Angeles and Savannah, to land border crossings in Laredo, Texas and Detroit, the United States boasts over 400 unique freight-handling ports (see Map 1).[8] These ports are also tremendously busy, with over 30 million separate trade entries per year on imports alone.[9] In addition to covering almost every corner of the country, these ports have unique characteristics when it comes to their global connections, commodities, and even the types of containers and products handled. The Port of Seattle, for instance, focuses on shipping standardized containers between East Asian markets, while Miami International Airport specializes in Latin American produce and flowers.

**Map 1. U.S. Customs Ports of Entry, 2014**



*Source: Brookings analysis of Customs and Border Protection Agency data*

*Note: This map represents ports by their county using a dot density visualization. The dots do not represent exact locations of ports within county boundaries.*

As a result, each of these ports plays an essential role binding the entire country together; to maximize economic returns at a national level, many regions depend on easy access to a specific set of ports and benefit from efficient operations within these facilities.

While the private sector often manages the flow of goods through individual ports—most notably as owners of marine terminals—a wide range of public actors are responsible for maintaining the infrastructure assets within and outside ports. For example, municipal, regional, and statewide port authorities own and operate airports and seaports, while federal agencies do the same for land border crossings.[10] These authorities, in turn, collaborate with local planning bodies to guide transportation investments and land use decisions.[11] Meanwhile, federal and state departments of transportation help construct and maintain long-distance connections to ports—with the exception of privately owned freight railroads.[12] Finally, the Customs and Border Protection Agency helps monitor the actual trade taking place on port property, ranging from customs collections to container security. These responsibilities represent a huge web of bureaucratic moving parts.

Unfortunately, public policies concerning ports frequently exist in modal and jurisdictional stovepipes. Separate pieces of federal legislation split investment programs and operational policies related to seaports, airports, and land border crossings, while a fourth law covers surface transportation.[13] In turn, federal programs and policies tend not to look at intermodal connections. With smaller pots of funding to deal with, Congress often downplays the importance of certain ports for national trade, favoring geographic equity instead. An example is the Harbor Maintenance Trust Fund—a fund to maintain the country's harbors and shipping channels—which does not adequately prioritize the busiest ports.[14] Support for aircraft operations via the Federal Aviation Administration's Airport Improvement Program also does not prioritize capital investment at the country's busiest airports.[15] Finally, various formula programs under the Federal Highway Administration do not reflect a performance-based system in service of the busiest corridors or port-connectors.[16]

Likewise, at the state and local level, many regions rely on separate port authorities—which may exist independently or as governmental agencies—for each transportation mode. These alignments limit coordination across different stakeholders and complicate future development plans and investments. For example, metropolitan Miami includes a separate agency or authority to govern each of its four international seaports and airports.[17] Likewise, while ports often serve large geographic markets, many of their negative externalities—most notably congestion and environmental justice consequences—are felt locally.[18]

The overall result is a lack of prioritization within an enormous national network of ports and related freight infrastructure. With financial resources spread thinly and with the lack of a clear, long-term freight strategy, American producers and consumers continue to operate at an economic disadvantage and fail to gain the best value from public infrastructure investment.

A key first step in addressing this policy failure is to investigate how international trade flows among the country's ports. This paper aims to address this information vacuum by demonstrating the role of metropolitan port complexes within the national economy. It begins by summarizing how the country moves goods by specific modes, and then analyzes the specific port complexes doing the majority of the work. It then examines the domestic flows in and out of the country's ports, looking at whether the sites of international commerce and domestic production and consumption are the same. The report concludes with implications for port and freight policy throughout a federalist system.

## Methodology

As with previous papers in the Metro Freight series, this report concentrates on the movement of goods among metropolitan and nonmetropolitan areas, this time focusing specifically on international trade and the role of multimodal ports. As such, this trade analysis aggregates the exchange of products among all industries and private households present in these domestic regions. By focusing on the physical sites of production and consumption—in addition to freight hubs and ports—the report examines the economic connections underlying the nation's freight movement.

This report uses a unique database, developed by Brookings and the Economic Development Research Group (EDR), to examine goods traded among different regions. While the U.S Department of Transportation's Freight Analysis Framework (FAF) serves as a statistical foundation, the database defines goods movement at a more precise metropolitan scale, measuring the total value and weight of goods transported to, from, and within the United States in 2010. These domestic and international movements can be seen across 17 commodity groups and seven transportation modes. Due to changes in FAF accounting between versions, the database contains only one statistical year and does not permit longitudinal analysis.

The database includes the exchange of goods across 409 domestic areas (361 metropolitan areas and 48 state remainders) and 40 international geographies (18 countries, 11 larger country groups, and 11 continental remainders). These exchanges are viewed in terms of the aggregate value of trade between ports and both the international geography and the domestic region. In this sense, all goods exchanges at ports are counted in each direction—also known as bilateral trade. In some instances, trade is analyzed within specific commodity groups. For a complete discussion of this report's methodology, see Appendix A.

## Definitions

**Region:** Any subnational geography based on three types of metropolitan area definitions.[19] The first group is the 100 largest metropolitan areas, as measured by population from the 2010 decennial census. The next includes all other metropolitan areas, which for this project includes another 261 areas.[20] The final group is the remainder of the country, referenced as nonmetropolitan areas. Any reference to an assembly of international countries is written as "international region."

**Goods trade:** The physical exchange of products or commodities between two distinct trading partners in different regions. These exchanges encompass the full range of commodities, from the rawest natural resources, like stones, to the most advanced manufacturing products, such as aerospace equipment.

**Ports:** Any port of entry as defined by U.S. Customs and Border Protection. Includes all transportation modes: water, air, truck, rail, multiple modes and mail, and pipeline. For a complete description of transportation modes, see Appendix A.

**Port complex:** The collection of all ports within a single region. Typically referenced by adding up all of the trade activity conducted at a region's ports.

**Port facilities:** A specific reference to the infrastructure contained within a port property. May reference a single port or an entire complex, depending on the situation.

**Trade volume:** The total quantity of goods traded in and out of a particular port complex. Volume is measured by value (in U.S. dollars) and by weight (in tons). This particular report measures trade in both directions.

**Trade balance:** The difference in trade volumes between imports and exports, with a negative value referencing greater imports.

**Domestic network:** A specific reference to the domestic portion of an international trade, i.e., the movement of goods to or from a port from the domestic site of production or consumption.

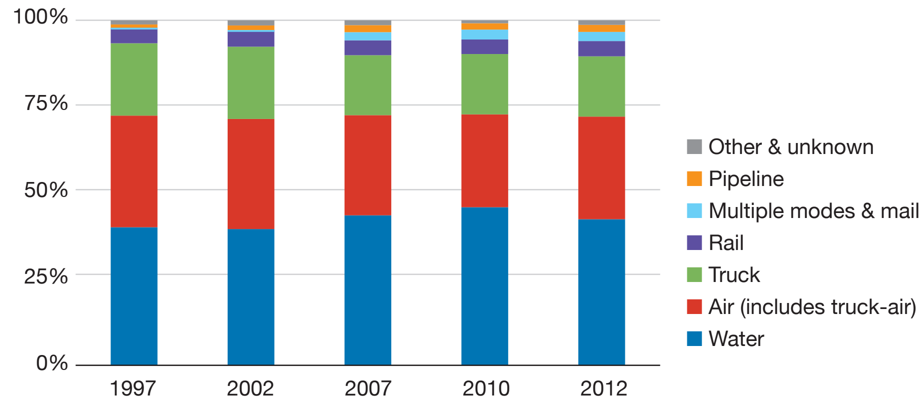
**Commodities:** This survey uses a collection of 17 commodities to better describe the goods that regions trade: agricultural products, stones/ores, energy products, chemicals/plastics, wood products, textiles, metals, tools and manufacturing products, machinery, electronics, transportation equipment, precision instruments, pharmaceuticals, furniture, waste, mixed freight, and unknown. For more information on these commodity groups, see Appendix A.

## Findings

***Ocean vessels and airplanes move over 70 percent of all internationally traded goods into and out of the U.S., a share consistent with transportation's modal trends over the past two decades.***

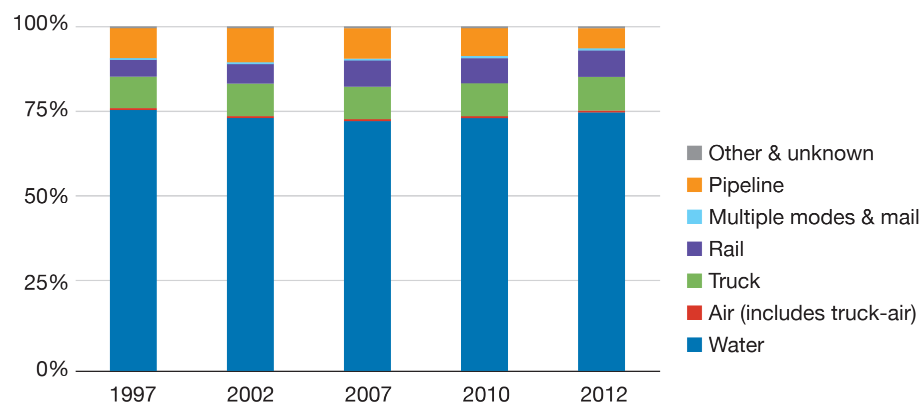
International goods trade represents an increasingly important measure of U.S. economic health. Between 1997 and 2012, trade expanded from $2.0 trillion to $3.8 trillion—a rate (91 percent) slightly faster than nominal GDP growth (88 percent) over the same period.[21] Yet, during this period of rapid trade growth, the transportation modes bringing goods in and out of the country remained remarkably consistent (Figures 1 and 2).

**Figure 1. Modal Share of Total International Goods Trade, by Value**




*Source: Brookings analysis of Commodity Flow Survey data*

**Figure 2. Modal Share of Total International Goods Trade, by Weight**

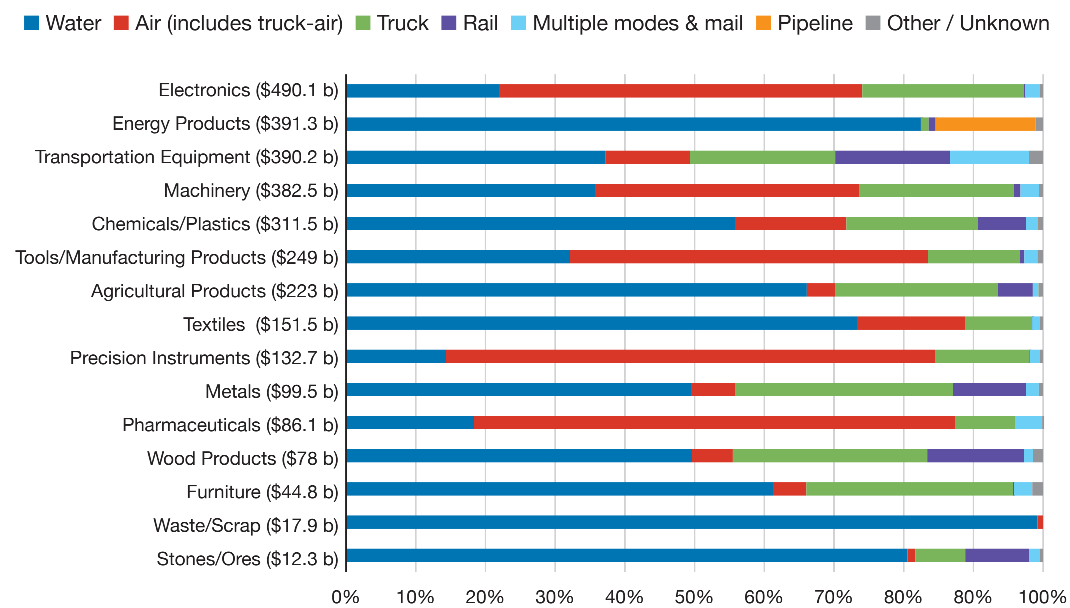



*Source: Brookings analysis of Commodity Flow Survey data*

Water and airborne transportation consistently move the most international goods—including exports and imports. Across the five reporting periods, ocean vessels always carried between 40 and 46 percent of all international value, with aviation fluctuating between 27 and 32 percent. Trucks rank third—with a range between 17 and 21 percent—followed by marginal rates via rail, pipeline, and multiple modes.[22] Waterborne trade plays an even larger role from a weight perspective, with ocean vessels always transporting around three-quarters of all goods. In contrast, airborne trade drops dramatically due to its natural specialization in high-value, low-weight goods. Trucks represent the next biggest modal share by weight, carrying around 10 percent, followed closely by pipelines and rail.

While the U.S. consistently depends on similar modes to ship goods internationally, modal specialties often emerge when it comes to particular commodities (Figure 3).

**Figure 3. Modal Share of Total International Goods Trade, by Commodity and Value, 2010**




*Source: Brookings analysis of EDR data*

Energy and agricultural products are especially noteworthy in this respect, given their relatively high weight and low value. While petroleum accounts for most of the energy products moved internationally—typically involving petroleum in oil tankers—agricultural products tend to involve huge amounts of bulk soybeans, cereal grains, and other non-refrigerated goods. In both cases, large ocean vessels are the ideal vehicle to move these relatively durable materials. Since their combined trade equals $614 billion and 1.2 billion tons—the latter of which represents nearly two-thirds of all international tonnage—they have an enormous effect on national modal shares.

On the other hand, advanced industrial goods such as electronics, machinery, precision instruments, and tools/manufacturing products are extremely high value and often low weight, thereby relying on a different set of modes. As part of global value chains employing "just in time" manufacturing processes, these time-sensitive products depend on a rapid, reliable shipping schedule. As a consequence, their $621 billion in air cargo represents over three-quarters of the country's total aviation trade. Pharmaceuticals are similar in this way, despite moving more frequently between domestic markets.

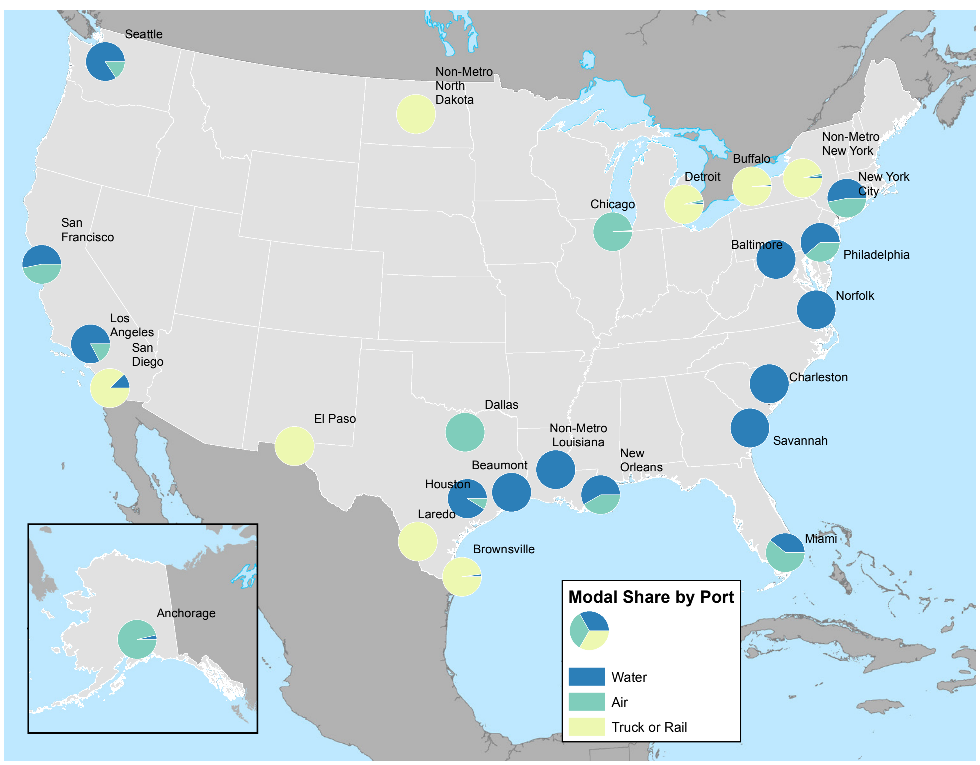
The United States' trading partners are another key component in national modal shares, and natural geography is the great indicator. Certainly, every country besides Canada and Mexico relies on ocean vessels or aircraft to trade goods with the United States. By contrast, water and air modes move less than 10 percent of U.S.-Canadian trade value, and their share of U.S.-Mexican trade is less than 20 percent. That means that an international modal conversation is really a NAFTA or "everywhere else" conversation.

Likewise, changing trade dynamics between the U.S. and specific global regions—whether due to new trade agreements or to booming economies—can have specific modal impacts at U.S. ports. For example, non-Eastern European countries are the traditional hubs of international aviation activity, but decades of strong economic growth and longer international supply chains dramatically boosted airborne trade with China, Japan, Korea, Singapore, and other Asia-Pacific economies.

***International trade concentrates among a small group of port complexes, including 25 metropolitan and nonmetropolitan areas that move 85 percent of all exports and imports by value.***

Although each year the United States' 400-plus unique freight-handling ports move international goods worth trillions of dollars, almost all this trade concentrates in a small group of regional port complexes. A collection of 25 metropolitan and nonmetropolitan areas move 85 percent of all goods by value and 74 percent of all goods by weight. This includes the five largest metro port complexes—Los Angeles, New York, Detroit, Houston, and Anchorage (Table 1)—which move an astonishing 42 percent of all the country's international value. Map 2 plots these regional ports, including their largest modes. Note that all but three of these ports are in metropolitan areas.

**Map 2. Top 25 Port Complexes by Value, Metropolitan and Nonmetropolitan Areas, 2010**




*Source: Brookings analysis of EDR data*

*Note: Metro area names are truncated to reduce label size*

In turn, the majority of these port complexes frequently specialize in particular modes, with waterborne commerce dominating many of the country's largest coastal metros. The largest of these seaports specialize in containers—which frequently match the loose 20-foot equivalent units (TEUs)

**Table 1. Top 25 Port Complexes, Value and Weight, 2010**

| Port Complex | Total Value ($ m) | Total Weight (k tons) | Top Trade Region (by value) | Top Commodity (by value) |
|---|---|---|---|---|
| Los Angeles-Long Beach-Santa Ana, CA | $417,536.6 | 128,892.8 | Asia Pacific | Electronics |
| New York-Northern New Jersey-Long Island, NY-NJ-PA | $349,230.3 | 108,881.1 | Europe | Tools / Manufacturing Products |
| Detroit-Warren-Livonia, MI | $206,690.8 | 100,911.9 | NAFTA | Transportation Equipment |
| Houston-Sugar Land-Baytown, TX | $168,089.3 | 217,828.2 | Latin America | Energy Products |
| Anchorage, AK | $137,387.6 | 6,284.4 | Asia Pacific | Electronics |
| Laredo, TX | $124,436.2 | 39,871.7 | NAFTA | Transportation Equipment |
| Miami-Fort Lauderdale-Pompano Beach, FL | $123,728.7 | 19,418.3 | Latin America | Electronics |
| Seattle-Tacoma-Bellevue, WA | $116,857.7 | 51,868.7 | Asia Pacific | Transportation Equipment |
| San Francisco-Oakland-Fremont, CA | $103,913.1 | 43,513.3 | Asia Pacific | Electronics |
| Chicago-Joliet-Naperville, IL-IN-WI | $92,817.8 | 36,281.9 | Asia Pacific | Electronics |
| New Orleans-Metairie-Kenner, LA | $78,250.1 | 103,695.9 | Asia Pacific | Electronics |
| Buffalo-Niagara Falls, NY | $76,638.0 | 44,752.6 | NAFTA | Transportation Equipment |
| Savannah, GA | $66,692.2 | 35,039.4 | Asia Pacific | Chemicals / Plastics |
| El Paso, TX | $57,686.4 | 17,037.9 | NAFTA | Electronics |
| Brownsville-Harlingen, TX | $56,956.0 | 25,650.0 | NAFTA | Electronics |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | $55,244.7 | 43,950.5 | Europe | Energy Products |
| Virginia Beach-Norfolk-Newport News, VA-NC | $54,003.5 | 48,985.7 | Europe | Chemicals / Plastics |
| Charleston-North Charleston-Summerville, SC | $47,839.7 | 15,714.4 | Europe | Chemicals / Plastics |
| Rest of New York | $44,540.6 | 28,618.7 | NAFTA | Chemicals / Plastics |
| Rest of Louisiana | $43,898.4 | 108,623.3 | Middle East / Africa | Energy Products |
| Baltimore-Towson, MD | $39,103.0 | 26,985.6 | Europe | Transportation Equipment |
| San Diego-Carlsbad-San Marcos, CA | $37,527.4 | 8,844.9 | NAFTA | Electronics |
| Rest of North Dakota | $37,307.2 | 38,999.1 | NAFTA | Machinery |
| Dallas-Fort Worth-Arlington, TX | $33,868.4 | 285.1 | Asia Pacific | Electronics |
| Beaumont-Port Arthur, TX | $28,226.7 | 62,005.9 | NAFTA | Energy Products |
| **United States total** | **$3,060,386.0** | **1,849,305.2** | **Asia Pacific** | **Electronics** |

*Source: Brookings analysis of EDR data*

definition—and these are the preferred method to move goods since their introduction in the mid-20th century.[23] Major container ports include the Western Hemisphere's largest seaport complex in Los Angeles ($343 billion), the East Coast-leading complex in New York ($185 billion), and Seattle ($73 billion), Savannah ($65 billion), and Norfolk ($53 billion). Houston ($153 billion) is the largest exception, since its largest business is in oils and chemicals that move via bulk carriers and tankers. However, all those liquids help make Houston the busiest port by weight (218 million tons), easily surpassing Los Angeles (129 million), New York (109 million), and nonmetropolitan Louisiana (109 million).[24]

Airborne commerce tends to follow major commercial passenger operations, with one major exception in Alaska. The four largest metropolitan aviation complexes—New York via JFK and Newark; Anchorage as the long-time home of NWA Cargo and now FedEx; Chicago via O'Hare's global hub; and Miami as the primary gateway to Latin America—are responsible for an astonishing 54 percent of all international airborne commerce ($445 billion). The next largest aviation complexes—Los Angeles

($72 billion), San Francisco ($49 billion), and Dallas ($33 billion)—are all major international commercial hubs, providing valuable cargo holds to store international goods.

For the most part, the NAFTA border crossings are highly specialized in surface transportation modes. Detroit ($192 billion), Laredo ($124 billion), and Buffalo ($64 billion) combine to move over 50 percent of all NAFTA trade, with Detroit alone representing 25 percent of the country's trade with Canada and Mexico. El Paso and Brownsville, Texas, and San Diego also operate major border crossings. Nonmetro New York State and North Dakota ports play a major role in NAFTA trade, with each ranking in the top 10 of surface ports by value. Based on their specialty in moving agriculture, energy, chemicals, and wood products, both states' rural ports are also high-ranking NAFTA ports based on weight.

Of course, most port complexes have commodity specialties, which interrelate to the types of modes used. For example, the largest container and surface ports—in places like Los Angeles, New York, and Detroit—move an enormous volume of all types of goods. Ports in energy-focused regions, such as Beaumont and Corpus Christi, Texas, and rural North Dakota, tend to concentrate in chemicals and petroleum products. Other ports, such as Dallas, San Diego, and Atlanta, leverage their local industries to focus on advanced manufacturing products.

Among all port complexes, mode and geography also tend to influence their most common international trade partners. While surface ports trade almost exclusively with NAFTA countries, major West Coast ports primarily connect with Asian economies and East Coast ports transport significant volumes with Europe. One exception, however, is Savannah, which ranks as the fastest-growing East Coast seaport, largely by attracting additional Pacific Asian business.[25] Miami also differs from other East Coast ports, where its aviation and waterborne business tend to flow through Latin America as opposed to Europe. Finally, port complexes along the Gulf Coast—such as Houston, New Orleans, and rural Louisiana—exchange a wide assortment of energy products with several international partners, led most notably by countries in the Middle East.

Together, the particular commodities and likely trade partners for a port complex can also affect its trade balance—whether it exports more goods than it imports, or vice versa. Considering the country's persistent trade deficits with most countries, imbalanced trade flows have serious logistical implications for ports and the country as a whole, most notably the need to move empty containers. As the country's primary importers of Asian goods, major West Coast port complexes often run the largest deficits. Los Angeles (74 percent imports by value), Anchorage (70 percent), Seattle (53 percent), and San Francisco (53 percent) all qualify as import-focused.[26] The same is true for many of the largest East Coast ports, including New York (63 percent imports), Savannah (61 percent), and Philadelphia (73 percent). However, the United States' truck trade with NAFTA countries is usually more balanced, with land border crossings in Detroit and Buffalo exporting more goods than they import. Interestingly, Miami is the most export-focused of all port complexes, primarily due to its high-value aviation exports to Latin America.

### *All port complexes primarily serve customers in other parts of the country, with only 4 percent of their goods either starting or ending in their local market.*

Many policymakers often emphasize the importance of ports as local economic assets, in particular the ability of ports to create employment opportunities and infrastructure impacts.[27] However, most ports concentrate on forging economic connections between other domestic markets and international peers. Across the entire country, only 4 percent of international goods passing through ports start or end in the same local market. In other words, ports primarily serve other places.[28]

This phenomenon is remarkably consistent across the country. Table 2, which lists the 25 largest regional port complexes, shows that local economies never provide more than 11 percent of all traded value or 14 percent of all traded weight. Large markets like Philadelphia and Miami, for instance, derive only 2 to 3 percent of their port business from local producers and consumers. Meanwhile, small metro areas like Savannah and Laredo barely register any local port activity at all. By comparison, the highest local-serving shares come from ports in the largest metropolitan economies like Houston, New York, and Seattle.

**Table 2. Local Trade Share at Top 25 Port Complexes, Value and Weight, 2010**

| Port Complex | Value ($ m) | | | Weight (k tons) | | |
|---|---|---|---|---|---|---|
| | Total | Local | Local Share | Total | Local | Local Share |
| Los Angeles-Long Beach-Santa Ana, CA | $417,536.6 | $24,876.2 | 6.0% | 128,892.8 | 6,406.1 | 5.0% |
| New York-Northern New Jersey-Long Island, NY-NJ-PA | $349,230.3 | $33,715.3 | 9.7% | 108,881.1 | 7,058.0 | 6.5% |
| Detroit-Warren-Livonia, MI | $206,690.8 | $10,218.3 | 4.9% | 100,911.9 | 2,321.4 | 2.3% |
| Houston-Sugar Land-Baytown, TX | $168,089.3 | $17,806.7 | 10.6% | 217,828.2 | 30,950.8 | 14.2% |
| Anchorage, AK | $137,387.6 | $315.9 | 0.2% | 6,284.4 | 22.6 | 0.4% |
| Laredo, TX | $124,436.2 | $25.1 | 0.0% | 39,871.7 | 6.2 | 0.0% |
| Miami-Fort Lauderdale-Pompano Beach, FL | $123,728.7 | $2,452.5 | 2.0% | 19,418.3 | 362.2 | 1.9% |
| Seattle-Tacoma-Bellevue, WA | $116,857.7 | $9,592.8 | 8.2% | 51,868.7 | 515.0 | 1.0% |
| San Francisco-Oakland-Fremont, CA | $103,913.1 | $4,551.8 | 4.4% | 43,513.3 | 2,685.4 | 6.2% |
| Chicago-Joliet-Naperville, IL-IN-WI | $92,817.8 | $4,254.6 | 4.6% | 36,281.9 | 1,633.1 | 4.5% |
| New Orleans-Metairie-Kenner, LA | $78,250.1 | $925.0 | 1.2% | 103,695.9 | 1,801.8 | 1.7% |
| Buffalo-Niagara Falls, NY | $76,638.0 | $299.1 | 0.4% | 44,752.6 | 138.9 | 0.3% |
| Savannah, GA | $66,692.2 | $180.5 | 0.3% | 35,039.4 | 172.7 | 0.5% |
| El Paso, TX | $57,686.4 | $109.9 | 0.2% | 17,037.9 | 33.8 | 0.2% |
| Brownsville-Harlingen, TX | $56,956.0 | $34.7 | 0.1% | 25,650.0 | 19.4 | 0.1% |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | $55,244.7 | $1,815.8 | 3.3% | 43,950.5 | 1,291.3 | 2.9% |
| Virginia Beach-Norfolk-Newport News, VA-NC | $54,003.5 | $291.8 | 0.5% | 48,985.7 | 106.0 | 0.2% |
| Charleston-North Charleston-Summerville, SC | $47,839.7 | $168.1 | 0.4% | 15,714.4 | 68.5 | 0.4% |
| Rest of New York | $44,540.6 | $271.9 | 0.6% | 28,618.7 | 173.1 | 0.6% |
| Rest of Louisiana | $43,898.4 | $693.8 | 1.6% | 108,623.3 | 1,652.6 | 1.5% |
| Baltimore-Towson, MD | $39,103.0 | $297.0 | 0.8% | 26,985.6 | 177.4 | 0.7% |
| San Diego-Carlsbad-San Marcos, CA | $37,527.4 | $600.3 | 1.6% | 8,844.9 | 86.7 | 1.0% |
| Rest of North Dakota | $37,307.2 | $113.8 | 0.3% | 38,999.1 | 195.9 | 0.5% |
| Dallas-Fort Worth-Arlington, TX | $33,868.4 | $1,767.6 | 5.2% | 285.1 | 12.0 | 4.2% |
| Beaumont-Port Arthur, TX | $28,226.7 | $1,579.2 | 5.6% | 62,005.9 | 3,353.8 | 5.4% |
| **United States total** | **$3,060,386.0** | **$122,280.2** | **4.0%** | **1,849,305.2** | **67,237.3** | **3.6%** |

*Source: Brookings analysis of EDR data*

The trend also holds when looking at ports' transportation modes and commodities. Goods arriving and leaving by ocean vessel start or end in the same region only 4 percent of the time, and the figure barely nudges to 5 percent when considering goods leaving or arriving by airplane. The share of local business is even lower for international trade by truck (2 percent) and rail (3 percent), owing to the large portion of NAFTA trade moving through smaller border metro areas. Commodities see a similar range, with tools and manufacturing equipment conducting the most local trading (7 percent) and stones/ores conducting the least (1 percent).

So far, this finding has considered international business from the perspective of a port. But switching to the perspective of how a local economy trades its international goods, the overarching trend is the same.

Even when a metro area contains numerous port facilities, the local economy tends not to use them. For example, the Los Angeles economy trades $101.2 billion of international goods each year, but it ships only $24.9 billion through local ports. That means that even with two of the busiest seaports in the Western Hemisphere and a large international air hub, most Los Angeles industries find it more efficient to do business through other ports. New York and Seattle also conduct only 25 percent of their international trade through local ports, and the shares quickly begin to fall among other large metro areas: Detroit (17 percent), Miami (10 percent), San Francisco (7 percent), Chicago (4 percent), and Philadelphia (3 percent).

Combined, these trends confirm that port trade is not just concentrated, but it is also highly specialized. Even though metro areas like Houston and Detroit maintain enormous port complexes, their diverse industrial bases and range of international connections compel them to use facilities specific to certain commodities and global trade partners. Meanwhile, all other markets have no choice but to rely on those few major port complexes. For example, metropolitan Washington trades nearly $40 billion in international goods each year, has a navigable river, and a major international airport. However, the lack of a major port facility means that less than 1 percent of its international goods arrive or depart via the Washington port complex.

Across the country, these results uncover an enormous spatial mismatch between where ports locate and where their trade originates.

***The average international good travels over 1,000 miles within the U.S. to get from a port to its market, underscoring how international trade relies on the domestic freight network.***

The reliance between local economies and other regions' ports reinforces the need for a reliable and well-connected domestic freight network. Average distance between ports and their U.S. customers is one metric for understanding this relationship.

Across the country, the average international good travels 1,082 miles between port complexes and domestic markets, as the crow flies.[29] This is double the distance traveled by goods that stay within the United States, which travel only 568 miles. The difference is especially striking when looking at trucking. Whereas the average domestic good travels only 467 miles by truck, an international good travels 985 miles by truck between its port complex and its U.S. customer. On average, then, these numbers confirm that international trade—while constituting a minority of total goods moving within the country—is heavily reliant on the domestic freight network.

Table 3, which ranks the largest port-region connections across the country, shows that most of the largest connections travel multiple hundreds of miles, often more than a thousand. Los Angeles' presence as the largest port complex is clear within this table, with six of the top 10 trading pairs running through its ports. There is also an Eastern directionality to these flows: Very few of the major East Coast or Gulf Coast port connections travel west, while the reverse is true of West Coast ports. This pattern represents how the West Coast ports currently dominate Asian trade flows. There are also a significant number of dual entries on this list: Los Angeles/Houston, Los Angeles/Seattle, Los Angeles/San Francisco, New York/Detroit. These pairs underscore how local economies rely on ports outside their region, even if a high-functioning port is nearby.

The relative isolation of West Coast ports means their goods travel the farthest on the domestic network. For example, ports in Seattle experience the longest average distance with their U.S. customers (1,569 miles), followed by ports in Los Angeles (1,421 miles) and San Francisco (1,202 miles). To put those distances in perspective, it's like every good at those ports starts or ends as far as Chicago. In comparison, goods at East Coast ports tend to travel much shorter distances, as apparent in Baltimore (614 miles) or New York (726 miles). Likewise, at NAFTA ports, Canadian border crossings often transport goods over shorter distances than ports along the Mexican border.

In either case, the hundreds of miles the average good travels within the U.S. from the nation's ports create strong economic connections across the country and require a reliable and efficient domestic freight network to connect ports with their regional peers. Map 3 visualizes the domestic trade flows to and from the Los Angeles port complex, demonstrating its national reach, whether the major Texas metro areas, the Great Lakes, or the Northeast Corridor.

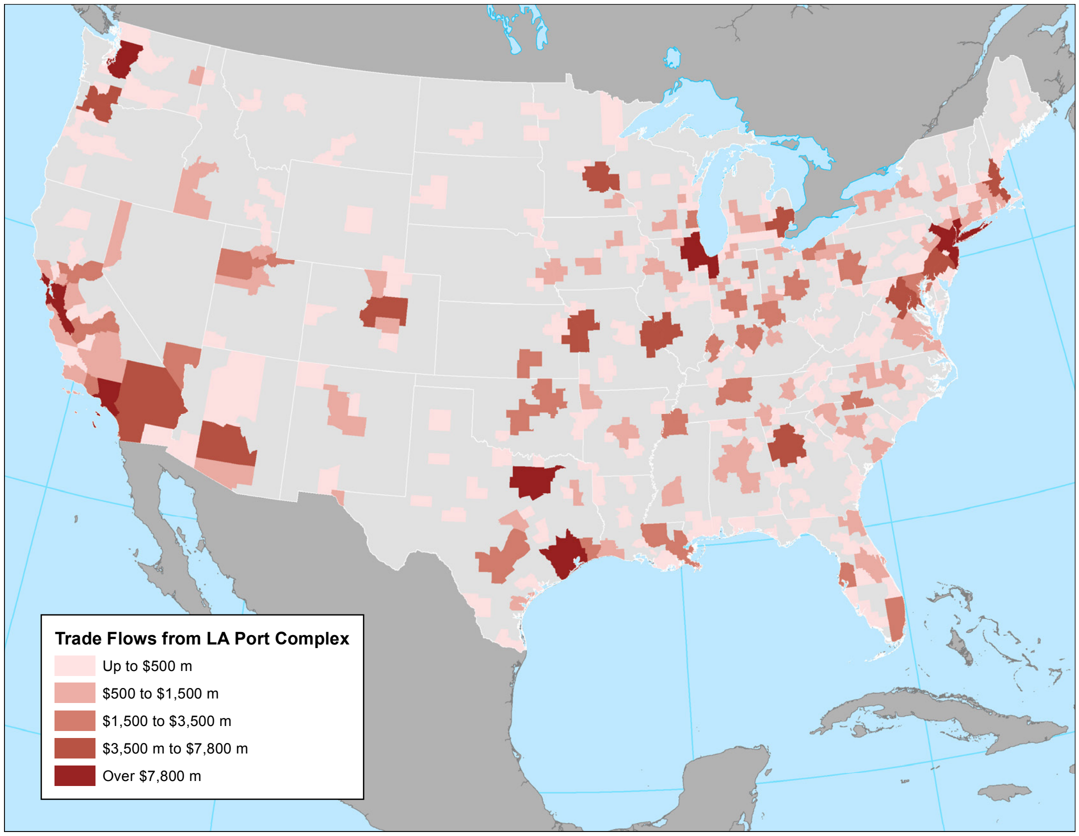
**Table 3: 25 Largest Domestic Connections To and From Port Complexes, by Value, 2010**

| Rank | Port Region | Trading Region | Total Value ($ mil) | Market Distance (miles) |
|---|---|---|---|---|
| 1 | Los Angeles-Long Beach-Santa Ana, CA | San Jose-Sunnyvale-Santa Clara, CA | $19,989.9 | 263.8 |
| 2 | Los Angeles-Long Beach-Santa Ana, CA | Houston-Sugar Land-Baytown, TX | $13,450.0 | 1,367.6 |
| 3 | New York-Northern New Jersey-Long Island, NY-NJ-PA | Chicago-Joliet-Naperville, IL-IN-WI | $13,255.8 | 726.5 |
| 4 | Los Angeles-Long Beach-Santa Ana, CA | New York-Northern New Jersey-Long Island, NY-NJ-PA | $12,987.3 | 2,445.4 |
| 5 | Los Angeles-Long Beach-Santa Ana, CA | Chicago-Joliet-Naperville, IL-IN-WI | $11,661.5 | 1,725.4 |
| 6 | Los Angeles-Long Beach-Santa Ana, CA | San Francisco-Oakland-Fremont, CA | $11,571.5 | 341.0 |
| 7 | New York-Northern New Jersey-Long Island, NY-NJ-PA | Boston-Cambridge-Quincy, MA-NH | $10,957.9 | 190.4 |
| 8 | San Francisco-Oakland-Fremont, CA | San Jose-Sunnyvale-Santa Clara, CA | $10,781.3 | 77.4 |
| 9 | New York-Northern New Jersey-Long Island, NY-NJ-PA | Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | $10,489.8 | 96.7 |
| 10 | Los Angeles-Long Beach-Santa Ana, CA | Dallas-Fort Worth-Arlington, TX | $10,455.3 | 1,224.5 |
| 11 | Anchorage, AK | San Jose-Sunnyvale-Santa Clara, CA | $9,639.8 | 2,120.0 |
| 12 | New York-Northern New Jersey-Long Island, NY-NJ-PA | Houston-Sugar Land-Baytown, TX | $8,105.0 | 1,421.4 |
| 13 | New York-Northern New Jersey-Long Island, NY-NJ-PA | Washington-Arlington-Alexandria, DC-VA-MD-WV | $7,952.3 | 228.7 |
| 14 | San Francisco-Oakland-Fremont, CA | Los Angeles-Long Beach-Santa Ana, CA | $7,944.2 | 341.0 |
| 15 | Los Angeles-Long Beach-Santa Ana, CA | Seattle-Tacoma-Bellevue, WA | $7,834.7 | 948.0 |
| 16 | Houston-Sugar Land-Baytown, TX | San Francisco-Oakland-Fremont, CA | $7,807.9 | 1,633.7 |
| 17 | Los Angeles-Long Beach-Santa Ana, CA | San Diego-Carlsbad-San Marcos, CA | $7,485.5 | 110.4 |
| 18 | Detroit-Warren-Livonia, MI | New York-Northern New Jersey-Long Island, NY-NJ-PA | $7,453.1 | 498.5 |
| 19 | New York-Northern New Jersey-Long Island, NY-NJ-PA | Detroit-Warren-Livonia, MI | $7,106.5 | 498.5 |
| 20 | Seattle-Tacoma-Bellevue, WA | Los Angeles-Long Beach-Santa Ana, CA | $6,909.3 | 948.0 |
| 21 | Anchorage, AK | Los Angeles-Long Beach-Santa Ana, CA | $6,833.7 | 2,371.8 |
| 22 | Detroit-Warren-Livonia, MI | Chicago-Joliet-Naperville, IL-IN-WI | $6,754.7 | 244.1 |
| 23 | Los Angeles-Long Beach-Santa Ana, CA | Detroit-Warren-Livonia, MI | $6,727.4 | 1,967.4 |
| 24 | Miami-Fort Lauderdale-Pompano Beach, FL | New York-Northern New Jersey-Long Island, NY-NJ-PA | $6,663.2 | 1,079.0 |
| 25 | Houston-Sugar Land-Baytown, TX | Los Angeles-Long Beach-Santa Ana, CA | $6,521.4 | 1,367.6 |

*Source: Brookings analysis of EDR data*

*Note: Includes only intermetropolitan port flows (ex: excludes Chicago's port trading with Chicago)*

Map 3. Domestic Market for Goods Shipping Through the Los Angeles Port Complex, 2010




*Source: Brookings analysis of EDR data*

Irrespective of the port location, most international goods travel on transportation modes within the country that are different from the ones traveled on when entering or leaving the country. While seaborne and airborne traffic moves nearly three-quarters of international trade, trucking's share of domestic trips jumps to 58 percent of total value while multiple modes and aviation combine to move another 25 percent. That effectively means ports are more than just aggregators of international commerce—they're also significant intermodal complexes that often transfer goods from one mode to another. As a result, transportation policy must focus on the intermodal activities happening within and near port facilities.

## Implications

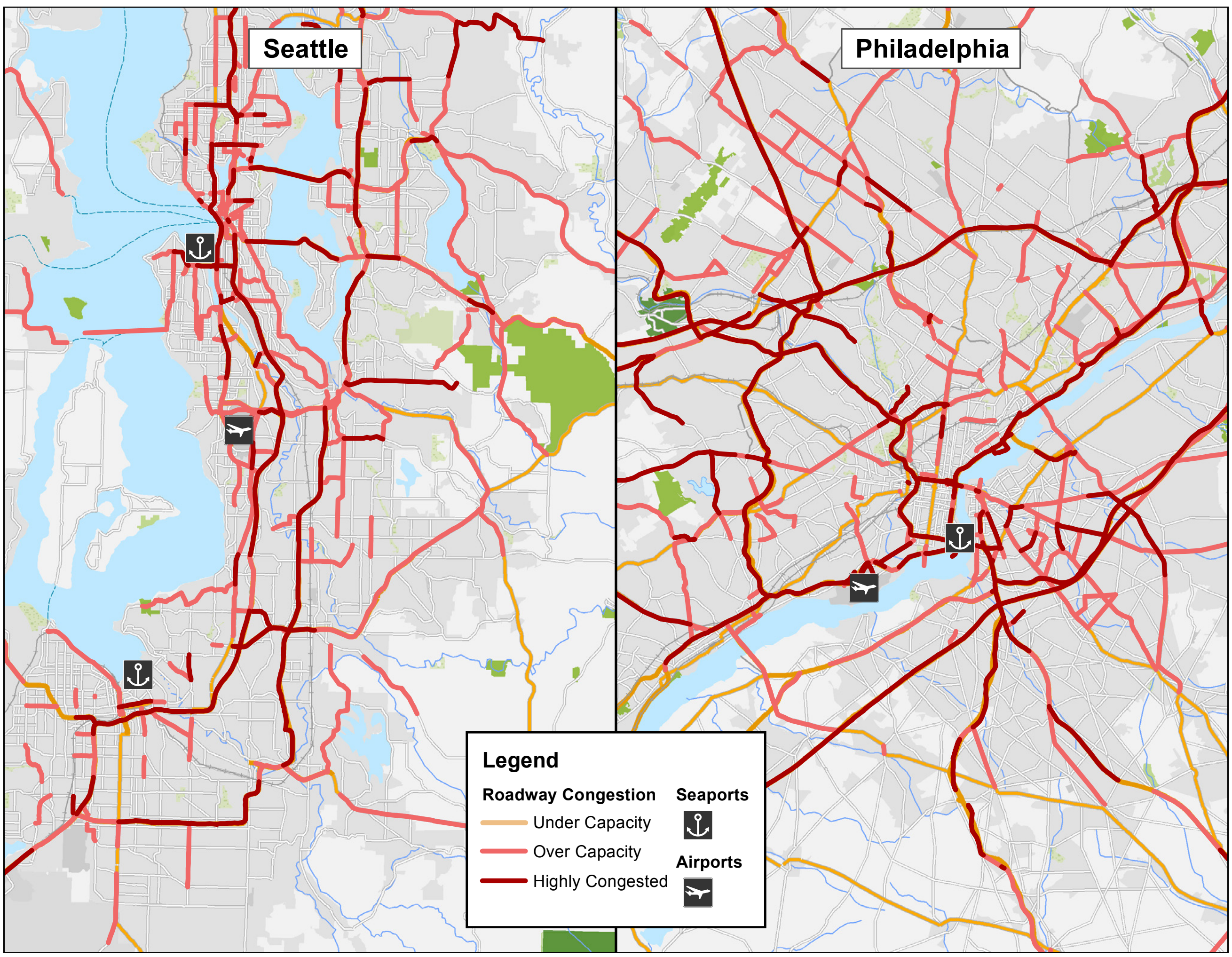
Innovations in global telecommunications, reductions in transportation costs, and the emergence of new producers and consumers worldwide have pushed levels of international trade to new heights. As the country's gateways to the global marketplace, ports are more important than ever as metropolitan and rural economies look to maximize their global economic competitiveness. By measuring how goods flow in and out of the country's ports, this paper describes these infrastructure assets in greater depth, revealing significant implications for federal, state, and local freight policies.

Above all, mapping these trade flows uncovers the immense concentration of freight activity in the United States. While the country prides itself on an enormous inventory of port facilities across all transportation modes, a small collection of 25 port complexes are responsible for 85 percent of all international goods trade by value. Yet even among the busiest ports, most specialize in moving specific commodities, trading with specific global regions, or both. From the focus of West Coast ports on Asian trade to the Gulf Coast ports' specialty in energy products, the entire country relies on a relatively small number of areas—and infrastructure assets—to access the global marketplace.

From the perspective of ports, these flows create an enormous logistical burden for serving hundreds of different areas across the United States, in addition to numerous global regions. This is best exemplified by the fact that 96 percent of a port's trade flows either originate in or are destined for another U.S. market. At the same time, international goods from these markets have to travel over 1,000 miles on average to reach these port facilities, underscoring the importance of interstate commerce in maintaining efficient connections. The country's persistent trade deficit also means many of these journeys include empty or partially filled containers.[30] As a result, the domestic infrastructure network is just as important to global trade as the port facilities themselves.

The country's busiest ports tend to operate in the largest metropolitan areas, which have the most congested roads in the country. The sheer geographic extent of markets like New York, Los Angeles, and Miami often forces port-related traffic to move through neighborhoods filled with bustling local economic activity. Historically, many of these ports also developed near the economic cores of cities, meaning today's port congestion is located near some of the busiest centers of innovation.[31] Map 4 demonstrates how port facilities in Seattle and Philadelphia confront extensive roadway congestion in each direction.

**Map 4. Roadway Congestion Surrounding Ports in Seattle and Philadelphia**




*Source: Brookings analysis of Freight Analysis Framework 3.4 (2007) data*

Of course, congestion is just as much of a concern inside the ports as it is outside of them. U.S.-Mexican border crossings consistently demonstrate delays that restrict economic growth, although performance measurement is too inconsistent to accurately gauge the problem.[32] The state of Michigan and the federal government finally reached a deal with the Canadian government to address the heavily congested corridor between Detroit and Windsor, Ontario—and that's with the Canadian government covering nearly all the costs of the new bridge.[33] Seaports and airports face their own freight-related congestion pressures. These include logistical delays related to overwhelming traffic, such as in New York's congested airspace.[34] They also face outdated regulations related to trade enforcement, such as paper-based filing, and potential problems with staffing levels and hours of operation.[35]

To improve the flow of goods in and out of the country's busiest ports—and thereby increase global competitiveness for the entire country—freight policy will require reforms at all levels of government.

Federal policies, in particular, need to prioritize the economic primacy of the country's major port infrastructure, including its airports, seaports, and land border crossings. Over the past decade-plus, legitimate concerns over national defense have heightened security at these facilities. Respecting the need to protect residents' physical security, it is also becoming increasingly imperative for policymakers to focus on economic security.

First, policymakers need to address challenges at ports themselves. Regardless of the specific legislation, federal dollars should flow to ports moving the bulk of the country's international goods, a change that will ultimately benefit all U.S. markets. While several smaller ports play a key role moving goods—and need reliable funding—spreading financial resources too thinly ignores the concentration of economic activity. For seaports, this redirection of funds means continued development and transparency of the Army Corps' project selection process and more targeted investments from the Harbor Maintenance Trust Fund. For airports, this means possible reforms of the Airport Improvement Program. And for all ports, including border crossings, it means funneling Customs and Border Protection facility investments and operational support to those ports most in need. Improved regulations—ranging from the increased use of GPS and radio-frequency identification (RFID) tracking, to promotion of paperless cargo tags, even to adoption of "single window" paperwork processing—can all speed up port activity with or without infrastructure investment.[36]

Second, improving the reliability of domestic port-connectors is also of vital importance. The most recent surface transportation legislation—Moving Ahead for Progress in the 21st Century Act (MAP-21)—makes strides in this area, qualifying more federal funding for port-connector infrastructure.[37] However, these policies can go further. With the end of the interstate-highway construction era, the federal program should focus on long-term maintenance needs and target capacity expansions based on clearer economic criteria. Considering the economic opportunities derived from international trade, port-connector infrastructure certainly qualifies for those expansions. Likewise, federal authorities and their state partners should prioritize major interstate arteries—including long-distance roads, rails, and waterways—between ports, which are critical to a wide range of industries.

Locally, public and private leaders should focus on what they can control.

Since local or state authorities operate port facilities, regional leaders should be more cognizant of their place in larger national port hierarchies. This is especially important since those local authorities, not the federal government, are the leading investor in the facilities' infrastructure.[38] For example, metro areas need to exercise more caution when expanding their local port facilities, providing incentives to terminal operators, and assessing long-term borrowing costs against future growth to further strengthen their role in the country's freight network. In this regard, the success of East Coast port investments motivated by the Panama Canal expansion will be an important test case in the coming decades.[39]

At the same time, public and private leaders can make sound land use and environmental decisions irrespective of their place in port hierarchies. Ports can act as both key anchors to attract clusters of complementary industries or as generators of unwanted local traffic—and land use decisions can help get the best use of these assets within urban environments.[40] The new Port Miami tunnel is an excellent example in this regard. It provides more direct access to the port, removes trucks from crowded city streets, and uses an innovative financing arrangement to reduce the public burden.[41] Ports of all modes often generate significant levels of noise, air, and water pollution, but local efforts around zoning and mitigation can help reduce the environmental impact of improvements.[42] For example, a Climate Action Plan devised by ports in Los Angeles and Long Beach aims to reduce the facilities' carbon footprint and negative effects on surrounding neighborhoods.[43]

Beyond the ports themselves, regional economic development efforts need to explore how port facilities can better support local producers and consumers. For example, there is an opportunity to minimize transportation costs for local businesses if they can connect more seamlessly to local port facilities, particularly those with similar commodity specialties, rather than exporting and importing through other ports. Alternatively, there may be additional opportunities to attract or grow more innovative, productive businesses, as is the case in Atlanta. While Atlanta ranks outside the nation's 25 largest port complexes, the enormous amount of international flights offers the potential to grow advanced industries specializing in valuable, light-weight air cargo. These are the exact kinds of efforts being undertaken through metropolitan export and foreign direct investment plans.[44]

## Conclusion

With the majority of global population and economic growth occurring outside the United States, international trade will continue to play a prominent role in strengthening domestic firms, attracting foreign direct investment, and improving the livelihood of workers. That puts extraordinary pressures on the country's ports to facilitate the movement of more than $4 trillion worth of goods.

Those pressures are not felt evenly across the country, with relatively small group of port complexes responsible for the vast majority of international trade. Those concentrations are even more extreme when looking at ports' specialties across transportation modes, the commodities being moved, and common trade partners. As a result, those port complexes primarily serve other domestic markets, reinforcing their role as national infrastructure assets.

Public policies must recognize the hierarchy and mechanics of international trade flows and build a federalist framework that will boost trade for the entire county. Such a framework will require federal policies that recognize the primacy of certain metropolitan port complexes, target investment in busy ports and key ports-connectors, and modernize regulations to expedite logistics. Local policies should support these efforts through sensible capital investments, coordinated land use and environmental regulations, and coordination between local industries and port operations.

Each port may exist in a specific place, but protecting its role in the national economy is a shared responsibility.

## Appendix A: Study design

### Goods trade database

This report uses a unique database measuring goods traded among U.S. metropolitan areas, nonmetropolitan regions, and international geographies. We used the data foundation and design scheme of the publicly available Freight Analysis Framework (FAF), Version 3.2. The U.S. Federal Highway Administration (FHWA) constructed the database with the help of the Oak Ridge National Laboratory (ORNL).[45] The database provides a comprehensive view of freight movement to, from, and within the United States. Originally based on calendar year 2007, Version 3.2 has been provisionally updated to estimate 2010 total freight volumes, or flows, by annual tonnage, value, and ton-mileage.

FAF estimates and assigns these flows through a matrix based on the shipment origin (O), shipment destination (D), commodity being transported (C), and mode used (M). To build this matrix and model freight movement, FAF draws from multiple data sources, but is principally derived from the Commodity Flow Survey (CFS), which is conducted every five years through a partnership between the U.S. Census Bureau and the Bureau of Transportation Statistics (BTS) as part of the Economic Census.[46] The CFS is a shipper-based survey that tracks the number of tons and dollar value of goods transported annually across all modes between different regions of the United States. However, because the CFS excludes imports and collects limited data for several freight-related industries, FAF uses a multistep approach and additional data sources to estimate these "out-of-scope" flows.

In total, the FAF matrix covers 131 geographic regions, 43 commodities, and seven transportation modes. Geographically, FAF's origin-to-destination (O-D) movements span 123 domestic regions and eight world regions, including 74 state-specific U.S. metropolitan areas, 33 state remainders, and 16 whole states. Metropolitan areas in FAF do not cross state lines, meaning metropolitan statistical areas are frequently divided into different parts depending on the states located within their respective bounds. Kansas City, for instance, is divided between two states (Missouri and Kansas). In addition, FAF does not follow a single metropolitan geographic definition, and instead uses both Combined Statistical Area (CSA) and Core Based Statistical Area (CBSA) definitions. For international flows, Canada, Mexico, and six groups of multiple other countries are included and classified in the same way as statistical regions by the United Nations.[47] Despite FAF's extensive spatial scope, it often lacks granularity for specific metro areas and even for most country-level origins and destinations.

FAF reports commodities at the Standard Classification of Transported Goods (SCTG) system's two-digit level. Collectively, there are 43 different two-digit SCTG commodity codes, ranging from live animals and fish (SCTG-01) to logs (SCTG-25) and mixed freight (SCTG-43). FAF relies on a variety of data sources to estimate these commodity flows because many goods, including agricultural and petroleum products, are concentrated in industries that fall outside the scope of the CFS.

By partnering with Economic Development Research Group (EDR), we were able to modify FAF to create a new database that identifies commodity flows with greater domestic and international precision. In addition to industry data from IMPLAN and Moody's Analytics, trade data from the World Institute for Strategic Economic Research (WISER) were particularly important to help model freight movement in terms of local economic activity. While carrying out this work, we also addressed several gaps and discrepancies inherent in FAF.

With an interest in showing domestic and international freight flows in, out, and among all of the country's metropolitan areas, we worked with EDR to estimate freight movement across combined statistical areas (CBSAs). Because FAF zones and CBSAs have overlapping spatial coverage at the county level, we first allocated FAF zone flows down to individual counties and then aggregated up to larger CBSAs. To accomplish this task, we used appropriate production, consumption, and port flow data when allocating totals—in both dollars and tonnage—to specific domestic origins and destinations.

Domestically, the estimation process varied slightly depending on the exact geography, mode, and type of flow in question. For example, we assigned flows between two distinct metropolitan areas on the basis of the magnitude of production and consumption in each area, while we used an additional gravity constraint when estimating flows that involved large FAF zones (such as state remainders) to match supply and demand over longer distances. A gravity constraint is a way to use distance alongside economic data when determining trade flows between places.

In all domestic regions, the estimation process followed three essential steps: (1) allocate the commodity supply on the basis of the county share of industries producing this commodity; (2) allocate the commodity demand on the basis of the county share of industries consuming this commodity; and (3) balance the commodity production and attraction on the basis of modal availability. We then aggregated these county commodity flows in turn to their respective CBSAs, while approximating the original FAF aggregate totals for the particular commodity. We classified remaining flows not included in the CBSAs under state remainders.

Internationally, the estimation process relied more extensively on a domestic gravity constraint to allocate export and import flows, primarily because of commodity sourcing issues in FAF. Because FAF defines international movement in two ways—separating the domestic and international legs—there was a statistical concern regarding port-related metros over-assigned local production and consumption trade flows. Miami, for instance, not only served as an enormous port for moving exports out of the country, but FAF also recorded it as one of the largest producers (or origins) for these exports. Anchorage, likewise, served as a primary port of entry for imports, but it was designated one of the largest consumers (or final destinations) for these imports. Our new database, by contrast, used WISER trade data and an additional gravity constraint to link the origin for exports and destination for imports more directly in terms of patterns of economic production and consumption. The results are a relative match for past Metropolitan Policy Program export research, sharing a 0.91 correlation with ExportNation's 2010 goods data.[48] However, because this report and ExportNation use different statistical bases, and only ExportNation includes service exports, the actual numbers will not match between the two datasets.

Among commodities that fall outside the scope of the CFS, crude petroleum (SCTG 16) required particular additional attention. Limited by the sample size for this commodity—along with numerous industry records suppressed for confidentiality—FAF relies on a variety of sources to estimate petroleum flows by value and weight at the county level. To address such gaps, our database allocates these missing flows to counties with nonsuppressed refinery data.

In summary, our new database uses the same design as FAF but adds geographic granularity and increased data certainty. It still includes all 43 two-digit SCTG commodities and seven transportation modes, described in the box below.[49]

**Transportation modes**[50]

**Truck:** includes private and for-hire trucks. Private trucks are owned or operated by shippers, and exclude personal use vehicles hauling over-the-counter purchases from retail establishments.

**Rail:** includes common carriers and private railroads, encompassing a range of Class I, II, and III companies.

**Water:** includes inland and intracoastal waterway movements. Shallow draft, deep draft, and Great Lakes shipments are also counted in this modal category.

**Air (includes truck-air):** includes shipments typically weighing more than 100 pounds that move by air or a combination of truck and air in commercial or private aircraft. Also includes air freight and air express.

**Pipeline:** primarily includes energy shipments via oil pipelines as well as flows from offshore wells to land.

**Multiple modes and mail:** includes truck-rail, truck-water, and rail-water intermodal shipments involving one or more end-to-end transfers of cargo between two different modes. It is not limited to containerized cargo, and also includes parcel delivery services.

**Other and unknown:** includes miscellaneous and other types of transportation.

**Table A1. International Geographies Included in Brookings Goods Trade Database**

| Foreign Geography | Geography Type |
|---|---|
| Argentina | Country |
| Brazil | Country |
| Canada | Country |
| Chile | Country |
| China | Country |
| Colombia | Country |
| France | Country |
| Germany | Country |
| India | Country |
| Japan | Country |
| Republic of Korea | Country |
| Mexico | Country |
| Netherlands | Country |
| Singapore | Country |
| South Africa | Country |
| Spain | Country |
| Turkey | Country |
| United Kingdom | Country |
| Western Africa | Country Group |
| Eastern Africa | Country Group |
| Northern Africa | Country Group |
| Middle Africa | Country Group |
| Caribbean | Country Group |
| Australia and New Zealand | Country Group |
| Melanesia | Country Group |
| Micronesia | Country Group |
| Polynesia | Country Group |
| Central Asia | Country Group |
| Eastern Europe | Country Group |
| Remainder of South America | Rest Of Group |
| Remainder of Central America | Rest Of Group |
| Remainder of Southern Africa | Rest Of Group |
| Remainder of North America | Rest Of Group |
| Remainder of Eastern Asia | Rest Of Group |
| Remainder of Southern Asia | Rest Of Group |
| Remainder of South-Eastern Asia | Rest Of Group |
| Remainder of Southern Europe | Rest Of Group |
| Remainder of Western Asia | Rest Of Group |
| Remainder of Northern Europe | Rest Of Group |
| Remainder of Western Europe | Rest Of Group |

*Source: Brookings Institution and Economic Development Research Group*

Geographically, the database now includes 361 metropolitan areas, 48 state remainders, and 40 international geographies.[51] Table A1 lists the specific countries, country groups, and continental remainders.

Finally, the database and report analytics are only an estimation of expected goods trade and freight activity. While the CFS and FAF are based on an extensive survey of freight shippers—as is EDR's use of WISER's international shipping information—even the best surveys may over- or understate certain trade levels. Likewise, while EDR uses well-regarded gravity constraints and production and consumption data, these data modifiers can miss certain trading relationships. For example, the data modifiers have no method to purposely account for under-reported intrafirm trading relationships. These pitfalls are no different from other survey-based statistical analyses, but they are worth considering if certain trade levels or trading relationships appear off-base.

### Time periods covered

Although FAF provides estimates of projected flows from 2007 through 2040, we include only 2010 provisional data in our database. Given the constantly changing nature of freight movement and other economic developments, it can be difficult to gauge these sudden—and sometimes lasting—fluctuations. Limitations and inconsistencies in existing freight data also make it challenging to track potential changes over time nationally, internationally, and between metro areas, most notably since FAF is the only subnational freight database and it precludes longitudinal comparisons. At the time of production, 2010 FAF estimates were the most current and comprehensive data available, which we adjusted to more precisely track commodity flows at the metropolitan scale. Future updates to our database would prove useful in monitoring freight movement changes over time, especially as the economy continues to emerge from the Great Recession.

### Intermetropolitan flows, intrametropolitan flows, and port-related flows

The MetroFreight series has primarily focused on goods trade between metropolitan areas, meaning the geographic origin and destination are always different places. However, there is also a significant share of goods trade that occurs within metropolitan areas. Typically, an assessment of intrametropolitan goods trade would require a closer examination of several alternate trading dynamics and freight concerns.

When it comes to international flows, though, our goods trade database is similar to FAF by separating the movement of exports and imports at particular ports of exit and entry, respectively. These international flows, moreover, are available by the type of foreign transportation mode and domestic mode used at each regional port. For example, we are not only able to see how many international goods travel by water and air through port facilities in New York or Los Angeles, but we can also see how these goods travel to inland locations, whether by truck, rail, or multiple modes. The same proves true at major land border crossings, such as Detroit and Laredo. As with all international flows, we can observe commodity-specific movements at each port.

Despite this added level of international detail, we are not able to track where domestic flows pass through particular regions; we can only see the final domestic origin or destination. In this way, our goods trade database does not reveal the full range of goods that may be recirculated in inland hubs like Memphis or Louisville. Other economic measures, such as logistics employment, offer a better idea of how these regions fit into the country's larger freight network.

### Industry connections and commodity groups

Goods trade volume and balances offer a useful way to gauge the profile of a metropolitan economy. By viewing commodities in light of the industries that "make" and "use" them, the following method allows us to assess this underlying relationship.

While partnering with EDR, we reviewed a series of input-output (I-O) tables, similar to those developed by the U.S. Bureau of Economic Analysis (BEA).[52] As defined by BEA, output (or make) tables show the production of commodities by industry, while input (or use/recipe) tables show the uses of commodities by intermediate and final users. Put simply, output tables illustrate the types of goods that different industries produce (in dollars), while input tables show the variety of goods used by these industries (also in dollars) to produce their final goods or services.[53] Furthermore, each industry features a unique "make share" and "use share" for specific commodities. Make shares depict the amount of a commodity that is produced per dollar of total output, and use shares depict the amount of a commodity required to produce every dollar of total output. In the furniture manufacturing industry, for instance, furniture products have a make share slightly less than 1, meaning that for every dollar of the industry's output, this commodity essentially represents the only final good produced. The same industry, though, commonly requires wood products to create this furniture, represented by a use share of less than 0.3. In other words, the industry uses 30 cents worth of wood products to create every dollar of output.

In many industries, there is a direct 1:1 relationship for particular commodities based on their make shares. Industries that specialize in automobile manufacturing, logging, or tobacco farming are among those that typically produce only one type of commodity. In contrast, there is often a one-to-many relationship for industries and commodities based on their use share, highlighting how industries frequently use different input commodities to create their output goods. In most cases, SCTG commodities such as base metals and machinery may account for only a fraction of a cent for every dollar of production. These commodities, in turn, are used as inputs in hundreds of industries, from steel manufacturers to electronics manufacturers.

With this background in mind, we analyzed the make-use shares for the 43 two-digit SCTG commodities across EDR's input-output matrix based on the North American Industry Classification System (NAICS). To manage the many industries that made products falling under multiple commodity codes, we created our own commodity classification system of 17 new commodity groups, shown in Table A2. This created a cleaner crosswalk between NAICS economic output data and SCTG commodity codes.

We were thereby able to clearly relate 107 "production-oriented" and 206 "service-oriented" four-digit NAICS industries to one of the 17 commodity groups. In short, the 107 production-oriented industries all had a make share for at least one commodity, while the remaining 206 service-oriented industries did not have a make share for any commodity. As a result, we classified production-oriented industries under 17 commodity groups, and created a 16th commodity group—for noncommodities—to classify service-oriented industries. While these service-oriented industries did not produce any physical goods, they did play an important role in using the 17 other commodities to provide their services, as based on their use shares.

After linking commodities with their respective NAICS industries, we were able to gauge how much production was linked to specific inputs and outputs across different metro areas. For each metro area, we downloaded 2010 GDP data from Moody's Analytics that applied to the four-digit industries included in our crosswalk. We then calculated the relative amount of production associated with each commodity on the basis of the industries linked to these goods, first in terms of output and later in terms of input.

There are two critical limitations to I-O tables and commodity crosswalks for this report's analytical approach. First, I-O tables do not capture household consumption patterns. Although I-O tables do show how much food or energy an industry may consume, they do not reference how much of similar products households may consume. In this sense, an I-O table cannot fully predict the aggregate level of commodity consumption taking place in a particular geography. Second, this report relied on a single I-O table for the entire country, and therefore does not capture variable industrial patterns by metropolitan area. Firms within the same industry will vary in the value of their inputs and outputs, meaning each metro should technically follow a unique I-O table based on its unique collection of firms and industry quality. This omission from our commodity-economic comparison will affect the results to an unknown degree and is an important area to improve in future research.

**Table A2: Commodity Groups Included in Goods Trade Database**

| Commodity Name | Description | Relevant SCTG Codes |
|---|---|---|
| Agricultural Products | Includes various animal products, baked goods, and agricultural crops, ranging from fruits and vegetables to nuts and cereal grains. Also includes processed foods, tobacco products, and alcoholic beverages. | SCTG 01-09 |
| Stones/Ores | Includes stone-related goods like gravel, a variety of non-metallic minerals like salt, and metal ores like iron. | SCTG 10-14 |
| Energy Products | Includes coal and its related byproducts, oil products like crude petroleum and gasoline, and other liquefied fuels and oils. | SCTG 15-19 |
| Chemicals/Plastics | Includes plastics, fertilizers, rubber, and a host of other organic and inorganic chemicals. Also includes pharmaceuticals and chemical mixtures for medical use. | SCTG 20-24 |
| Wood Products | Includes logs, lumber, and other wood products, such as particle board. Also includes numerous paper products in the form of pulp, sheets, or printed materials. | SCTG 25-29 |
| Textiles | Includes fabrics, yarns, and similar textiles used for clothing, carpets, and household furnishings. Also includes leather used for footwear, luggage, and other apparel. | SCTG 30 |
| Metals | Includes base metals, such as steel, copper, and aluminum, in the form of bars, rods, and wire. Also includes ceramics, glass, and other cement mixtures. | SCTG 31-32 |
| Machinery/Tools | Includes machines, parts, and gears used in a variety of mechanical equipment, such as engines, fans, and refrigerators. Also includes metal articles and tools, plus miscellaneous manufactured products like toys, clocks, and musical instruments. | SCTG 33-34, 40 |
| Electronics | Includes a range of electrical components and equipment, from circuits and semiconductors to televisions and computers. Also includes communications equipment and transmission apparatus. | SCTG 35 |
| Transportation Equipment | Includes parts and vehicles for automobiles, railroads, aircraft, ships, and other transportation equipment. | SCTG 36-37 |
| Precision Instruments | Includes medical, scientific, and optical instruments, among other advanced surgical and navigational tools. | SCTG 38 |
| Furniture | Includes household and office furniture, mattresses, medical furniture, and lighting fixtures. | SCTG 39 |
| Waste/Scrap | Includes scrap and waste from wood, paper, glass, and metals. | SCTG 41 |
| Mixed Freight | Includes miscellaneous food and supplies for offices and retail establishments, such as convenience stores and restaurants. | SCTG 43 |
| Unknown | Includes goods not classified under any other commodity group. | SCTG 99 |

*Source: Brookings Institution and Economic Development Research Group*

## Endnotes

1. Multiple modes, which include truck-rail, truck-water, and rail-water intermodal shipments, also account for a portion of these international movements. Additional information on multiple modes is available in Appendix A.

2. Brookings analysis of World Trade Organization data.

3. Brad McDearman, Ryan Donahue, and Nick Marchio, "Export Nation 2013" (Washington: Brookings Institution, 2013).

4. For more information on how imports benefit domestic manufacturing, see Kevin L. Kliesen and John A. Tatom, "U.S. Manufacturing and the Importance of International Trade: It's Not What You Think,"(Federal Reserve Bank of St. Louis Review 95, no. 1 (January/February 2013): 27-49.

5. "Interconnected Economies: Benefitting From Global Value Chains" (Paris: Organization for Economic Cooperation and Development, 2013).

6. For more information on transports costs, including global variability and elasticity, see Alberto Behar and Anthony J. Venables, "Transport Costs and International Trade," in *Handbook of Transport Economics*, André de Palma, Robin Lindsey, Emile Quinet, and Roger Vickerman, eds. (Edward Elgar, 2010).

7. For more background on the impact of transportation on U.S. trade flows, see David Hummels, "Transportation Costs and International Trade in the Second Era of Globalization," *Journal of Economic Perspectives* 21, no. 3 (Summer 2007): 131-54).

8. Brookings analysis of U.S. Census Bureau (including Schedule D from the Foreign Trade Division) and Bureau of Transportation Statistics data. This includes separate customs facilities within a larger port, such as the DHL facility at John F. Kennedy International Airport.

9. U.S. Customs and Border Protection, "Import Trade Trends - FY 2012, Year-End Report,"available online at **http://www.cbp.gov/sites/default/files/documents/Trade%20Trends%20fy12_yearend.pdf** (accessed April 2015).

10. There are some notable exceptions, including the Detroit Windsor Bridge between Michigan and Ontario, Canada, where a private entity owns and/or operates the physical facility. For more background on the history of seaport ownership and governance, see James A. Fawcett, "Port Governance and Privatization in the United States: Public Ownership and Private Operation," *Research in Transportation Economics* 17 (2006): 207–35.

11. Federal departments, most notably the Federal Aviation Administration and the Army Corps of Engineers, also make direct investments in these port facilities, although some investments operate as passthrough grants to port authorities.

12. The public responsibility includes U.S. and state roads, aircraft navigation equipment, and waterway maintenance.

13. Authorizing legislation related to customs facilities has long been up for reauthorization, with the most recent bill in the 113th Congress titled "Trade Facilitation and Trade Enforcement Act." The most recent waterborne commerce bill, Water Resources and Reform Development Act, was passed in 2014. The most recent aviation bill, the FAA Modernization and Reform Act of 2012, expires the year of this publication. The same applies to the 2012 surface transportation bill, Moving Ahead for Progress in the 21st Century Act.

14. John Frittelli, "Harbor Maintenance Finance and Funding" (Washington: Congressional Research Service, 2013).

15. Robert Kirk, "Airport Improvement Program (AIP): Reauthorization Issues for Congress" (Washington: Congressional Research Service, 2009).

16. U.S. Government Accountability Office, "Restructured Federal Approach Needed for More Focused, Performance-Based, and Sustainable Programs," Report GAO-08-400, 2008.

17. This includes Miami-Dade Seaport Department (representing PortMiami), Miami-Dade Aviation Department (representing Miami International Airport), Broward County's Port Everglades Department, and an independent authority representing the Port of Palm Beach.

18. For more information on seaport environmental concerns, see Diane Bailey et al., "Harboring Pollution: Strategies to Clean Up U.S. Ports" (Washington: National Resources Defense Council, 2004). For more information on airport sound mitigation efforts, see Jon M. Woodward, Lisa Lassman Briscoe, and Paul Dunholter, "Aircraft Noise: A Toolkit for Managing Community Expectations" (Washington: Transportation Research Board, ACRP Report 15, 2009).

19. A metropolitan area is a collection of adjacent counties that include at least one urban core of 50,000 people and share commuting ties. For the complete current definition of metropolitan areas, see Office of Management and Budget, "OMB Bulletin No. 13-01" (February 28, 2013). This report uses metropolitan borders defined from the 2000 decennial census.

20. Appendix A includes a complete list of metropolitan areas, based on 2000 definitions, not included in this database. These metropolitan areas are part of their states' nonmetropolitan remainders.

21. Brookings analysis of World Trade Organization and Bureau of Economic Analysis data.

22. Truck and rail trade via Canada and Mexico can include goods, in particular imports, that originally pass through ports in those two countries. Of particular importance is the rapid growth in seaport container operations at British Columbia ports. See Peter Tirschwell, "Prince Rupert Expects Wave of Diversion Cargo From LA-LB Congestion," *Journal of Commerce*, October 23, 2014.

23. For the history of the TEU container, see Marc Levinson, *The Box* (Princeton, N.J.: Princeton University Press, 2006).

24. These statistics look only at international trade flows, which ignore the domestic tonnage moved at specific seaports. When combined, the Port of South Louisiana moved the most tonnage in 2010. See the Army Corps dataset at http://www.navigationdatacenter.us/wcsc/porttons10.html (accessed April 2015).

25. Margaret Newkirk and James Nash, "Savannah Surges as Major Port for Imports on U.S. Growth," Bloomberg Business, October 28, 2014, available online at **http://www.bloomberg.com/news/articles/2014-10-28/savannah-surges-as-major-port-for-imports-on-u-s-growth** (accessed April 2015).

26. However, metropolitan Seattle's ports do export more goods by weight than they import.

27. Joseph Kane and Robert Puentes, "Expanding Opportunity through Infrastructure Jobs" (Washington: Brookings Institution, 2015).

28. For the purposes of this paper, non-local trade is anything beyond the metro area where the port is located, which differs from definitions of "captive markets" sometimes used in seaport literature. For more specific information on elasticity of customers, see Robert C. Leachman, "Port and Modal Elasticity Study," prepared for the Southern California Association of Governments, 2005, available online at **http://www.psrc.org/assets/3363/elasticity.pdf** (accessed April 2015).

29. "As the crow flies" references Euclidean distance, or the straight-line distance between two points irrespective of geology or infrastructure. These distances do not reflect the exact route a truck or even airplane would take between two domestic regions.

30. Sotirios Theofanis and Maria Boile, "Empty Marine Container Logistics: Facts, Issues, and Management Strategies," *GeoJournal* 74, no. 1 (February 2009): 51-65.

31. Bruce Katz and Julie Wagner, "The Rise of Innovation Districts: A New Geography of Innovation in America" (Washington: Brookings Institution, 2014).

32. See Appendix I and V in U.S. Government Accountability Office, "CBP Action Needed to Improve Wait Time Data and Measure Outcomes of Trade Facilitation Efforts," Report GAO-13-603, 2013.

33. Joseph Kane and Adie Tomer, "Latest Deal on Detroit-Canada Bridge a Huge Boost for Metro Trade," available online at **http://www.brookings.edu/blogs/the-avenue/posts/2015/03/02-detroit-canada-bridge-metro-trade-kane-tomer** (accessed April 2015).

34. U.S. Government Accountability Office, "FAA Has Made Some Progress in Midterm Implementation, but Ongoing Challenges Limit Expected Benefits," Report GAO-13-264, 2013.

35. Vivian C. Jones and Marc R. Rosenblum, "U.S. Customs and Border Protection: Trade Facilitation, Enforcement, and Security" (Washington: Congressional Research Service, 2013).

36. In particular, see Port Information Systems and Equipment discussions in Chapter 3 of Olaf Merk, "The Competitiveness of Global Port-Cities: Synthesis Report" (Paris: Organization for Economic Cooperation and Development, 2014).

37. This includes making surface transportation infrastructure within port facilities eligible for surface Transportation Program funding.

38. U.S. Government Accountability Office, "Opportunities Exist to Improve the Effectiveness of Federal Efforts to Support the Marine Transportation System," Report GAO 13-80, 2013.

39. Max Taves, "Port Cities Prep for Wider Panama Canal," *Wall Street Journal*, July 8, 2014, available online at **http://www.wsj.com/articles/port-cities-prep-for-wider-panama-canal-1404852994** (accessed April 2015).

40. Suzann Rhodes et al., "Guidebook for Understanding Urban Goods Movement" (Washington: Transportation Research Board, NCFRP Report 14, 2012).

41. For more details specific to the Port of Miami tunnel project, including financing, visit the webpage **http://www.fhwa.dot.gov/ipd/project_profiles/fl_port_miami_tunnel.aspx** (accessed April 2015).

42. Christensen Associates et al., "Preserving and Protecting Freight Infrastructure and Routes" (Washington: Transportation Research Board, NCFRP Report 16, 2012).

43. For more information on the San Pedro Bay Port Climate Action Plan, see the website at **http://www.cleanairactionplan.org/** (accessed April 2015).

44. For more information on the metropolitan export and foreign direct investment planning efforts, visit the website **http://www.brookings.edu/about/projects/global-cities/exchange** (accessed April 2015).

45. The complete FAF3 documentation is available at **http://faf.ornl.gov/fafweb/Data/FAF3ODCMOverview.pdf** (accessed July 2014).

46. To learn more about the CFS, see the online summary at **www.census.gov/econ/cfs/** (accessed July 2014).

47. The United Nations country-level codes and continental groupings are available at **http://unstats.un.org/unsd/methods/m49/m49regin.htm** (accessed July 2014).

48. This correlation compares the 361 metropolitan areas shared between the two datasets. The complete ExportNation dataset and research series is available at **www.brookings.edu/about/projects/state-metro-innovation/mei** (accessed July 2014).

49. Note that EDR's estimation process caused two SCTG commodities—mixed freight (SCTG 43) and commodity unknown (SCTG 99)—to be separated individually in domestic trade but not in international trade. However, they are still included in the international totals, collapsed with the other commodity groups.

50. This report uses the modal definitions included in the Freight Analysis Framework, available at **http://faf.ornl.gov/fafweb/Data/FAF3ODDoc611.pdf** (accessed April 2015). A separate modal category, "no domestic mode," is also included in the total trade volumes throughout this report, but isnot analyzed separately in detail.

51. Due to statistical limitations, the following five metropolitan areas were not included in the database: Cape Girardeau-Jackson, MO-IL; Lake Havasu City-Kingman, AZ; Manhattan, KS; Mankato-North Mankato, MN; and Palm Coast, FL. All five were upgraded from micropolitan statistical areas to metropolitan statistical areas in the 2000s. Their trading relationships are added to the appropriate 'Remainder of State' totals.

52. For the full methodology of BEA tables, see **www.bea.gov/papers/pdf/IOmanual_092906.pdf** (accessed July 2014).

53. Note that goods can be simply consumed as well.

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