Title
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California Freight Patterns

Summary

This paper presents key statistics and trends in freight transportation in the United States and California. While California is obviously a large and integral part of the national economy, there are many important differences in shipment patterns between the state and the nation as a whole. These differences are primarily a result of California's role as an economic and social trendsetter for the country as well as its role as a "gateway" to the emerging Pacific Rim economy.

A larger share of California shipments is related to the high technology sector than the rest of the nation. By value, the top ten list of shipments for the nation is dominated by commodities that serve as products of or factor inputs for industrial activities. In contrast, the top ten list of shipments by value for California is dominated by high-value electronic equipment and other finished products. Also, while 90 percent of the total weight of California shipments originating in 1997 weighed 10,000 pounds or greater, 44 percent of the value of all shipments originating there were for shipments of less than 1,000 pounds. These findings indicate that while attention is often focused on bulky, heavy shipments and the high profile means used to move them, from an economic perspective great emphasis should be placed on smaller, high-value shipments, which are often moved by air transport. Also, during the period from 1993 to 1997, the per unit value of rail's share of shipments fell while air freight and the use of multiple modes grew. This trend again illustrates the growing importance to the California economy of high value, low weight shipments that can be easily transported by air or shifted from mode to mode.

Trucking dominates shipments in California to a greater extent than for the nation—it captures nearly 63% in ton-miles of California's shipments compared to only 38.5% for the nation as a whole. When viewed in terms of the value of shipments in California, trucking's importance increases even more, capturing more than 67% of the value of all shipments. Trucking's dominance appeared to grow during the 1990s in California as it increased its share from just under 55% to over 62% of all ton-miles from 1993 to 1997. However, in terms of the value of those shipments, trucking's share of total shipments remained flat during the same period at just under 68%.

Trucking's impact on highways is felt both in truck share of traffic, which affect traffic conditions including auto driver comfort, and in total numbers. Many of the California state routes with very high proportions of truck traffic are in sparsely populated counties where logging, agricultural, and mining activities dominate local economies. Routes with the highest overall volume of trucks are mostly located in the major metropolitan areas, serving interstate movements and providing port access. Containers and small packages both move by truck.

Ports and airports are also major freight centers in California. The Los Angeles-Long Beach ports dominate water shipments, capturing nearly 80 percent of all gross tons shipped to California in 1999. Air freight is concentrated in LAX, Oakland, Ontario, and SFO airports.

Introduction

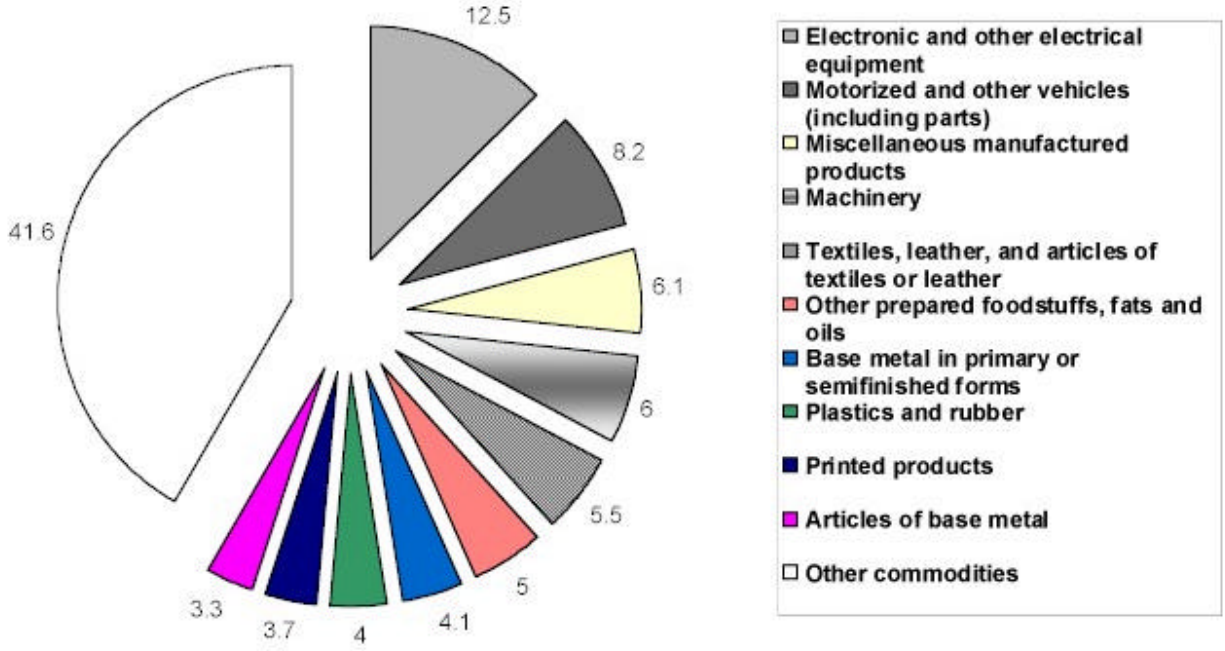
Freight transportation is a relatively small share of traffic on California's highways and at its airports, but trucking and air freight transport, along with water and rail freight transportaton and related facilities and guideways. all play critical roles in the state's economy. They also have significant social and environmental impacts. This paper examines freight transportation in California and the nation as a whole, looking at commodity flows by mode, weight and value, and identifying key issues.

What's Being Shipped: Freight Movements in California and the Nation

California's freight transport activities differ significantly from the rest of the nation. Figure 1 shows the Top 10 commodities by shipment value for the United States. Figure 2 shows the Top 10 commodities by shipment value for California. By comparing the two, we see that California has unique freight shipment patterns resulting from its position as a locus for high technology development and as a point of entry for goods from the Pacific Rim.

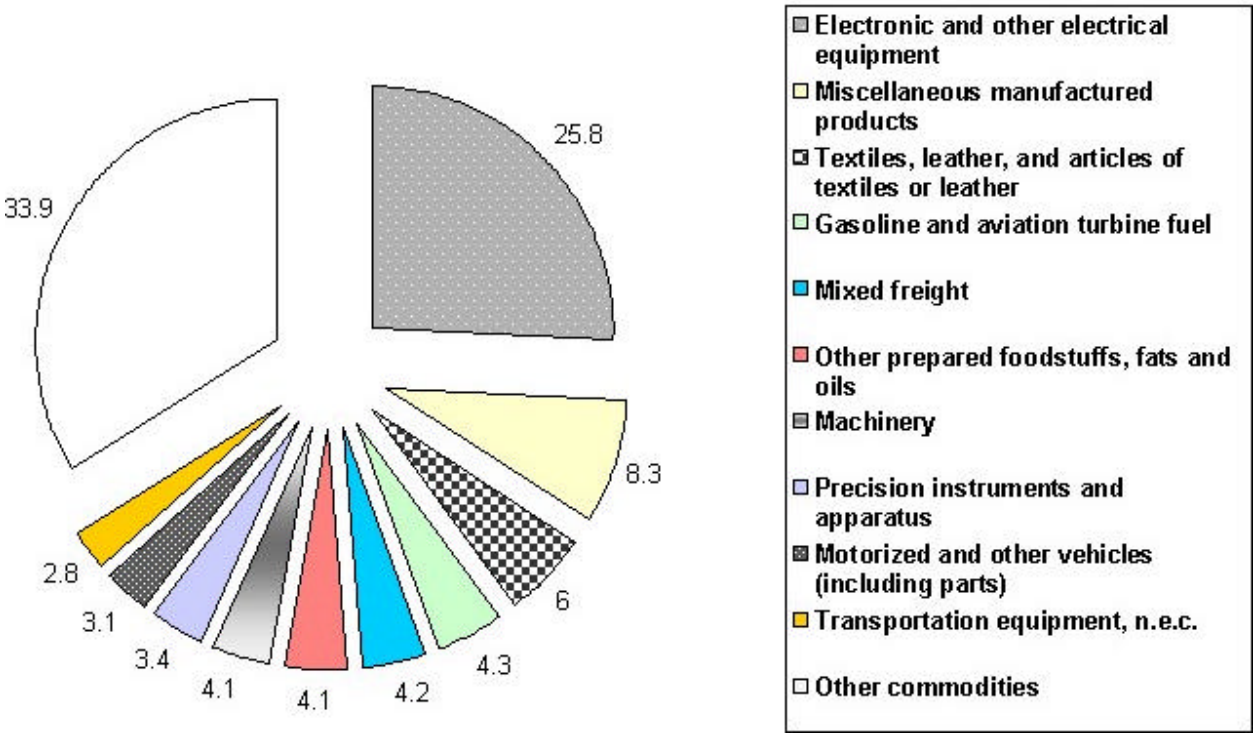
FIGURE 1:

United States' Top 10 Commodities by Shipment Value (%): 1997



Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

FIGURE 2:
California's Top 10 Commodities by Shipment Value (%): 1997



Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

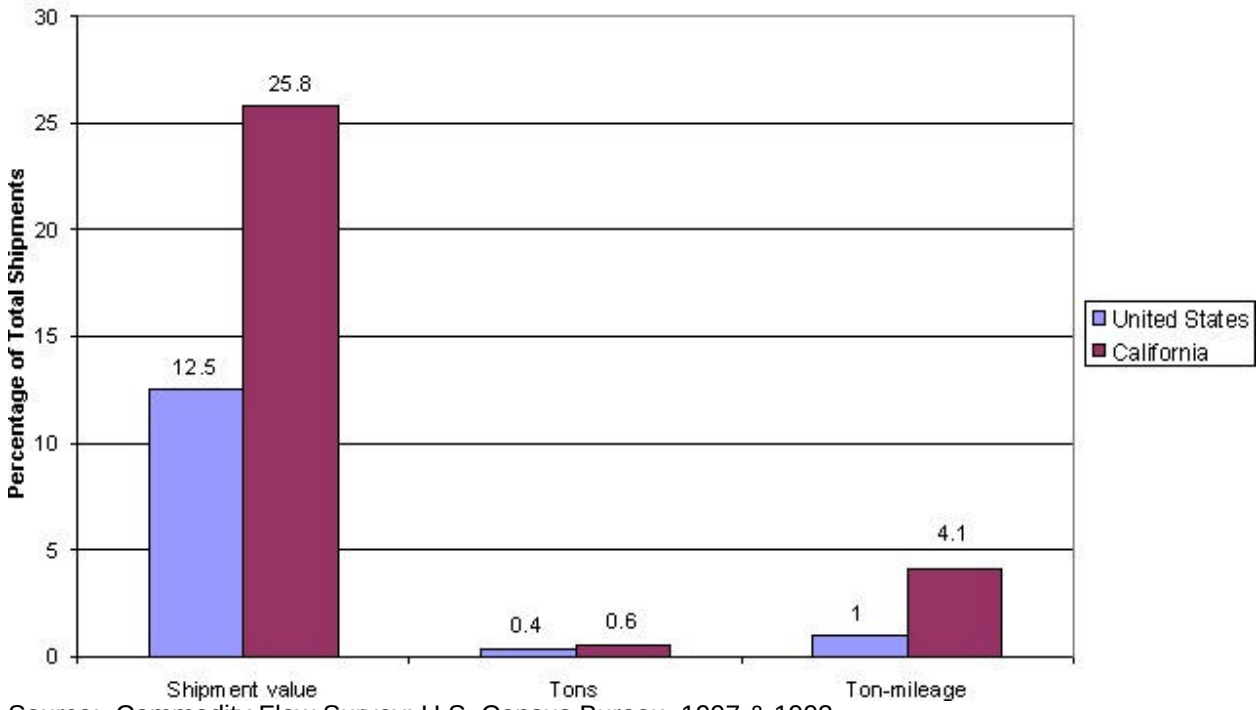
Thirty-seven percent of goods shipped in the United States can be clearly associated with an industrial economy—Miscellaneous Manufactured Products, Textiles and Leather and Products Made of Textiles and Leather, Machinery, Motorized and Other Vehicles, Miscellaneous Manufactured Products, and Base Metal—and all speak of an economy and a freight system that is heavily dependent on manufacturing. Nevertheless, the highest value category is Electronic and Other Electrical Equipment—which captured 12.5% of the total value of shipments. This highlights the growing importance of the high technology sector in the U.S. economy.

However, the differences in California's economic and freight patterns speak to the state's role as a trendsetter for the rest of the nation and its comparative advantage in electronics. Over one-quarter of the value of all state shipments were in the Electronic and Other Electrical Equipment sector—more than twice as much as in the nation as a whole. A second category in the top ten list for California—Precision Instruments and Apparatus—and its absence on the national list further emphasizes the concentration of high technology businesses in the state and the importance of the transportation system for these firms.

Since many high technology products are low weight and low bulk, measuring shipments using tons or ton-miles may underestimate the importance of these commodity flows to the state's economy. Figure 3 illustrates this point, showing that while electronic equipment captures less

than one percent of total tonnage shipped and less than four percent of ton-miles shipped in both the U.S. and California, the value of those shipments is nearly 26 percent of all shipments in California and nearly 13 percent in the U.S. as a whole. While an analysis of freight weights and volumes moved within the state may indicate this sector plays a small role due to the products' typically small weight and bulk, the high value product value shows the economic importance of these shipments.

FIGURE 3:
Electronic Equipment: Share of Total Shipments in the United States and California



Source: Commodity Flow Survey; U.S. Census Bureau, 1997 & 1993, http://www.bts.gov/ntda/cfs/prod.html.

Differences between the U.S. and California's top ten commodities shipped by value point to the State's role as a gateway from and to important Pacific Rim economies. While California has a small role in automobile manufacturing, the Motorized and Other Vehicles (Including Parts) and Transportation Equipment sectors both make it into the top ten for the state in terms of value of goods shipped. This is primarily due to California's role as a port of entry for Asian automobile manufacturers. These high weight, high bulk, high value products are offloaded in the ports of Oakland, Los Angeles-Long Beach, and San Diego and shipped out by train and truck to points throughout the state, the west, and the nation.

While many of the top ten values of shipment categories in the U.S. are unfinished products or raw materials that serve as factor inputs for further industrial processing, California's shipments of highest value are dominated by finished products of high value, particularly high technology and high value goods such as automobiles.

Heavy, bulky goods dominate, California's shipments overall. Nevertheless, according to Table 1, smaller, lighter shipments capture a much larger proportion of the total value of shipments.

Table 1:
Shipments Originating in California by Value, Tons, & Ton-miles: 1997

Weight (lbs.)	Percent of Total Shipments		
	Value	Tons	Ton-miles
0 to 99	23	1	2
100 to 999	21	2	4
1,000 to 9,999	23	7	15
10,000 to 49,999	23	37	45
50,000 +	10	53	35
Total	100	100	100

Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

While only one percent of the total weight of all shipments is in the "0 to 99" pound category, these shipments represent 23 percent of the value of all shipments originating in California. A comparison between the Value and Ton-miles of all shipments in Table 1 shows a similar pattern. While most shipments are of high weight and are shipped long distances, the value of shipments is almost evenly distributed between weight categories. With the rise of high technology production in California, the importance of low weight shipments to California's economy is growing. Table 2 illustrates this point.

Table 2:
Changes in Percent of Shipments Originating in California by Value, Tons, & Ton-miles: 1993 to 1997

Weight (lbs.)	Change in Percent of Total Shipments		
	Value	Tons	Ton-miles
0 to 99	3.9	0.0	0.0
100 to 999	0.8	0.0	0.9
1,000 to 9,999	-2.3	0.4	6.1
10,000 to 49,999	-1.0	3.0	3.5
50,000 +	-1.3	-3.4	-10.4

Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

While there were few changes from 1993 to 1997 in the weight or Ton-mile shares of total shipments for the "0 to 99" pound category, the value of these shipments increased by nearly four percentage points (roughly from 19 to 23 percent of total shipment value). Similarly, the

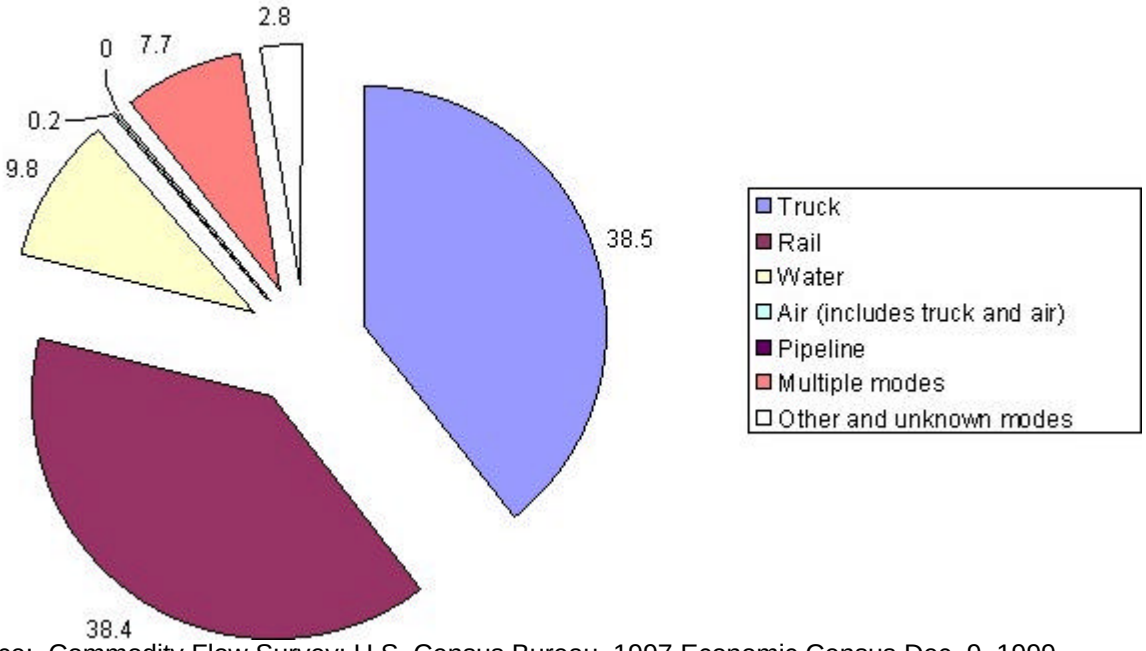
share of total shipment value for shipments over 1,000 pounds declined. These findings verify a trend in California away from bulky, high weight manufactured goods and manufacturing inputs, towards high value, high technology products.

Trends in Freight Mode Share

Freight shipments in both the United States and California are clearly dominated by truck and rail (see Figures 4 and 5). Nevertheless, there are important differences in California's freight mode share profile when compared to the rest of the nation.

FIGURE 4:

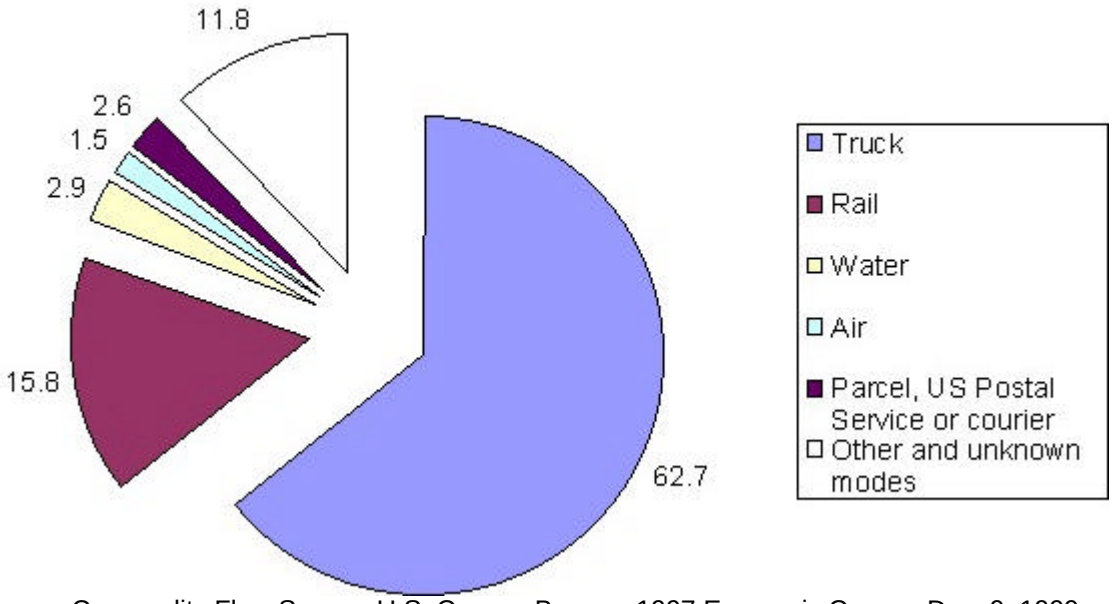
United States Shipments by Mode (Ton-miles %) 1997



Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

FIGURE 5:

California Shipments by Mode (Ton-miles %) 1997

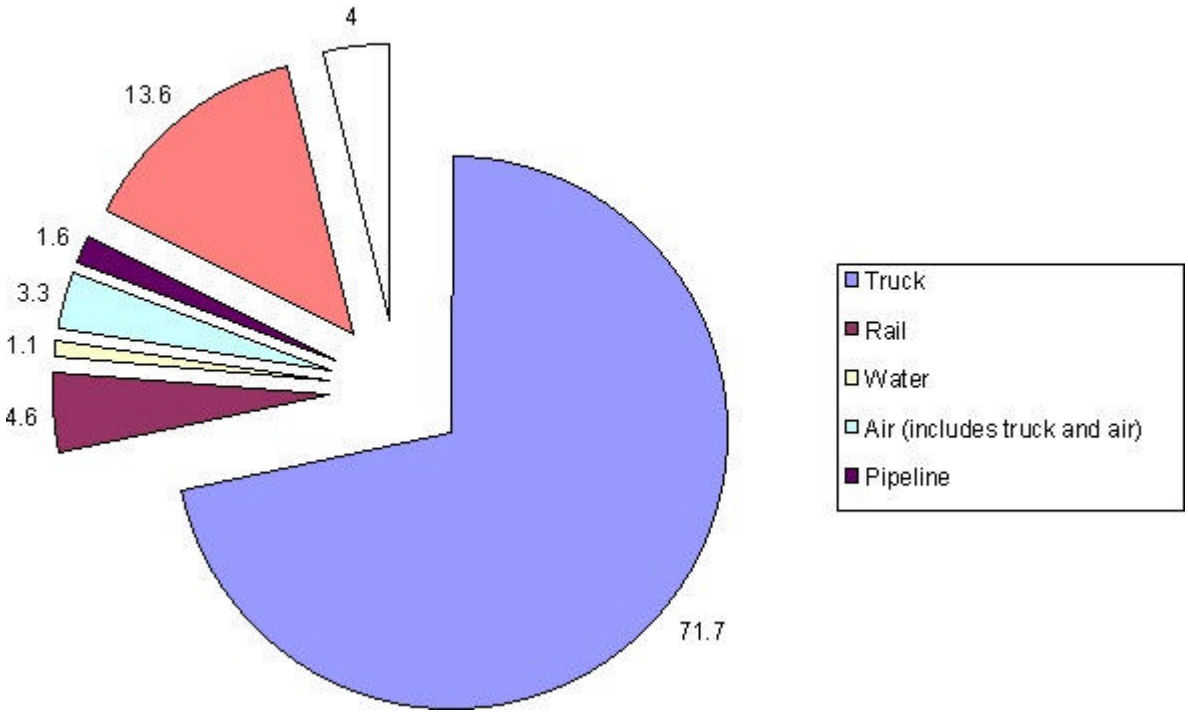


Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

First, in terms of ton-miles, rail and truck shipments in the U.S. are at virtual parity (each held roughly 39% of the mode share in 1997), but shipments in California are overwhelmingly dominated by trucks, which held nearly 63% of total ton-miles in 1997 compared to only 16% for rail. This stark difference speaks to the importance of the highway system in California for goods movement.

While Figures 4 and 5 appear to indicate that air transport plays an insignificant role in freight movements for the state and nation as a whole, there are several patterns worthy of note in the comparison of these figures. First, while air's mode share for the U.S. is 0.2% in terms of ton-miles, air transport in California captures 7.5 times the proportion of ton-miles with 1.5% of total shipments. Further, when we compare the value of shipments by air, the importance of this mode rises substantially.

FIGURE 6:
United States Shipments by Mode (Value %) 1997

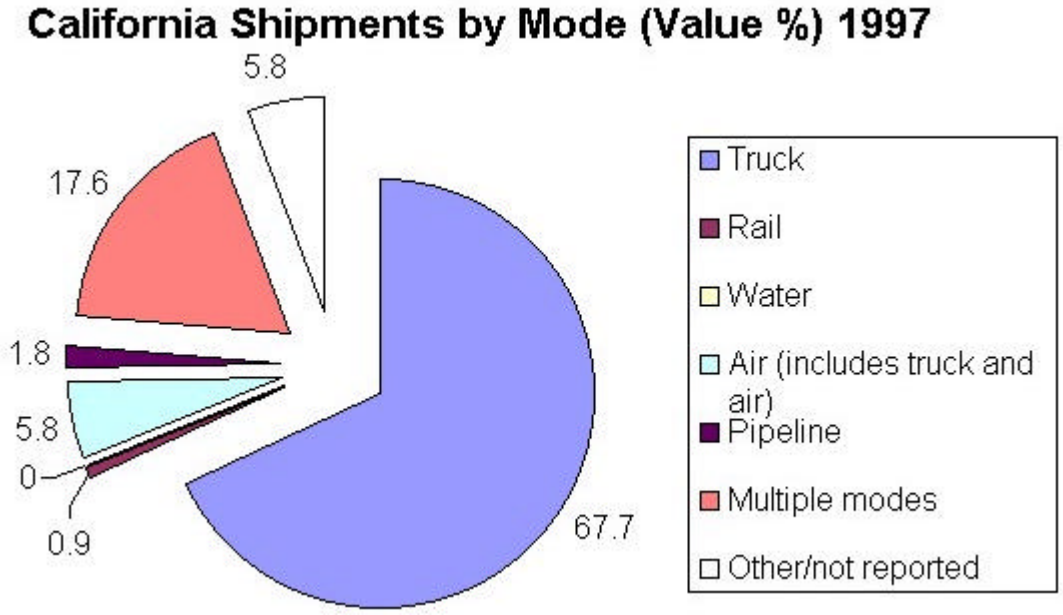


Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

Figure 6 shows freight mode share for the United States according to the value of shipments. This graph tells a dramatically different story for the relative importance of air transport. While air only captured 0.2 % of total ton-miles nationally, the value of those shipments are much higher on average, bringing air's mode share by value up to 3.3%.

Analysis of Figure 6 also changes our impressions of the relative importance of rail and trucks. While nationally, each of these modes shared roughly 39% of total ton-miles shipped in 1997, trucking's mode share jumps to nearly 72% of all shipments when analyzed in terms of dollar value for the same year. Rail's shipment value mode share is under 5%. Figure 7 shows a similar breakdown by value of shipments by mode in California, which echoes the findings discussed from Figure 6 for the nation. Clearly, trucking is critical to goods movement and the economy in general for California and the nation.

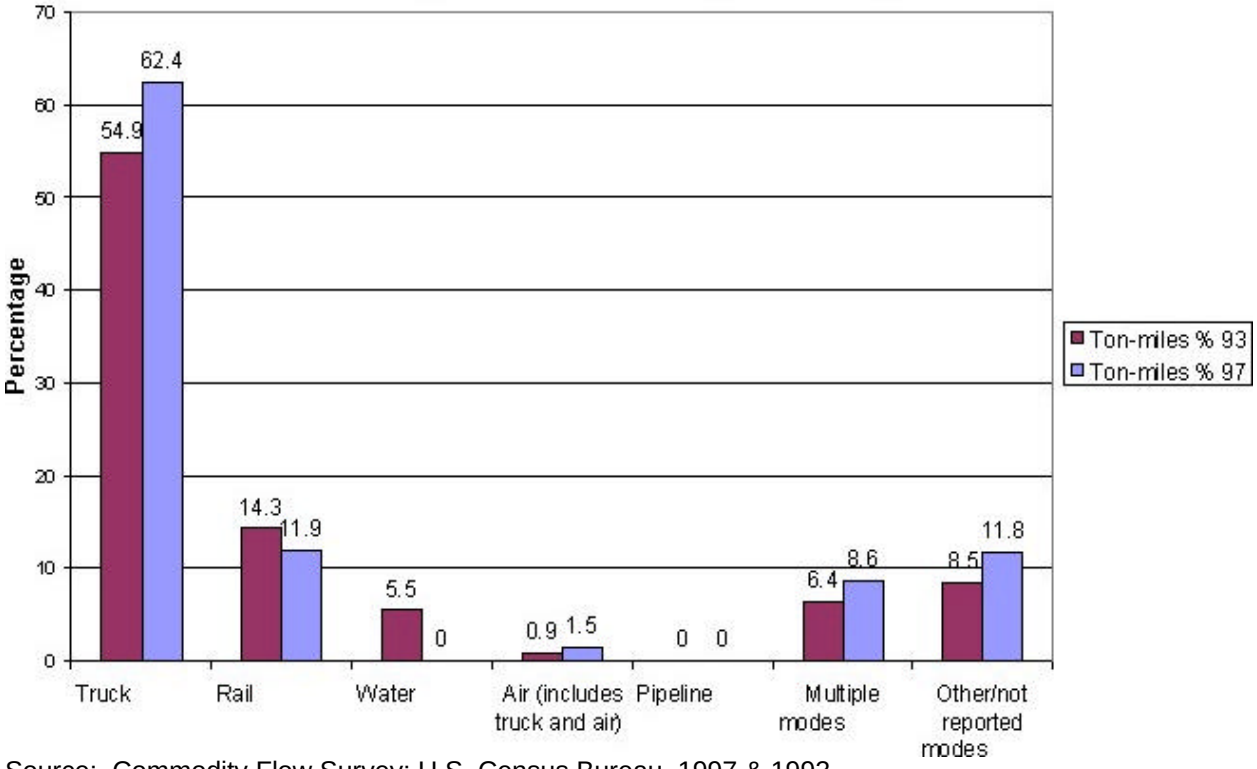
FIGURE 7:



Source: Commodity Flow Survey; U.S. Census Bureau, 1997 Economic Census Dec. 9, 1999, http://www.bts.gov/ntda/cfs/prod.html.

Furthermore, the importance of trucking in terms of mode share has been growing during the 1990s. Figure 8 shows mode share by ton-miles for California for 1993 and 1997. Analysis of Figure 8 reveals the growing importance of truck freight transport, which increased its share of ton-mile shipments from 55% in 1993 to over 62% in 1997. Air transport, the use of multiple modes, and other and unknown modes all gained during the same period. These gains were made at the detriment of rail, which dropped from just over 14% to just under 12% during the same period, as well as water transport, which fell from 5.5% to zero.

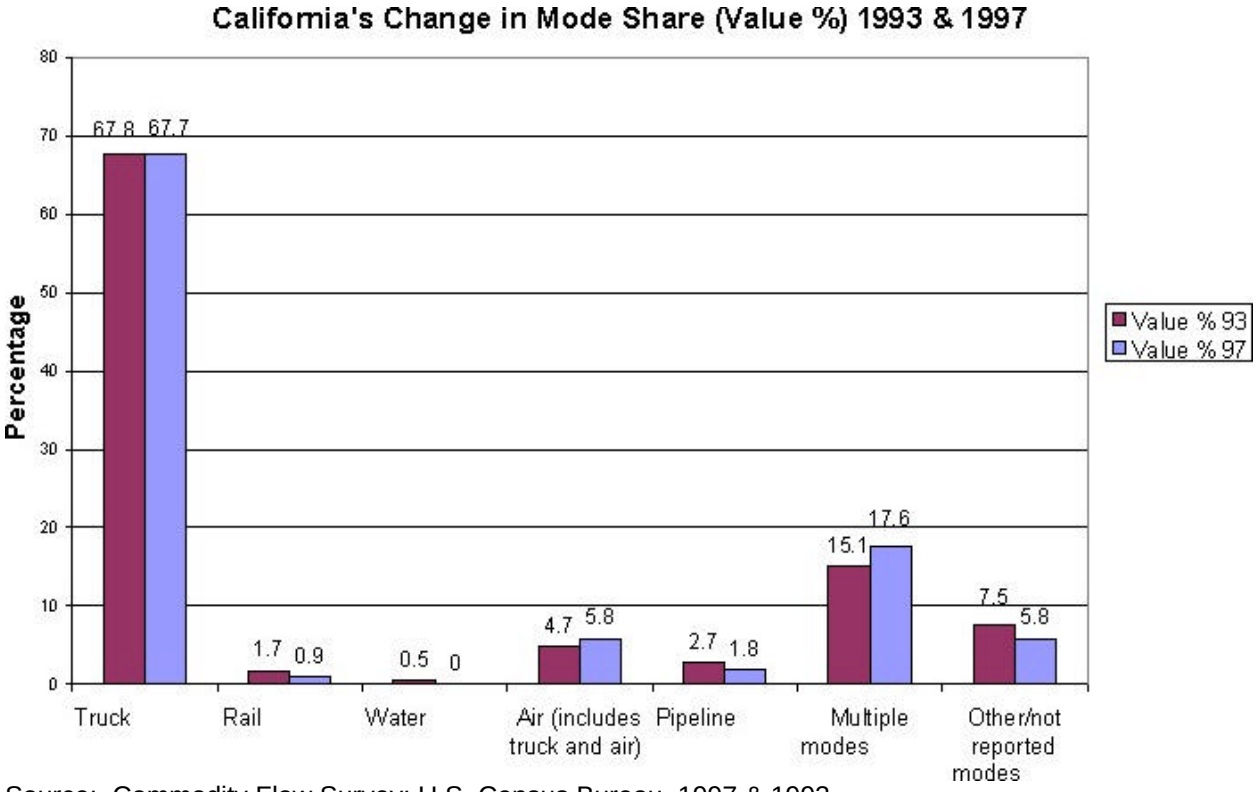
FIGURE 8:
California's Change in Mode Share (Ton-miles) 1993 & 1997



Source: Commodity Flow Survey; U.S. Census Bureau, 1997 & 1993, http://www.bts.gov/ntda/cfs/prod.html.

It is useful to compare Figure 8, which is tabulated in terms of ton-miles, to a similar breakdown in terms of shipment value. Figure 9 displays these data. A comparison of Figures 8 and 9 reveals that while trucking's share of total shipments in terms of ton-miles grew between 1993 and 1997, the total value of those shipments remained flat. This indicates that while trucking was handling more freight over longer distances in California, the value of those shipments did not increase.

FIGURE 9:



Source: Commodity Flow Survey; U.S. Census Bureau, 1997 & 1993, http://www.bts.gov/ntda/cfs/prod.html.

In fact, when we consider that the mass of these shipments by truck increased, but the value remained flat, the average value per unit shipped actually dropped during this period. The only categories that gained market share in terms of the value of commodities shipped were Air and Multiple Modes, indicating that high value, low weight goods that are easily transported by air and easily shifted from mode to mode represent an important, high growth sector of the shipping business in California.

Important Truck Freight Routes

Trucking activities and commodity flows are associated with agricultural production, resource extraction, intra-firm trade, deliveries to retail establishments, and deliveries to customers. As a result, the identification of major routes of freight activity is not a simple matter of finding the most heavily traveled routes in the densest urban areas of the state. In fact, most of the routes in the state with the largest proportion of truck traffic are in the most sparsely populated counties where logging, agricultural, and mining activities dominate the local economies. Table 3 illustrates this point, showing the routes in the state with the highest proportion of truck traffic.

TABLE 3:

Top 20 California Routes with the Highest Share of Truck Traffic (by County)

County	Route	Average Annual Daily Traffic	Average Annual Daily Truck Traffic	% Trucks	Urban Area County?
Mono	270	540	519	96.1%	
Imperial	98	5,100	2,240	43.9%	
Kern	46	4,875	1,993	40.9%	
Riverside	10	17,200	6,674	38.8%	Yes
Siskiyou	96	780	301	38.5%	
Siskiyou	97	2,800	1,060	37.9%	
San Bernardino	40	11,050	4,097	37.1%	Yes
Kern	58	14,719	4,918	33.4%	
Merced	5	21,200	6,824	32.2%	
Siskiyou	5	15,300	4,885	31.9%	
Modesto	139	1,000	313	31.3%	
San Benito	101	48,000	14,843	30.9%	
San Bernardino	58	7,900	2,433	30.8%	Yes
Shasta	36	270	80	29.6%	
Kern	43	3,075	897	29.2%	
Shasta	5	20,600	5,786	28.1%	
Kern	166	2,200	601	27.3%	
Tulare	43	1,900	518	27.3%	
Kern	33	3,550	928	26.1%	
Tulare	99	33,500	8,710	26.0%	

Notes: Data selected for routes where counts were conducted ("Verified") in 1993 or later. AADT figures for individual detector stations along routes within a single county were averaged to get a mean AADT for all traffic and trucks along each route.

Source: California Department of Transportation; Traffic Volumes On The California State Highway System (CSHS); http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm.

From a safety perspective, the routes shown in Table 3 deserve close scrutiny due to percentage of truck traffic levels and the potential for conflicts between passenger and freight traffic. Furthermore, these routes are playing critical roles in the rural economy of the state, providing valuable links from the state's resource production areas to the cities and their wider markets for finished products.

Analysis of Table 4 reveals a different story. This table focuses on major routes (those with average annual daily traffic over 30,000) with the highest truck traffic in the state. Here, the most heavily traveled routes for trucks are in agricultural counties and counties along major intra-state travel such as Interstate 5, U.S. 101, and U.S. 99. Other routes in the top 20 of this table are in major metropolitan areas, specifically on routes that lead to and from major ports—routes such as S.R. 238 in Alameda County.

TABLE 4:
Top 20 High Volume California Routes with the Highest Percentage of Truck Traffic (by County)

County	Route	Average Annual Daily Traffic	Average Annual Daily Truck Traffic	% Trucks	Urban County?
San Benito	101	48,000	14,843	30.9%	
Tulare	99	33,500	8,710	26.0%	
San Joaquin	5	42,250	9,861	23.3%	
San Bernardino	15	36,500	5,740	15.7%	Yes
Stanislaus	99	72,000	10,725	14.9%	
San Joaquin	4	58,000	7,680	13.2%	
San Benito	18	32,750	3,868	11.8%	
San Joaquin	205	73,000	8,365	11.5%	
Riverside	215	102,000	11,172	11.0%	Yes
Ventura	101	157,333	16,836	10.7%	Yes
Riverside	60	103,000	10,815	10.5%	Yes
Los Angeles	14	78,000	7,956	10.2%	Yes
Los Angeles	5	184,333	18,561	10.1%	Yes
Los Angeles	105	189,500	17,529	9.3%	Yes
Sonoma	101	83,643	7,619	9.1%	Yes
Sonoma	116	32,500	2,893	8.9%	Yes
Alameda	238	68,786	5,819	8.5%	Yes
Los Angeles	605	220,700	18,139	8.2%	Yes
Los Angeles	10	231,000	18,942	8.2%	Yes
San Bernardino	10	231,000	18,942	8.2%	Yes

Notes: "Major Routes" defined as those routes with 30,000 AADT or greater on routes where counts were conducted ("Verified") in 1993 or later. AADT figures for individual detector stations along routes within a single county were averaged to get a mean AADT for all traffic and trucks along each route.

Source: California Department of Transportation; Traffic Volumes On The California State Highway System (CSHS); http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm.

Table 4 reveals those routes that circulate traffic within and between the largest metropolitan areas in the state. As such, these routes are critical for both freight and normal vehicular traffic are likely subject to conflicts between these uses. As noted previously with reference to those routes highlighted by Table 3, these routes should be considered for safety measures designed to reduce potential conflicts between freight and non-freight uses.

Table 5 provides a third view into the state's highway freight movements. Here, the top twenty routes with high traffic volumes and the highest truck traffic counts are shown. While these routes may not have the highest percentage shares of truck traffic, they represent the routes of most importance to the trucking industry since they carry the greatest amount of absolute truck traffic.

TABLE 5:
Top 20 Major California Routes with the Highest Truck Traffic Counts (by County)

County	Route	Average Annual Daily Traffic	Average Annual Daily Truck Traffic	% Trucks	Urban County?
Los Angeles	10	231,000	18,942	8.2%	Yes
San Bernardino	10	231,000	18,942	8.2%	Yes
Los Angeles	5	184,333	18,561	10.1%	Yes
Los Angeles	605	220,700	18,139	8.2%	Yes
Los Angeles	105	189,500	17,529	9.3%	Yes
Ventura	101	157,333	16,836	10.7%	Yes
San Benito	101	48,000	14,843	30.9%	
San Mateo	101	212,750	14,011	6.6%	Yes
Alameda	980	184,000	12,678	6.9%	Yes
Alameda	880	172,400	11,325	6.6%	Yes
Riverside	215	102,000	11,172	11.0%	Yes
Riverside	60	103,000	10,815	10.5%	Yes
Stanislaus	99	72,000	10,725	14.9%	
Santa Clara	101	136,567	10,287	7.5%	Yes
Orange	5	197,000	10,266	5.2%	Yes
San Joaquin	5	42,250	9,861	23.3%	
San Mateo	380	132,500	9,726	7.3%	Yes
Alameda	680	121,111	9,371	7.7%	Yes
Alameda	80	202,500	8,857	4.4%	Yes
Tulare	99	33,500	8,710	26.0%	

Notes: "Major Routes" defined as those routes with 30,000 AADT or greater on routes where counts were conducted ("Verified") in 1993 or later. AADT figures for individual detector stations along routes within a single county were averaged to get a mean AADT for all traffic and trucks along each route.

Source: California Department of Transportation, Traffic Volumes On The California State Highway System (CSHS); http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm.

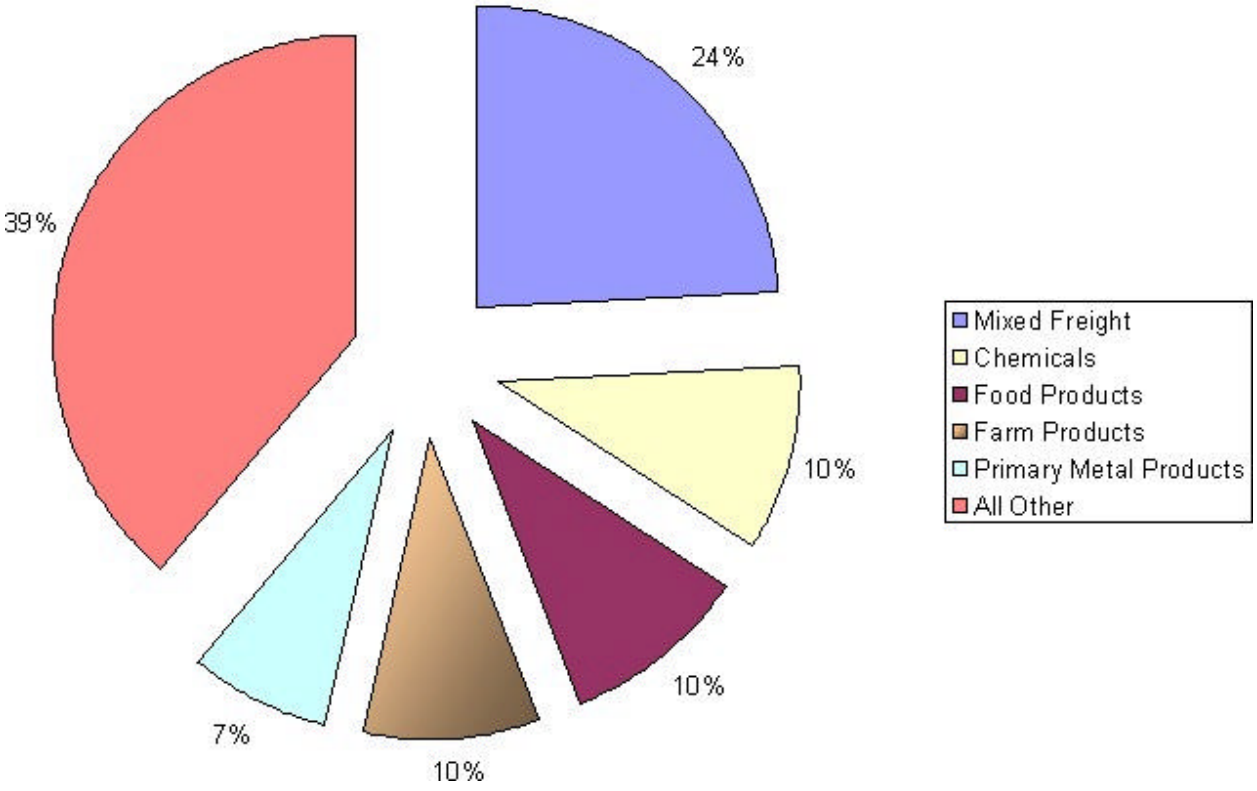
Not surprisingly, routes that are within urban areas dominate Table 5, showing that urban highway links are critical to the movement of goods within the state. Prominent among these are routes that provide access to and from air and maritime ports; routes such as Highways 101 and 380 near the San Francisco airport, Highways 80, 880, and 980 near Oakland's air and sea ports, and Highways 5, 10, and 605 near the ports and airports of Los Angeles-Long Beach.

Rail Shipment Patterns

As mentioned earlier, industrial factor inputs and agricultural products dominate rail shipments in California and the nation. However, there are significant differences between the type of shipments that originate in California, and those that reach their destination there. Figure 10 shows that the category with the largest share of shipments to California (besides the "Other" category) is mixed freight. The industrial and agricultural sectors are heavily represented, with

chemicals, food products, farm products, and primary metal products each capture from seven to ten percent of all shipment tons each.

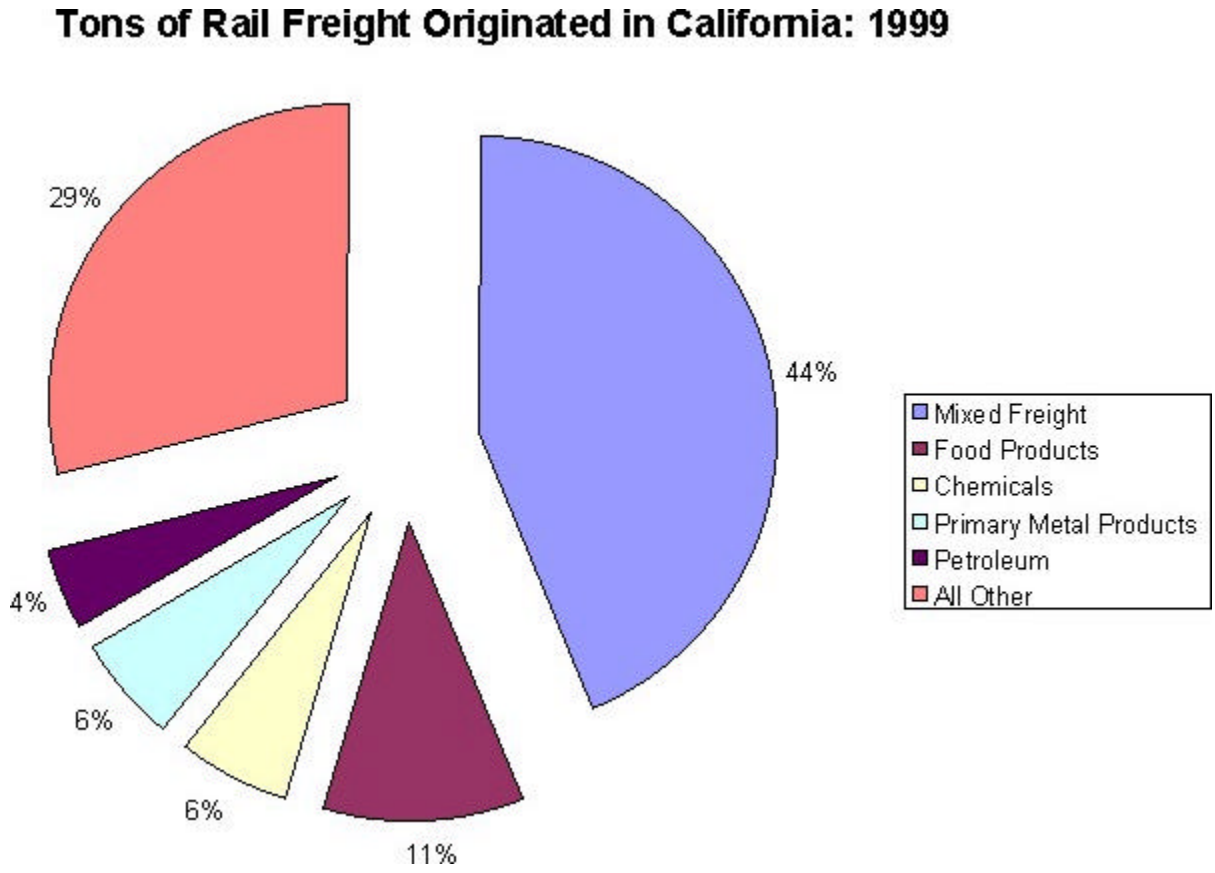
FIGURE 10:
Tons of Rail Freight Terminated in California: 1999



Source: The Association of American Railroads, 1999. http://www.aar.org/rrstates1999.nsf

Figure 11 shows the share of tons shipped from California by rail for the largest freight categories.

FIGURE 11:



Source: The Association of American Railroads, 1999. http://www.aar.org/rrstates1999.nsf

Here, mixed freight again captures the largest share of shipments (as it does for shipments destined for California), but captures a larger share of total shipment tons. Shipments with California as its origin are fully 44 percent mixed freight, as compared to 24 percent of shipments sent to California. This difference between inbound and outbound shipments shows the role of California's economy as an importer of raw and industrial production materials—as represented by the inbound categories of chemicals, food products, farm products, and primary metal products, and an exporter of a more diverse set of processed, value-added products, broadly classified as "Mixed Freight".

Air Freight

Air freight shipments in the United States, while somewhat concentrated in the largest metropolitan areas, is also concentrated in some smaller cities of the country that have some national, locational advantage or history as a major transportation hub for the nation. Table 6 shows the top twenty cargo airports for the United States in 1999.

TABLE 6:

Top 20 U.S. Cargo Airports: 1999

Rank	Airport	City, State	Gross Landed Weight (Millions of Tons)
1	Anchorage Intl	Anchorage, AK	6.40
2	Memphis Intl	Memphis, TN	5.96
3	Louisville Intl	Louisville, KY	3.81
4	Los Angeles Intl	Los Angeles, CA	2.96
5	Miami Intl	Miami, FL	2.88
6	Indianapolis Intl	Indianapolis, IN	2.78
7	John F Kennedy Intl	New York, NY	2.56
8	Honolulu Intl	Honolulu, HI	2.41
9	Cox Dayton Intl	Dayton OH	2.39
10	Newark Intl	Newark, NJ	2.07
11	Chicago O'hare Intl	Chicago, IL	1.89
12	Oakland Intl	Oakland, CA	1.77
13	Dallas/Fort Worth Intl	Dallas-Fort Worth, TX	1.72
14	Philadelphia Intl	Philadelphia, PA	1.43
15	The William B Hartsfield	Atlanta, GA	1.28
16	San Francisco Intl	San Francisco, CA	1.26
17	Ontario Intl	Ontario, CA	1.25
18	Seattle-Tacoma Intl	Seattle, WA	0.99
19	Toledo Express	Toledo, OH	0.98
20	Denver Intl	Denver, CO	0.94

Source: Federal Aviation Administration, Office of Airports. 1999 ACAIS Database. http://www.faa.gov/arp/A&D-stat.htm

Note: Source only gives statistics for those airports with annual cargo landings greater than 100 million tons.

Table 7 shows the top cargo airports for California.

TABLE 7:

Top California Cargo Airports: 1999

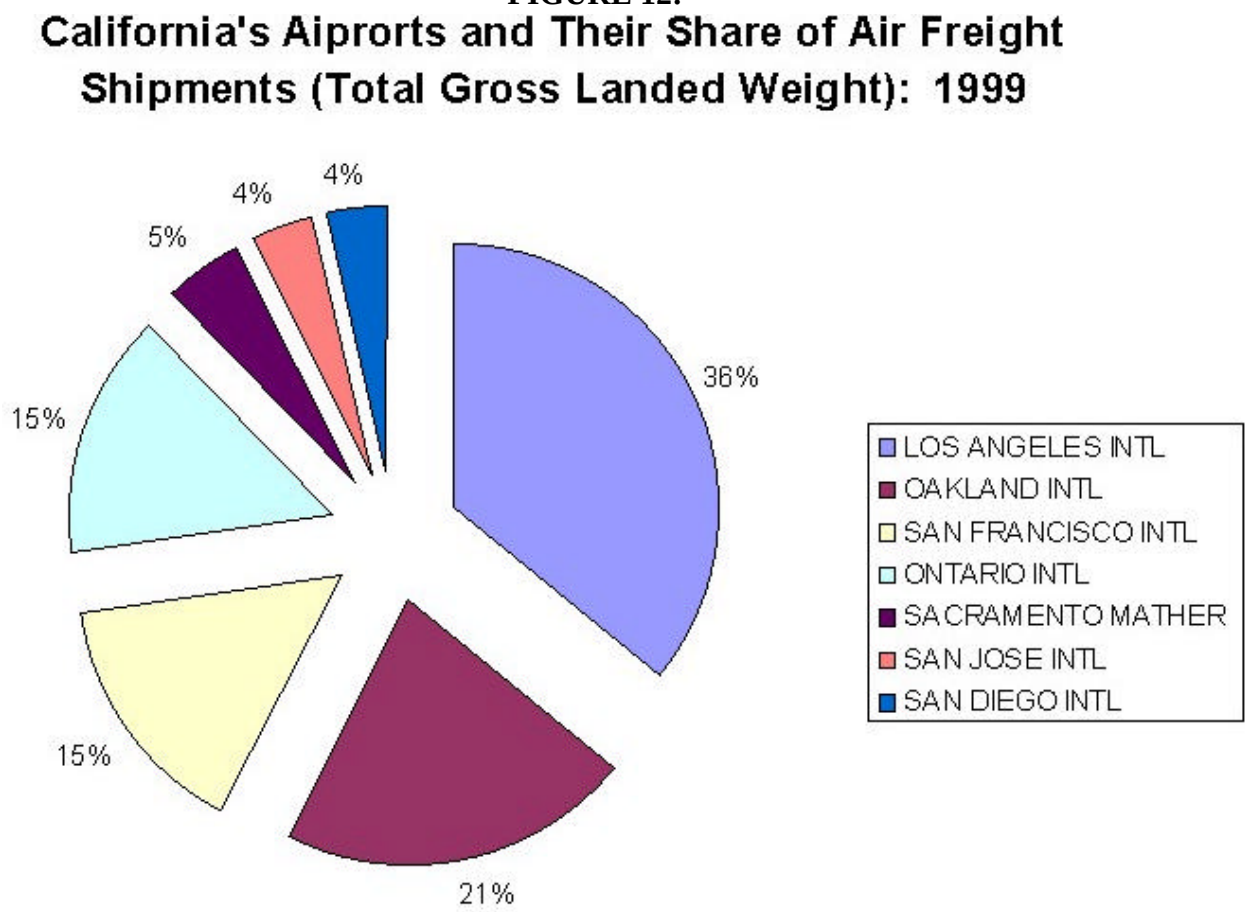
National Rank	Airport	City	Gross Landed Weight (Millions of Tons)
4	Los Angeles Intl	Los Angeles	2.96
12	Oakland Intl	Oakland	1.77
16	San Francisco Intl	San Francisco	1.26
17	Ontario Intl	Ontario	1.25
48	Sacramento Mather	Sacramento	0.38
53	San Jose Intl	San Jose	0.33
58	San Diego Intl	San Diego	0.30
93	Fresno Yosemite Intl	Fresno	0.13

Source: Federal Aviation Administration, Office of Airports. 1999 ACAIS Database. http://www.faa.gov/arp/A&D-stat.htm

Note: Source only gives statistics for those airports with annual cargo landings greater than 100 million tons.

Air freight shipments in California are heavily concentrated in the largest metropolitan area airports. Figure 12 shows the proportional share of shipments in California for its major commercial airports.

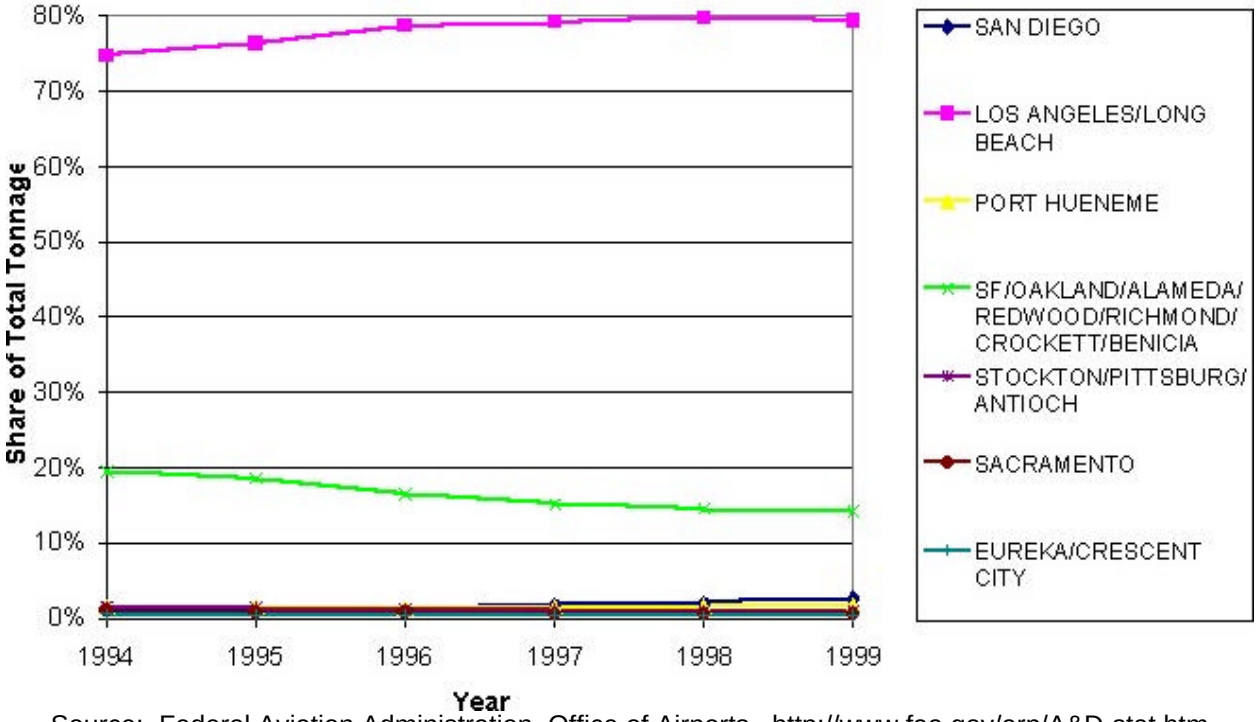
FIGURE 12:



Source: Federal Aviation Administration, Office of Airports. http://www.faa.gov/arp/A&D-stat.htm

Los Angeles International Airport (LAX) is the state's largest airport for enplanements by persons and in gross tons of landed weight air cargo. The trends shown in Figure 13 reveal that LAX's lead in air freight handling is continuing to grow, widening the gap between it and the other state's airports. In the northern part of the state, the largest share of air travel passes through San Francisco International (SFO) airport, but as seen in Figure 13, Oakland surpasses San Francisco as the major air freight airport for the Bay Area.

FIGURE 13:
Trends in the Share of Total California Shipments by Port (Tons): 1994-1999



Source: Federal Aviation Administration, Office of Airports. http://www.faa.gov/arp/A&D-stat.htm

Port Activities

The top ranked U.S. ports by annual tons handled are shown in Table 8.

TABLE 8:

Top 20 U.S. Ports: 1999

Rank	Port Name, State	Tons Handled (Millions)
1	Port of South Louisiana, LA	214.20
2	Houston, TX	158.83
3	New York, NY and NJ	133.72
4	Los Angeles-Long Beach, CA	103.15
5	New Orleans, LA	87.51
6	Corpus Christi, TX	78.15
7	Beaumont, TX	69.41
8	Baton Rouge, LA	63.73
9	Port of Plaquemines, LA	62.46
10	Valdez, AK	53.39
11	Pittsburgh, PA	52.93
12	Tampa, FL	51.52
13	Lake Charles, LA	50.74
14	Texas City, TX	49.50
15	Seattle-Tacoma, WA	46.55
16	Mobile, AL	45.44
17	Duluth-Superior, MN and WI	42.30
18	Norfolk Harbor, VA	40.78
19	Philadelphia, PA	39.27
20	Baltimore, MD	37.29

Source: U.S. Army Corps of Engineers, Navigation Data Center, Waterborne Commerce Statistics Center, New Orleans, LA.
http://www.wrsc.usace.army.mil/ndc/datappor.htm

Review of Table 8 tells us that California's only listing in the top 20 of all U.S. ports is the fourth-ranked Port of Los Angeles-Long Beach. This list would seem to indicate that California plays a small role in terms of the shipping industry when compared to the rest of the nation. However, California's importance to the nation in handling waterborne cargo is as a gateway to the Pacific Rim, and as such, serves as a platform for trade with other nations. Table 9 shows the top 20 U.S. ports ranked by tons of goods exchanged in foreign trade activities (national imports and exports).

TABLE 9:

Top 20 U.S. Ports in Foreign Trade: 1999

Rank	Port Name, State	Tons Handled (Millions)
1	Houston, TX	102.09
2	Port of South Louisiana, LA	94.74
3	Los Angeles-Long Beach, CA	78.87
4	New York, NY and NJ	63.48
5	Corpus Christi, TX	55.85
6	Beaumont, TX	53.86
7	New Orleans, LA	48.91
8	Texas City, TX	31.24
9	Lake Charles, LA	30.75
10	Norfolk Harbor, VA	30.69
11	Seattle-Tacoma, WA	29.71
12	Philadelphia, PA	25.27
13	Mobile, AL	24.06
14	Baltimore, MD	23.07
15	Freeport, TX	22.52
16	Port of Plaquemines, LA	21.85
17	SF-Oakland-Richmond, CA	21.58
18	Baton Rouge, LA	20.40
19	Tampa, FL	19.01
20	Portland, ME	18.46

Source: U.S. Army Corps of Engineers, Navigation Data Center, Waterborne Commerce Statistics Center, New Orleans, LA.
http://www.wrsc.usace.army.mil/ndc/datappor.htm

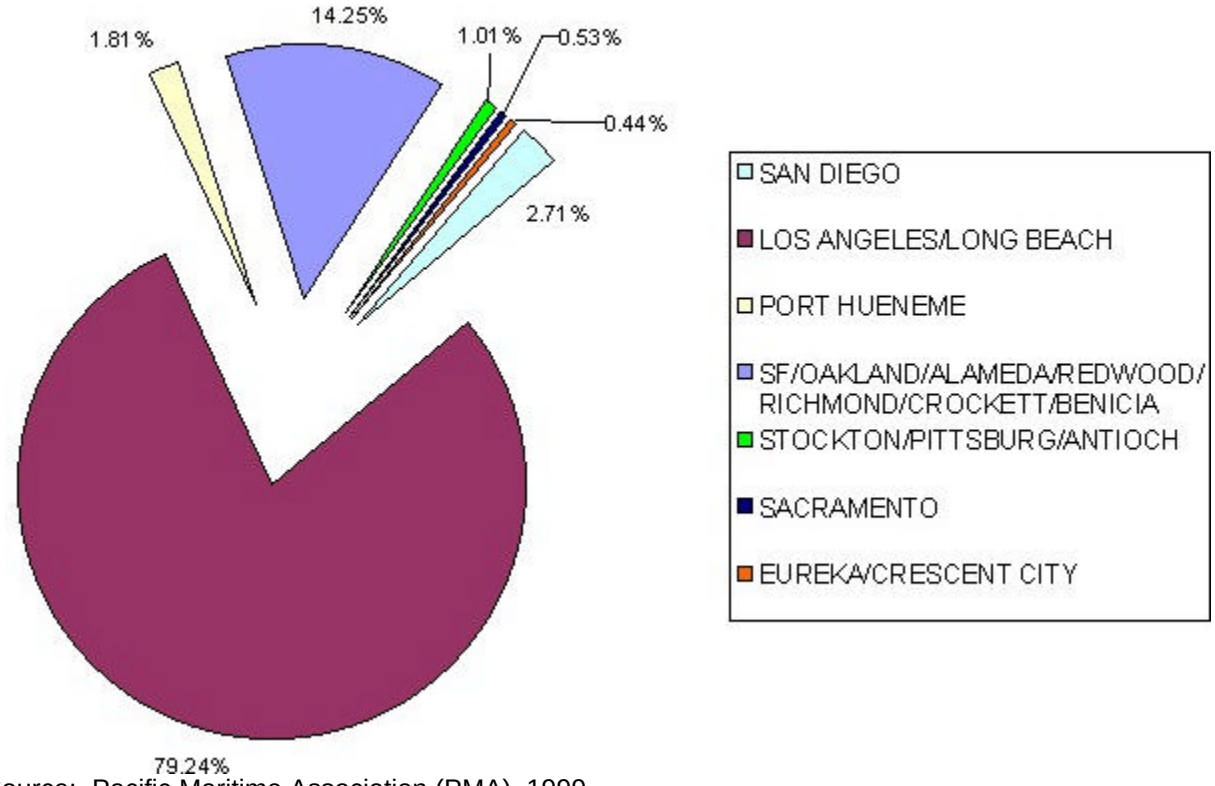
Table 9 shows that when our attention is focused on foreign trade, the Los Angeles-Long Beach port moves up to third place nationally, and the San Francisco Bay Area (SF-Oakland-Richmond) moves into the top 20 to seventeenth place. A simple calculation of national port activity data supports this point. While California ports handled only six percent of the nation's total port tons shipped in 1999, it handled more than nine percent of total foreign trade port tons.[1]

As the shipping industry moves towards greater use of containers and larger, "deep draft" ships (greater than 45 feet), competitive advantages flow towards those ports that can accommodate these trends. Container shipment activities require large land areas adjacent to the berths to house the large container handling equipment (e.g., cranes) required for quick loading and off-loading, as well as for the circulation and storage of these large containers as they are moved to and from ships, trains and trucks. The new, larger deep draft ships require ports that can accommodate their drafts in excess of 45 feet. Ports that have been able to easily shift to accommodate these trends are reaping rewards in terms of market share of shipping. Figure 14

[1] Calculated from data provided by the U.S. Army Corps of Engineers, Navigation Data Center, Waterborne Commerce Statistics Center, New Orleans, LA. http://www.wrsc.usace.army.mil/ndc/datappor.htm

suggests that in California, the ports of the Los Angeles area have been successful at capturing the vast majority of shipments (just under 80 percent) to the state when measured in tonnage.

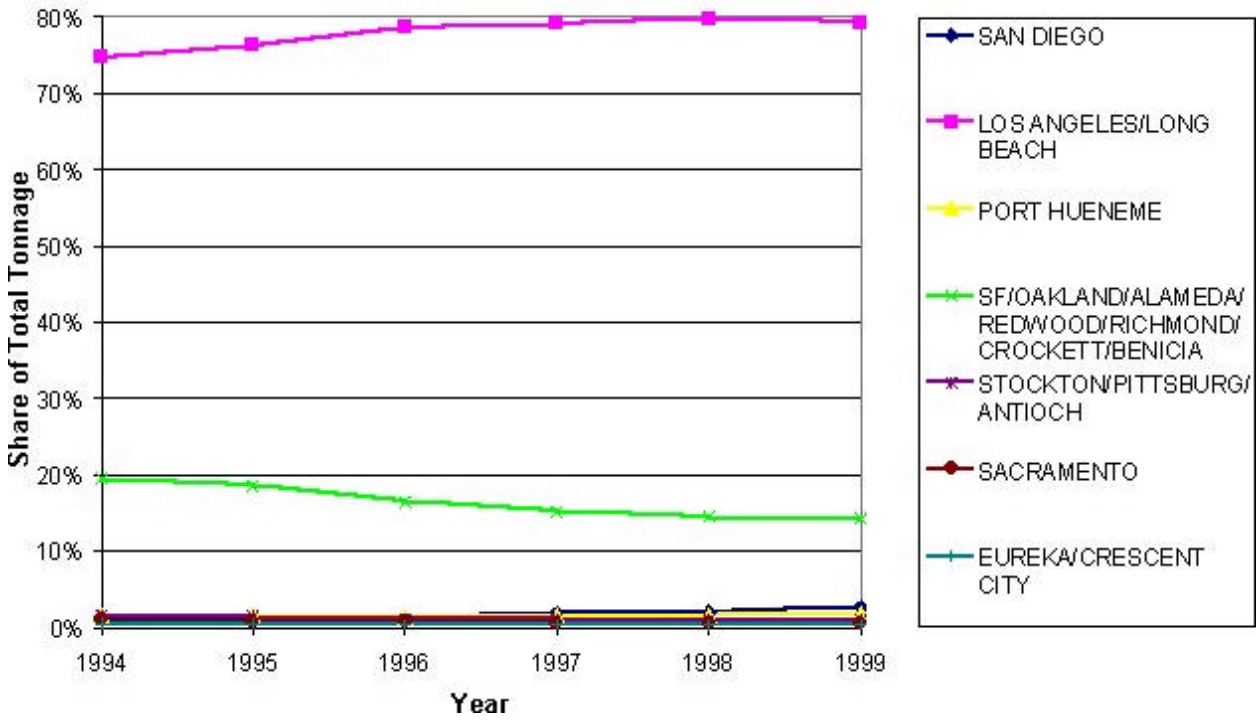
FIGURE 14:
Major Ports of California and Their Share of Total Shipments
(% Total Tonnage in 1999)



Source: Pacific Maritime Association (PMA), 1999.
http://www.pmanet.org/annualreports/1999/pages_75-86.pdf

The next largest competitor port system is the San Francisco Bay Area, whose ports captured around 14 percent of the state's total port shipments in 1999. However, according to Figure 15, the Bay Area's share of total shipments has been dropping through most of the 1990s, while Los Angeles's share has been climbing.

FIGURE 15:
Trends in the Share of Total California Shipments by Port (Tons): 1994-1999

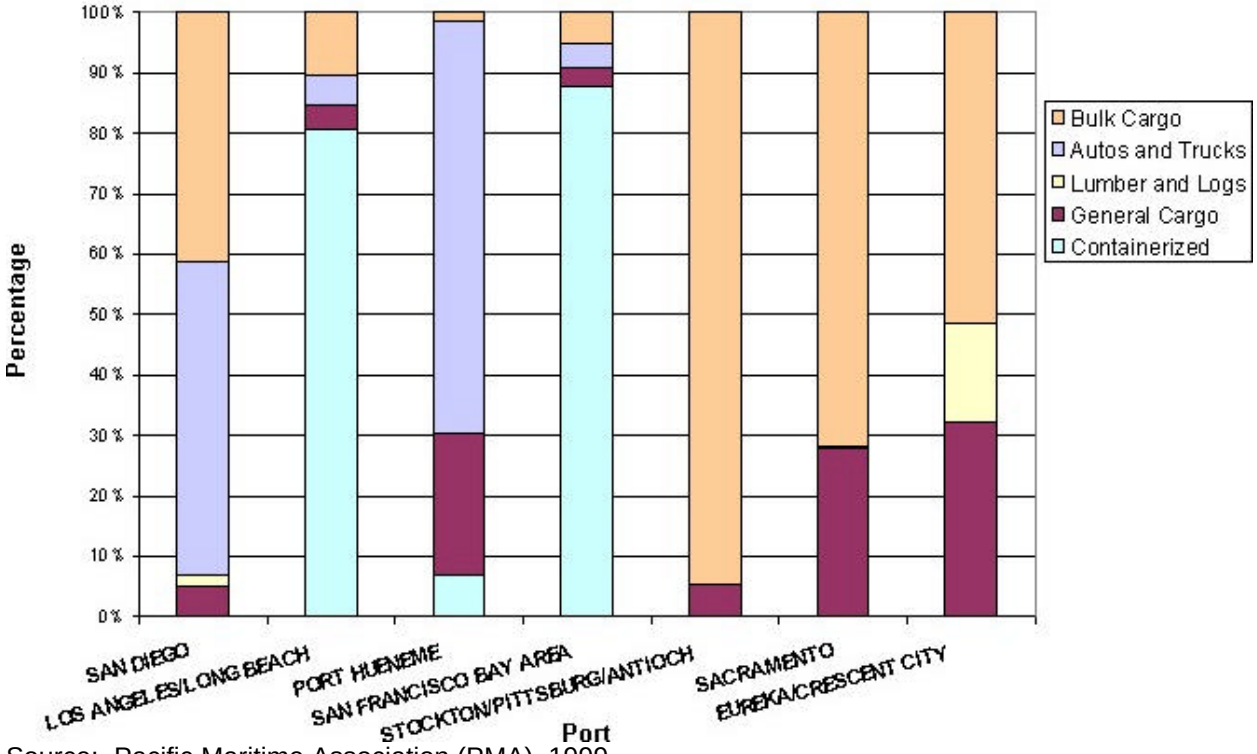


Source: Pacific Maritime Association (PMA), 1999.
http://www.pmanet.org/annualreports/1999/pages_75-86.pdf

While the San Francisco Bay Area's ports captured nearly twenty percent of total tons shipped through California's ports in 1994, its share slipped to just over fourteen percent in 1999. These losses mostly benefited the Los Angeles port system, which rose from a share of just under 75 to just over 79 percent, and San Diego, which rose from one to 2.7 percent over the same period.

While San Francisco and its associated ports have been losing ground to Southern California, the percentage of total shipments (as seen in Figure 16) shows the priority that the Bay Area has placed on capturing a larger share of the container market.

FIGURE 16:
Commodities Shipped by Port and Their Share of Total Shipments: 1999 (Tons)



Source: Pacific Maritime Association (PMA), 1999.
http://www.pmanet.org/annualreports/1999/pages_75-86.pdf

Figure 16 shows that the San Francisco Bay Area's ports have the highest percentage of shipments that are containerized of any port in the state. While the Los Angeles ports have a larger share of total container shipments, the Bay Area has come to specialize in this form of shipment more than any other port area.

Key Issues Facing California's Freight Industries

Planning for the future of California's freight industries must take several important factors into account.

First, it is reasonable to assume that with continued domestic economic growth, and the incorporation of former socialist nations into the global, capitalist economic system, the demand for freight movement will grow. In addition, the globalization of freight services will increase domestic competition for that freight business, placing strains on domestic carriers to compete on economic turf once reserved for them alone (Regan et al. 2001). These pressures and opportunities will likely motivate carriers to increase their productivity and solidify their connections to customers by being more responsive to their needs. Increasingly, information technologies will be used not only as a way to coordinate internal activities, but will also be used to connect to customers to gather information on their needs and advertise the services of the firm.

The growing importance of telecommunications and computer technologies will also enhance the role of consumers in the freight industry. As consumers utilize more online, e-commerce forms of shopping and goods acquisition, they will also demand more control over the services they receive from shippers. These demands will further drive the trends towards increased integration of information technologies with freight systems (Regan et al. 2001).

The growth of e-commerce is also likely to radically change the nature of shipments. Increased direct shipments to customers' homes will tend to decrease the average size of shipments, increase the frequency of shipments, and will place greater emphasis on the reliability of scheduled deliveries (Regan et al. 2001; DeWitt & Clinger 2001).

Firms are also using information technologies are also being used by firms to radically change the nature of production logistics. So called, "Just In Time" (JIT) deliveries of products and materials to manufacturing and retail operations when they are needed allow firms to reduce on-site stock. This strategy requires precise integration of suppliers, producers, and distribution networks to ensure that the end products are in demand, that the materials to produce the products are available, and that the freight system is in place and ready to make the connections between these actors. Information technologies, properly applied, can provide for the real-time coordination of these processes. However, the shift from a mass production, stock pilling in warehouses system of production and distribution to the JIT system will increase the importance and use of freight shipments as shippers expand their business models to become logistics companies that are essentially warehouses on wheels. These firms, called third party logistics (3PL) providers and their business in the U.S. grew from $10 billion in 1992 to $40 billion in 1998 in gross revenue (Regan et al. 2001, 4). If this growth continues, it is certain that they will place even greater strains on California's transportation infrastructure, particularly at locations that serve as terminal transition points between modes.

While shippers in past years have increased efficiencies by increasing their economies of scale (i.e., more trucks for a trucking firm), today's freight companies are finding increased efficiencies through increased economies of scope. Due to the rapidly changing requirements of the global supply chain and production system, intermodal transportation is increasingly favored since it provides flexibility for freight movement (DeWitt & Clinger 2001). The growth of intermodal transportation in California is shown in Figures 8 and 9. This means that competitiveness in today's logistics industry (and by implication, tomorrow's as well) will be found in the ability to coordinate multiple modes (Regan et al. 2001). It is reasonable to assume that if these trends continue, increased demand for California to improve the diversity, quality, and most importantly, the integration of its freight shipment modes will result. These needs can be addressed in two ways. First, traditional infrastructure improvements will be needed to address the growth in demand for freight services. Improvements to intermodal transport will require upgrades to terminal, interchange points between modes such as ports, rail yards, airports, and trucking distribution centers. California needs to be ready to respond to technological changes in the freight industry that may have serious implications for these interchange points. Efforts to develop new transportation technologies such as FastShip, which could cut ocean shipping time in half, and RoadRailer which would permit low cost transfer

between truck and rail (DeWitt & Clinger 2001), may leave California' s ports and rail yards ill-equipped to handle the new transportation patterns that would accompany these changes.

Second, traditional infrastructure should be augmented with information technologies to improve intermodal coordination (DeWitt & Clinger 2001). As the capabilities of freight handlers are improved to track individual packages in real-time through electronic tagging systems, the capabilities to manage terminal operations and intermodal transfer points will be enhanced (DeWitt & Clinger 2001), further increasing the flexibility and cost-competitiveness of multimodal freight systems. While these improvements are made within the terminals, the public infrastructure of California will need to improve its operations as well to keep pace. Information technologies, in the form of Intelligent Transportation Systems (ITS), will surely play an important role in these efforts.

Conclusions

With increasing dispersal of employment centers from traditional core metropolitan areas, the flexibility of trucking to supply manufacturing inputs and distribute manufactured outputs to markets for California's economic system is leading to the dominance of this mode in handling freight. Furthermore, trucking is of critical importance to the agricultural and raw materials extraction sectors of the state's economy. If California intends to maintain its role as an agricultural and raw materials production center, the state's rural road system must be maintained and improved to provide the means to transport these goods to market.

When viewed by the value of shipments, the growth of air and other multi-modal means of shipments are shown to be of particular importance. The speed and convenience of air shipments for handling high value, low weight products is tied, in part, to the state's high technology, knowledge-intensive industries. However, air freight is also of critical importance to the multi-sectoral global system of production that relies on "just-in-time" deliveries and manufacturing. Access to airports for high value, high technology freight movements provides a competitive advantages to the Los Angeles and San Francisco Bay Area economies, linking them directly to the developing global production system. It is likely that industries will favor the locational advantages that proximity to these air connections offers.

The growth in multi-modal freight shipments indicates the importance of an integrated, flexible state freight transportation system. California's transportation policy-makers should consider the importance of improving ground freight transportation systems around airports.

Finally, due to the rising importance of multimodal freight transportation systems, and the growing use of information technologies to manage the movement of freight by logistics firms, California's ability to apply information technologies in a similar manner to the links in the transportation system that are under its control could prove to be a critical issue. California's local, regional, and state transportation planning and financing agencies should work towards the tight integration of ITS systems deployments and those systems currently being developed and deployed within the freight and logistics industries.

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