

Arizona Multimodal Freight Analysis Study



Technical Memorandum #3 Appendix A

The Economic Significance of the Freight Transportation Industry in Arizona

September, 2008

Table of Contents

Economic Impact Assessment Methodology	A-2
<i>Infrastructure Indicators</i>	<i>A-2</i>
<i>Operating Indicators.....</i>	<i>A-4</i>
Impact of Domestic and International Trends on Freight in Arizona.....	A-9
<i>Supply Chain Management.....</i>	<i>A-9</i>
<i>Foreign Exchange Fluctuations</i>	<i>A-10</i>
<i>Emerging and Expanding Foreign Markets</i>	<i>A-10</i>
<i>Inland Ports</i>	<i>A-11</i>
<i>Distance and Time as Factors for Trade</i>	<i>A-12</i>
Economic Significance of the Transportation Industry in Arizona	A-13

Table of Exhibits

Exhibit A-1: Public Roadway Mileage, 2005	A-3
Exhibit A-2: Roadway Infrastructure Conditions, 2005	A-3
Exhibit A-3: Infrastructure Grade by State, 2008.....	A-4
Exhibit A-4: Operating Railroads and Corresponding Mileage, 2005	A-4
Exhibit A-5: Truck Transportation Trade with NAFTA and Mexico, millions 2007\$	A-5
Exhibit A-6: Rail Transportation Trade with NAFTA and Mexico, millions 2007\$	A-5
Exhibit A-7: State Exports as a Percentage of Gross State Product, 2006	A-6
Exhibit A-8: Transportation and Warehousing Employment 2006	A-6
Exhibit A-9: Establishments in the Transportation and Warehousing Industry Sector	A-7
Exhibit A-10: Percent of Transportation and Warehousing Establishments of Total - 2006	A-8
Exhibit A-11: Commercial Truck Tractor and Trailer Registrations, 2001 and 2006.....	A-8
Exhibit A-12: Employment -Transportation and Warehousing Industry (2006).....	A-14
Exhibit A-13: Income - Transportation and Warehousing Industry (2006)	A-15
Exhibit A-14: Output - Transportation and Warehousing Industry (2006)	A-16
Exhibit A-15: Economic Significance of Transportation and Warehousing in 2014	A-16

Economic Impact Assessment Methodology

Arizona's transportation and warehousing industry, including various subsectors, serves the overall economy by facilitating trade and providing the requisite foundation for the operations and sustainability of all the other industry sectors through the movement of intermediate production inputs and final goods and services. Additionally, transportation and warehousing, as an industry itself, contributes to total employment, income, and gross domestic product within the State.

Significance of the transportation and warehousing industry to the economy of Arizona is quantified in two distinct measures: the direct economic effect and the multiplier effects (indirect and induced). Both effects are enumerated by employment, income, and gross state product (economic output). Direct economic effects result from expenditures only within the transportation and warehousing industry. Multiplier effects are comprised of both the indirect and induced effects. Indirect effects are the result of expenditures by the transportation and warehousing industry on other industries within the economy, with those supporting industries hiring employees, paying wages, and producing the goods and services purchased by the transportation and warehousing industry (economic output). Induced effects incur as a result of the expenditures of earned income by employees in both directly and indirectly affected industry sectors and the recirculation of that income throughout the economy. Total economic significance of the transportation and warehousing industry is captured by summing the direct and multiplier effects.

In this analysis, the facilitating effects of transportation and warehousing on the operations of the other industry sectors in the economy, which invariably rely on transportation, are not taken into consideration because estimating the facilitating effect is quantitatively difficult. Nonetheless, the very nature of the transportation and warehousing industry is the underpinning of the market economy and its function as a market facilitator is not inconsequential.

Freight and logistics industries within Arizona compete and collaborate with similar and disparate industries in both proximity and distant geographies and markets. Because of this interaction, it is important to understand the relative merits and competitive advantages of the freight and logistics industries within Arizona compared to those within other geographies. In this section, a number of indicators pertaining to the relative physical size and economic performance of the freight and logistics industry in Arizona are benchmarked against those in the five bordering states: California, New Mexico, Utah, Nevada, and Colorado.

Infrastructure Indicators

For any economic region the extent of the physical transportation infrastructure determines the underlying capability and capacity of the freight and logistics industries to facilitate goods and services movements. A detailed discussion of Arizona's freight infrastructure was presented in Technical Memorandum #2. Some indicators pertaining to the physical transportation infrastructure within Arizona are reiterated here for comparative purposes.

As of 2005, Arizona claims 59,789 miles of roadways, including highways, arterials, and local roads, of which, 2.0%, or 1,169 miles comprise the interstate network. Only Utah, of the five comparison states, has a percentage of total roadway miles attributable to interstate highways

**Arizona Multimodal Freight Study
Technical Memorandum #3: Appendix A**

greater than the respective percentage in Arizona, see **Exhibit A-1**. A relatively high percentage of interstate mileage, of total roadway mileage, is an indication that Arizona is well poised to accommodate long-distance traffic, including freight, in terms of infrastructure availability.

Exhibit A-1: Public Roadway Mileage, 2005

State	Interstate		Arterials		Collectors		Local		Total	
	miles	%	miles	%	miles	%	miles	%	miles	%
Arizona	1,169	2.0%	5,876	9.8%	8,163	13.7%	44,581	74.6%	59,789	100.0%
California	2,460	1.4%	28,476	16.8%	31,869	18.8%	107,101	63.0%	169,906	100.0%
Colorado	956	1.1%	9,236	10.5%	16,250	18.6%	61,155	69.8%	87,597	100.0%
Nevada	562	1.6%	3,064	8.8%	5,007	14.5%	25,991	75.1%	34,624	100.0%
New Mexico	1,000	1.6%	5,088	8.0%	8,485	13.3%	49,186	77.1%	63,759	100.0%
Utah	940	2.2%	3,469	8.0%	7,745	17.8%	31,419	72.1%	43,573	100.0%
United States	46,608	1.2%	404,600	10.1%	790,495	19.8%	2,753,932	68.9%	3,995,635	100.0%

Source: State Transportation Statistics, 2006; Bureau of Transportation Statistics

In addition to the relatively extensive highway network, which favors freight and logistics industries, the entire roadway network in Arizona is considered in better condition than a majority of the roadway infrastructure networks in the comparison states and the nation as a whole, based on the International Roughness Index. As indicated in **Exhibit A-2**, 56.8% of the roadway mileage in Arizona is rated as either very good or good (representing 37.5% and 21.1%, respectively). With the exception of Nevada, not one of the other comparable states, or the nation, claims a “very good” percentage rating of total roadway miles that approaches the percentage exhibited in Arizona.

Exhibit A-2: Roadway Infrastructure Conditions, 2005

State	Very Good	Good	Fair	Mediocre	Poor	Unreported
Arizona	37.5%	21.1%	28.6%	5.7%	2.6%	4.5%
California	2.6%	17.2%	41.3%	20.9%	17.8%	0.1%
Colorado	11.2%	35.5%	41.7%	8.6%	3.0%	0.1%
Nevada	39.4%	24.4%	27.3%	4.8%	3.1%	1.0%
New Mexico	19.9%	19.9%	28.4%	22.1%	9.2%	0.5%
Utah	9.0%	30.5%	55.3%	3.7%	1.5%	0.2%
United States	12.9%	27.8%	41.5%	10.4%	7.0%	0.5%

Source: State Transportation Statistics, 2006; Bureau of Transportation Statistics

In terms of overall statewide infrastructure, including the transportation network, each state is assessed a grade by the PEW Center on the States, based on the efficacy of the state planning process and the ability to monitor and address the arising needs of capital projects. Arizona is assigned a “B-” infrastructure grade, the same as the average of all fifty states. California and Nevada are also designated a rating equal to the nationwide average. Only Utah, of the comparable states to Arizona, is attributed a grade higher than that given to Arizona; in fact, it is the only state in the nation designated the highest available grade, that is, an “A”. New Mexico and Colorado are given a “C+” for their infrastructure, see **Exhibit A-3**.

Exhibit A-3: Infrastructure Grade by State, 2008

State	Grade
Arizona	B-
California	B-
Colorado	C+
Nevada	B-
New Mexico	C+
Utah	A
United States	B-

Source: Measuring Performance, State Management Report Card for 2008, PEW Center on the States, Government Performance Project, March 2008

Arizona's statewide railroad network has the same number of Class 1 lines as the other five comparable states; however, the miles operated by those rail lines in Arizona are fewer than the miles operated in the other states, excluding Nevada, see **Exhibit A-4**.

Exhibit A-4: Operating Railroads and Corresponding Mileage, 2005

State	Class I		Regional		Local		Switching and terminal		Total	
	lines	mi.	lines	mi.	lines	mi.	lines	mi.	lines	mi.
Arizona	2	1,287	0	0	6	325	2	203	10	1,815
California	2	3,993	1	52	15	1,271	11	475	29	5,791
Colorado	2	2,048	3	157	5	246	3	78	13	2,529
Nevada	2	1,200	0	0	0	0	0	0	2	1,200
New Mexico	2	1,589	0	0	2	94	1	310	5	1,993
Utah	2	1,330	0	0	2	58	2	81	6	1,469
United States	7	95,664	30	15,388	320	22,519	203	6,678	562	140,810

Source: State Transportation Statistics, 2006; Bureau of Transportation Statistics

Operating Indicators

While the physical transportation infrastructure is the underlying factor in determining the capacity of the freight and logistics industries, operations must also be taken into account and compared. Technical Memorandum #1 provides an overview of statewide freight movements; however, a few key operational indicators are reiterated here, as well as some indicators not previously discussed. These indicators are then compared to the same indicators for the states neighboring Arizona.

A significant portion of international trade in the United States is conducted with Canada and Mexico. In 2005, 30.7% of all international trade in the United States, by value, was conducted with NAFTA trading partners.* **Exhibit A-5** depicts the value of trade (in current millions of dollars) between states in the Southwest and NAFTA partners (combined Canada and Mexico, and Mexico exclusively) via truck transportation. **Exhibit** depicts the value of trade (in current millions of dollars) between states in the Southwest and NAFTA partners by railroad transportation. Presented trade values are in 2007 dollars for 2007.

* North American Freight Transportation: U.S. Trade with Canada and Mexico. Bureau of Transportation Statistics. June 2006.

**Arizona Multimodal Freight Study
Technical Memorandum #3: Appendix A**

Exhibit A-5: Truck Transportation Trade with NAFTA and Mexico, millions 2007\$

with NAFTA					with Mexico				
Rank	State	Total Trade	Exports	Imports	Rank	State	Total Trade	Exports	Imports
14	Arizona	11,604.08	5,698.64	5,905.44	4	Arizona	9,607.40	4,431.43	5,175.97
2	California	65,247.91	25,901.59	39,346.31	2	California	46,387.96	15,260.69	31,127.26
26	Colorado	4,198.74	2,195.53	2,003.21	23	Colorado	1,481.26	819.95	661.31
41	Nevada	1,352.20	576.12	776.08	38	Nevada	363.59	110.20	253.39
42	New Mexico	1,183.39	507.68	675.71	29	New Mexico	830.02	355.82	474.21
35	Utah	2,206.18	959.15	1,247.04	35	Utah	581.68	162.67	419.02

Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, TransBorder Freight Data

In terms of NAFTA trade by truck, Arizona ranks 14th among all the states, exporting about \$5.7 billion and importing a comparable \$5.9 billion. In terms of trade by truck with Mexico, Arizona ranks 4th among all states, and second among the comparison states exporting \$4.4 billion and importing \$5.1 billion. California is the only state of the five comparison states that exhibits larger trade values with either NAFTA as a whole, or individually with Mexico.

Trucking, as a share of all freight transportation modes, accounted for 86 percent of the value of all commodities moved in Arizona. The predominance of trucking as the preferred mode is supported by the significant value of international trade, primarily with Mexico. International, long-haul trucking is a significant industry sector in Arizona. Arizona trades more extensively with NAFTA as a whole, and Mexico, individually, in terms of annual dollar value of trade by truck transportation, than the aggregate trade of all the comparison states, less California, (**Exhibit A-5**).

In terms of trade by rail transportation, Arizona ranks 33rd in NAFTA trade and 13th for trade by rail with Mexico. Arizona's NAFTA trade by rail amounted to \$757 million. Among the comparison states, Arizona was third, behind California and Colorado, in NAFTA trade by rail, and second in rail trade with Mexico (**Exhibit A-6**).

Exhibit A-6: Rail Transportation Trade with NAFTA and Mexico, millions 2007\$

with NAFTA					with Mexico				
Rank	State	Total Trade	Exports	Imports	Rank	State	Total Trade	Exports	Imports
33	Arizona	756.56	371.55	385.01	13	Arizona	430.76	319.56	111.19
2	California	14,902.43	2,051.08	12,851.36	4	California	2,358.58	904.34	1,454.24
28	Colorado	845.22	273.84	571.38	32	Colorado	128.68	83.31	45.37
40	Nevada	410.86	119.36	291.50	45	Nevada	9.90	1.04	8.86
47	New Mexico	139.70	60.99	78.71	39	New Mexico	48.64	14.53	34.11
42	Utah	261.18	53.21	207.98	42	Utah	27.96	27.14	0.82

Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, TransBorder Freight Data

It should be noted that, for either major surface transportation mode, Arizona exhibits a relatively more favorable NAFTA trade balance than most of the comparison states. A majority of the comparison states, with Colorado the exception, have trade imbalances with NAFTA trading partners, generally importing more in terms of dollar value than exporting.

International trade, measured as a percentage of gross state product, can be a proxy measure for the relative extent to which the freight and logistics industries serve long-distance trade within a

state. **Exhibit A-7** displays the percentage of exports to gross state product of the comparison states in 2006. Arizona exhibits the largest percentage of export trade value to gross state product, at 7.9%. A relatively large percentage finding indicates that the economy in Arizona is more reliant on international trade than the economies of its neighbors, suggesting the freight and logistics industries in Arizona serve a relatively larger facilitating role.

Exhibit A-7: State Exports as a Percentage of Gross State Product, 2006

State	Percent
Arizona	7.9%
California	7.4%
Colorado	3.5%
Nevada	4.6%
New Mexico	3.8%
Utah	7.0%
United States	7.9%

Source: TradeStats Express, State Export Data: Office of Trade and Industry Information (OTII), Manufacturing and Services, International Trade Administration, U.S. Department of Commerce

Another proxy measure for the economic significance of freight and logistics industries is the percentage of total statewide employment that is employed in those industries. Although Arizona has higher foreign export trade per gross state product compared with its neighboring states, the percentage of total employment in the transportation and warehousing industry sector is not significantly different. In 2006, Arizona's percentage of transportation and warehousing industry employment was the average among the comparison states (**Exhibit A-8**).

Exhibit A-8: Transportation and Warehousing Employment[†] 2006

State	Transp. & Wareh.	Total Emp.	Percent
Arizona	90,681	3,366,381	2.7%
California	542,277	20,530,550	2.6%
Colorado	84,745	3,175,505	2.7%
Nevada	53,175	1,611,973	3.3%
New Mexico	26,505	1,099,758	2.4%
Utah	52,430	1,591,686	3.3%
United States	5,767,200	178,342,900	3.2%

Source: Regional Economic Information System, Bureau of Economic Analysis

Economic comparisons of the transportation industries in Arizona to those in the surrounding states suggests that, while transportation, as an economic sector, is not concentrated in Arizona, foreign export trade does constitute a relatively larger percentage of gross state product than for neighboring states. Additionally, the analysis suggests that the transportation industries in Arizona are relatively more efficient, as compared to neighboring states.

In addition to employment, the number of establishments is another good comparative indicator for determining the relative size of an industry within a state's economy. **Exhibit A-9** shows the

[†] Transportation and warehousing employment data from the BEA does not include postal services and therefore percent of total industry employment calculations for comparison purposes differ from the first section of this analysis by the magnitude employment in the postal services subsector.

**Arizona Multimodal Freight Study
Technical Memorandum #3: Appendix A**

number of transportation and warehousing establishments for both 2001 and 2006 in Arizona, the comparison states, and total U.S. In 2006, Arizona claimed 3,175 establishments in the transportation and warehousing industry sector and 1,644 establishments in the trucking industry subsector. While Arizona ranks behind California and Colorado in the number of establishments, the historical growth rate for these establishments in Arizona have outpaced the growth rates in both California and Colorado. Between 2001 and 2006 in Arizona, the number of establishments in the transportation and warehousing industry appreciated by 17.5%, or 3.3%, on average, annually. In the same historical timeframe, the number of establishments in the trucking industry increased 27.1%, or 4.9%, on average, annually. Industry establishment growth rates in both industries outpaced the respective national averages, with only two of the comparison states increasing the number of establishments at a rate faster than that of Arizona: Nevada and Utah.

Exhibit A-9: Establishments in the Transportation and Warehousing Industry Sector

NAICS 48-49 Transportation and Warehousing					NAICS 484 Truck Transportation				
State	Year		Percent Change		State	Year		Percent Change	
	2001	2006	Total	Avg. Ann.		2001	2006	Total	Avg. Ann.
Arizona	2,702	3,175	17.5%	3.3%	Arizona	1,293	1,644	27.1%	4.9%
California	18,253	19,122	4.8%	0.9%	California	8,549	8,667	1.4%	0.3%
Colorado	3,384	3,749	10.8%	2.1%	Colorado	1,838	2,094	13.9%	2.6%
Nevada	1,218	1,866	53.2%	8.9%	Nevada	502	824	64.1%	10.4%
New Mexico	1,290	1,427	10.6%	2.0%	New Mexico	665	815	22.6%	4.2%
Utah	1,771	2,319	30.9%	5.5%	Utah	1,106	1,499	35.5%	6.3%
United States	209,741	217,980	3.9%	0.8%	United States	113,704	117,863	3.7%	0.7%

Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages

The percentage share of transportation and warehousing industry establishments statewide, and the number of trucking industry subsector establishments for Arizona and comparison states are presented in **Exhibit A-10**. Establishments in the respective sector and subsector in Arizona are less concentrated than in neighboring states, aside from California. In 2006, 2.2% of all private establishments in Arizona were classified as transportation and warehousing industry establishments and 1.1% were trucking establishments.

A relatively smaller percentage of private establishments in either the transportation and warehousing industry sector or truck transportation industry subsector may be attributed to having more individuals employed per establishment in Arizona as compared to neighboring states or the U.S. as a whole. Larger establishments suggest operations utilizing economies of scale.

Exhibit A-10: Percent of Transportation and Warehousing Establishments of Total - 2006

State	NAICS 48-49	NAICS 484
Arizona	2.2%	1.1%
California	1.5%	0.7%
Colorado	2.2%	1.2%
Nevada	2.6%	1.2%
New Mexico	2.9%	1.7%
Utah	2.8%	1.8%
United States	2.6%	1.4%

Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages

An expanding number of establishments in the transportation and warehousing industry and trucking industry subsector, coupled with the sizeable number of establishments to begin with, reveal the increasing importance of the freight and logistics industry in Arizona.

Exhibit A-11 presents the numbers of annual commercial truck tractor and trailer registrations in Arizona and comparison states for the years 2001 and 2006. Arizona has experienced truck tractor and truck trailer annual registration increases of 52.0% and 46.1%, respectively, over the half decade between 2001 and 2006, or annual growth rates of 8.7% and 7.9% respectively: the largest percentage increases among all the comparison states. Again, the growth in truck tractor and truck trailer registrations follow closely the growth trends exhibited in transportation and warehousing and trucking pertaining to employment and the number of establishments, providing supporting evidence that the freight and logistics industries within Arizona are becoming increasingly important.

Exhibit A-11: Commercial Truck Tractor and Trailer Registrations[‡], 2001 and 2006

State	Truck Tractors		Percent Change		State	Commerical Trailers		Percent Change	
	2001	2006	Total	Avg. Ann.		2001	2006	Total	Avg. Ann.
Arizona	20,490	31,142	52.0%	8.7%	Arizona	74,407	108,674	46.1%	7.9%
California	123,945	143,188	15.5%	2.9%	California	719,915	818,997	13.8%	2.6%
Colorado	13,319	6,824	-48.8%	-12.5%	Colorado	147,997	55,845	-62.3%	-17.7%
Nevada	7,131	8,197	14.9%	2.8%	Nevada	10,211	11,558	13.2%	2.5%
New Mexico	11,774	13,078	11.1%	2.1%	New Mexico	40,022	44,453	11.1%	2.1%
Utah	31,823	40,988	28.8%	5.2%	Utah	35,903	46,569	29.7%	5.3%
United States	1,663,541	1,966,248	18.2%	3.4%	United States	4,864,350	5,589,584	14.9%	2.8%

Source: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 2001 and Highway Statistics 2006, Table MV-9 and Table MV-11

[‡] FHWA excludes re-registrations and renewals in the number of registrations calculations.

Impact of Domestic and International Trends on Freight in Arizona

Economic trends have implications for the freight industries within Arizona. In this section, current and projected economic trends with possible ramifications for the freight industry within Arizona are presented. Technical Memorandum #1 presents a comprehensive discussion of trade and economic trends with implications on the transportation infrastructure and industries in Arizona. These trends include structural changes in the domestic and global economy, growth in international global trade, globalization, changing shipping routes, expanding state population, and employment, and regional corridors, distribution centers, and staging areas. In this section, additional trends are identified, which may occur concurrently with the trends previously discussed; but, this supplemental discussion does not supersede previously discussed topics.

Supply Chain Management

The goal of supply chain management (SCM) is to optimize the movement of goods and services from the point of production to the point of consumption. In the past several decades, SCM has become the catalyst for companies to become and remain globally competitive. Two of the key cost-cutting strategies of SCM are just-in-time (JIT) logistics, and just-in-case logistics (JIC), each with a distinct approach for mitigating production costs and implications for transportation.

JIT is a strategy for reducing production costs by minimizing inventory holdings and reducing variability in transportation delivery times. Inventory levels are reduced by supplying materials on-demand, in the right quantities, at the right time. JIT strategies require sophisticated communications and coordination with suppliers and service providers on both ends of the production process. Implications for the freight industry from JIT include amplified peaks and troughs in demand for services, an increase in the frequency of freight movements, and possible corresponding reductions in load factors (volume per movement) resulting in lower productivity per operating unit. Growing levels of traffic and congestion in Arizona, coupled with a time sensitive supply system, is likely to cause bottlenecks when demand surges, in turn, requiring carriers to inject longer delivery lead times in order to maintain shipment reliability.

To accommodate some inherent disadvantages of JIT strategies, namely supply shocks and the unpredictability of delivery caused by external factors, "just-in-case" (JIC) supply chain management has developed. JIC management is typically practiced in conjunction with JIT strategies, incorporating additional contingency plans to effectively insure product and material supply for production continuation in the event of shocks to the supply chain. Any number of factors can contribute to an immediate shock to product and material supply, including natural disasters, geopolitical conflicts, labor disputes, and drastic macroeconomic variables changes such as the foreign exchange rate, all of which can be disastrous for JIT strategies.

JIC supply chain management takes into consideration potential shocks that would adversely affect unabated production. It stocks additional inventories as insurance against abrupt supply shortages. In determining the most appropriate inventory levels, JIC "...[shifts focus] from the inventory itself to the operating drivers of inventory including: shorter supply lead times,

improved supplier reliability, more frequent replenishments, improved predictability of demand, and more explicitly managed tolerances regarding shortages.”[§]

JIC and JIT have implications for the transportation and freight industries by requiring industries to become more flexible and adaptable to external shocks. Logistics industries will have to operate smarter, find alternative and redundant routes to hedge against possible setbacks, and provide increasingly value-added services to their existing repertoire, as companies and individuals demand and expect more.

Foreign Exchange Fluctuations

Changes in exchange rates can have implications for trade between countries, with differing impacts from long-term changes in exchange rates (consistent appreciation or depreciation of one currency relative to another) or rate volatility.

In terms of long-term currency exchange revaluations, a depreciating domestic currency effectively results in a reduced ability to purchase foreign goods and services, as the price of foreign goods and services effectively increase due to less buying power of the currency.. Conversely, domestic products become relatively cheaper for foreign countries to purchase with a depreciating domestic currency. In general terms, when domestic currency depreciates, import trade is likely to decrease as well, while export trade is likely to increase. If the domestic currency appreciates, then imports are likely to increase as foreign goods and services become relatively cheaper and exports are likely to decrease as domestic goods and services become relatively more expensive to foreign buyers.

Volatility in foreign exchange rates (rather than a distinct directional trend), though likely to result in temporary aberrations in bilateral trade flows, do not appreciably affect trade. “Real exchange rate volatility depressed trade in differentiated goods...[however,] the size of the effect is fairly small and unevenly distributed,”^{**} which is a finding supported by recent empirical research conducted by the International Monetary Fund: “If exchange rate volatility has a negative effect on trade, this effect would appear to be fairly small and is by no means a robust, universal finding.”^{††}

In Arizona, a state with appreciable foreign trade, alterations in the exchange rates of U.S. currency relative to foreign currencies could impact the magnitude and directional flows of goods and services. Of particular importance are the exchange rates between the United States and Arizona's key foreign trade partners: Mexico and Eastern Asia..

Emerging and Expanding Foreign Markets

As discussed in Technical Memorandum #1, world trade has increased in recent decades at a rate exceeding world production output, resulting in a world economy that is increasingly more globalized where individual countries are more reliant on others for the acquisition of goods and services not produced domestically. In this global economy, emerging and expanding countries

[§] Martha, Joseph and Sunil Subbakrishna. Targeting a Just in Case Supply Chain for the Inevitable Next Disaster. Supply Chain Management Review. September 1, 2002. <<http://www.scmr.com/article/CA243747.html>>

^{**} Broda, Christian and John Romalis. Identifying the Relationship Between Trade and Exchange Rate Volatility. November 2003.

^{††} Clark, Peter; Tamirisa, Natalia; Wei, Shang-Jin; Sadikov, Azim; and Li Zeng. Exchange Rate Volatility and Trade Flows – Some New Evidence. International Monetary Fund. May 2004.

such as Central and South America, and East Asia are likely to becoming more important to Arizona's economy due to common borders and proximity to west coast gateways that facilitate the movement of goods from Asia.

Of all the trends that may affect freight movements in Arizona, China the emerging giant of merchandise trade with the United States, may have the largest impact:

“Imports from China alone have quadrupled [for the entire United States] in the past decade, with Los Angeles and Long Beach preferred destinations for that commerce. As America's trade expands with China and throughout the Pacific Rim, Arizona's ties to the two Southern California ports have tightened, as well.”^{‡‡}

However, Mexico is also likely to have considerable impact on the future economy of Arizona because of potential trade flows. As Mexico continues to develop its economy and infrastructure, Arizona is poised in a strong geographical and cultural position to serve as a key gateway for trade between Mexico, the United States and Canada.

One particular trend pertaining to Mexico with bearing on Arizona is the potential development of intermodal facilities in western Mexico: Punta Colonet and Guaymus. Both of these locations in Mexico could divert container traffic from the congested ports at Los Angeles and Long Beach, CA and serve the United States markets so long as the point(s) of entry is well developed and fluid. If this development comes to fruition, Arizona, despite potentially decelerated trough traffic from freight arrivals in California, could experience an increase in total freight traffic as freight from the Mexican ports enter trough, likely through Nogales or Yuma.

“A sea port at the Sea of Cortez could have a significant economic impact on Arizona by enabling Arizona to become *part* of annually moving more than 15 billion tons of freight with a total value of over \$9.1 trillion.”^{§§}

Inland Ports

As a consequence of historically growing import volumes in the United States, inland ports located throughout the country have developed. Inland ports are an emerging and relatively new business concept in the freight transportation complex; having been planned, developed, and implemented in multiple locations in recent years. Major existing inland ports include: Inland Empire (San Bernardino, CA), AllianceTexas Global Logistics Hub (Dallas/Forth Worth, TX), Virginia Inland Port (Port Royal, VA), Memphis, TN, CenterPoint Intermodal Center (Chicago, IL), CenterPoint Intermodal Center (Kansas City, MO), Harrisburg, PA, North Carolina Inland Port Terminals, and the Columbus Rickenbacker Inland Port (Columbus, OH). Inland ports have been recently developed with the justification for positioning container facilities at non-congested inland locations, where rail and truck access are easier, where land use conflicts are less, and where economic development is desired.

According to the National Association of Development Organizations^{***}, inland ports are defined as facilities located away from water port terminals, supplying regions with an intermodal

^{‡‡} Wiles, Russ. How Ports in L.A. Drive Arizona's Economy: Lucrative Role as Hub for Trade Boosts State. The Arizona Republic. January 4, 2008.

^{§§} Garrido, Jon. Economic Development. March 20, 2006. Act Arizona.
<http://www.actaz.org/economic_development.htm>

^{***} <<http://www.nado.org/rtoc/jan3.html>>

terminal or a merging point for transportation modes – rail, and/or air, and/or trucking routes – involved in distributing merchandise that comes from water ports. Inland ports act as staging areas for containers, with those containers, holding a variety of cargo items and ranging in size from 20 to 45 feet, commonly moved by crane from one transportation mode to another.

Public private partnerships (PPP) are often used as a major funding platform for developing inland ports. As inland ports are developed and evaluated, the body of knowledge about them is expanding. As information pertaining to inland ports increases and an understanding of their implications, there appears to be potential for the development of inland intermodal ports major urban areas in Arizona, where the interstate and rail lines intersect. As the Mexican gateways (abovementioned in subsection 4.3) develop and Arizona manages to capture significant freight flows, the inland port concept in the State may gain an additional dimension and potential, becoming a viable option for the future of freight movements. Potential development of an inland port in Arizona constitutes a major research topic that may warrant further detail study.

Distance and Time as Factors for Trade

In a time sensitive trading environment, large transport distances and correspondingly long transport times are unfavorable and avoided if possible, resulting in a clear negative correlation between distance and level of trade. Empirical economic models have been developed, that is, gravity models, which represent bilateral trade flows between two countries as a function of the distance between and their respective economic sizes, with an inverse relationship between trade and distance.

Supply chain management strategies strive to reduce production costs by reducing transport costs through reduced distances and times. As such, neighboring trading partners, aside from any geographical or political similarities which may bolster trade, may be the most valuable trading partners because of the ability to trade, and adjust trade, quickly and with ease relative to trade across longer distances. Close proximity countries can minimize the distance of overall trade, in turn, decreasing the time of trade transport, increasing reliability and predictability, which reduces costs of trade.

Despite significant worldwide trade levels increasing in recent history, “the distance that a typical product travels has remained roughly constant for the last fifteen years,”^{†††} and “roughly a quarter of world trade takes place between countries sharing a common border, and half of the world trade occurs between partners less than 3,000 km apart.”^{†††} A possible reasoning for the unchanging distance of trade, despite increases in worldwide trade volumes above global production output, is that ocean shipping, the facilitator of long-distance, international shipping, has not experienced significant price declines within the last half decade.^{§§§} If ocean-bound transportation costs significantly decrease, then trade distances may increase, based exclusively on price sensitivities; however, the costs of transport time, because of increasing time sensitivities, may be sufficiently large to discourage trade beyond a quantified time threshold and, thus, distance.

^{†††} Berthelon, Matias and Caroline Freund. On the Conservation of Distance in International Trade. World Bank Policy Research Paper 3293. May 2004.

^{†††} Hummels, David. Transportation Costs and International Trade in the Second Era of Globalization. Journal of Economic Perspectives. Volume 21, Number 3. Summer 2007. Pages 131-154.

^{§§§} Ibid.

Time delays at the country of trade origin, aside from just distance, for long-distance international trade also have a negative impact on trade. It is estimated that, “on average, each additional day that a product is delayed prior to being shipped reduces trade by at least 1 percent. Put differently, each day [of delay] is equivalent to a country distancing itself from its trade partners by 70 km [43 miles] on average.”****

Distance and time are important trade determinates, with companies and countries striving to minimize either, or both, in efforts to reduce costs and increase reliability and predictability. Arizona, as a bordering state with Mexico, is especially aware of the effect of proximity and time (border crossing sensitivities) to trade. If trade continues to increase as it has historically and trading distances remain relatively unchanged, as the case historically, then Arizona is poised, because of geography, to be beneficially impacted by trade from Mexico.

Economic Significance of the Transportation Industry in Arizona

The transportation and warehousing industry within Arizona plays a vital role in the economy, not only enabling the operations of all the other industry sectors by facilitating the movement of goods and services, but also serving as an important industry sector producing significant jobs and earnings. The transportation and warehousing industries in Arizona currently directly employ 3.0 percent of total statewide employment and contribute directly toward 5.3 percent of Arizona's gross state product.

For all industries, the total significance to a state or regional economy in terms of employment and output results from the combined effect from both direct and an indirect spending and employment. The indirect economic impacts of an industry can be mathematically determined through regional input-output models.

"Input-output accounting describes commodity flows from producers to intermediate and final consumers. The total industry purchases of commodities, services, employment compensation, value added, and imports are equal to the value of the commodities produced."¹

The outputs of these complex models are captured as industry multipliers that describe the change in output for each and every regional industry caused by a one dollar change in final demand for any given industry. For this analysis, Wilbur Smith Associates purchased economic multipliers from the Minnesota IMPLAN Group, Inc. The IMPLAN ((IMPact analysis for PLANning) multipliers for this analysis are applied to the estimated direct effects for determining the cumulative total economic impact of Arizona's transportation and warehousing industry subsectors.

When economic multiplier effects from the transportation and warehousing industry are counted, this sector has an even larger bearing on the Arizona economy; contributing 237,600 jobs and \$27.7 billion toward Arizona's gross state product. In 2006, the Arizona transportation and warehousing industry, counting both direct and indirect economic contributions, provided 7.1

**** Djankov, Simon; Caroline Freund; and Cong S. Pham. Trading on Time. World Bank Policy Research Working Paper 3909. May 2006.

**Arizona Multimodal Freight Study
Technical Memorandum #3: Appendix A**

percent of statewide employment and 11.9 percent of gross state product (refer to Appendix A for a discussion of multipliers used).

In the southwestern U.S., Arizona's transportation industry and infrastructure performance rank highly when evaluated against neighboring states. While the state appears poised to capture continued growth in the transportation and warehousing industry sector, other states in the region such as California are investing billions of dollars in freight related infrastructure to remain competitive.

Economic Impacts (2006): In 2006, the last year for which comprehensive data is available, the transportation and warehousing industry sector, including governmental postal services, directly employed 102,638 people in Arizona (**Exhibit A-12**). In the same year, total employment in Arizona amounted to almost 3.37 million.² The transportation and warehousing industry, including postal services, accounted for 3.0 percent of the total employment within the State. Truck transportation was the largest subsector industry employer of the transportation and warehousing industry, with almost 28.0 thousand employees. Trucking was followed by air transportation, and couriers and messengers, with 17.2 and 14.8 thousand employees, respectively. When the multiplier effects of Arizona's transportation and warehousing industry are considered, this industry is estimated to provide jobs to 237,600 individuals.

Exhibit A-12: Employment -Transportation and Warehousing Industry (2006)

NAICS Code	Industry	Employment	
		Direct	Direct + Indirect
48-49	Transportation and Warehousing	102,638	237,608
481	Air Transportation	17,151	58,585
482	Rail Transportation	2,789	11,098
483	Water Transportation	(D)	(D)
484	Truck Transportation	27,933	67,796
485	Transit & Ground Passenger Transport	8,243	13,506
486	Pipeline Transportation	251	1,587
487	Scenic And Sightseeing Transportation	861	1,789
488	Support Activities For Transportation	9,594	19,938
491	Postal Service	12,255	22,210
492	Couriers And Messengers	14,800	25,155
493	Warehousing And Storage	8,761	15,944

Source: Bureau of Economic Analysis, Regional Economic Information System; Bureau of Labor Statistics; and, Minnesota IMPLAN Group, Inc.³

Income earned by those directly employed in the transportation and warehousing industry sector amounted to \$5.1 billion in 2006 (**Exhibit A-13**), resulting in an average income per transportation and warehousing employee of \$49,744 per year. Average personal income for all industries within Arizona in 2006 was \$58,522 per year, or 17.6% greater than the average income per employee in the transportation and warehousing industry sector.⁴

Exhibit A-13: Income - Transportation and Warehousing Industry (2006)

NAICS Code	Industry	Income (in millions \$)	
		Direct	Direct + Indirect
48-49	Transportation and Warehousing	\$5,105.56	\$10,945.11
481	Air Transportation	\$1,226.41	\$2,975.86
482	Rail Transportation	\$278.24	\$650.29
483	Water Transportation	(D)	(D)
484	Truck Transportation	\$1,298.83	\$3,070.21
485	Transit & Ground Passenger Transportation	\$217.37	\$444.16
486	Pipeline Transportation	\$28.86	\$87.65
487	Scenic And Sightseeing Transportation	\$50.07	\$90.16
488	Support Activities For Transportation	\$557.98	\$1,004.60
491	Postal Service	\$645.41	\$1,066.10
492	Couriers And Messengers	\$427.65	\$875.64
493	Warehousing And Storage	\$374.74	\$680.45

Source: Bureau of Economic Analysis, Regional Economic Information System; Bureau of Labor Statistics; and, Minnesota IMPLAN Group, Inc.

For all industry sectors, personal income in Arizona in 2006 totaled \$197.0 billion.⁵ Direct income attributable to the transportation and warehousing industry sector accounted for 2.6% of the total income earned in the State. Employees of the truck and air transportation subsectors contributed the largest shares within the industry with total earnings of \$1.3 and \$1.2 billion, respectively. Together these two subsectors account for about half of the total earnings in the aggregate transportation and warehousing industry. When the multiplier impacts are added to the sector, transportation and warehousing is estimated to contribute \$10.9 billion toward Arizona's total earned income.

Economic output, expressed as gross state product, quantifies the value of goods and services produced in a given period. Arizona's gross state product derived directly from the transportation and warehousing industry amounted to \$12.4 billion in 2006. Total output for all subsectors of the transportation and warehousing industry are shown in the table of **Exhibit A-14** on the following page. As with income, the truck and air transportation subsectors accounted for a majority of the economic output in the transportation and warehousing sector. It should be noted that, despite employing fewer persons, the air transportation subsector has a higher economic output than the truck transportation subsector, suggesting that the air transportation subsector is relatively more productive, in terms of output per employee.

In 2006, total gross state product for Arizona was an estimated \$232.5 billion.⁶ With an estimated economic output of \$12.4 billion, the transportation and warehousing industry accounted for 5.3% of the total gross state product. A ratio of output (5.3%) to employment (3.0%) for the transportation and warehousing sector in Arizona suggests that the sector is nearly twice as productive, per industry employee, as the average industry in the State. When multiplier effects of the industry are considered, transportation and warehousing contributed \$27.7 billion in gross state product in 2006.

Exhibit A-14: Output - Transportation and Warehousing Industry (2006)

NAICS Code	Industry	Output (in millions \$)	
		Direct	Direct + Indirect
48-49	Transportation and Warehousing	\$12,382.80	\$27,705.16
481	Air Transportation	\$3,999.20	\$8,586.27
482	Rail Transportation	\$800.89	\$1,761.96
483	Water Transportation	(D)	(D)
484	Truck Transportation	\$3,646.21	\$8,302.56
485	Transit & Ground Passenger Transportation	\$485.45	\$1,081.73
486	Pipeline Transportation	\$168.26	\$317.93
487	Scenic And Sightseeing Transportation	\$71.25	\$172.20
488	Support Activities For Transportation	\$793.97	\$1,918.76
491	Postal Service	\$841.48	\$1,969.42
492	Couriers And Messengers	\$961.20	\$2,150.89
493	Warehousing And Storage	\$614.90	\$1,443.46

Source: Bureau of Economic Analysis, Regional Economic Information System; Bureau of Labor Statistics; and, Minnesota IMPLAN Group, Inc.

As a percentage of Arizona's statewide economy, in 2006 the cumulative economic significance of the transportation and warehousing industry represented **7.1%** of total employment, **5.5%** of total state income and **11.9%** of the gross state product.

Economic Impacts (2014): According to Arizona labor market publications,⁷ the transportation and warehousing industry is expected to increase, in terms of employment, by an annual average rate of 1.69 percent between 2004 and 2014. Individuals directly employed in the transportation and warehousing industry in 2014 are projected to number 117.3 thousand. In applying estimated earnings and output per employee,^{††††} respectively, those employees are anticipated to earn an estimated \$5.8 billion (2006\$) in income and produce \$14.1 billion (2006\$) in output, as indicated in **Exhibit A-15**.

Assuming the multipliers for calculating the cumulative (direct and multiplier) significance remain constant over the time period between 2006 and 2014, the transportation and warehousing industry is estimated to contribute 271,600 employees, provide earnings totaling \$12.5 billion (2006 dollars), and produce \$31.7 billion (2006\$) towards Arizona's economy in the year 2014.

Exhibit A-15: Economic Significance of Transportation and Warehousing in 2014

Economic Impact	Direct	Direct + Indirect
Employment	117,347	271,661
Income (in millions 2006-\$)	\$5,837.26	\$12,513.70
Output (in millions 2006-\$)	\$14,157.42	\$31,675.70

^{††††} In this calculation, earnings and output per employee, respectively, are assumed to remain constant (in real dollar terms) between 2006 and 2014.

**Arizona Multimodal Freight Study
Technical Memorandum #3: Appendix A**

Source: Bureau of Economic Analysis, Regional Economic Information System; Bureau of Labor Statistics; Minnesota IMPLAN Group, Inc.; and, Arizona Workforce Informer, Data Analysis, Industrial Employment Projections

¹ Scott A. Lindall, Douglas C. Olson, Minnesota Implan Group, Inc. THE IMPLAN INPUT-OUTPUT SYSTEM. Accessed online at: <http://www.implan.com/>

² Source: Table SA25 of the Regional Economic Information Systems, the Bureau of Economic Analysis.

³ Data provided in exhibits was primarily culled from the publications of the Bureau of Economic Analysis, with supplemental data for governmental postal services employment incorporated from the Bureau of Labor Statistics. Indirect and induced employment, income, and output are derived from economic multipliers, provided by the Minnesota IMPLAN Group, Inc.

⁴ Source: Calculated from data in Table SA1-3 and Table SA25 of the Regional Economic Information Systems, Bureau of Economic Analysis.

⁵ Source: Table SA04 of the Regional Economic Information Systems, Bureau of Economic Analysis.

⁶ Source: Bureau of Economic Analysis: Regional Economic Accounts, Gross Domestic Product by State.

⁷ Source: Arizona Workforce Informer, Data Analysis, Industrial Employment Projections