www.cpcstrans.com

Report

Arizona State Freight Plan

(ADOT MPD 085-14)

Economic Context of Freight Movement in Arizona

Prepared for:

Arizona Department of Transportation

Prepared by:

CPCS

In association with:

HDR Engineering, Inc.
American Transportation Research Institute, Inc.
Elliott D. Pollack & Company
Dr. Chris Caplice (MIT)
Plan*ET Communities PLLC (Leslie Dornfeld, FAICP)
Gill V. Hicks and Associates, Inc.

Solutions for growing economies

CPCS Ref: 14325
December 16, 2015

Report on Economic Context of Freight Movement in Arizona

This report provides an overview of the role of freight in Arizona's economy. It includes a synthesis of broad economic trends, how top freight sectors use the transportation system, their transportation performance needs, and the transportation issues hindering their competitiveness.

Acknowledgements

The CPCS team would like to thank the Arizona Department of Transportation (ADOT) for its guidance and input in developing this report, as well as the input and comments of those consulted in its development. Further input from the Technical Advisory Committee (TAC) and Freight Advisory Committee (FAC) would be welcome and appreciated.

Opinions

Unless otherwise indicated, the opinions herein are those of the author and do not necessarily reflect the views of ADOT, the TAC, FAC, or the State of Arizona.

Contact

Questions and comments on this working paper can be directed to:

Marc-André Roy
Project Director
T: +1.613.237.2500 x 306
mroy@cpcstrans.com

Donald Ludlow
Project Manager
T: +1.202.772.3368
dludlow@cpcstrans.com

Table of Contents

Executive Summary

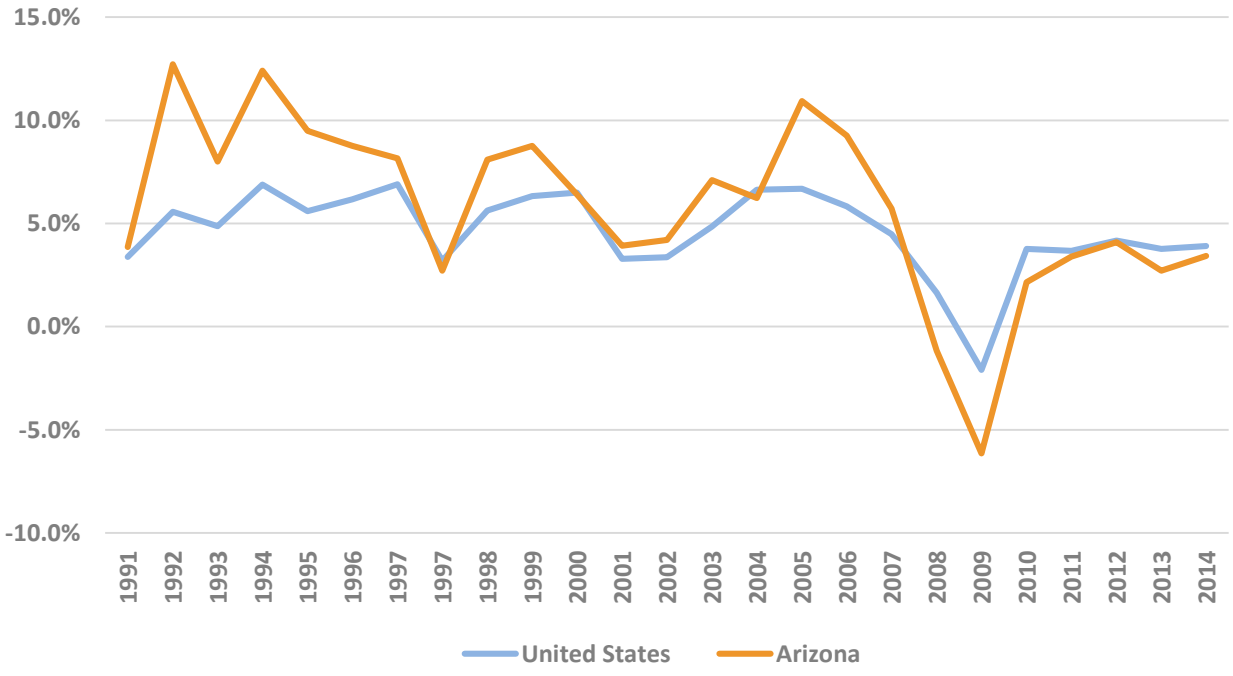
Wider Economic Trends

Prior to the 2008/09 recession, Arizona achieved GDP, employment and population growth above national averages. Since the recession, Arizona's recovery has been relatively slow as compared to the national average and nearby states. In 2014, residential housing starts in Arizona were still less than a third of pre-recession levels and were still at levels not seen in the pre-recession period since 1991.

Arizona's economy and transportation trends are also driven by seasonal trends such as increases in agricultural activity and tourism during the winter months. Employment and agricultural flows tend to follow cyclical trends based on these factors.

Strong increases observed in Mexican manufacturing and agricultural imports into the United States (U.S.) have impacted Arizona and other border states. Border flows from Mexico have increased at the quickest pace through Texas, with smaller increases achieved in other border states including Arizona. The increase in Mexican manufacturing activity and agricultural imports is expected to continue to impact Arizona.

Figure ES-1: Arizona versus United States Nominal GDP Growth, 1991-2014



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts: GDP by State (current dollars)

Freight Roles and Impacts

To enhance Arizona's economic competitiveness and quality growth, the Arizona State Freight Plan should focus on addressing the transportation performance needs of the freight sectors that drive Arizona's economic activity and growth.

The team identified Arizona's top 10 freight sectors[1], which can generally be grouped into four freight sector groups sharing similar transportation characteristics: consumer goods sectors, manufacturing sectors, natural resources sectors, and the transportation and logistics sector. Their contribution to Arizona's economy is significant:

$82 billion in State GDP, or 30 percent of Arizona's overall GDP (2013)

873,000 Arizona jobs, or 30 percent of Arizona's total employment (2013), including over half of the 83,000 jobs generated from foreign direct investment in the state

$43 billion in annual income for Arizona residents, or 29 percent of the total employment income of Arizona (2013)

$18 billion in exports: the top 10 sectors generate $17.7 billion, or 96 percent of all of Arizona's foreign exports; and $17 billion, or 90 percent of all of the state's foreign imports (2012)

$11 billion in annual taxes on production and investment in the state, 58 percent of the taxes on production and investment collected (2013)[2]

In absolute terms, consumer goods sectors are by far the greatest contributor to Arizona's economy among freight sector groups, in terms of GDP, GDP growth, employment, income and taxes.

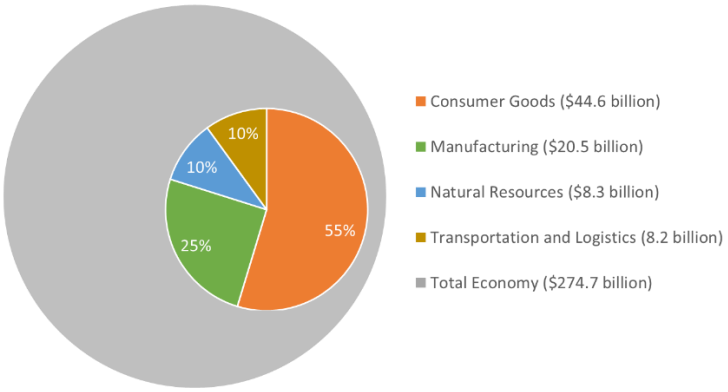
The contribution of Arizona's manufacturing and natural resources sectors are smaller than those of consumer goods sectors, but generate the greatest share of exports and a significant share of Arizona's direct investment – key drivers of quality, high paying jobs and investment in the State.

[1] The top 10 freight sectors are: Wholesalers and Retailers, Food and Beverage, High-Tech Manufacturing, General Manufacturing, Transportation Equipment Manufacturing, Transportation and Logistics, Mining (except oil and gas), Energy (oil and gas), Agriculture, and Forestry. These sectors cover most freight industry and flows in Arizona. For example, the top 10 sectors represent 86% of state GDP of freight sectors, and over 96% of all state export flows (by value).

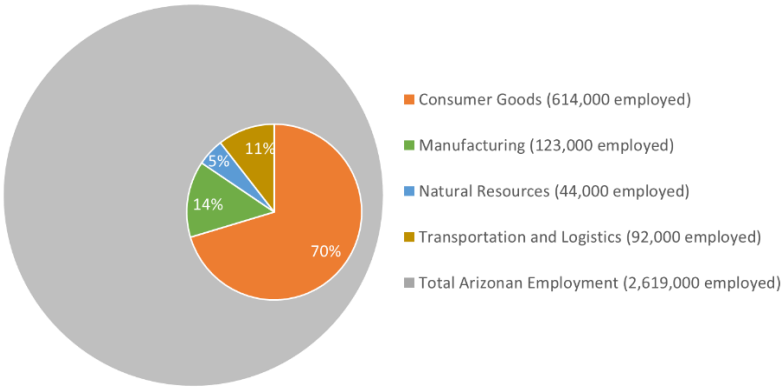
[2] Combined state, local and federal excise taxes.

Figure ES-2: Relative Economic Importance of Top Freight Sectors to the State of Arizona

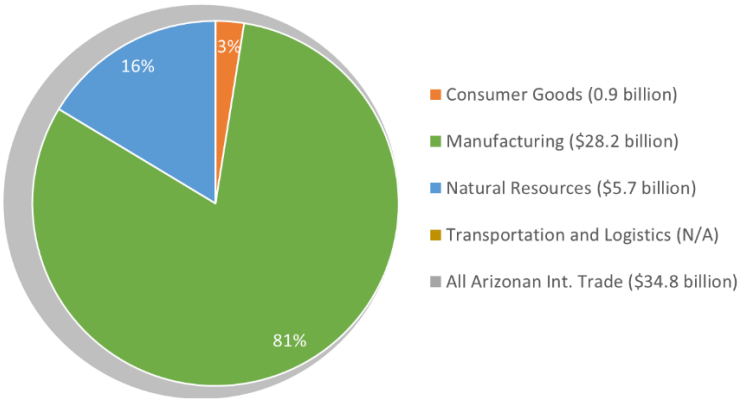
GDP (30% of state total)



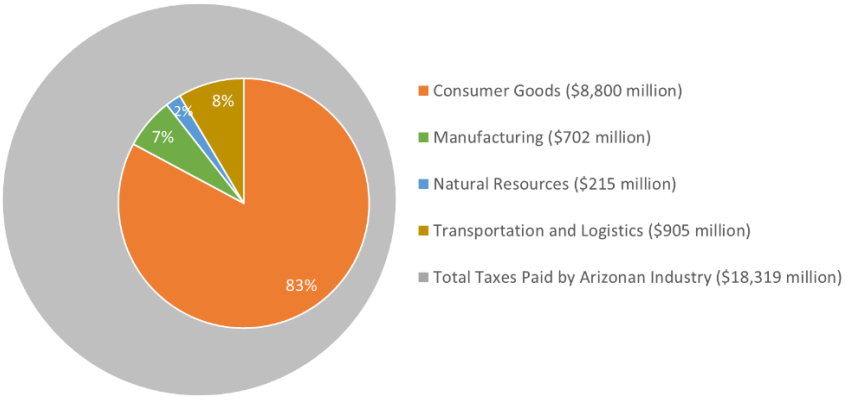
Employment (32% of all jobs)



International Trade Flows (95% of total)



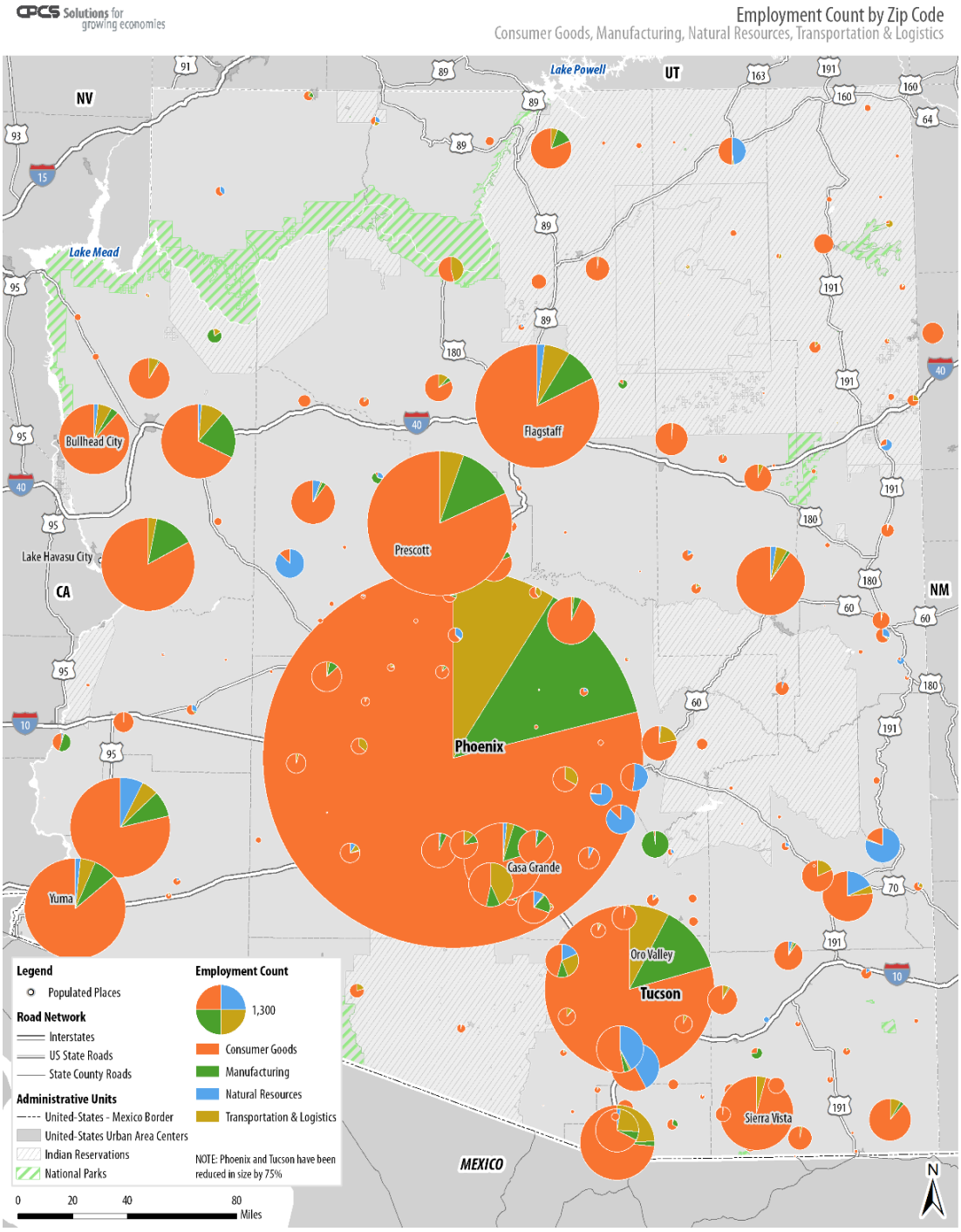
Taxes on Production and Imports (58% of total)



Source: CPCS Analysis of the Bureau of Economic Analysis Regional Accounts for the State of Arizona (GDP, Employment and Taxes for 2013) and United States Census Bureau's Trade Data Online (2012 data)

Phoenix and Tucson areas are Arizona's freight activity centers for consumer goods, manufacturing, and transportation and logistics clusters, owing in large part of the size the consumer market and labor pool in these regions. Natural resources sectors are clustered around sources of production, including the Southeast (mining), Southwest (agriculture) and North and Northeast (forestry).

Figure ES-3: Freight Sector Employment Clusters (2013)

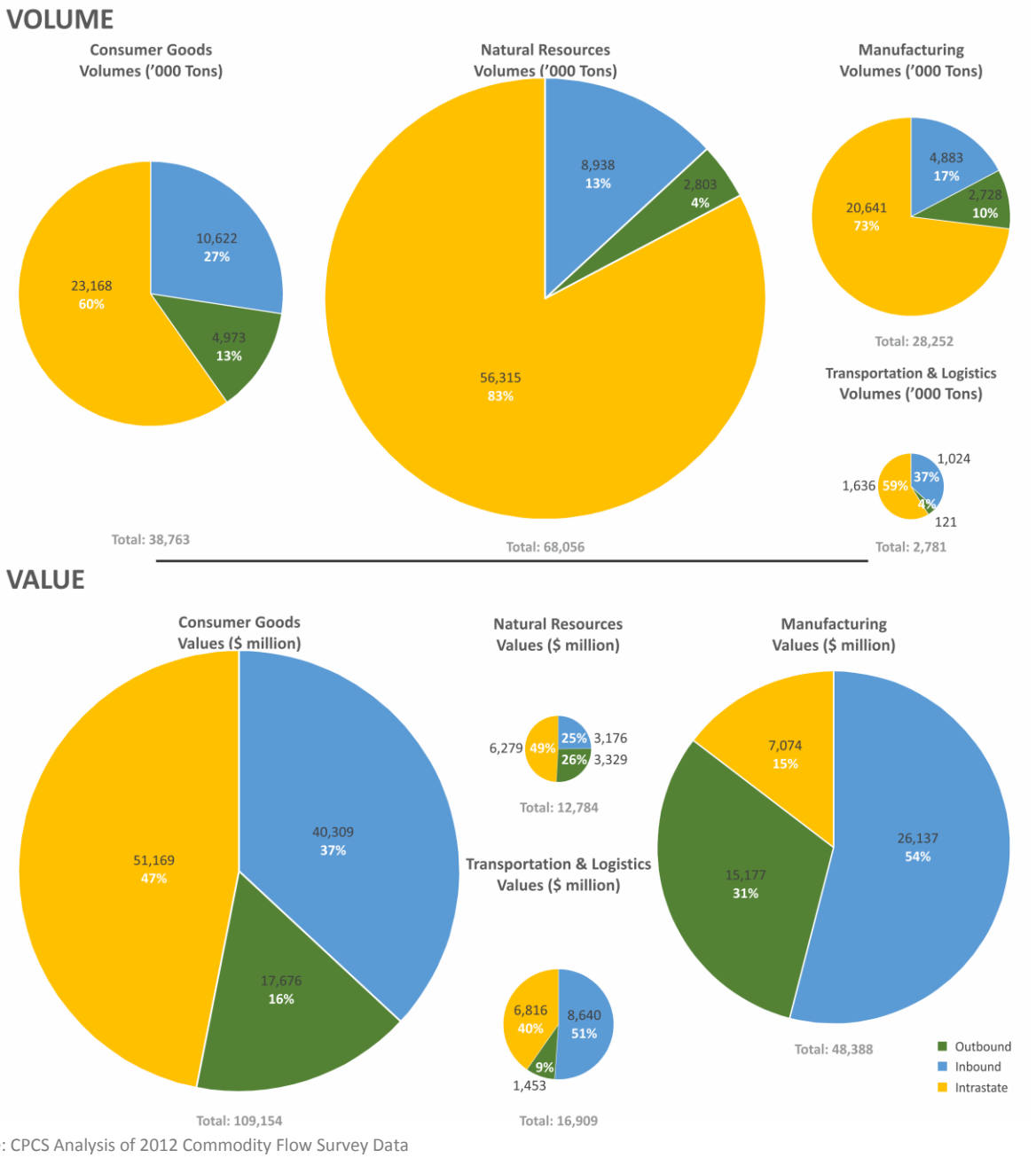


Source: County Business Patterns, US Census Bureau

Over $188 billion in freight flows are generated by Arizona's top freight sectors, of which 41 percent is inbound to Arizona, 21 percent is outbound from Arizona, and 38 percent are intrastate flows within the borders of Arizona. Consumer goods sectors represent 58 percent of these flows, by value (2012).

Over 137 million tons in freight flows are generated by Arizona's top freight sectors, of which 18 percent are inbound to Arizona, 8 percent are outbound from Arizona, and 74 percent are intrastate flows within the borders of Arizona. Natural resources sectors contribute 49 percent of these flows, by volume (2012).

Figure ES-4: Volumes and Values of Freight Flows to, from and within Arizona (2012)

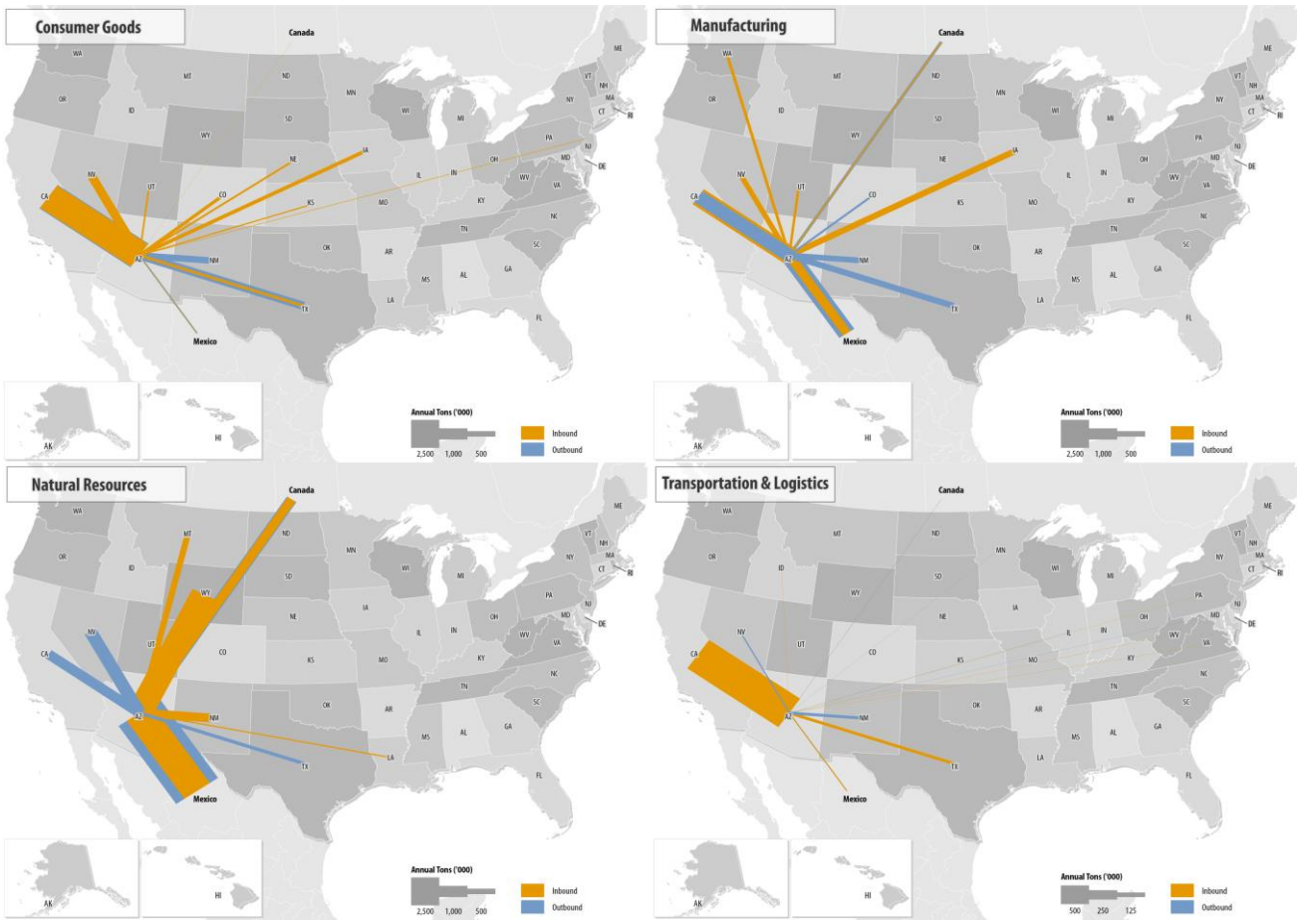


Source: CPCS Analysis of 2012 Commodity Flow Survey Data

California, Texas, and Mexico are the predominant inbound and outbound freight markets, by volume.

Major trade lanes include inbound consumer goods and transportation and logistics sector flows from California, bi-directional manufacturing flows to and from Mexico and California, and bi-directional natural resources flows to and from Mexico.

Figure ES-5: Inbound and Outbound Freight Flows, by Volume (tons, 2012)



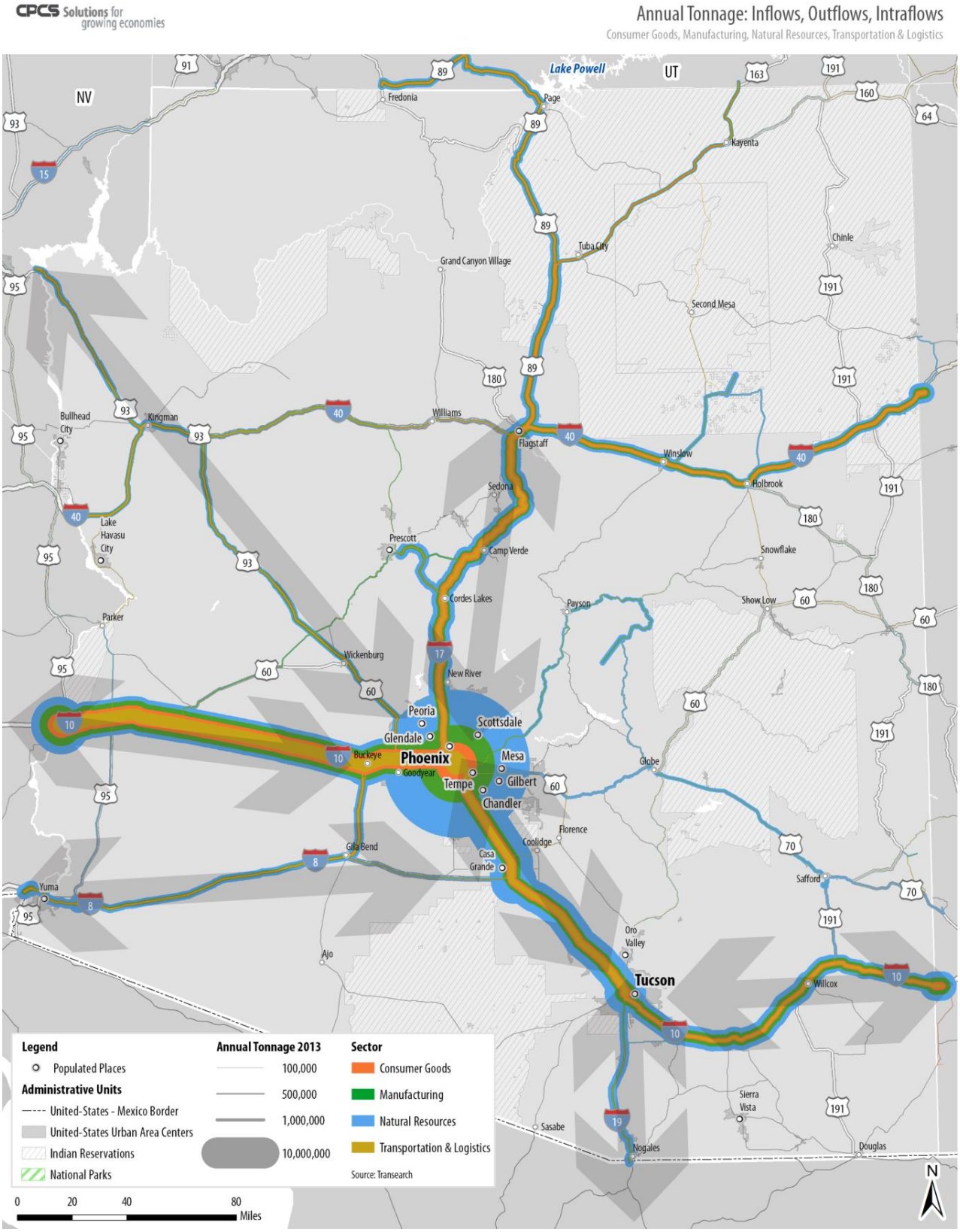
Source: CPCS Analysis of 2012 Commodity Flow Survey Data

The I-10 is Arizona's most heavily used freight corridor.

This corridor is dominated by traffic flows generated by manufacturing, consumer goods and transportation and logistics sectors, highlighting the importance of trade with California for these sectors.

The I-19 to Mexico is another important corridor, particularly for natural resources sectors, and manufacturing sectors.

Figure ES-6: Freight Sector Flows (Inbound, Outboud and Intra) on Arizona's Key Commerce Corridors (2012)



Source: CPCS Analysis of 2012 Commodity Flow Survey Data, Key Commerce Corridors (arrows)

Transportation performance needs differ by sector.

Transit time, reliability and service levels are particularly important to freight sectors moving high value and time-sensitive goods, such as high-tech manufacturing sector outputs, or perishable goods such as produce. Logistics costs are also important, but tend to be the primary focus of sectors moving low value, high volume goods, such as construction aggregate, forestry products or other non-perishable natural resources.

Because most Arizona freight activity is centered around major population (i.e. consumption) centers, local or regional transportation issues (e.g. from distribution center to storefront) typically have a significant impact on overall transportation performance.

Many freight sectors have similar transportation issues.

One of the most notable findings in consulting with Arizona freight transportation system stakeholders was that most were largely satisfied with the performance of the transportation system. This is not to suggest that there are no transportation performance issues in Arizona. Consultations with freight transportation system stakeholders revealed the following issues, common to most sectors:

Recurring congestion and bottlenecks in and around urban centers, particularly Phoenix: Peak congestion and associated bottlenecks were identified by virtually all freight sectors as problematic, and a barrier to transportation system performance and sector competitiveness.

Non-recurring congestion and bottlenecks: Although less frequently cited as an issue, several stakeholders – across most sector groups – noted non-recurring congestion and road closures as hindering the reliability of their transportation operations. Cited causes are many and include road construction-related lane closures, crashes, and weather events.

Axle-load restrictions: Several shippers, across sectors noted that axle load restrictions in Arizona are low relative to other states that allow gross vehicles weights in excess of 80,000 lbs.[3] This issue was particularly noted by natural resources sectors stakeholders.

Truck driver shortage: The shortage of truck drivers is a national phenomenon. In Arizona, the driver shortage is aggravated by the improving economy and the tightening labor pool in which trucking companies compete with construction and other trades for talent.

Funding constraints impacting future quality. Many stakeholders, and notably those in the transportation and logistics sector, highlighted concerns about the limited funding available to maintain and expand the state's highway network.

Other issues noted in consultations, specific to freight sector groups, include:

[3] ADOT allows motor carriers to operate at FHWA limits

Consumer Goods Sectors

- Municipal noise ordinances as a barrier to off-peak deliveries
- Location specific truck manoeuvrability issues, particularly relating to delivery docks at shipping centers

Manufacturing Sectors

- Dissatisfaction with limited international air connections and service at Phoenix Sky Harbor International Airport
- Unpredictability of crossing times at the Mexican border at Nogales

Natural Resources Sectors

- Truck reliability and availability during peak periods

Transportation and Logistics Sector

- Inadequate truck parking facilities

The Arizona State Freight Plan should focus on the needs of those sectors that will drive economic activity and growth.

Long term economic competitiveness and quality growth – the primary goals of the Arizona State Freight Plan – means increasing GDP, attracting greater private investment, growing trade and exports all resulting in more high paying, high quality jobs in Arizona.

The role of each freight sector group in achieving these ends will differ, and so too should the emphasis placed on addressing sector transportation performance needs and issues in the Arizona State Freight Plan.

To most effectively contribute to enhancing Arizona's economic competitiveness and quality growth, the Arizona State Freight Plan should be oriented to addressing the needs of the sectors of the economy that:

- **Compete for markets *outside* Arizona**. The exports generated by these sectors bring dollars to Arizona, which in turn can stimulate employment and economic activity in the State.
- **Attract investment to Arizona**. Direct investment, and in particular investment coming from outside the State, will directly contribute to Arizona's gross domestic product (GDP), employment in the state, and taxes, which in turn can be used to reinvest in the State's future growth and prosperity.

The manufacturing and natural resources sectors both meet these criteria. The consumer goods and transportation and logistics sectors, though larger, tend to be oriented towards local consumption, suggesting that the growth of these sectors is perhaps more constrained (i.e. by

local population growth and consumptions patterns) than those selling *outside* Arizona, such as the manufacturing and natural resources sectors.

These findings suggest that the Arizona State Freight Plan should place particular emphasis on addressing the transportation performance needs of the manufacturing and natural resources sectors, since transportation improvements are most likely to affect an increase in the competitiveness of these sectors, attracting investment to these sectors, and in turn, enhancing Arizona's economic competitiveness and growth.

Also of critical importance to the State Freight Plan is the fact that many freight sector groups use the same transportation infrastructure and also share this infrastructure with passenger vehicles – for instance the Interstate Highway System in and around the Phoenix and Tucson areas. Addressing common freight sector transportation challenges can go a long way to both enhance economic competitiveness and growth, and improve the quality of life of Arizona's residents.

Acronyms and Abbreviations

3PLs	THIRD PARTY LOGISTICS PROVIDERS
ADOT	ARIZONA DEPARTMENT OF TRANSPORTATION
ACA	ARIZONA COMMERCE AUTHORITY
CARB	CALIFORNIA AIR RESOURCE BOARD
CBP	CUSTOMS AND BORDER PROTECTION
CDL	COMMERCIAL DRIVER LICENSE
CES	CONSUMER EXPENDITURE SURVEY
chips	INTEGRATED CIRCUITS
CNG	COMPRESSED NATURAL GAS
COGs	COUNCILS OF GOVERNMENTS
DCs	DISTRIBUTION CENTERS
FAC	FREIGHT ADVISORY COMMITTEE
fabs	WAFER FABRICATION PLANTS
FAHP	FEDERAL AID HIGHWAY PROGRAM
GDP	ARIZONA'S GROSS DOMESTIC PRODUCT
HTF	HIGHWAY TRUST FUND
HURF	HIGHWAY USER REVENUE FUND
JIT	JUST-IN-TIME
KCCs	KEY COMMERCE CORRIDORS
MPD	ADOT'S MULTIMODAL PLANNING DIVISION
MPOs	METROPOLITAN PLANNING ORGANIZATIONS
MW	MEGAWATT
NAICS	NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM
PHX	PHOENIX SKY HARBOR INTERNATIONAL AIRPORT
POE	THE MARIPOSA PORT OF ENTRY
POLA/POLB	PORTS OF LOS ANGELES AND LONG BEACH
PRNS	PROJECTS OF REGIONAL AND NATIONAL SIGNIFICANCE
RARF	REGIONAL AREA ROAD FUND
SSDs	SOLID-STATE DRIVES
"STEEP"	SOCIAL, TECHNICAL, ENVIRONMENTAL, ECONOMIC AND POLITICAL
TAC	TECHNICAL ADVISORY COMMITTEE
TIFIA	TRANSPORTATION INFRASTRUCTURE FINANCE AND INNOVATION ACT
TIGER	FEDERAL TRANSPORTATION INVESTMENT GENERATING ECONOMIC RECOVERY GRANT PROGRAM

1 Introduction

Key Messages

The Arizona Department of Transportation, Multimodal Planning Division, retained a team led by CPCS Transcom Inc. to assist in the development of Arizona's State Freight Plan.

The State Freight Plan will define immediate and long-range investment priorities and policies that will generate the greatest return for Arizona's economy.

The purpose of this component report is three-fold:

1. To provide an overview of broad economic trends influencing freight transportation in Arizona.
2. To provide an overview of the role of freight in Arizona's economy.
3. To provide a synthesis of how top freight sectors use the transportation system, their transportation performance needs, and the transportation issues hindering their competitiveness.

1.1 Introduction: Context

Arizona's economic potential is supported by the state's transportation infrastructure, which connects sources of production to markets.

When transportation infrastructure and related services are efficiently designed and competitively positioned, businesses benefit from lower transport costs, faster and better transportation services, and increased reliability; which in turn contribute to their own competitiveness and growth, and that of the broader region.

Effective freight planning and programming can help achieve these ends. Yet, fiscal realities are such that the Arizona Department of Transportation (ADOT) cannot address all transportation system needs and constraints. Rather, it must be strategic in defining and prioritizing its investments and system improvements.

To this end, ADOT's Multimodal Planning Division (MPD), is developing Arizona's State Freight Plan (Freight Plan, or Plan) which will provide strategic guidance to achieve its vision, goals and objectives.

Vision: Arizona's freight transportation system enhances economic competitiveness and quality growth through effective system performance and management.

Figure 1-1: Arizona State Freight Plan Goals and Objectives

Source: CPCS, as validated by ADOT, and the Arizona State Freight Plan Technical Advisory and Freight Advisory Committees

1.2 Project Objectives

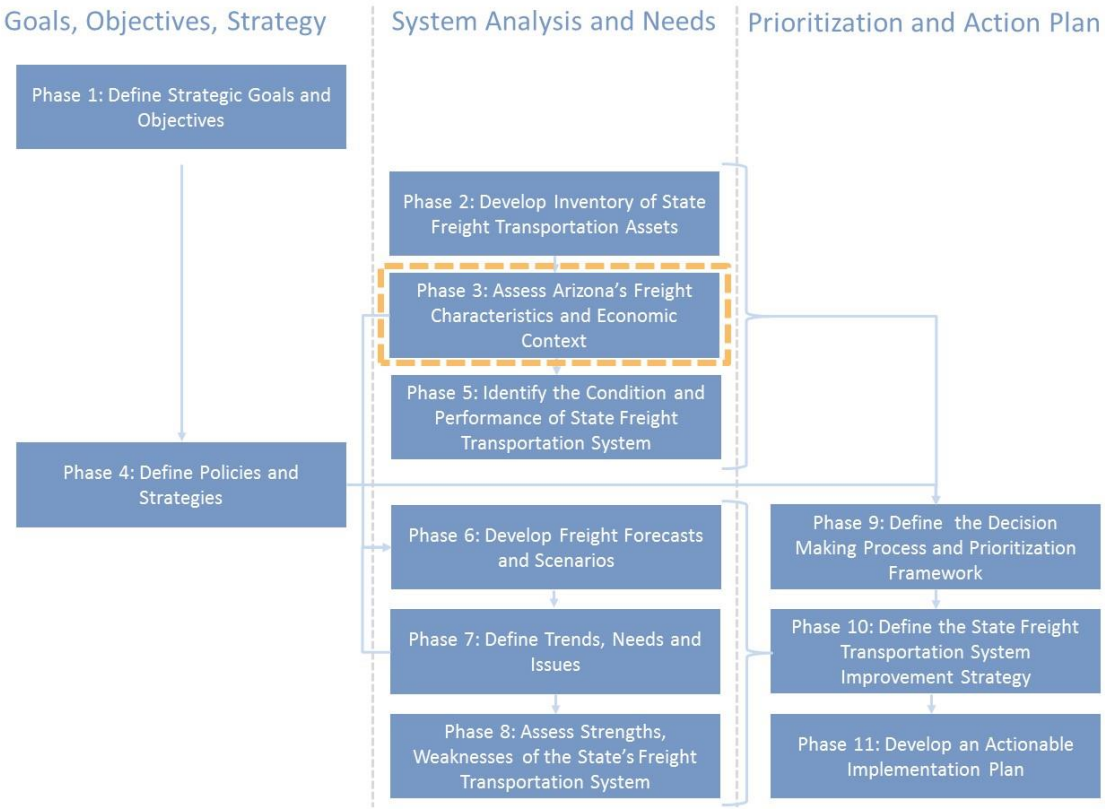
The State Freight Plan will define immediate and long-range investment priorities and policies that will generate the greatest return for Arizona's economy, while also advancing other key transportation system goals, including national goals outlined in MAP-21. It will identify freight transportation facilities in Arizona that are critical to the State's economic growth and give appropriate priority to investments in such facilities.

The State Freight Plan will ultimately provide Arizona with a guide for assessing and making sound investment and policy decisions that will yield outcomes consistent with the State's visions, goals, and objectives, and notably, promote regional competitiveness and economic growth.

1.3 Freight Plan Development Phases

The State Freight Plan is being developed in 11 phases, organized under three overarching headings, as summarized in the Figure 1-2. The present report is the output of Phase 3.

Figure 1-2: Phased Approach to the Development of Arizona's State Freight Plan



1.4 Purpose of this Report

The purpose of this report is two-fold:

1. To provide an overview of the role of freight in Arizona's economy.
2. To provide a synthesis of how top freight sectors use the transportation system, their transportation performance needs, and the transportation issues hindering their competitiveness.

Forecasts of freight flows will be included in the forthcoming Phase 6 and 7 deliverables.

This report is submitted for review and comment by the Technical Advisory Committee (TAC) and Freight Advisory Committee (FAC). It will subsequently be revised or updated based on TAC and FAC comments, as appropriate.

1.5 Methodology

This report is informed by a combination of literature review, data collection and empirical analysis, and extensive consultation with Arizona freight sector stakeholders.

This report is informed in large part by 10 individual economic sector working papers, covering Arizona's top freight sectors: Wholesalers and Retailers, Food and Beverage, High-Tech Manufacturing, General Manufacturing, Transportation Equipment Manufacturing, Transportation and Logistics, Mining (except oil and gas), Energy (oil and gas), Agriculture, and Forestry. These sector working papers are available separately on ADOT's website: www.azdot.gov/freight

Sources used or reviewed are footnoted throughout the report, as appropriate. A list of those consulted is provided in the appendices of the individual economic sector working papers.

1.6 Limitations

This report is in many cases informed by data and input provided by third parties. CPCS has verified this information to the extent possible through analysis and cross-checking with other sources but cannot guarantee the accuracy of data received from third parties.

2 Economic Trends

Key Messages

Prior to the 2008/09 recession, Arizona achieved GDP, employment and population growth above national averages. Since the recession, Arizona's recovery has been relatively slow as compared to the national average and nearby states. In 2014, residential housing starts in Arizona were still less than a third of pre-recession levels and were still at levels not seen in the pre-recession period since 1991.

Arizona's economy and transportation trends are also driven by seasonal trends such as increases in agricultural activity and tourism during the winter months. Employment and agricultural flows tend to follow cyclical trends based upon these factors.

Strong increases in Mexican manufacturing and agricultural activity and imports in to the United States impact Arizona and other border states. Border flows from Mexico have increased at the quickest pace through Texas, with smaller increases achieved in other border states including Arizona.

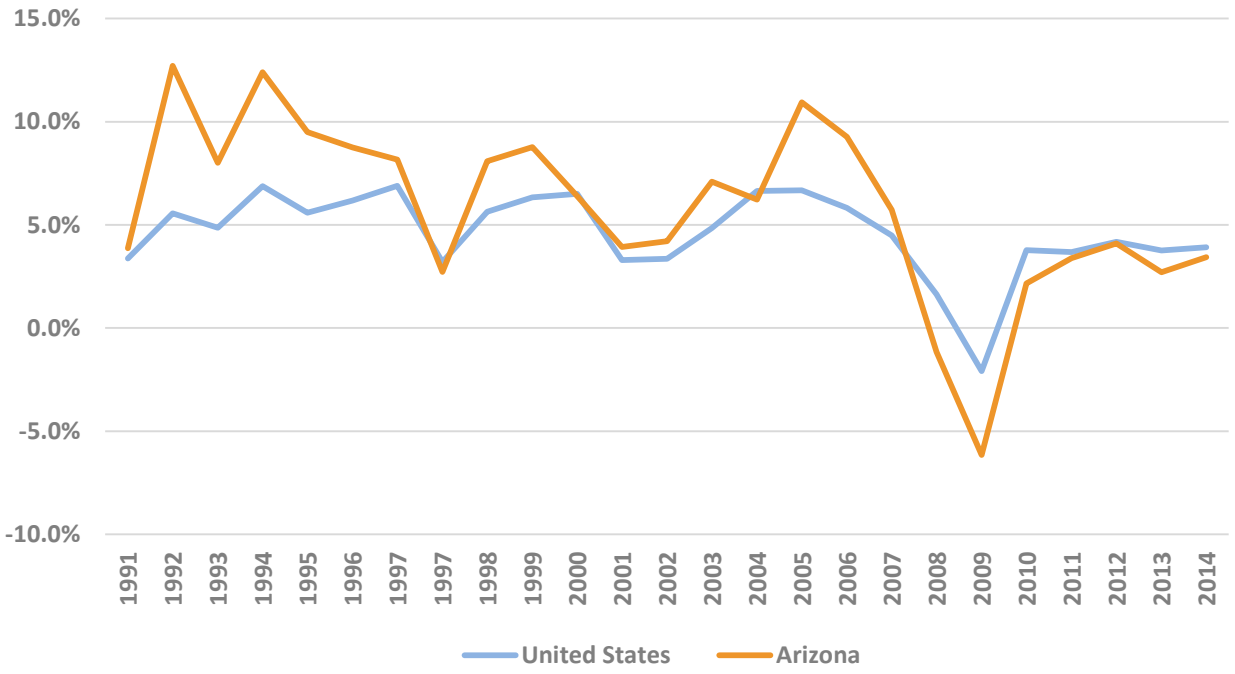
This chapter provides an overview of the broad economic context of the state of Arizona, providing trends on GDP, population, employment, retail trends, transportation activity, and Mexican trends impacting the state. Following the context provided in this chapter, this report then examines the role and impact of freight and the identified top freight generating sectors on Arizona's economy.

2.1 GDP Growth

2.1.1 Arizona versus United States GDP Growth

Figure 2-1 compares annual GDP growth in Arizona with that of the U.S., the data being in current dollars or nominal terms. The most evident feature is the clear slowdown that has occurred in Arizona since the deep recession of 2008-2009.

Figure 2-1: Arizona versus United States Nominal GDP Growth, 1991-2014



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts: GDP by State (current dollars)

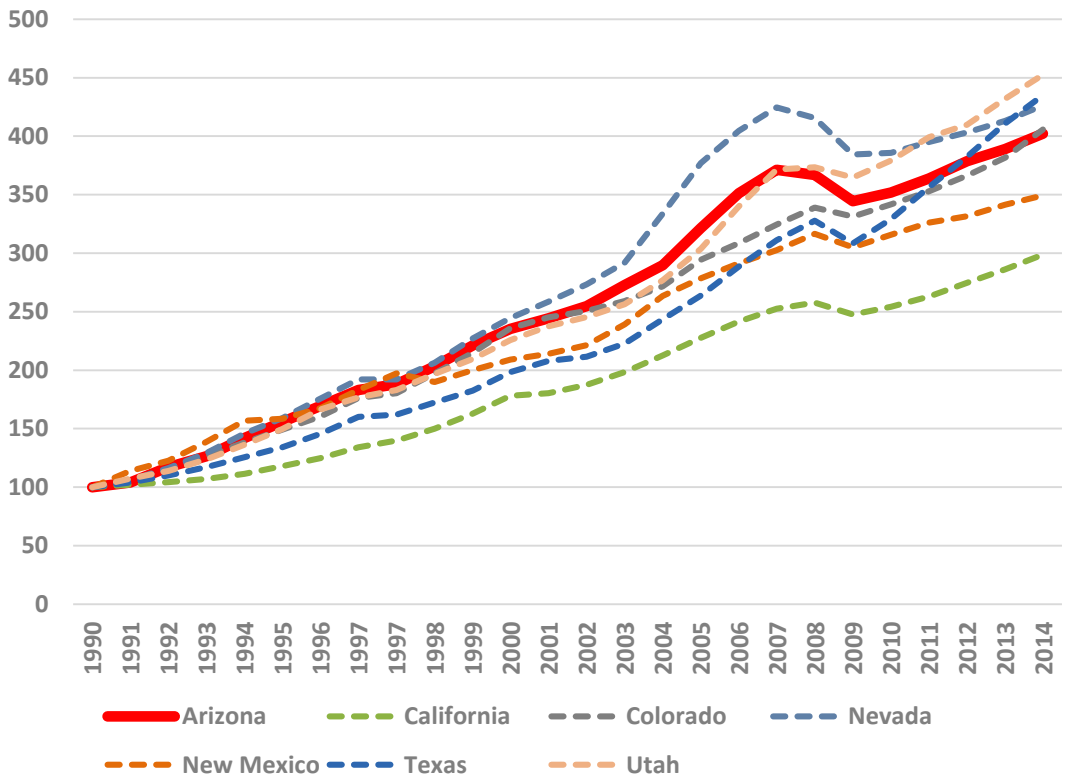
Beginning with the 1990s and continuing through 2007, nominal GDP growth in Arizona averaged 8.0 percent per year, while growth in the U.S. as a whole averaged 5.7 percent per year.[4] In contrast, from the bottom of the recession in 2009 through 2014, the growth in Arizona has underperformed that of the U.S., averaging 3.2 percent per year compared to the U.S. average of 3.9 percent per year.

[4] Average growth rates reported in this chapter are all compound annual rates of growth (CAGR).

2.1.2 Arizona versus Neighboring States GDP Growth

Figure 2-2 compares the growth of Arizona GDP with that of a number of neighboring states, the data again being in nominal terms. Evident here is Arizona's middle ranking performance over the period shown. Between 1990 and 2014, GDP growth in Arizona matched that of Colorado, exceeded that of New Mexico and California, and fell below that of Utah, Nevada and Texas. Also evident is the generally rapid growth experienced by these states during the period of strong worldwide growth that preceded the 2008-2009 recession. However, since the bottom of the recession in 2009, growth in Arizona has lagged that of the other states with the exception of Nevada and New Mexico (Figure 2-3).

Figure 2-2: Arizona versus Neighboring States Nominal GDP Growth Indices (1990=100, 1990-2014)



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts: GDP by State (current dollars)

Figure 2-3: Arizona versus Neighboring States GDP Growth, 2009-2014

State	Nominal Annual GDP Growth 2009-2014
Arizona	3.2
California	3.8
Colorado	4.1
Nevada	2.1
New Mexico	2.8
Texas	7.1
Utah	4.4

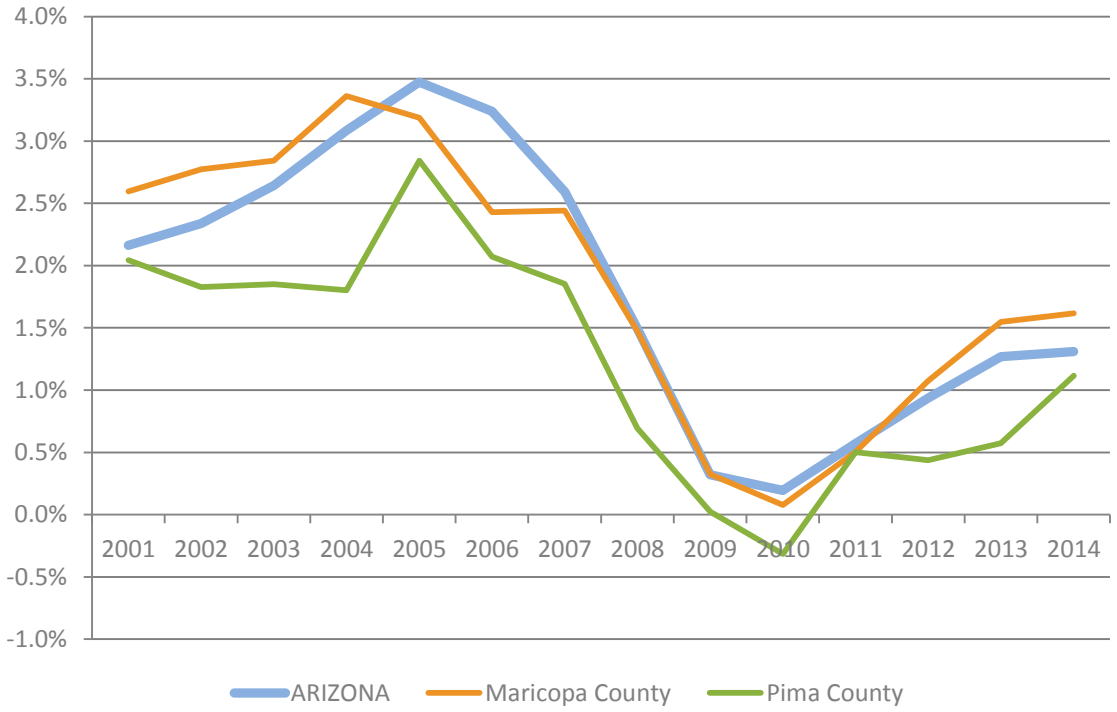
Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts: GDP by State (current dollars)

2.2 Population Growth

Population growth in Arizona, although showing a slowing trend, has consistently outpaced that of the U.S. in recent decades. Between 1970 and 2014, Arizona's population grew by approximately 3.8 times, compared to the U.S. increase of approximately 1.6 times.[5]

Recent years have seen a significant slowing in the growth of population in Arizona. Between 1970 and 2000, Arizona's population grew at an average rate of 3.6 percent per year.[6] This, however, has since slowed considerably as may be seen in Figure 2-4. From 2001 through 2007, prior to the 2008-2009 recession, population growth in Arizona averaged 2.6 percent per year. Since 2009, Arizona's population growth has slowed further, averaging only 1.2 percent per year.

Figure 2-4: Arizona, Maricopa and Pima Counties Annual Population Growth, 2001-2014



Source: CPCS analysis of Interim Intercensal Population Estimates for Arizona, Its Counties, and Incorporated Places

Arizona's population growth has generally reflected that of its two largest counties combined, Maricopa and Pima, which together make up approximately three fourths of the State's population. Since 1970, Maricopa population has grown by 4.2 times, outpacing that of the State as a whole, while that of Pima has been considerably slower, increasing by 2.8 times.[7] Since 2000, Maricopa population has grown at virtually the same pace as Arizona's, while Pima population growth has continued to be significantly slower (Figure 2-4).

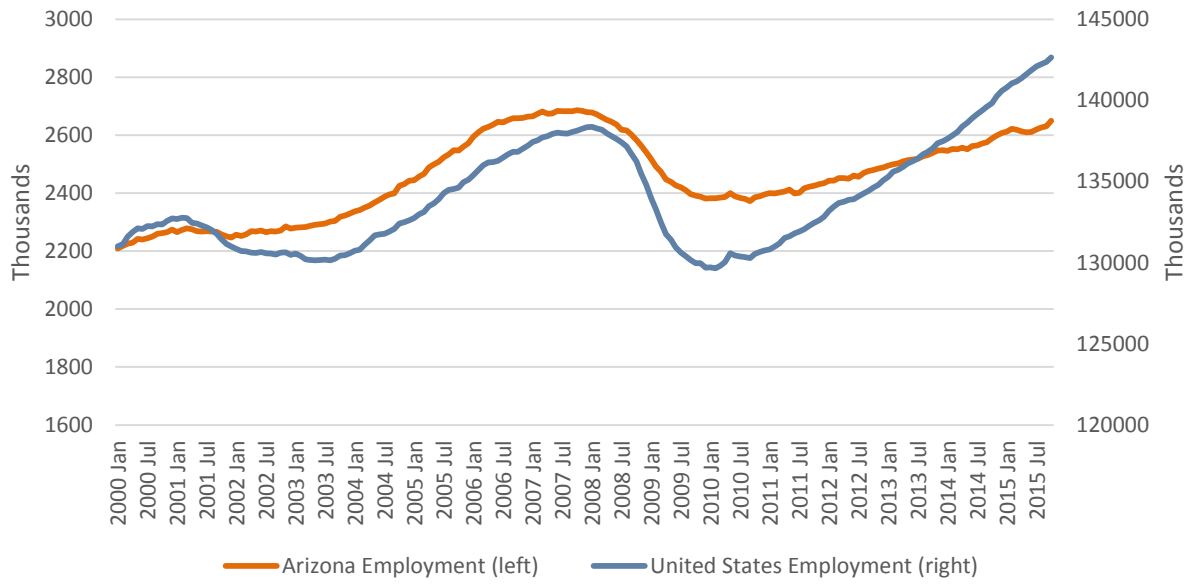
[5] http://arizonaindicators.org/demographics/population
[6] Ibid.
[7] Ibid.

2.3 Employment

2.3.1 Arizona and United States Non-Farm Employment

Figure 2-5 compares Arizona and U.S. monthly seasonally adjusted non-farm employment over the period from January 2000 through October 2015. In both cases employment rose strongly in the years prior to the 2008/2009 recession and then dropped sharply. In Arizona, employment peaked at 2,686,000 in October 2007, subsequently dropping to a recession low of 2,373,000 in September 2010, for a loss of 313,000 jobs. Since then, employment in Arizona has risen to 2,650,000, regaining almost 90% of the jobs lost. However, as may be seen in Figure 2-5, nationwide employment has surpassed its recession low, standing at 142,654,000 in October 2015, a gain of 3.1% over the pre-recession peak of 138,365,000 reached in January 2008.

Figure 2-5: Arizona and United States Non-farm Employment (seasonally adjusted)



Source: BLS State and Area Employment, Hours and Earnings

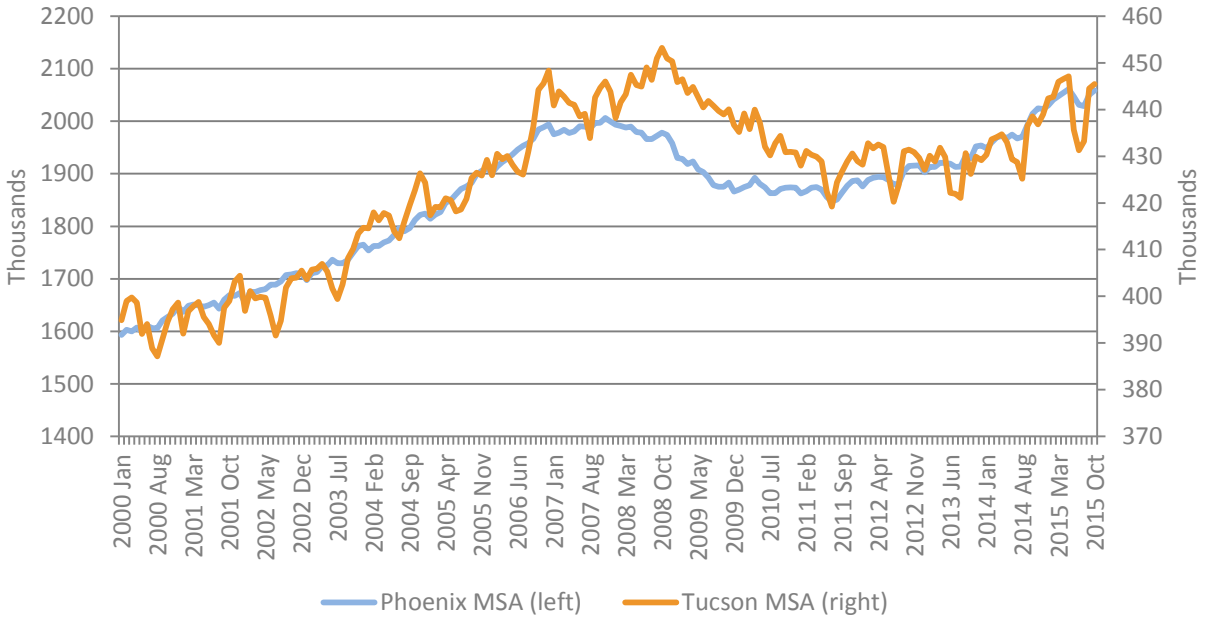
2.3.2 Phoenix and Tucson Employment

Figure 2-6 displays the monthly, non-seasonally adjusted employment for the Phoenix and Tucson Census Metropolitan Statistical Areas from January 2000 through October 2015. In both areas employment rose strongly in the years before the 2008/2009 recession and then dropped sharply. Also evident is the much greater variability of employment in Tucson as compared to Phoenix due to the greater influence of seasonal factors in Tucson.

In Phoenix, pre-recession employment peaked at 2,006,000 in November 2007, subsequently dropping to a low of 1,856,000 in June 2011, for a decline of 150,000 jobs over this period. Employment in Phoenix has since risen to 2,059,000 in October 2015, for a gain of 2.6% over the pre-recession peak reached in November 2007.

In Tucson, employment peaked at 453,000 in October 2008, subsequently dropping to a low of 419,000 in July 2011, a decline of 34,000 jobs over this period (and bearing in mind the strong seasonality evident in Tucson employment). Employment in Tucson has since risen to 445,000 in October 2015, almost matching its October 2008 level.

Figure 2-6:Phoenix and Tucson Metropolitan Area Employment (not seasonally adjusted)

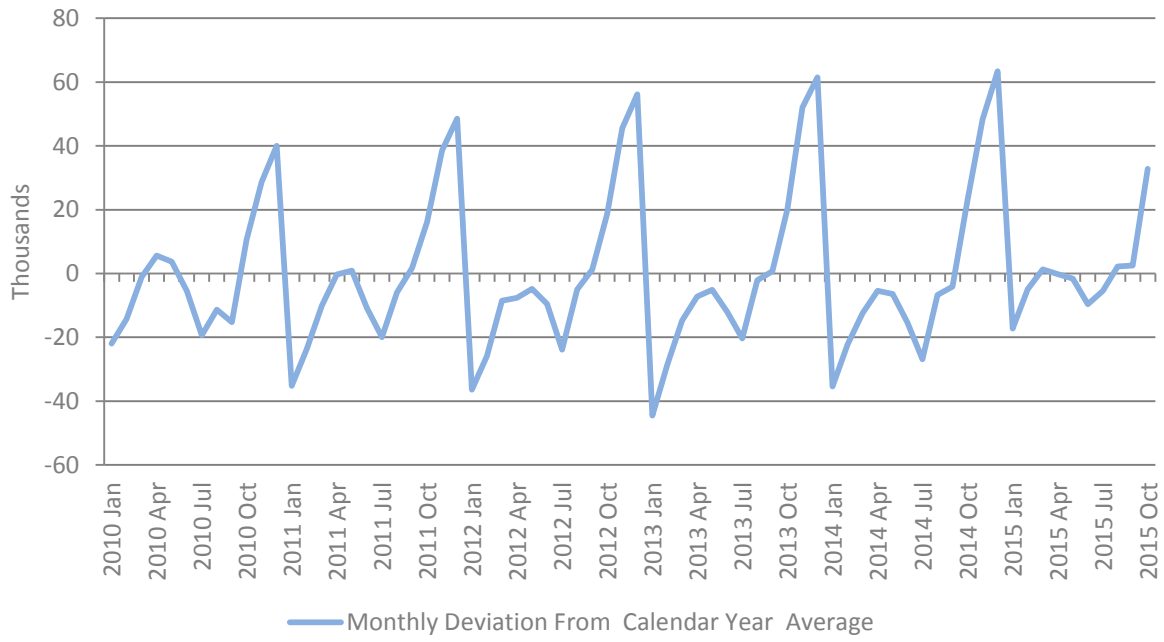


Source: BLS Local Area Unemployment Statistics

2.3.3 Arizona Employment Seasonality

Figure 2-7 shows the seasonality in private sector employment in Arizona over the past six years, i.e. January 2010-October 2015. Seasonal variation is indicated here by the deviation in each month's employment from the corresponding calendar year's average employment. The seasonal pattern clearly shows a high degree of regularity, with the first and fourth quarters exhibiting the greatest variation. Over the period shown, the first quarter deviations average approximately - 22,000 (-1.0%), while the fourth quarter deviations average approximately +38,000 (+1.8%).

Figure 2-7: Arizona Total Private Employment Seasonality



Source: CPCS analysis of BLS State and Area Employment, Hours and Earnings

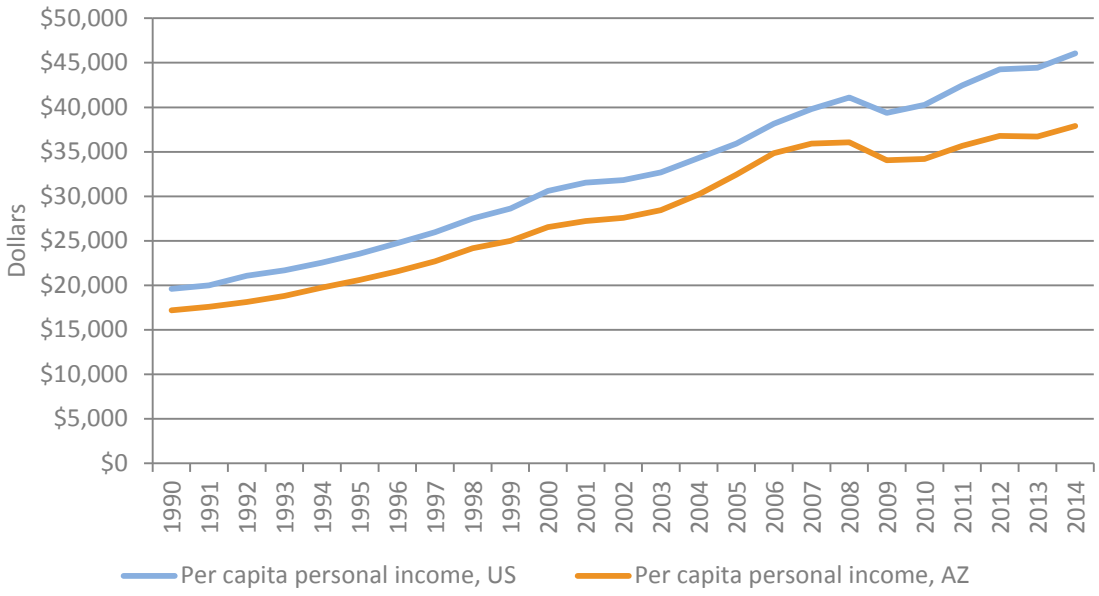
2.4 Personal Incomes

2.4.1 Personal Income

Figure 2-8 shows the growth in Arizona and U.S. per capita personal income since 1990. The growth over this period has been similar, averaging 3.3 per cent per year for Arizona and 3.6 percent per year for the U.S. Arizona per capita personal income, however, is generally below that of the U.S. as a whole, the difference having averaged about -13 percent.

Arizona's recovery from the 2008/2009 recession has been significantly slower than the U.S.', with Arizona per capita personal income since 2009 growing on average 2.2 percent per year as compared to 3.2 percent per year for the U.S. as a whole. As a result, the gap in per capita personal income has widened, with per capita personal income in Arizona now 18 percent less than that of the U.S.

Figure 2-8: Per Capita Personal Income, United States and Arizona (dollars)



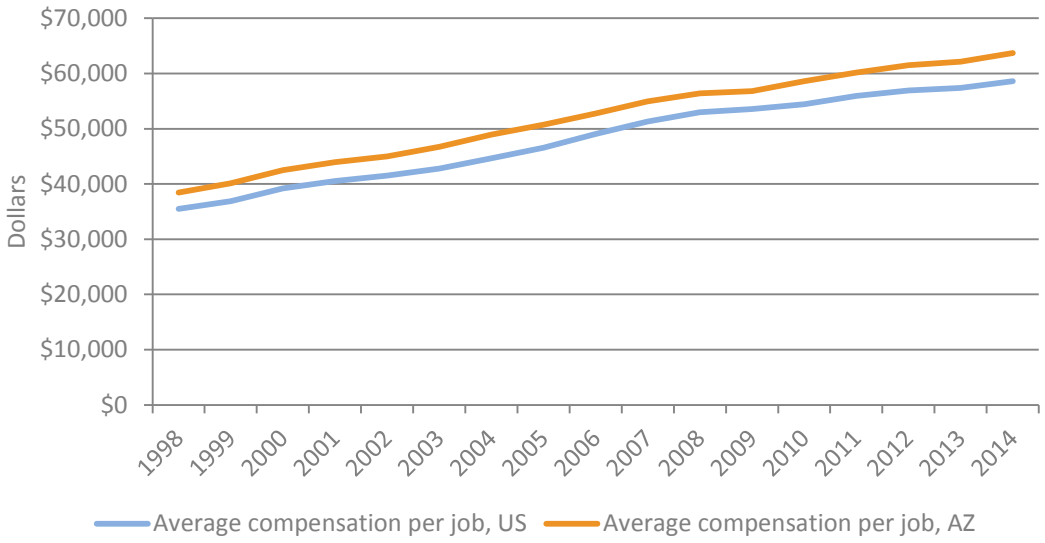
Source: BEA Persona Income Summary

2.4.2 Employee Compensation

Figure 2-9 shows the average employee compensation per job for Arizona and the U.S. since 1998. This is calculated as the total compensation of employees divided by total full-time and part-time wage and salary employment. As may be seen, the level of Arizona employee compensation per job compares favorably to that of the U.S. as a whole.

For both Arizona and the U.S., compensation per job has grown on average by 3.2 percent per year since 1998. This is also slightly ahead of inflation, the annual CPI having increased on average by 2.4 percent per year between 1998 and 2014. As with several of the other metrics, Arizona's performance since the 2008/2009 recession has lagged behind that of the U.S., with Arizona compensation per job since 2009 growing on average 1.8 percent per year as compared to 2.3 percent per year for the U.S. as a whole.

Figure 2-9: Average Employee Compensation per Job (Dollars)



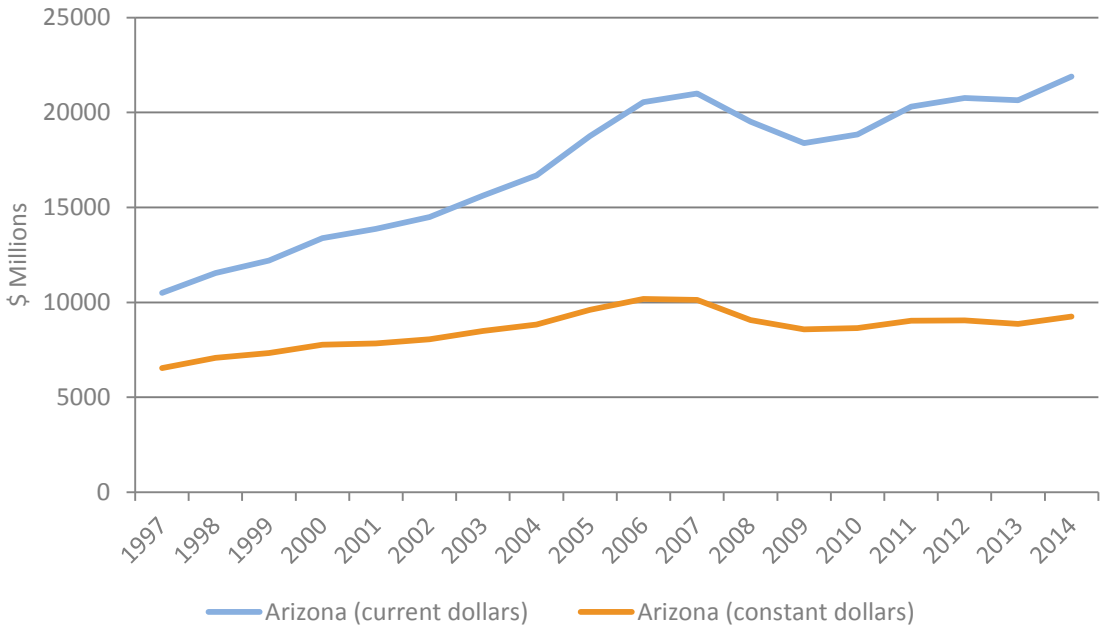
Source: BEA Compensation of Employees by NAICS Industry

2.5 Retail Trends

2.5.1 Arizona Retail Activity

Figure 2-10 shows Arizona retail trade activity (the retail trade component of Arizona GDP) in current and constant dollars since 1997. From 1997 through 2007, retail trade grew on average at 4.8 percent per year in nominal terms and 2.3 percent per year in real terms, with particularly strong growth occurring in the years leading up to the 2008/2009 recession. However, as with most of the other indicators examined in the chapter, growth since the recession has been significantly slower. From 2009 through 2014, retail activity in Arizona grew on average at 3.5 percent per year in nominal terms and at 1.5 per year in real terms. Although in nominal terms retail activity has surpassed its previous peak, in real terms it has yet to do so.

Figure 2-10: Arizona Retail Trade Activity, 1997-2014 ($ Millions)

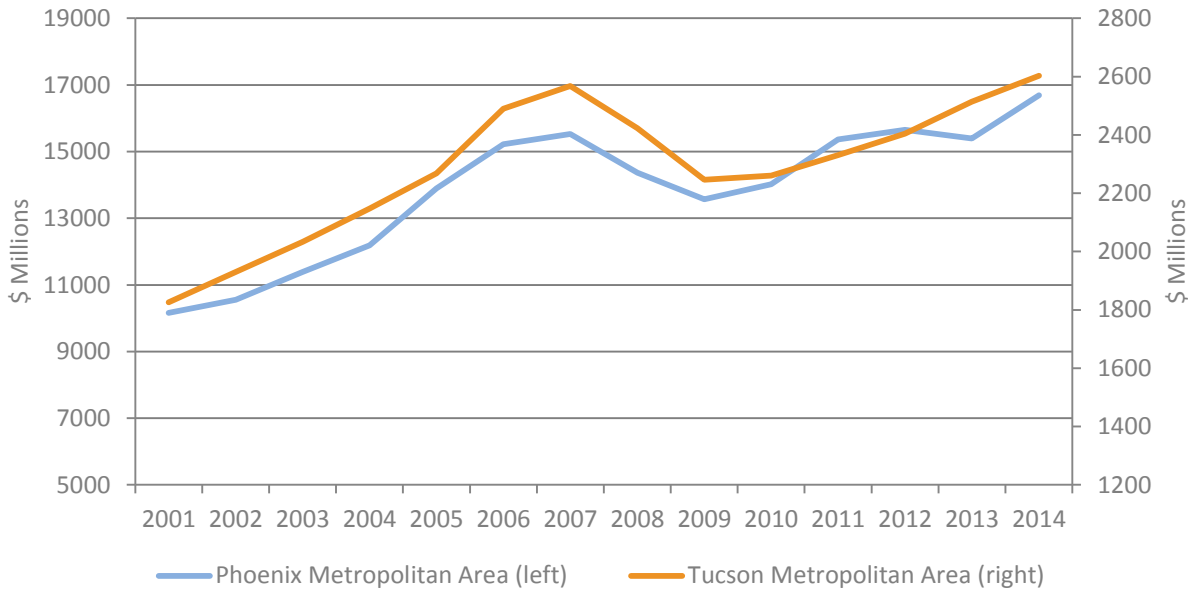


Sources: CPCS analysis of BEA Gross Domestic Product by State and BLS US Consumer Price Index

2.5.1 Phoenix and Tucson Retail Activity

Figure 2-11 shows retail activity in current dollars in the Phoenix and Tucson Metropolitan Areas. As with the overall activity, retail activity in both of the metropolitan areas rose strongly in the years prior to the 2008/2009 recession and then dropped sharply. From 2001 through 2007, retail activity grew on average at 7.3 percent per year in the Phoenix area and 5.8 percent per year in the Tucson area. Since 2009, the retail activity has grown much more slowly, averaging 4.2 percent per year in Phoenix and 3.0 percent in Tucson.

Figure 2-11: Phoenix and Tucson Metropolitan Area Retail Activity ($ Millions)

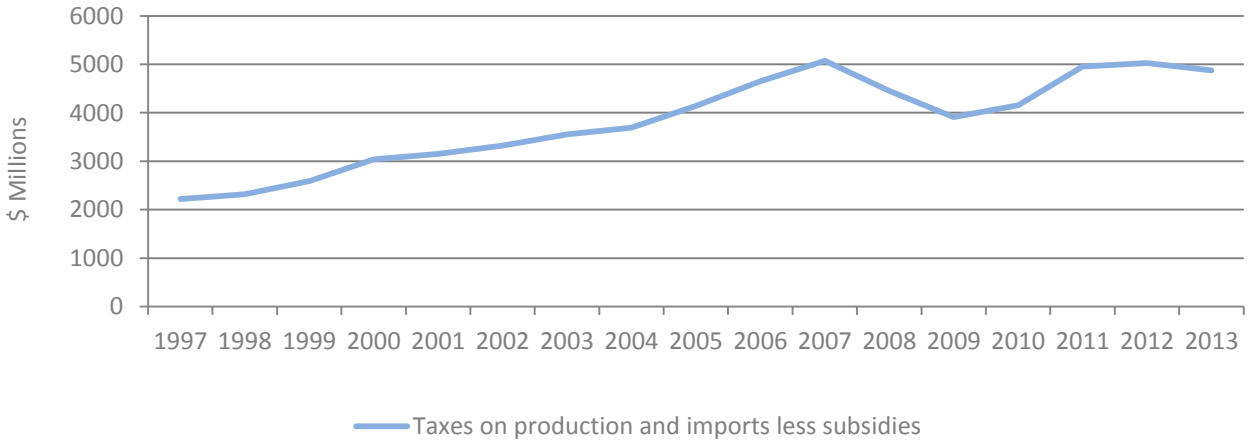


Source: BEA Gross Domestic Product by State

2.5.1 Taxes on Retail Trade Production and Imports

Figure 2-12 shows, for the retail sector in Arizona, the taxes on production and imports less subsidies. These taxes include excise, sales, property and other taxes relating to business production. Over the period shown these taxes have more than doubled, growing on average at 5 percent per year. However, after recovering from the 2008/2009 recession, these taxes on business production have remained flat.

Figure 2-12: Taxes on Arizona Retail Trade Production and Imports ($ Millions)



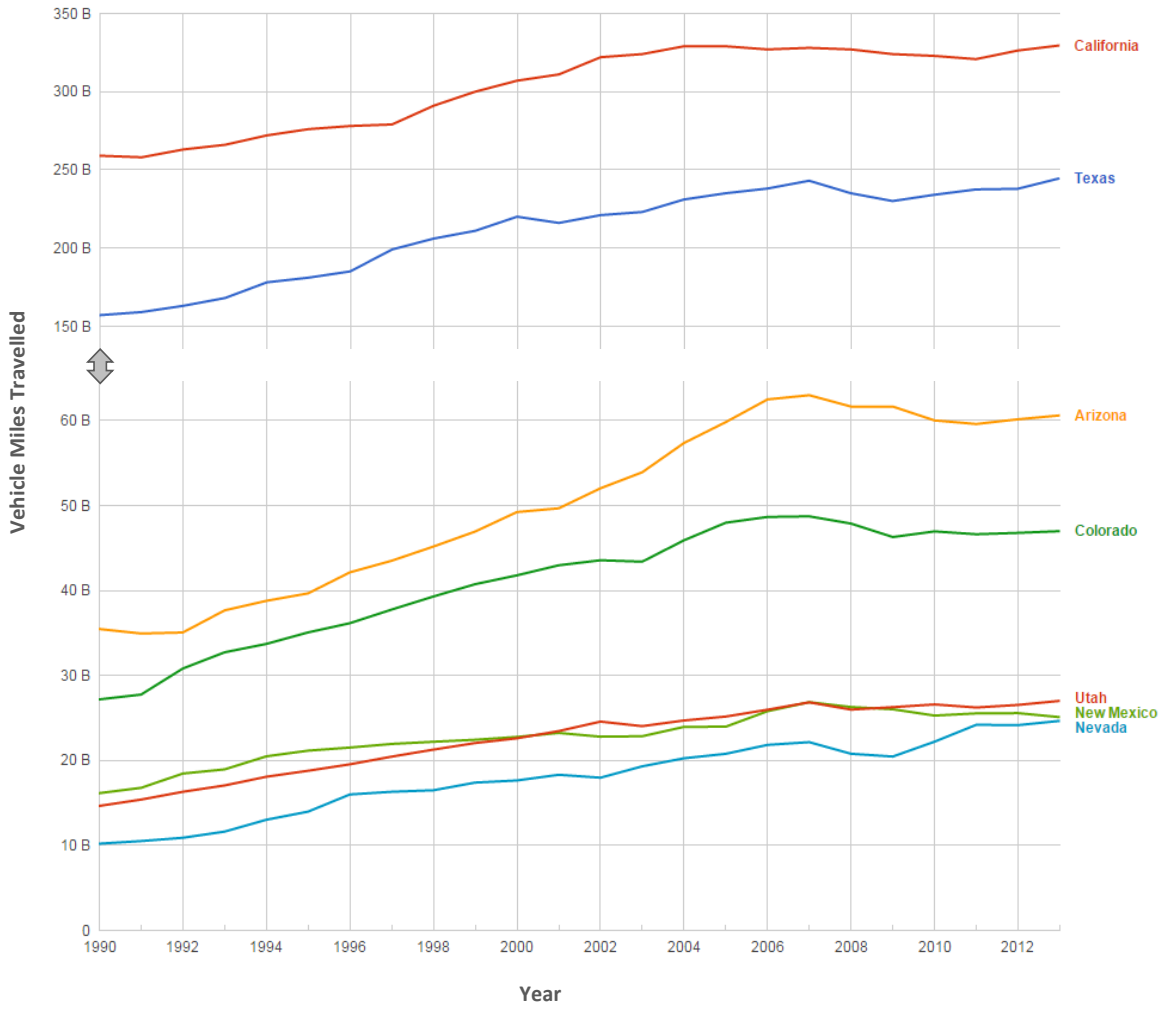
Source: BEA Taxes on Production and Imports less Subsidies

2.6 Transportation Activity

2.6.1 Vehicle Miles of Travel

Figure 2-13 compares the total vehicles miles of travel (VMT) on all public roads in Arizona with that of neighboring states over the period since 1990. As with GDP, the growth experienced by Arizona in VMT has been middle ranking. Between 1990 and 2013, the growth of VMT in Arizona averaged 2.4 percent per year, basically matching that of both Colorado (at 2.4 percent) and Utah (at 2.7 percent). Nevada experienced the strongest annual average growth (at 3.9 percent), while California, Texas and New Mexico experienced the slowest growth (all at less than 2.0 percent per year).

Figure 2-13: Arizona and Neighboring States Total Vehicle Miles of Travel (Billions)



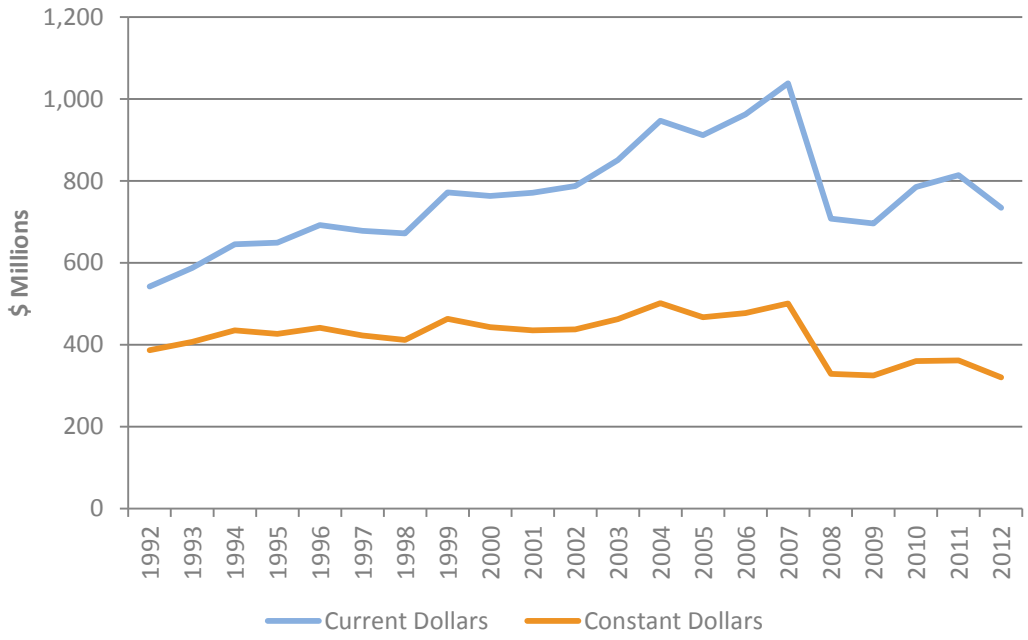
Source: FHWA, http://www.google.com/publicdata/explore?ds=gb66jodhlsaab

For all of the states, Figure 2-13 highlights the more rapid growth in VMT over the period up to 2007 as compared to the years since 2007. In Arizona's case, the growth in VMT averaged 3.4 percent per year between 1990 and 2007. This was followed by the decline due to the recession, and since 2009 the recovery in VMT in Arizona has been sluggish, remaining below its 2009 level.

2.6.2 Highway User Revenues

Figure 2-14 displays the trend in Arizona state highway user revenues since the early 1990s, in both current and constant dollars (the latter based on deflating by the Consumer Price Index). The essential observation to be made is that these revenues, which are expended on state and local roads and represent about one fourth of the state revenues used for highways (2012), have not managed to keep abreast of inflation, as indicated by the constant dollar revenues shown in Figure 2-14. Arizona, however, is not unique in this respect. The problem of traditional highway revenue sources not growing sufficiently is a generally recognized nationwide phenomenon.

Figure 2-14: Arizona State Highway User Revenues ($ Millions)



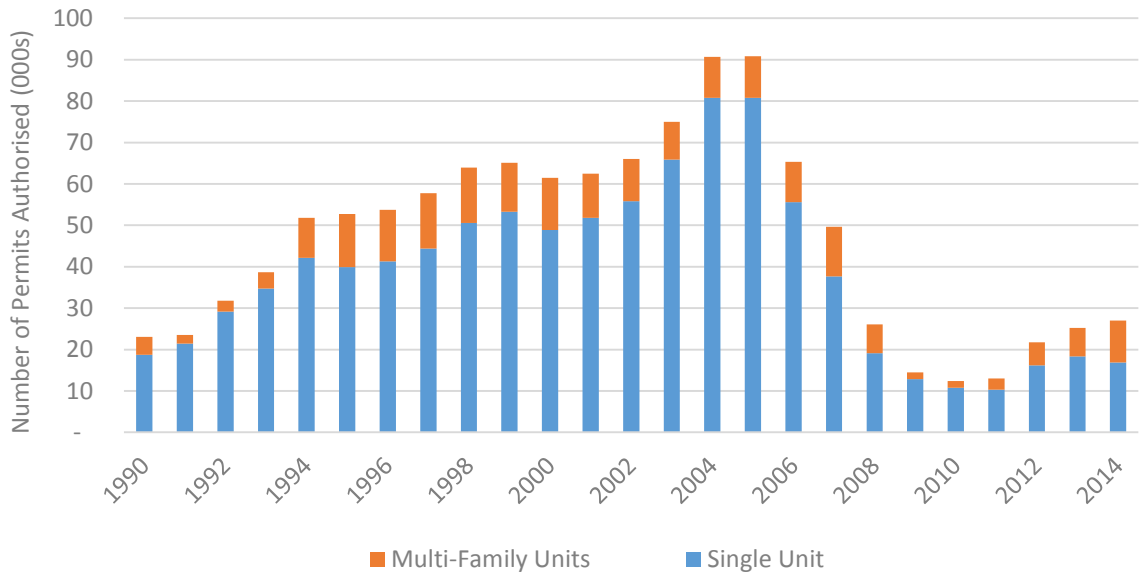
Sources: FHWA Highway Statistics Series and BLS Consumer Price Index tables

2.7 Residential Construction

Following a major construction boom from the mid-1990s through the mid-2000s, residential construction activity in Arizona fell dramatically beginning in 2006. The level is only now recovering to that of the early 1990s (Figure 2-15). Nationwide, housing construction over this period has experienced a similar boom-bust cycle. The Arizona economy is one of the state economies in the country most affected by housing.[8]

[8] See, e.g., Bureau of Economic Analysis, "Gross Domestic Product by State, Advance Statistics for 2008 and Revised Statistics for 2005–2007," *Survey of Current Business* Vol. 89, No. 6 (June 2009) at http://bea.gov/scb/toc/0609cont.htm.

Figure 2-15: Residential Building Permits Authorized, Arizona, 1990- 2014



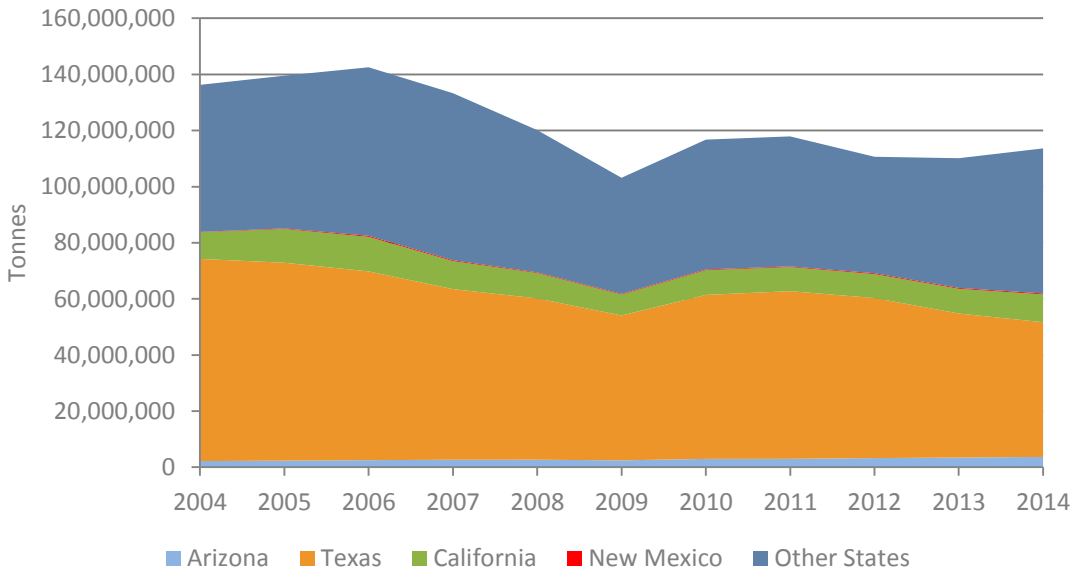
Source: US Census Bureau, Building Permits Survey: www.census.gov/construction/bps/stateannual.html

2.8 International Factors

2.8.1 Imports from Mexico

Figure 2-16 shows import volumes from Mexico according to selected U.S. states of entry. In 2014, the U.S. imported approximately 113 million tonnes (125 million tons) of goods from Mexico, down 17 percent from the volume imported in 2004. Texas is clearly the dominant state of entry, with 42 percent of the goods entering through Texas in 2014. Arizona's share of the imports from Mexico is small but Arizona has seen its share grow, both in absolute and relative terms. Imports into the United States entering through Arizona totalled 3.7 million tonnes (4.1 million tons) in 2014, up from 2.2 million tonnes (2.4 million tons) in 2004.

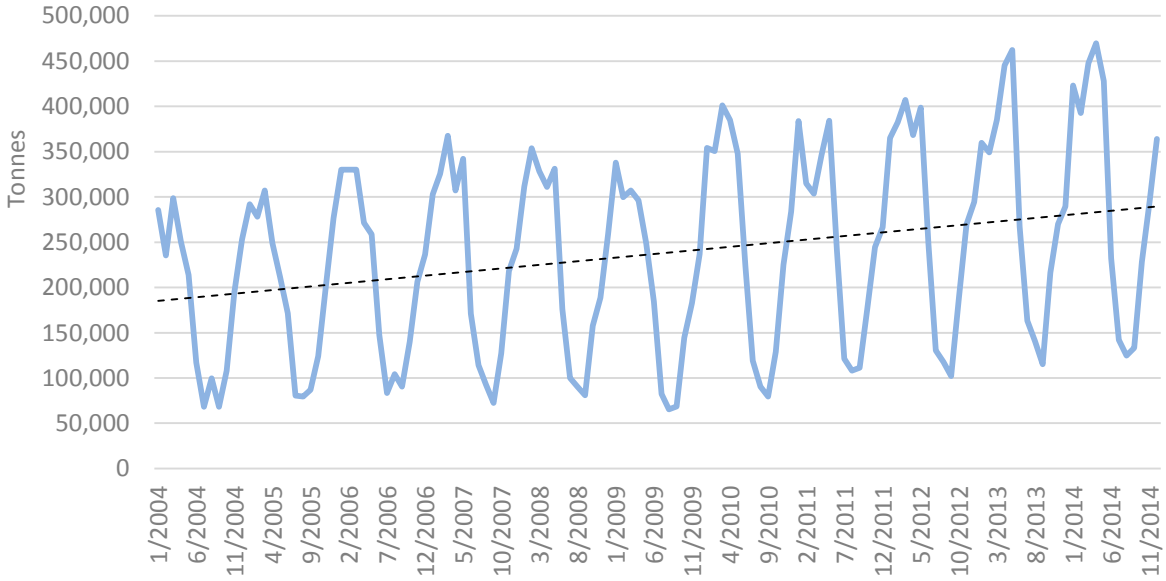
Figure 2-16: U.S. Import Volumes from Mexico



Source: US Bureau of Transportation Statistics North American Transborder Freight Data

Imports entering the United States through Arizona are highly seasonal, as shown in Figure 2-17. The seasonal pattern is clearly regular, with the first and third quarters exhibiting the greatest variation.

Figure 2-17: Mexican Imports Entering Through Arizona by Month



Source: US Bureau of Transportation Statistics North American Transborder Freight Data

2.8.2 Mexico Manufacturing Employment Growth

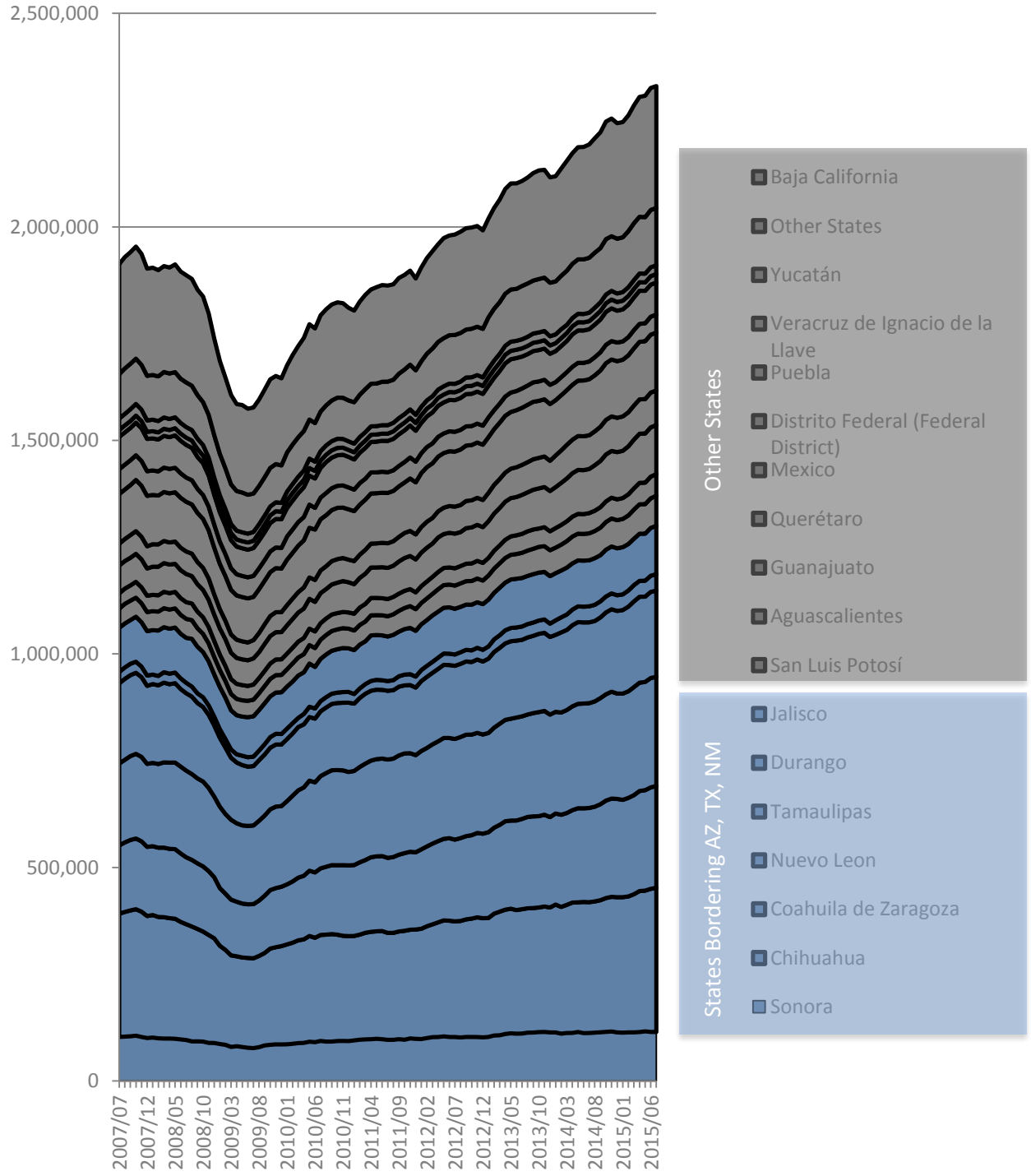
Figure 2-18 shows the growth in Mexico manufacturing employment by state since mid-2007. States in proximity to the U.S.' border states of Arizona, New Mexico and Texas are in blue in the bottom portion of the graph.

In total, manufacturing employment in Mexico grew by 417,067, or 22 percent, over the eight years shown in Figure 2-18, from 1,912,745 in July 2007 to 2,329,812 in July 2015. On average, the growth over the period was 2.5 percent per year. In addition, recovery from the 2008/209 recession has been strong with employment, growing by 755,732 since bottoming out in June 2009.

Considering the individual states, the four states bordering New Mexico and Texas — Chihuahua, Coahuila, Nuevo Leon and Tamaulipas — together account for 44 percent of the total employment (July 2015). Moreover, two of these states — Coahuila, Nuevo Leon — have experienced relatively rapid employment growth over the period, 49 percent and 33 percent, respectively.

Sonora, the Mexican state bordering Arizona, accounts for a relatively small share of the manufacturing employment, 4.9 percent. In addition, the employment growth in Sonora has been slow, having increased by only 11 percent over the eight years, or on average by 1.3 percent per year.

Figure 2-18: Number of Manufacturing Employees, Total and by State, Mexico (July 2007-August 2015)



Source: Instituto Nacional de Estadística y Geografía (México), Banco de Información Económica

3 Economic Profile of Arizona's Freight Sectors

Key Messages

Arizona's top 10 freight sectors can generally be segmented into four similar freight transportation system sector groups: consumer goods sectors, manufacturing sectors, natural resources sectors, and the transportation and logistics sector.

These freight sectors generate $82 billion in GDP and close to 900,000 jobs, equivalent to 30% of Arizona's total GDP and employment.

In absolute terms, consumer goods sectors are the greatest contributor to Arizona's economy among freight sectors, in terms of GDP, GDP growth, employment, income and taxes.

Arizona's manufacturing and natural resources sectors, are smaller than the consumer goods sectors in most respects, but generate the greatest share of exports and a significant share of Arizona's direct investment – key drivers of quality, high paying employment growth in the State.

3.1 Arizona's Top Freight Sectors

To enhance Arizona's economic competitiveness and growth, the Arizona State Freight Plan should focus on addressing the transportation performance needs of the freight sectors that drive Arizona's economic activity and growth.

To this end, the team identified Arizona's "top 10" freight sectors, below, based on a range of factors, including volumes and values of traffic, contribution to GDP, trade and employment, and other criteria (Appendix A) informed by the economic competitiveness goals and objectives of the Arizona State Freight Plan.[9, 10]

Arizona's Top 10 Freight Sectors[11]

- Wholesale and Retailers
- Food and Beverage
- High-Tech Manufacturing
- General Manufacturing
- Transportation Equipment Manufacturing (incl. aerospace)
- Transportation and Logistics
- Mining (except oil and gas)*
- Energy (oil and gas)*
- Agriculture*
- Forestry*

*Also included are the focus sectors identified in MAP-21[12] and FHWA Guidance[13].

[9] Industries have been identified as being freight intensive. There is to some degree a concurrence with those targeted within the State's various economic development plans. The "freight" sectors have components of the targeted "base" sector industries that drive an economy, as well as those indirect and induced activities that combine to make up the whole of an economy.

[10] Arizona's top goods movement sectors, by different metrics, are provided for reference in Appendix B.

[11] North American Industry Classification System (NAICS) codes corresponding to Arizona's top 10 freight sectors:

	Proposed Sector	Corresponding NAICS Codes
1	**Wholesalers and Retailers**	42, 44, 45 (includes some retail related to other sectors such as gas stations, food retail, etc.)
2	**Food and Beverage**	311, 312, 722
3	**High-Tech Manufacturing**	334-335
4	**General Manufacturing**	313-315, 325-327, 331-333, 337, 339
5	**Transportation Equipment**	336
6	**Transportation and Logistics**	48, 49
7	**Mining (except oil and gas)**	212, 213
8	**Energy (oil and gas)**	211, 324
9	**Agriculture**	111, 112, 115
10	**Forestry**	113, 321, 322

[12] MAP-21 Section 1118(b)(5) "in the case of routes on which travel by heavy vehicles (including mining, agricultural, energy cargo or equipment, and timber vehicles) is projected to substantially deteriorate the condition of roadways, a description of improvements that may be required to reduce or impede the deterioration"

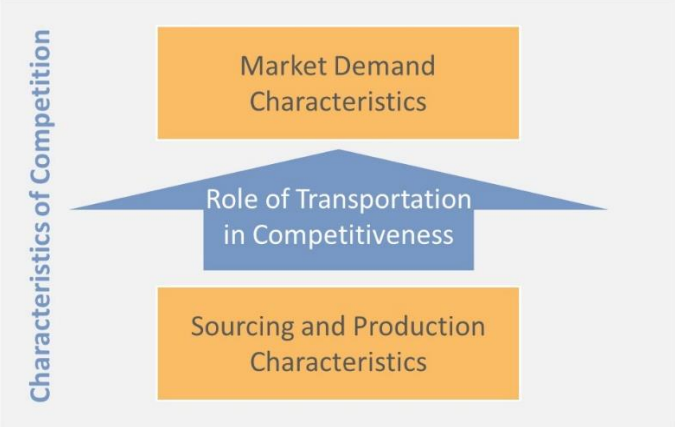
[13] FHWA Guidance: State freight plans also include mining, agriculture, energy, and timber industries by defining the assets that support those industries and how the state's freight improvement strategy will affect the routes supporting the mining, agriculture, energy, and timber industry.

3.2 Arizona's Key Freight Sector Groups and their Contribution to the Economy

The "top 10" freight sectors in Arizona are varied, as is their use of Arizona's freight transportation system, and their respective transportation needs and issues. Nevertheless, certain freight sectors share common characteristics, which can in turn be used to segment Arizona's top 10 freight sectors into groups that use the transportation system in similar ways, and that have common needs and issues.

In simplified terms, four factors can be used to segment Arizona's top freight sectors into freight transportation system user groups: market demand characteristics, sourcing and production characteristics, characteristics of sector competition, and the role of transportation in sector competitiveness.

Figure 3-1: Factors Influencing Use of the Freight Transportation System



Source: CPCS

Using these factors, Arizona's top freight sectors can generally be segmented into the following sector groups: consumer goods sectors, manufacturing sectors, natural resources sectors, and the transportation and logistics sector. Note, the colors used to denote each sector group below are used throughout this report.

Figure 3-2: Freight Sector Group Segment Charateristics

Sector Groups	Top 10 Sector	Market Demand	Sourcing and Production	Competition	Role of Transportation
Consumer Goods ***(Orange)***	• Wholesalers and Retailers • Food and Beverage	Predominantly tied to local consumption	Varied – Local to global	Predominantly for the Arizona market (end consumers)	Varied, depending on nature of products
Manufacturing ***(Green)***	• High-Tech • General • Transportation Equipment	Important focus outside Arizona, incl. global	Arizona, though supply chains extend beyond	• Arizona • US • Global	• Market access • Supply chain integration
Natural Resources ***(Blue)***	• Mining • Agriculture • Forestry • Energy	Important focus outside Arizona, incl. global	• Arizona • US (Energy)	Price takers, driven by commodities prices	• Market access • Focus on low cost
Transportation and Logistics ***(Brown)***	• Transportation and Logistics	Predominantly tied to Arizona freight sectors' needs	Local	Predominantly for the Arizona market (shippers)	Service

Source: CPCS

3.3 The Importance of Freight to Arizona's Economy

Arizona's top 10 freight sectors represent a significant share of Arizona's economy[14]:

$82 billion in State GDP, or 30 percent of Arizona's overall GDP (2013)

873,000 Arizona jobs, or 30 percent of Arizona's total employment (2013), including over half of the 83,000 jobs generated from foreign direct investment in the state

$43 billion in annual income for Arizona residents, or 29 percent of the total employment income of Arizona residents (2013)

$38 billion in domestic exports: the top 10 sectors generate $38 billion in exports from Arizona to other U.S. states; and $79 billion in imports from other states to Arizona (2012). Some of this trade may ultimately be destined to or originated in international markets.

$18 billion in international exports: the top 10 sectors generate $17.7 billion, or 96 percent of all of Arizona's foreign exports; and $17 billion, or 90 percent of all of the state's foreign imports. (2012)

$11 billion in annual taxes (combined state, local and federal excise taxes) on production and investment in the state, 58 percent of the taxes on production and investment collected (2013)[15]

The relative contribution and importance of Arizona's key economic sectors in terms of GDP, employment, trade, and taxes is presented in the subsequent sub-sections.

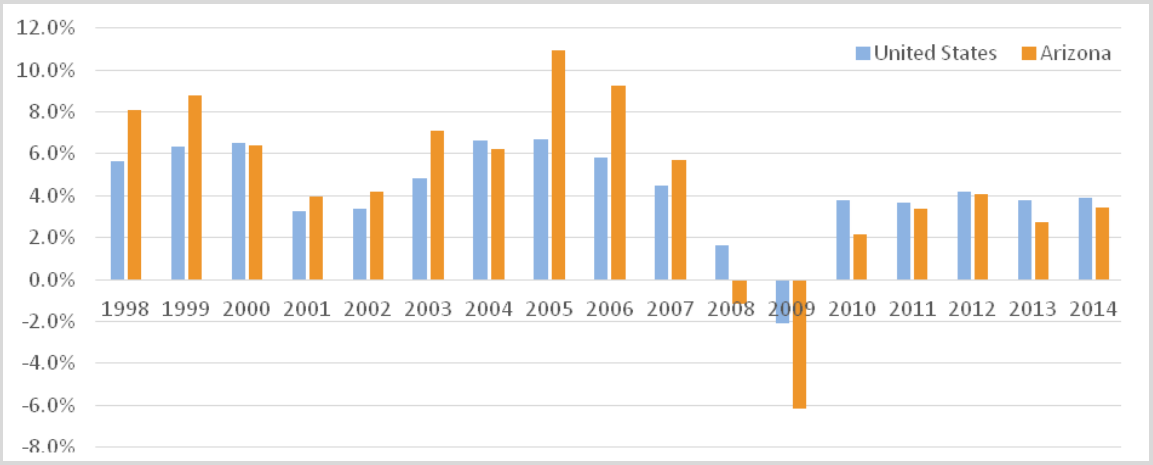
[14] The data in this chapter analyzes the economic impact on Arizona of the noted top 10 freight sectors. These sectors cover most freight industry and flows in Arizona. For example, the top 10 sectors represent 86% of state GDP of freight sectors, and over 96% of all state export flows (by value).
[15] Combined state, local and federal excise taxes.

3.4 Gross Domestic Product

Arizona's GDP Outpacing GDP Growth of the U.S. as a Whole

Overall since 1997, Arizona's Gross Domestic Product[16] has grown at an annualized rate of 4.6 percent compared to 4.2 percent for the U.S. as a whole.[17]

Figure 3-3: Year-over-Year Change in GDP for the United States and Arizona



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts: GDP by State (current dollars)

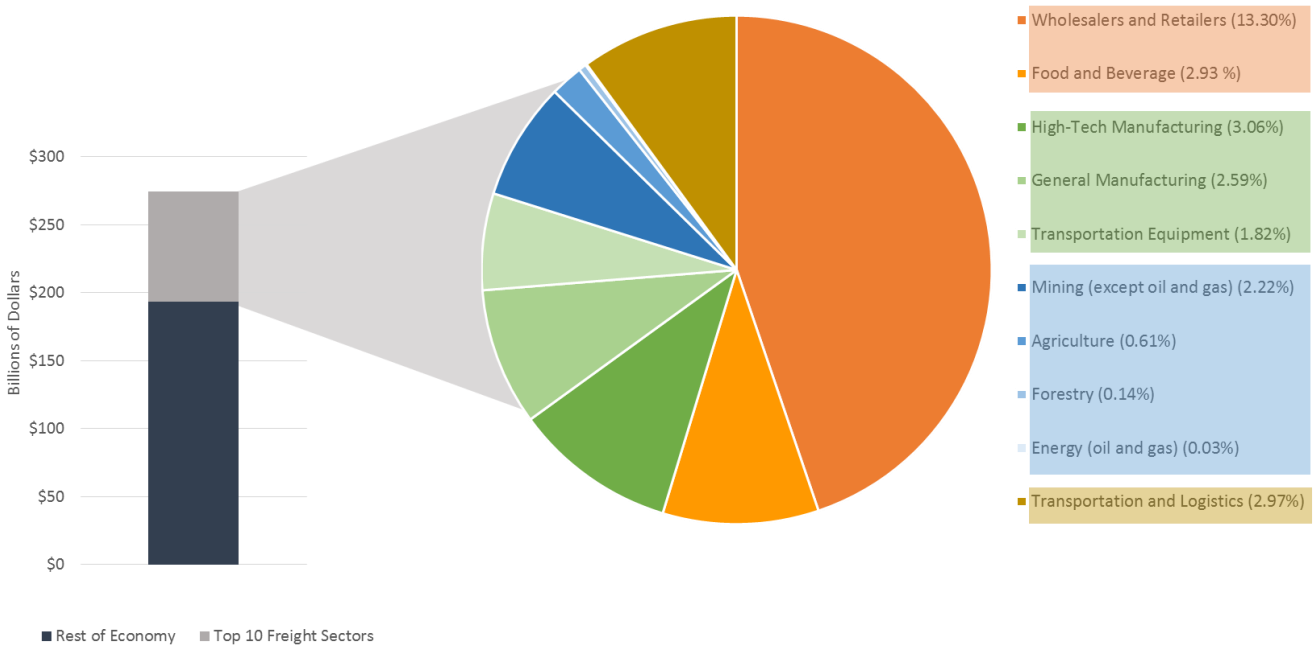
Consumer goods sectors represent the largest freight sector group, in terms of contribution to Arizona's economy ($44.6 billion, and 55 percent of the contribution of the freight sector as a whole).

The consumer goods sector's contribution to GDP is shown in orange in the figure below. Also important to Arizona's economy is the manufacturing sector, shown in green ($20.5 billion, and 25 percent of the contribution of the freight sector as a whole) followed by natural resource sectors in blue ($8.2 billion, and 10 percent of the contribution of the freight sector as a whole) and transportation and logistics in brown ($8.2 billion, and 10 percent of the contribution of the freight sector as a whole).

[16] For output at the state level, GDP is sometimes referred to as Gross State Product (GSP). This report maintains the more commonly used terminology of "GDP". For example, the Bureau of Economic Analysis no longer uses the term "GSP" and now reports state-level output using the term "GDP by State". For further discussion refer to the BEA's 2006 report "Gross Domestic Product by State Estimation Methodology".

[17] CPCS analysis of Bureau of Economic Analysis Data: GDP by State (current dollars)

Figure 3-4: Arizona State GDP for Top 10 Freight Sectors (2013)



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts: GDP by State for 2013 (current dollars) for Top 10 Freight Sectors

Since 1997, these top 10 freight sectors have generated $26.3 billion in GDP growth in the State, or 22 percent of all the GDP growth in the State.[18]

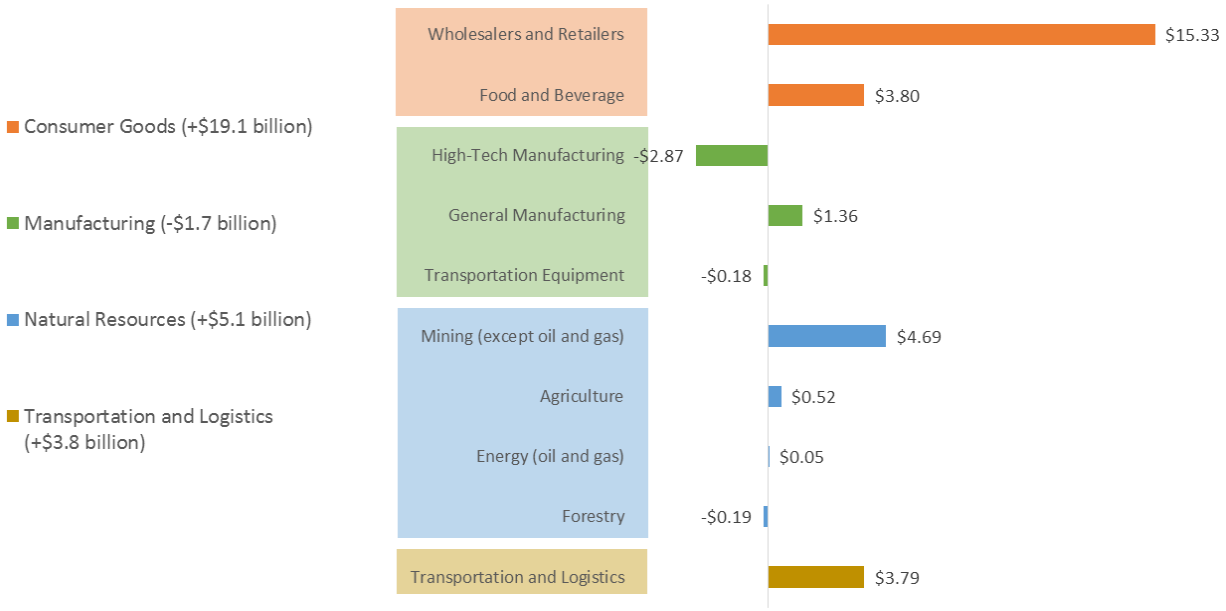
The consumer goods sectors generated the largest share of GDP growth ($19.1 billion, or 16 percent of total state GDP growth), driven in significant part by GDP growth associated with the wholesalers and retailers sector ($15.33 billion, or 13 percent of total State GDP growth).

The GDP growth associated with other freight sectors since 1997 has been more modest, and in some cases, negative. Among other freight sector groups, natural resources sectors have seen the most growth ($5.1 billion, or 4.3 percent of total State GDP growth), driven in large part by GDP growth associated with the mining sector ($4.69 billion, or 3.9 percent of total State GDP growth). The transportation and logistics sector has also contributed to state GDP growth ($3.79 billion since 1997, or 3.2 percent of total State GDP growth), driven in large part by the growth associated with the consumer goods sectors. Manufacturing sectors have seen a net drop in GDP contribution since 1997 (-$1.7 billion), driven in large part by a decline in the GDP

[18] CPCS analysis of Bureau of Economic Analysis Regional Accounts Data: GDP by State (current dollars) for the top 10 sectors between 1997-2012. Based on revised numbers for 1997-2013 released on June 10, 2015.

contribution of high-tech manufacturing (-$2.87 billion), though general manufacturing did contribute positively to Arizona's GDP growth since 1997 ($1.36 billion, or 1.1 percent of total State GDP growth).

Figure 3-5: Total Cumulative Change in GDP Levels of Top 10 Freight Sectors in Arizona 1997-2013 ($ billion)



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts: GDP by State for 2013 (current dollars) for Top 10 Freight Sectors

3.5 Employment

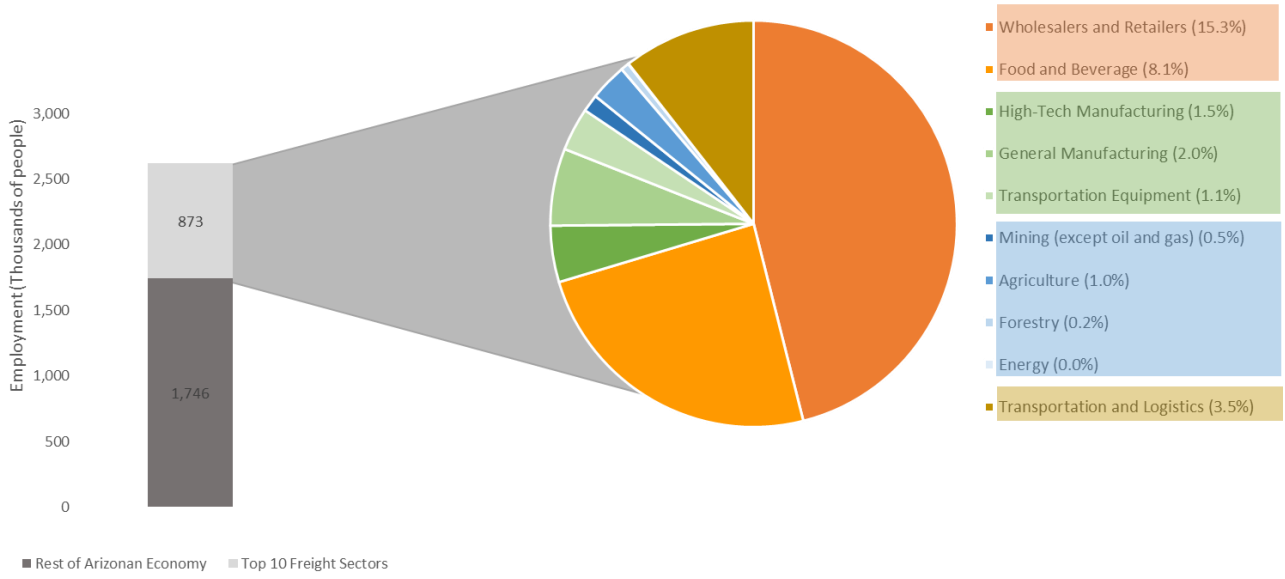
The top 10 freight sectors contribute one third of the total wage and salary employment in the state of Arizona.[19]

Consumer goods sectors account for the largest share of employment among freight sectors (614,000 jobs, or 23.4 percent of total employment in the State).

This is driven by the wholesalers and retailers sector (412,000 jobs, or 15.3 percent of total employment in the State) and the food and beverage sector (212,000 jobs, or 8.1 percent of total employment in the State). The number of jobs in the manufacturing sector is 123,000, or 4.7 percent of total jobs in the State. The transportation and logistics sector, which is in many respects tied to consumer goods sectors, accounts for 92,000 jobs, or 3.5 percent of total jobs in the State. Employment in the natural resources sectors is lowest, at 44,000 jobs, or 1.7 percent of the total number of jobs in the State.

Figure 3-6 below summarizes the employment breakdown of the top 10 freight sectors in the Arizonan economy, by freight sector group.

Figure 3-6: Breakdown of Employment in Top 10 Freight Sectors (2013)



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts Employment Data (Table SA7N) by Industry for Arizona

[19] CPCS Analysis of Bureau of Economic Analysis Regional Accounts Data: Table SA7N, Employment by Industry. Note: Analysis excludes self-employment figures. In 2013 the top 10 sectors employed 872,593 people and the remaining industries in the economy employed 1,746,462 people.

3.5.1 Income / Wages

In total, the top 10 freight sectors generated over $43 billion in personal income (wages, salaries and benefits) for the 872,593 people employed in the sectors in 2013, equating to an average compensation per employee of $49,353. This is somewhat below the state overall average of $57,393 in compensation per employee, likely due to the large amount of employment in lower-skilled jobs and part-time jobs in the food and beverage, retail, and agriculture sectors.

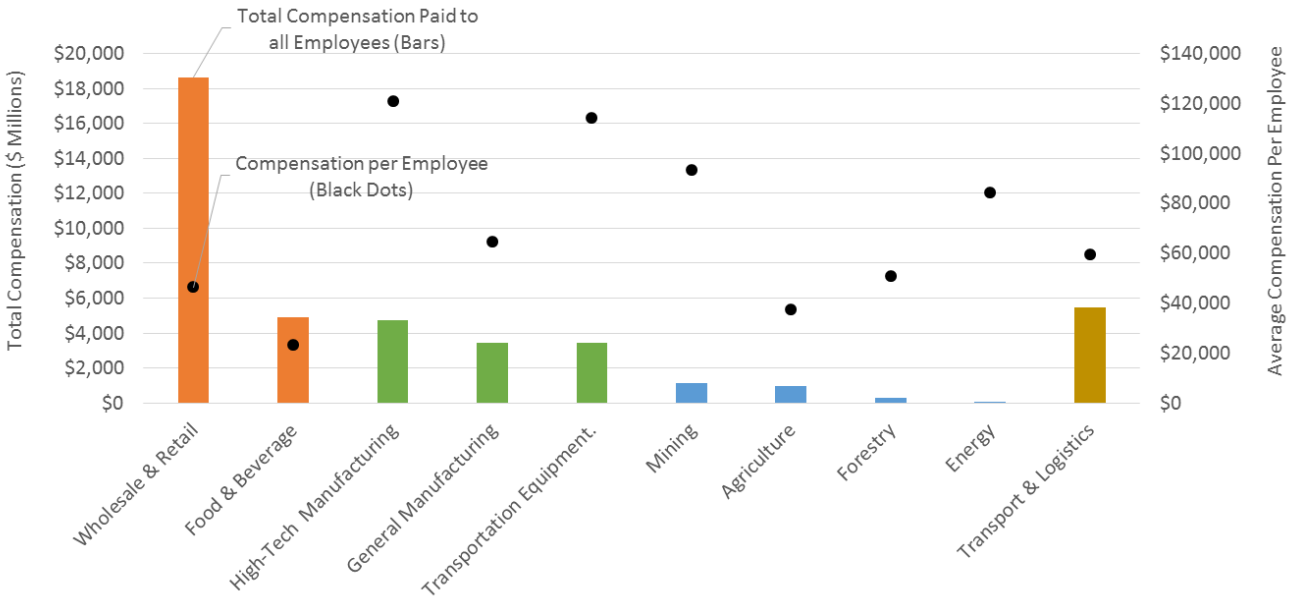
Figure 3-7 below shows the total salaries and benefits paid by each sector (bars) and the average salaries and benefits paid by each sector per employee (dots).

The consumer goods sectors, account for the largest share of total freight sector employment incomes in Arizona, totalling over $23 billion in wages, though average annual incomes per employee are also the lowest among freight sector groups ($38,355). Manufacturing sectors account for $11.6 billion in annual wages, or 7.7 percent of total employment income in Arizona.

Manufacturing sector wages are the highest among freight sector groups, at close to $95,000 per employee, which likely reflects the highly skilled nature of key manufacturing subsectors, notably high-tech manufacturing and transportation equipment manufacturing.

The transportation and logistics sector accounts for $5.5 billion of total employment income in Arizona, or 3.7 percent of the state total. Related sector wages are relatively high, at close to $60,000 per employee on average. Total wages in the natural resources sectors, as well as average wages, are relatively low ($2.4 billion, and close to $54,000 per employee on average, respectively.

Figure 3-7: Total Compensation Paid by Sector (Bars, Left-Axis) and Average Compensation per Employee (Black Dots, Right-Axis) for Top 10 Freight Sectors (2013)



Source: CPCS Analysis of Bureau of Economic Analysis Regional Accounts Employment and Compensation Data

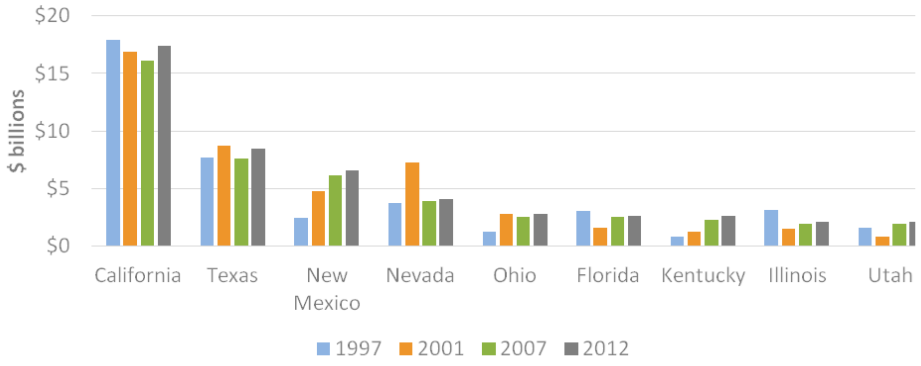
Arizona's freight sector also generates a sizeable portion of the foreign direct investment for the state. Of the 83,000 workers in Arizona employed by foreign firms, 50 percent are employed in the manufacturing, wholesale and retail sectors alone.[20]

[20] CPCS analysis of Bureau of Economic Analysis Foreign Direct Investment in the United States (FDIUS). Employment by State and Industry 2007-2012.

3.6 Trade

Arizona's exports to other U.S. states total approximately $76 billion (2012), representing 68 percent of trade with other U.S. states. California and Texas have consistently been the leading destination states, with these states together accounting for more than one third of Arizona's domestic exports in 2012.

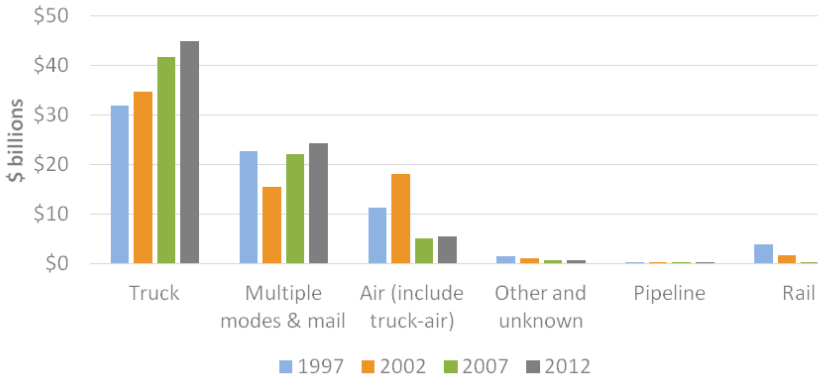
Figure 3-8: Arizona Domestic Exports, Top Destinations



Source: FHWA Office of Freight Management and Operations, Freight Analysis Framework

Trucking dominates the movement of Arizona exports to other states and has been growing in importance. In 2012, the movement of exports by truck accounted for nearly 60 percent of the shipment of exports to other states.

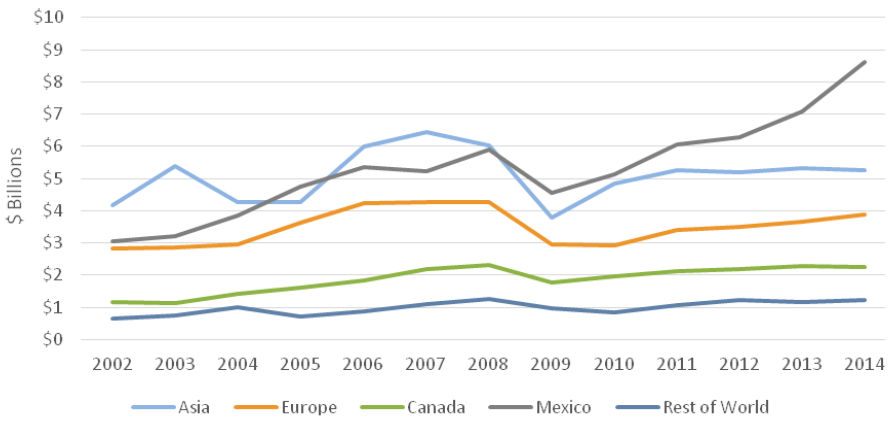
Figure 3-9: Arizona Domestic Exports by Transport Mode



Source: FHWA Office of Freight Management and Operations, Freight Analysis Framework

Arizona's total exports to international destinations have grown strongly, from $11.9 billion in 2002 to $21.2 billion in 2014, an increase of nearly 80 percent over this period, or 5 percent per year. Asia, Europe, Canada and Mexico are Arizona's predominant international export markets. Notable is the strong growth in exports to Mexico (some of which are ultimately destined to other regions), including the steady growth in the years following the 2009 recession.

Figure 3-10: Arizona International Exports by Destination



Source: US Census Bureau, Trade Data Online

The Domestic Trade section below provides an overview of flows between Arizona and other states. [21] Some of these flows, such as a portion of the domestic flows moving from Arizona to California, may be destined to international destinations or vice versa. The International Trade section analyzes flows to and from Arizona that are destined to countries outside of the United States.[22] Import and export values are for goods only, and do not include other forms of "trade" such as tourism activities or Federal government payments.

3.6.1 Domestic Trade

The top freight sectors generated $116 billion dollars in domestic trade flows between states in 2012.[23]

The consumer goods sectors generated the largest share of inter-state flows, totalling $58 billion in 2012, including $17.7 billion in outflows to others states, driven by $15 billion in outflows from the wholesaler and retailers sector and $2.7 billion in outflows in the food and beverage sector. The largest destination of consumer goods flows originating from Arizona was California ($6.6 billion).

The next largest generator of domestic trade flows were the manufacturing sectors that generated $41 billion in domestic flows in 2012, including $15.2 billion in outflows to other states, driven by the general manufacturing sector ($8.4 billion in outflows), high-tech manufacturing ($3.5 billion in outflows) and transportation equipment manufacturing ($3.3

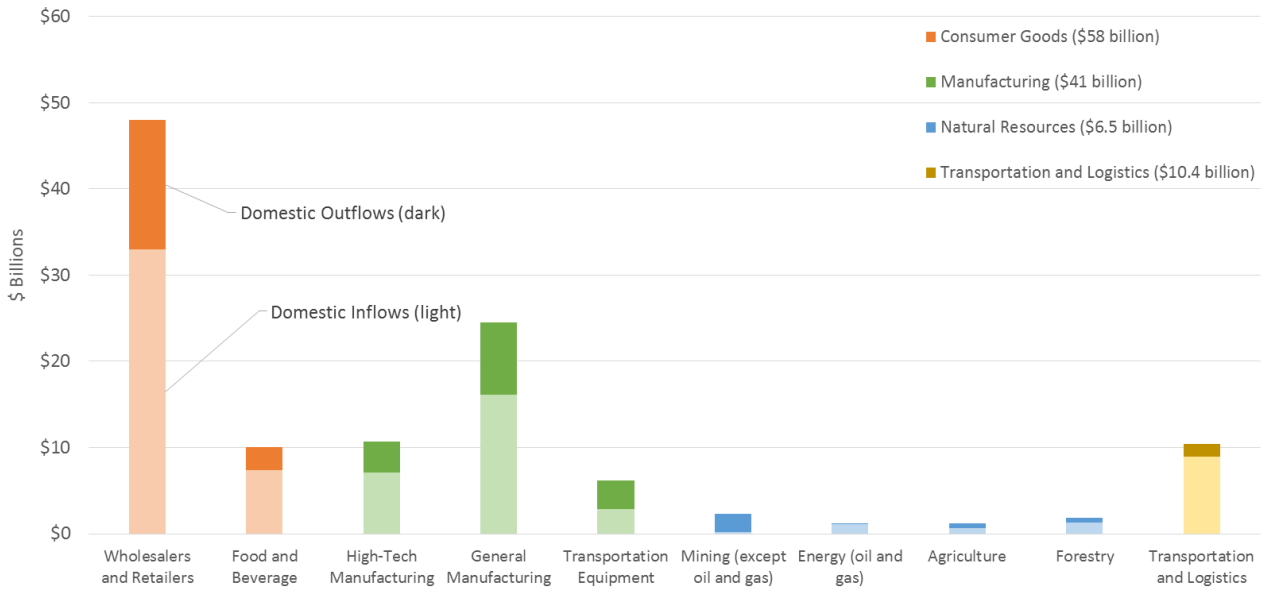
[21] Data sourced from the Bureau of Transportation Statistics and United States Census Bureau's Commodity Flow Survey
[22] Data sourced from United States Census Bureau trade data online
[23] CPCS analysis of the Commodity Flow Survey by the Bureau of Transportation Statistics and United States Census Bureau. Note: Some of these flows may subsequently destined for other countries, for example some flows that are registered as destined to California in the Commodity Flow Survey may have an international final destination via export through a Californian port.

billion in outflows). The largest destination of flows from the manufacturing sectors was California ($6.3 billion in outflows from Arizona).

The transportation and logistics generated over $10 billion dollars in domestic trade flows between itself and other states, which were predominantly inflows from other states ($8.9 in inflows versus $1.5 in outflows). The largest destination of flows from the transportation and logistics sector was Colorado ($0.8 billion in outflows).

The natural resources sectors generated $6.5 billion in domestic trade in 2012, including $3.3 billion in outflows to other states, driven by outflows from the mining sector ($2.1 billion), forestry (0.6 billion in outflows), and agriculture (0.6 billion in outflows).

Figure 3-11: Domestic Trade Imports (light) and Exports (dark) ($billion), 2012



Source: CPCS Analysis of 2012 Commodity Flow Survey

3.6.2 International Trade

The top 10 freight sectors generated over $39 billion in international two-way trade flows in 2012, of which 49 percent were exports.[24] This represents 96 percent of total Arizona exports.

The manufacturing sectors generated the largest share of international exports, totaling $14.3 billion, or 77 percent of total Arizona exports, by value.

This was driven, in order or importance, by the high-tech manufacturing sector ($6.1 billion), the general manufacturing sector ($5.1 billion), and the transportation equipment

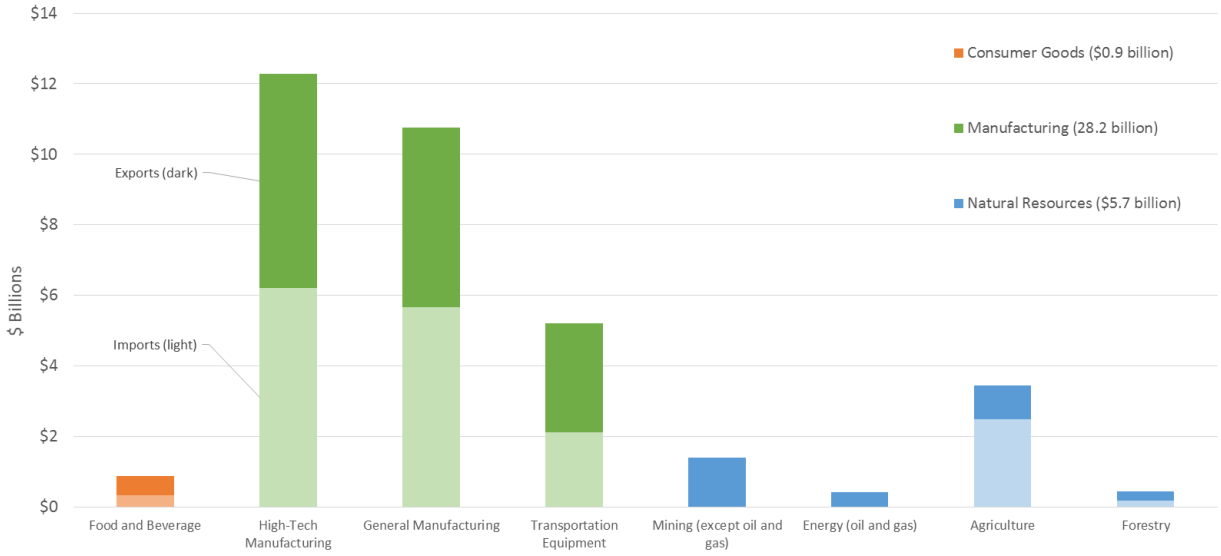
[24] Excluding Wholesalers and Retailers sector and Transportation and Logistics sector, for which no international trade data was available.

manufacturing sector ($3.1 billion). The largest share of these exports are destined to Asia ($4.4 billion) followed by Mexico ($4.1 billion) and Europe ($3 billion). The manufacturing sector's international imports were $14 billion, or 74 percent of Arizona's total imports, by value.

The natural resources sector also generated significant international exports, totaling $3 billion, or 16 percent of total Arizona exports, by value.

This was driven, in order or importance, by the mining sector (1.4 billion), the agricultural sector ($952 million), and forestry sector ($258 million). The largest share of these exports are destined to Mexico ($1.8 billion). The natural resources sector's international imports were $2.7 billion, or 14 percent of Arizona's total imports, by value.

Figure 3-12: International Trade Flows ($billion), 2012



Source: CPCS Analysis of United States Census Bureau Trade Data Online. Arizonan International Trade in 2012.

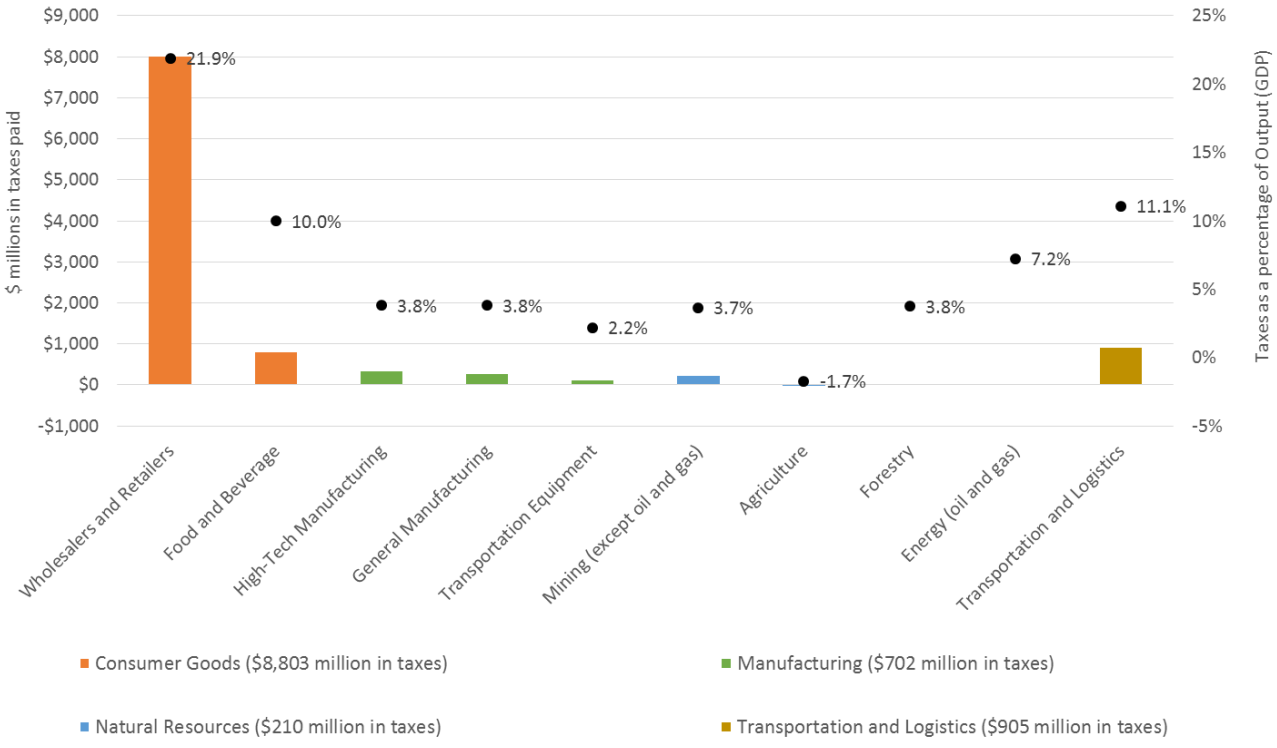
3.7 Taxes

The top 10 freight generating sectors contributed $10.6 billion in local, state and excise taxes in 2013. Figure 3-13 below summarizes the taxes paid for each of the top 10 freight sector net of subsidies received. Figures include taxes on production and imports for the top 10 freight sectors such as property taxes, general sales taxes, as well as federal excise taxes on goods and services. Personal income and dividend taxes are excluded. The bars show total amount of taxes paid by the sector and the dots represent the taxes paid as a percentage of state GDP the sector produces.

By far, the consumer goods sector group contributed the greatest share in taxes in 2013 ($8.8 billion, driven in large part by the wholesalers and retailers sector, which on average pays the highest taxes as a percentage of output (21.9 percent).

The transportation and logistics sector is the sector group that contributed the second most to Arizona taxes ($905 million), in part because this sector pays the second highest level of tax on output, on average (11.1 percent). The tax contribution of other freight sectors – manufacturing sectors and natural resources sectors - is relatively lower, as is their average level of taxes as a percentage of output.

Figure 3-13: Taxes Paid by Top Freight Sectors (2013)



Source: CPCS Analysis of Bureau of Economic Analysis State GDP (current dollars) and Taxes on Production and Imports Less Subsidies (TOPI).

3.8 Implications for the Arizona State Freight Plan

In absolute terms, consumer goods sectors are by far the greatest contributor to Arizona's economy among freight sectors, in terms of GDP, GDP growth, employment, income and taxes.

Yet the long term growth of consumer goods sectors are largely tied to the long term growth of Arizona's population and their consumption patterns. The surest way to increase the contribution of Arizona's consumer goods sectors is to attract investment and jobs to Arizona, and to increase the disposable income of Arizona residents.

One way to do this may be to focus on increasing the competitiveness of Arizona's manufacturing and natural resources sectors, which though smaller than the consumer goods sectors, generate the greatest share of exports and a significant share of Arizona's direct investment – key drivers of quality, high paying employment growth.

The implications for the Arizona State Freight Plan:

Improving the performance of the freight transportation system can help make Arizona a more competitive environment for exporters and investments in manufacturing and natural resources sectors, which in turn will drive economic growth in the State.

4 Arizona Freight Sector Transportation Activity and Flows

Key Messages

In 2012, inbound, outbound and intrastate fright transportation flows totaled over $188 billion and 137.8 Mt in freight flows. The greatest share of these moves by value relate to interstate, likely last mile, consumer goods sector flows. The greatest share by volume, relate to the movement of aggregate for regional construction projects, particularly around urban centers.

The high concentration of freight activity around major population centers – particularly Phoenix and Tucson - means that freight traffic competes for capacity with urban and sub-urban passenger traffic.

Linkages to California, Texas, and Mexico are critical to the movement of Arizona inbound and outbound freight. The I-10 and I-19 are the most important corridors for Arizona trade.

4.1 Freight Activity and Flows in Arizona

The key characteristics of freight activity in Arizona are as follows:

Phoenix and Tucson areas are the major freight activity centers for consumer goods, manufacturing, and transportation and logistics clusters, owing in large part of the size the consumer market and labor pool in these regions. Natural resources sectors are clustered around sources of production, including the South East (mining), South West (agriculture) and North and North East (forestry).

Over $188 billion in freight flows are generated by Arizona's top 10 freight sectors, of which 42 percent is inbound to Arizona, 20 percent is outbound from Arizona, and 38 percent are intrastate flows within the borders of Arizona (2012)

58 percent: share of consumer goods flows by value (2012)

Over 137 million tons in freight flow are generated by Arizona's top 10 freight sectors, of which 18 percent is inbound to Arizona, 8 percent is outbound from Arizona, and 74 percent are intrastate flows within the borders of Arizona

49 percent: share of natural resources flows by volume (2012)

The I-10 is Arizona's most heavily used freight corridor. This corridor is dominated by traffic flows generated by manufacturing, consumer goods and transportation and logistics sectors, highlighting the importance of trade with California for these sectors. The I-19 is also a heavily used corridor for natural resources and manufacturing sectors.

The relative importance of Arizona's key freight sectors transportation activity and flows is discussed in the following sub-sections.

4.2 Freight Activity Clusters

Freight activity clusters are concentrated around Arizona's major population centers – particularly Phoenix – and notably for the consumer goods, manufacturing and transportation and logistics sectors.

Natural resources activity clusters are generally more spread out and tied to location of natural resources production. The following provides an overview of freight activity clusters across sector groups and sub-sectors.

4.2.1 Consumer Goods Sectors

Transportation flows associated with consumer goods are most directly linked to local consumption in Arizona, which is in turn driven by population growth, income, and consumptions patterns. Not surprisingly, the major activity clusters are located in and around Phoenix, and to a lesser extent Tucson and other cities.

Arizona's Rapid Population Growth Concentrated in Urban Centers

Arizona is today home to some 6.7 million people. The state's population has been one of the fastest growing in the U.S. (between 2010 and 2014, Arizona was the eighth fastest growing state), in large part due to migration, from other (colder) states, Mexico and Canada.[25] Growth in population is also expected to continue. Between 2012 and 2050, an additional 5.1 million people are expected to be living in the state, meaning the population will increase by almost 80 percent, or 1.5 percent annually, from 6.5 million people in 2012 to 11.6 million in 2050.[26]

In relative terms, Metro Phoenix in 2050 will be 1.9 times its population in 2012.

Of the 5.1 million additional inhabitants expected to be living in Arizona between 2012 and 2050 (according to the "medium forecast"), it is forecast that 77 percent of those will be located in the Phoenix Metro Area, 10 percent will be located in the Tucson Metro area, and the remaining 13 percent will be located in other areas of the state. [27]

The most significant clusters for the wholesalers and retailers sector are around Phoenix and Tucson, with smaller clusters around Flagstaff, Bullhead City, Lake Havasu City, Yuma and the border crossing of Nogales.

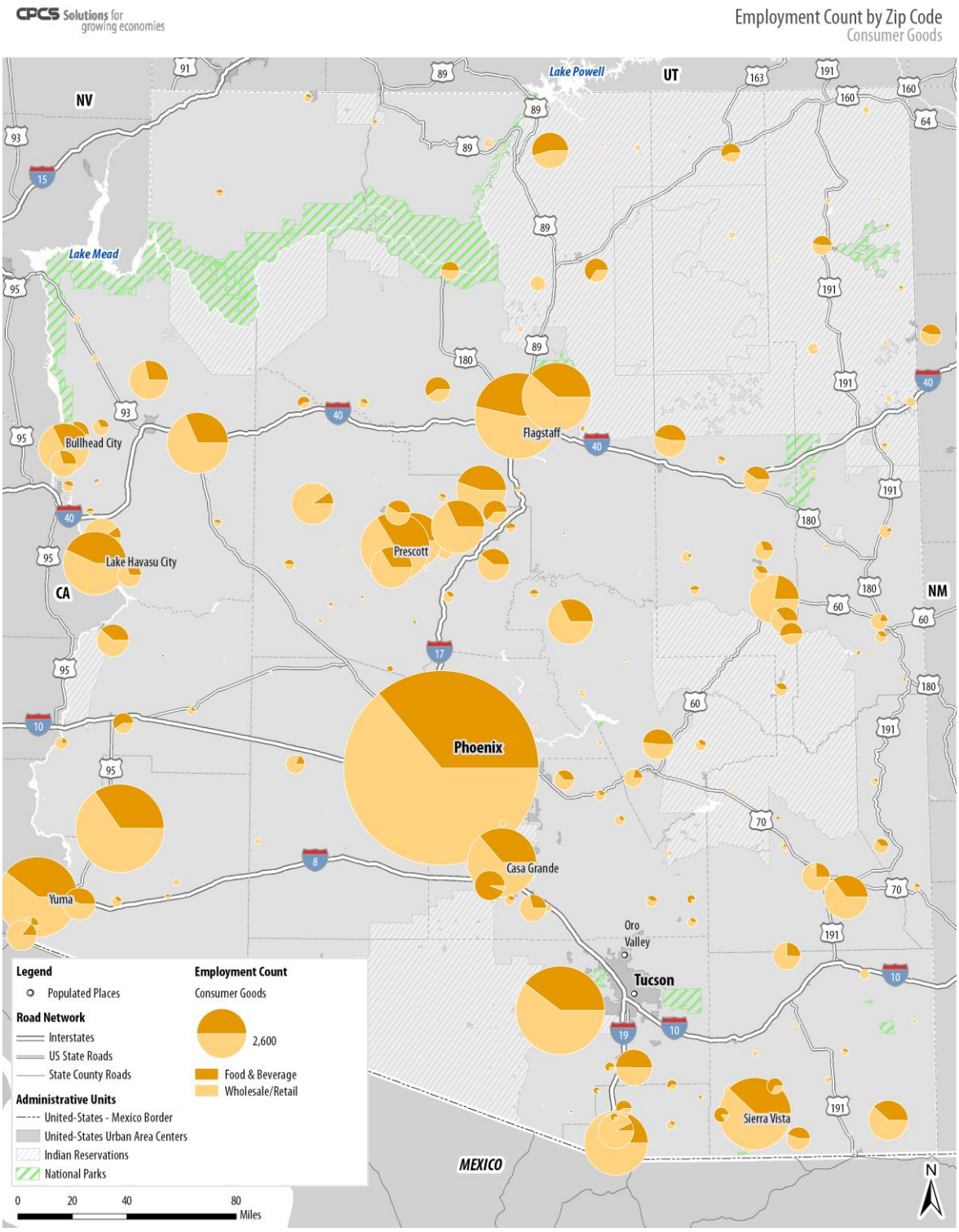
Locations such as food stores, gas stations and other retails are spread across the clusters. Wholesalers are concentrated more in the Southern parts of Phoenix and at the border town of Nogales. In the Phoenix area, the major concentrations are at Tolleson and Sky Harbor.

---

[25] Arizona Indicators, *Indicator Insight, Demographics, An Expert's Insight on the Issue in Arizona*, Volume 4, Issue 1 (March 2013).
[26] Arizona Department of Administration, Office of Employment and Population Statistics, *Arizona State and County Population Projections; 2012 to 2050, Medium Series* at https://population.az.gov/population-projections.
[27] Ibid.

There is a concentration of food manufacturing activity around in the suburbs of Phoenix (e.g. Tolleson, Goodyear, Tempe) and Casa Grande. Restaurants and bars, on the other hand, are clustered around urban areas with high populations, as expected.

Figure 4-1: Consumer Goods Sectors - Employment Clusters (2013)



Source: County Business Patterns, US Census Bureau

4.2.2 Manufacturing Sectors

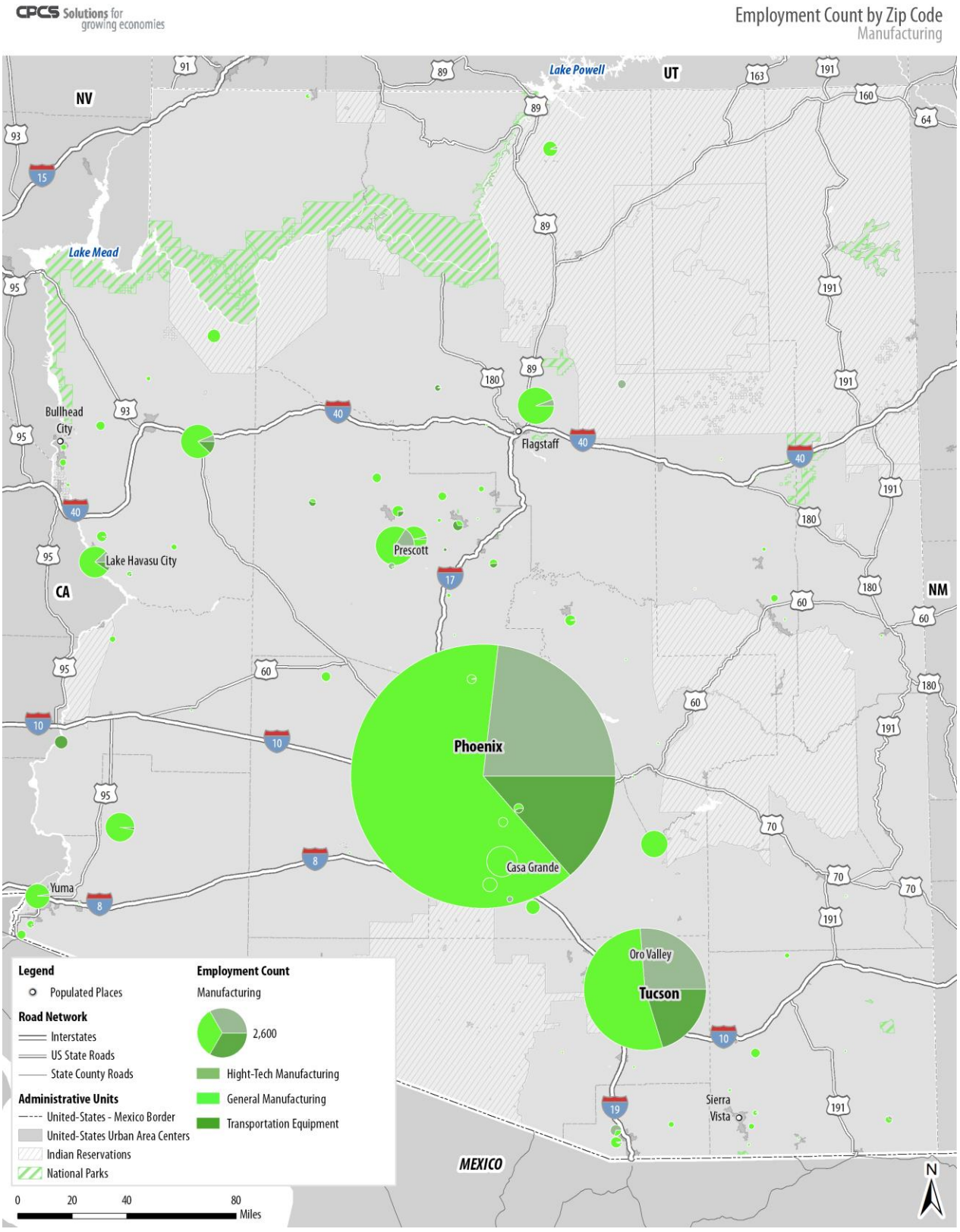
Manufacturing activity is also located in close proximity to Arizona's major population centers, in large part due to access to labor supply and basic infrastructure.

The biggest concentrations of employment in the general manufacturing sector are located in Phoenix (mostly in the Southern part of the metropolitan area), as well as Tucson and Casa Grande.

The overwhelming majority of employees in the high-tech sector are also clustered in Phoenix, Tucson and also in Oro Valley (near Tucson). In Phoenix, the clusters are mostly located in the outskirts, notably in Tempe, Chandler and Northern Phoenix.

In the transportation equipment manufacturing sector, employment is also overwhelmingly concentrated in Phoenix, around Tempe and Chandler, and Tucson (where Raytheon, one of the sector's largest employers, maintains a large presence).

Figure 4-2: Manufacturing Sectors - Employment Clusters (2013)



Source: County Business Patterns, US Census Bureau

4.2.3 Natural Resources Sectors

Natural resources sectors are distinct from other sector groups in that production is tied not to consumer markets or population centers, but to the location of the natural resources themselves.

With respect to copper mining – Arizona's largest mining sector output by value - nearly all the copper produced in Arizona is produced in the Southeast quadrant of the State, with the exception of one mine – Freeport-McMoRan's Bagdad mine - in the Northwestern part of the State.

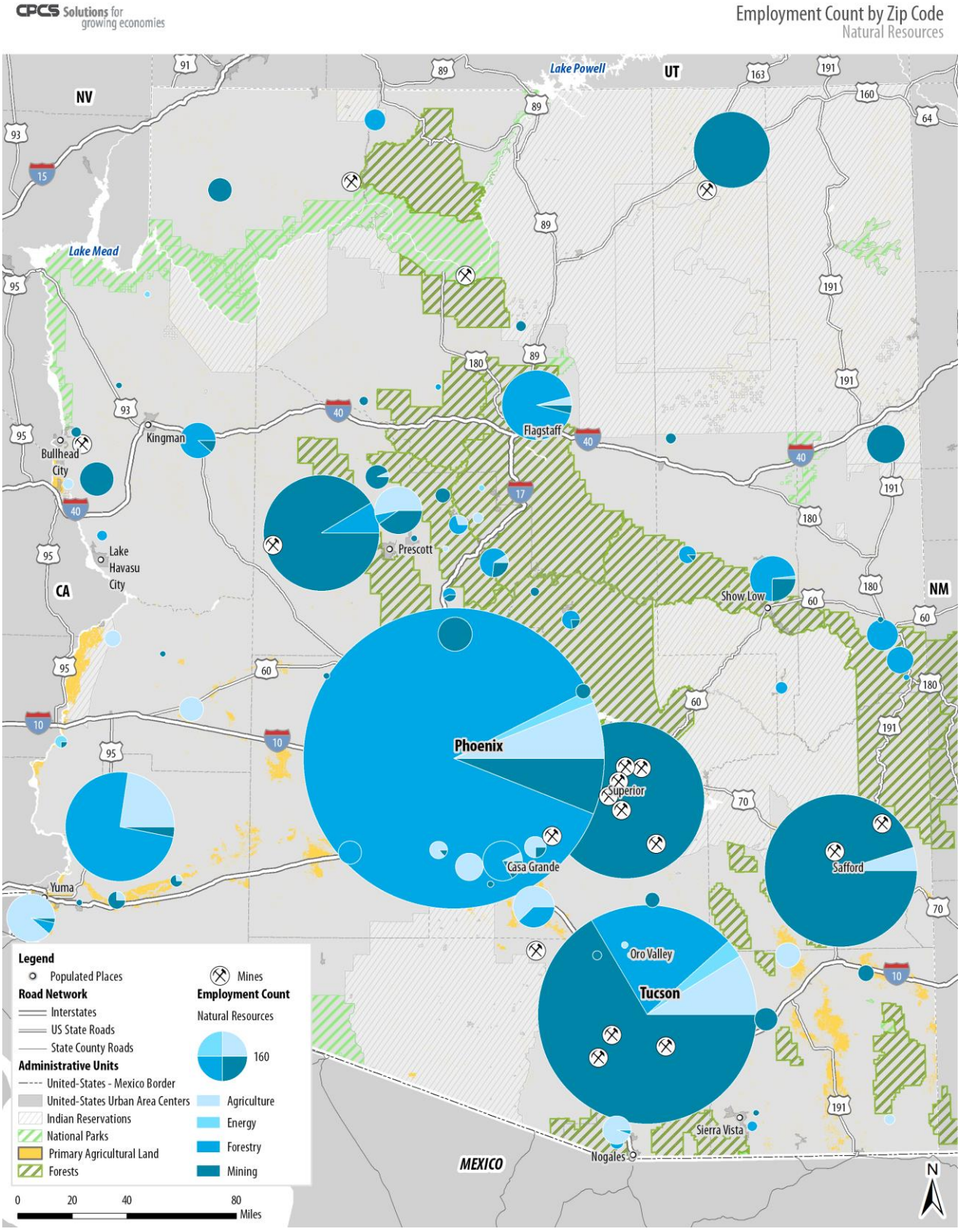
Production of construction aggregates, which represent the largest mining sector output by volume, are more spread out, though highest in the in the Phoenix and Tucson areas, in large part due to higher levels of construction around urban centers.

With respect to the agricultural sector, crop production is concentrated in the Southern part of Arizona, notably around Yuma, Green Valley – South of Tucson, Casa Grande and the Mount Graham area. Pinal and Maricopa Counties are also important agriculture producing regions.[28] As for animal production and aquaculture, the clusters are mostly concentrated near Oro Valley – South of Tucson and around Deer Valley – North of Phoenix.

Forestry sector production, including logging activities and wood products production, is concentrated in the mountainous regions around North and Northeastern Arizona, though there are also important downstream activities (such as paper products production) taking place in the Phoenix and Tucson areas, among others. Forestry sector employment around Yuma, for example, is likely associated with wood pallet manufacturing; pallets are used by the important agricultural activities in the region and in nearby Mexico, as well as for regional manufacturing and beverage retail companies.

[28] USDA Census of Agriculture

Figure 4-3: Natural Resources Sectors - Employment Clusters (2013)



Source: County Business Patterns, US Census Bureau

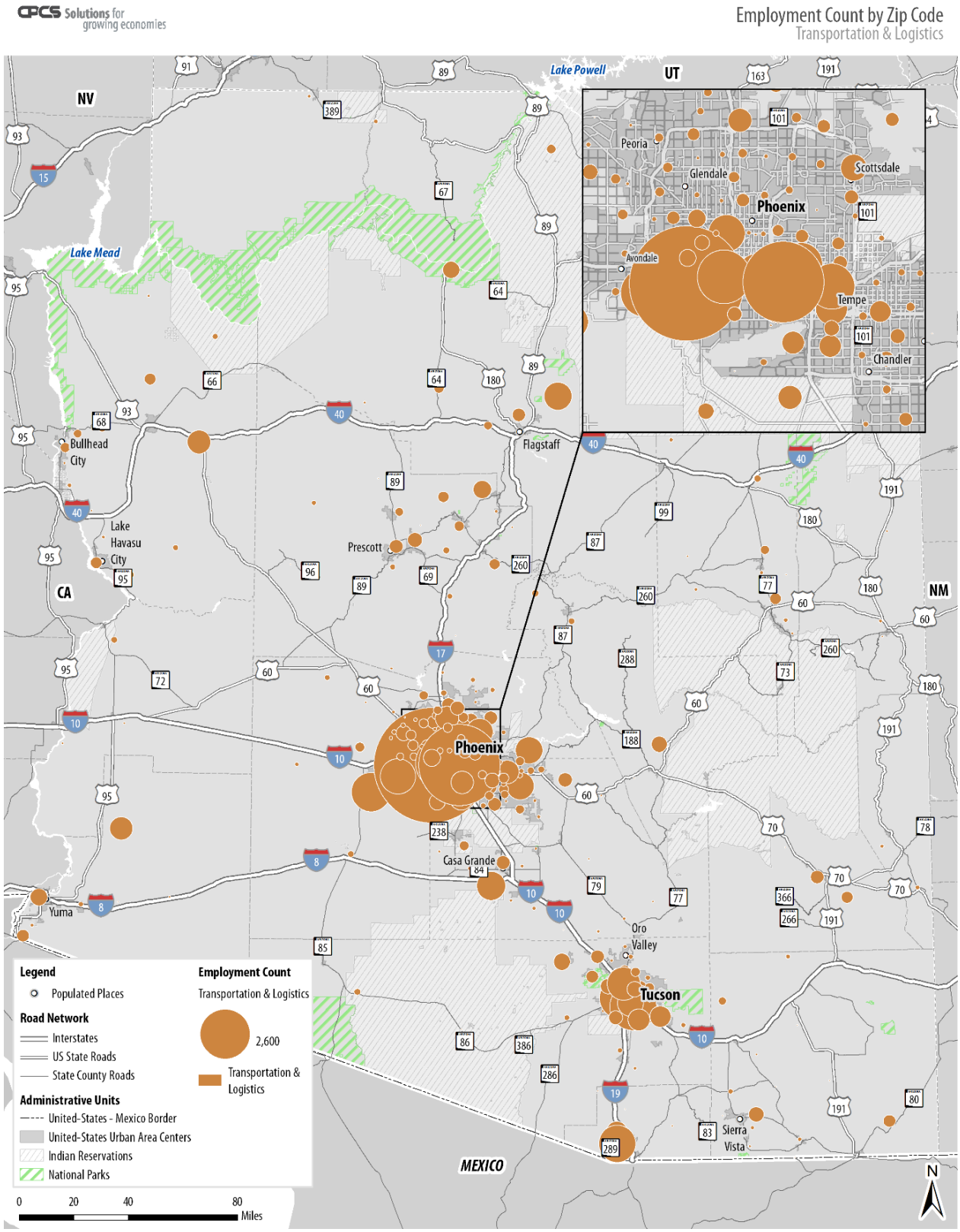
4.2.4 Transportation and Logistics Sector

The largest transportation and logistics sector activity cluster is in the Phoenix area, followed by the area around Tucson and to a lesser extent, Nogales.

The highest concentration of transportation and logistics sector activity is clustered along the I-10 corridor in the Phoenix metropolitan area (including - from west to east—Tolleson, western Phoenix, and areas of Tempe near Sky Harbor), Tucson, and near the border crossing of Nogales. Other, smaller clusters are located at Kingman, Yuma, and Flagstaff.

Figure 3-4 shows the core of the largest cluster of transportation and warehousing activity in Phoenix bounded roughly by I-10 on the North, Lower Buckeye Road on the South, 99th Avenue on the West and 43rd Avenue on the East.

Figure 4-4: Transportation and Logistics Sector - Employment Clusters (2013)



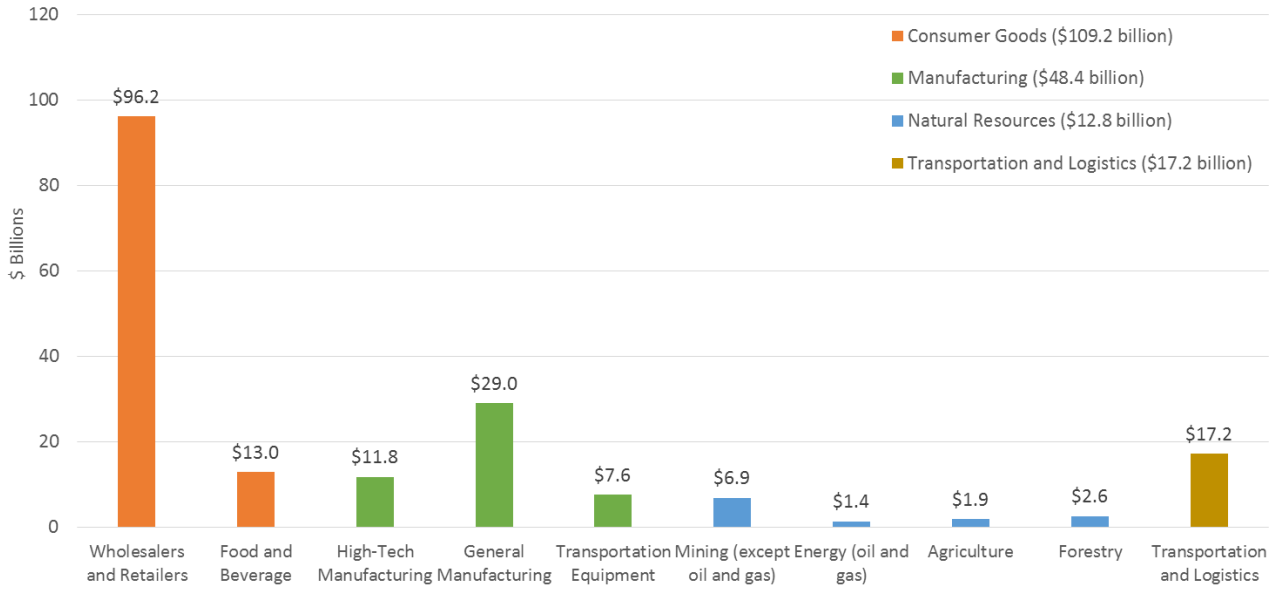
Source: County Business Patterns, US Census Bureau

4.3 Freight Transportation Flows

Overall, the top 10 sectors in Arizona generated $188 billion in flows into, out of, and within Arizona in 2012, corresponding to 98 percent of total Arizona freight flows, by value.

The consumer goods sector generated by far the largest value of flow of goods at almost $110 billion, while manufacturing generated almost $50 billion. The transportation and logistics sector generated just over $17 billion, while the natural resources sector generated close to $13 billion dollars in flows of goods.

Figure 4-5: Top 10 Freight Sector Freight Flows Into, Out of, and within Arizona, by Value (2012)



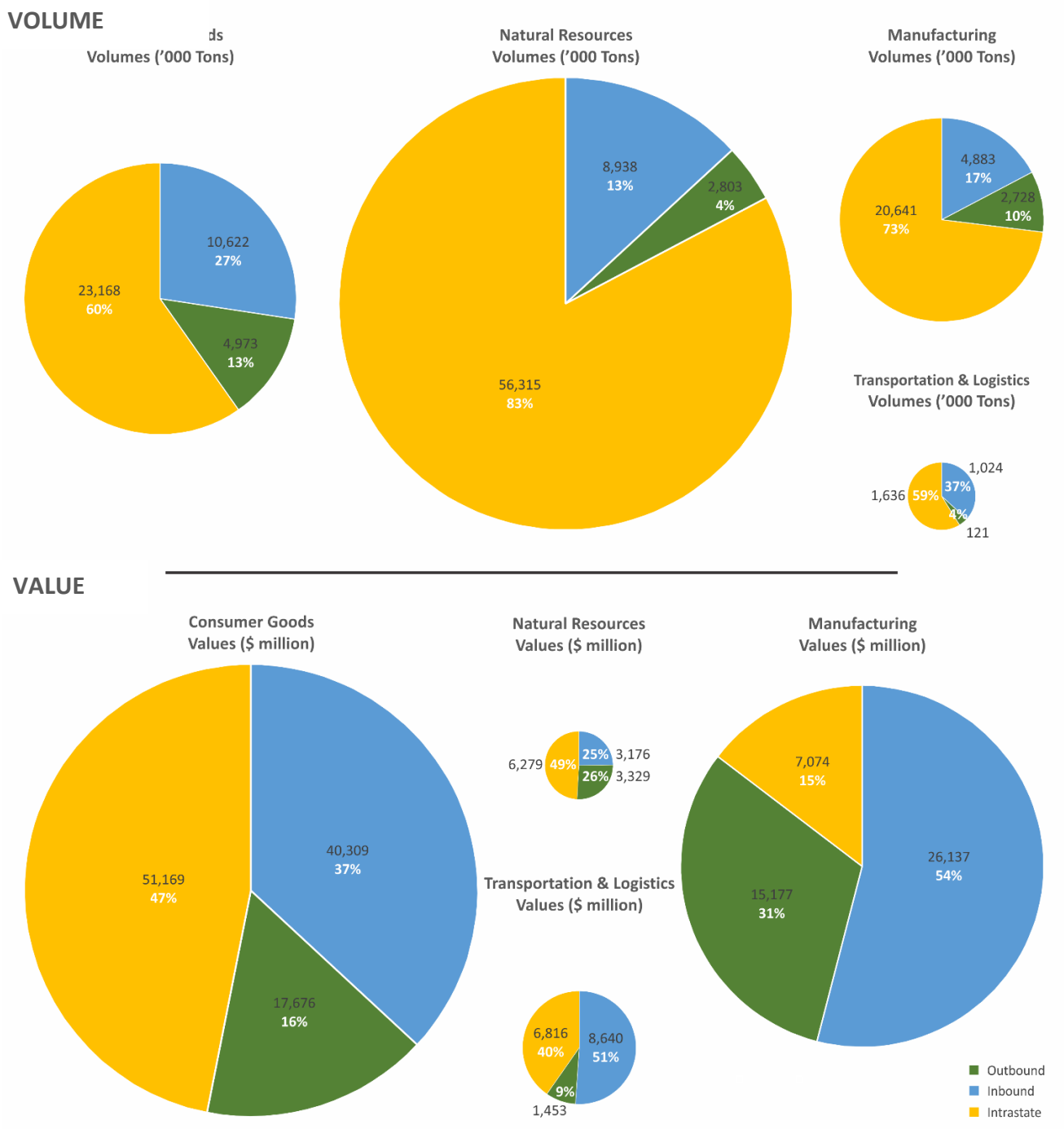
Source: CPCS Analysis of 2012 Commodity Flow Survey Data

By volume, the top 10 sectors in Arizona generated close to 138 million tons in flows into, out of, and within Arizona in 2012, corresponding to 99.8 percent of total Arizona freight flows, by volume.

The natural resources sector generated by far the largest volume of flow of goods at over 68 million tons.

The consumer goods sectors generated flows of 38,763,000 tons, and the manufacturing and transportation and logistics sectors generated flows of 28,252,000 tons, and 2,781,000 tons, respectively.

Figure 4-6: Top 10 Freight Sector Freight Flows Into, Out of, and within Arizona, by Volume (2012)



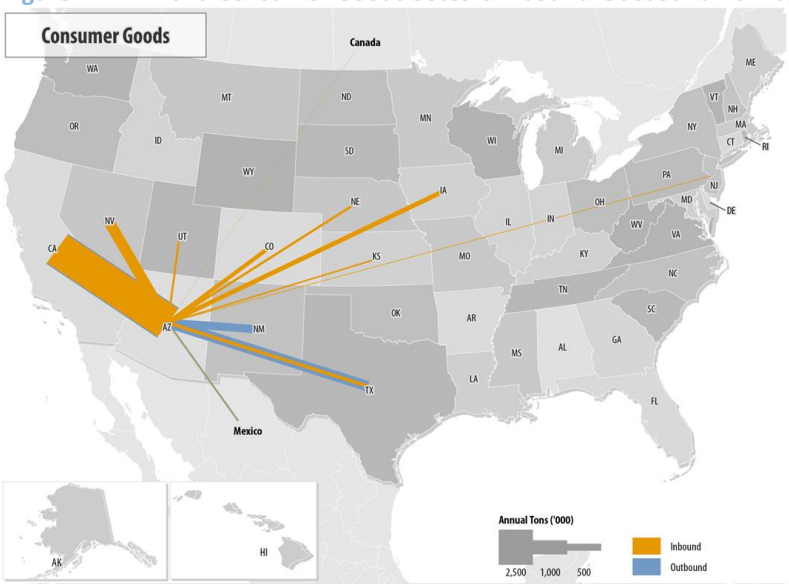
Source: CPCS Analysis of 2012 Commodity Flow Survey Data

The following provides an overview of key freight flow characteristics, by sector group.

4.3.1 Consumer Goods Sectors

The wholesalers and retailers sector, and the food and beverage sector account for over $109 billion of freight flows into, out of, or within Arizona (2012), representing 28 percent (38.7 Mt) of the total freight tonnage in the state (the sector generates the second highest volume of flows, second only to mining)[29]. Most of the wholesale and retail movements take place within the state, representing "last mile" shipments and are destined to the Phoenix area, and other population centers. Wholesale and retail sector inflows from outside the state predominantly (60 percent by tonnage) arrive via California via Interstate 10, reflecting in large part the importance of the Ports of Los Angeles and Long Beach (POLA/POLB) for imports.

Figure 4-7: Arizona Consumer Goods Sectors Inbound-Outbound Tonnages

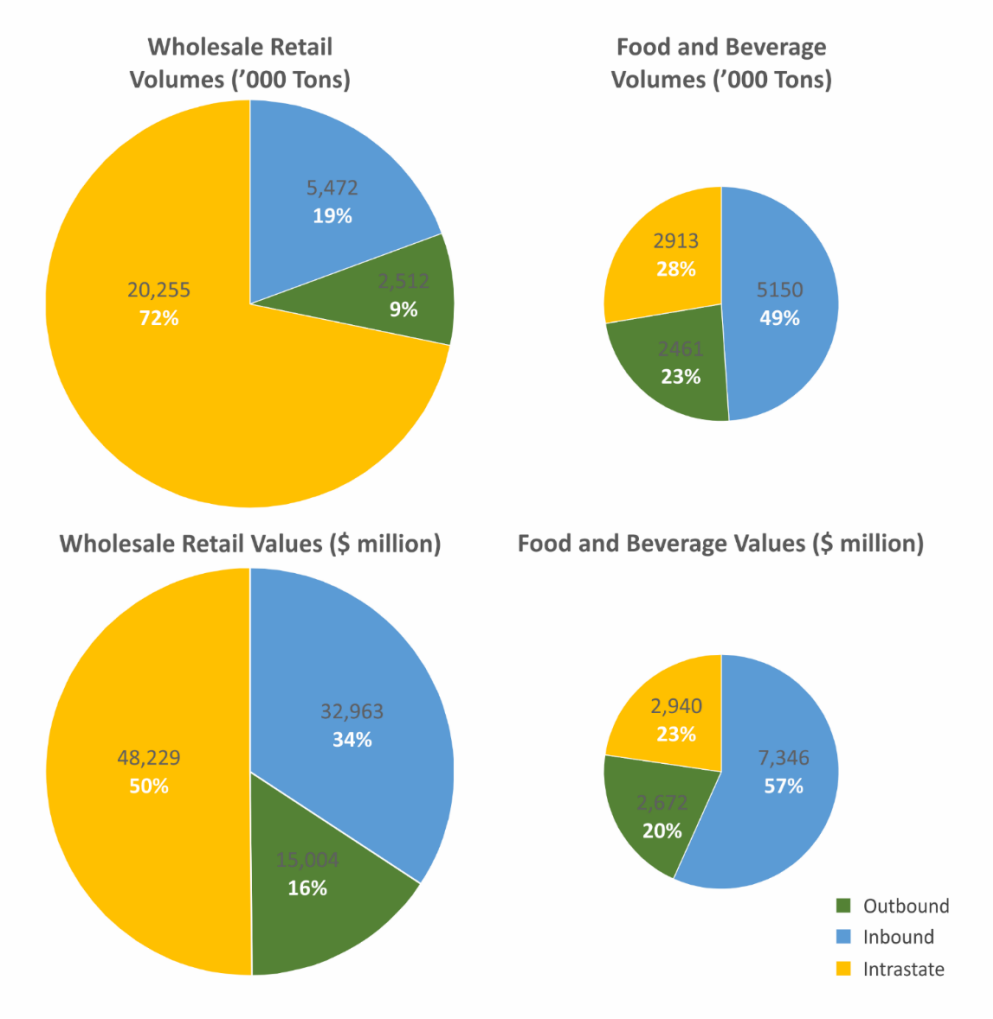


Source: CPCS analysis of Commodity Flow Survey, 2012. The import/export figures were obtained from Freight Analysis Framework 3 estimates for 2012

The food and beverage sector generated flows of $13 billion into, out of, or within Arizona in 2012, representing about eight percent of all freight tonnage in the state. The majority of these flows are inbound, from outside Arizona.[30] Approximately half of the food and beverage sector volumes in Arizona are inbound freight – much of it destined to the Phoenix area, of which roughly half of that comes from California, also via the I-10. Arizona also exports a significant share of food manufacturing outputs to California and Texas.

[29] CPCS analysis of Commodity Flow Survey, 2012
[30] CPCS analysis of Commodity Flow Survey, 2012

Figure 4-8: Consumer Goods Sectors Values ($ billion) and Volumes (tons) of Flows in 2012



Source: CPCS Analysis of 2012 Commodity Flow Survey Data

Trucking is the predominant mode of transportation for consumer goods sectors, representing over 95 percent of the flows.

These sectors rely heavily on state highway infrastructure both for moving inbound products to their facilities and distribution centers and to deliver products to local stores, restaurants and bars. Rail and air play a small role; rail generally handles longer distance, lower value goods, whereas air handles higher value or time-sensitive goods.

4.3.2 Manufacturing Sectors

Among manufacturing sectors, general manufacturing represents the largest share of transportation flows, generating $29 billion of goods flows and 20 percent (28 Mt) of Arizona's total freight by volume.

By contrast, the high-tech manufacturing sector generates $11.8 billion of goods flows and less than 0.1 percent of total freight tonnage in the state. The transportation equipment manufacturing sector generates $7.65 billion in goods flows and a similarly low (about 0.1 percent) share of total freight tonnage in the state.

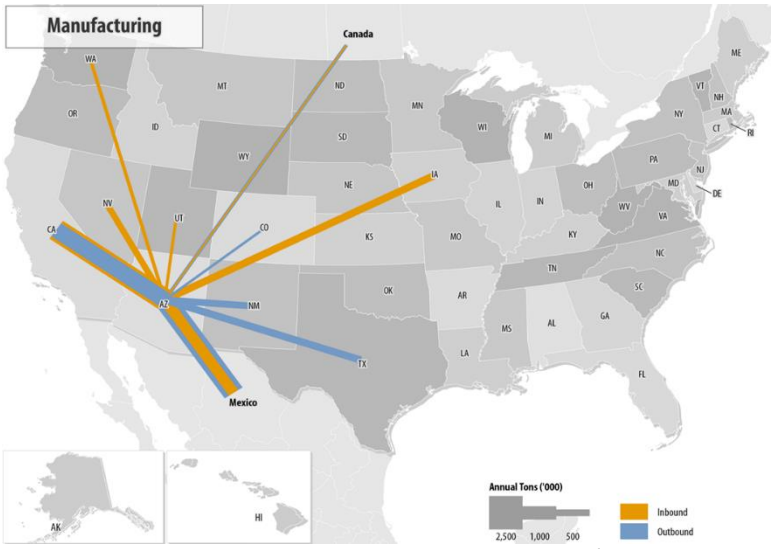
The origins and destinations of freight movements within Arizona's manufacturing sector are varied. But unlike the consumer goods sectors which tend to be oriented towards "last mile" intra-Arizona flows, manufacturing sector flows are linked to markets outside Arizona to a far greater degree. For instance, by value, the total share of flows relating to inflows and outflows is approximately 85 percent for general manufacturing sector, over 90 percent for high-tech manufacturing, and over 80 percent for transportation equipment manufacturing sector.

In terms of domestic flows, California is the most important domestic trade partner of Arizona's general manufacturing sector (for both inbound and outbound traffic). The major corridors used by the general manufacturing sector are I-10, I-17 leading to I-40 Eastward. Overall, trucking is the major mode for transportation of general manufacturing commodities, in terms of both volume and value.[31] In terms of tonnage, railways carry an important proportion of inbound and outbound freight (more than 20 percent), though the dollar value of such shipments is far lower.

By volume, the largest volume of inbound traffic for the high-tech sector originates in Utah, Ohio and Virginia. Canada and Mexico, followed by California and Texas, account for the majority of outbound traffic. Trucking is the dominant mode, though air cargo sector handles over 20 percent of flows.

Mexico is the largest origin and destination for high-tech manufacturing products by weight, and the largest destinations for sector exports. The air sector handles

Figure 4-9: Arizona Manufacturing Sectors Inbound-Outbound Tonnages

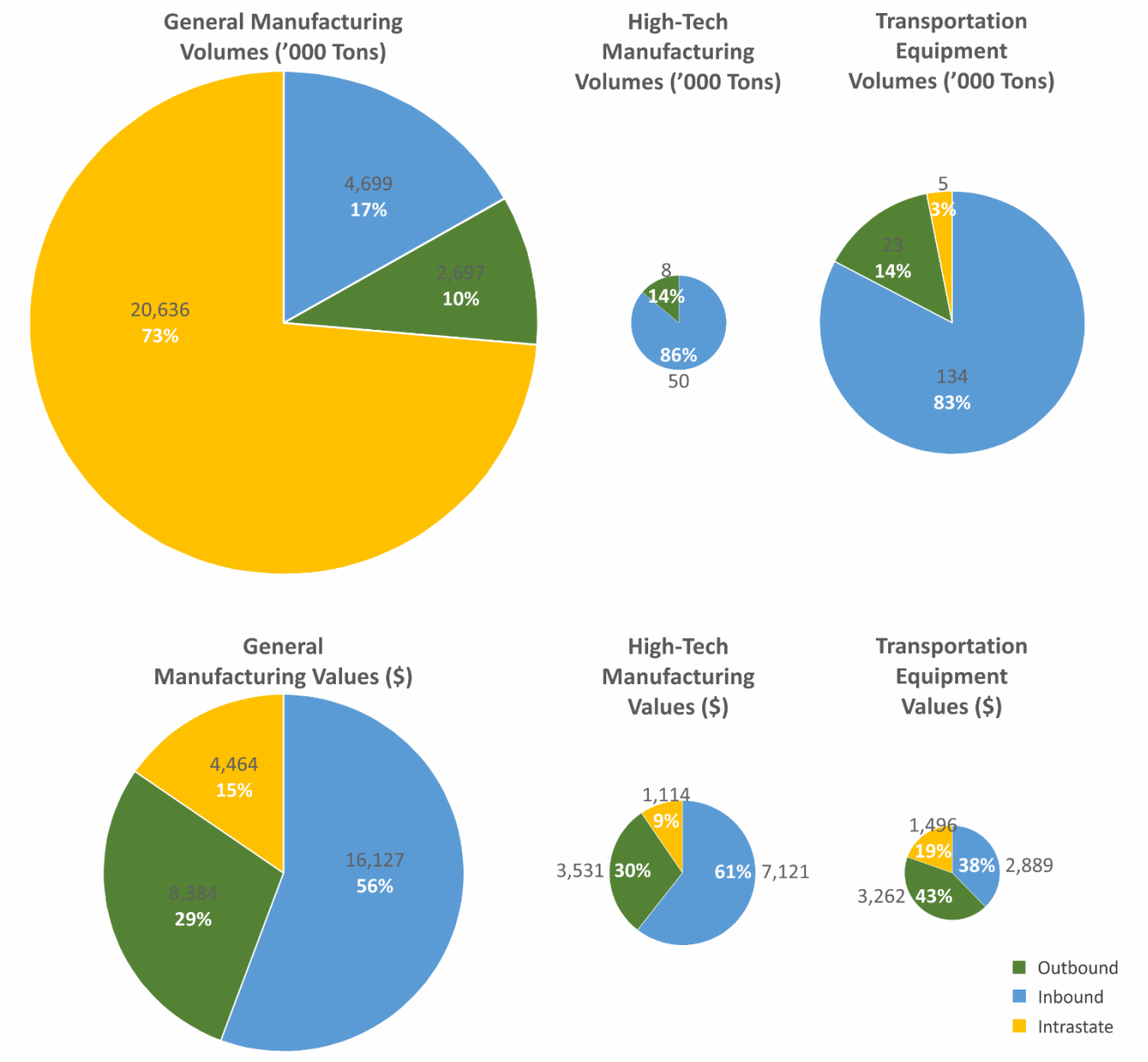


Source: CPCS analysis of Commodity Flow Survey, 2012. The import/export figures were obtained from Freight Analysis Framework 3 estimates for 2012

[31] Please note that in CFS dataset, the individual mode volumes do not add up to the aggregate "All Mode" which is due to the data suppression and rounding at detailed mode level.

a significant share of inbound and outbound flows for the high-tech manufacturing sector – a majority by value.

Figure 4-10: Manufacturing Sectors Values ($ billion) and Volumes (tons) of Flows in 2012



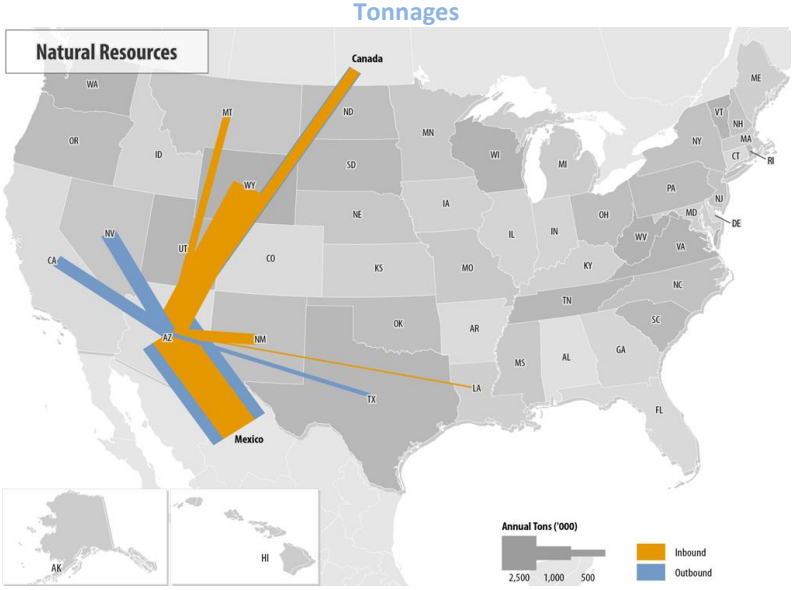
Source: CPCS Analysis of 2012 Commodity Flow Survey Data

4.3.3 Natural Resources Sectors

The mining sector drives the greatest volume of freight on Arizona's transportation system – over 60 million metric tons (2012), or nearly 45 percent (68 Mt) of Arizona's total freight flows by volume. The value of these freight flows are close to $7 billion per year. The greatest share of this by value relates to copper mining and the greatest share by volume relates to construction aggregates. Some 88 percent (approximately 54 Mt) of the mining volumes transported are intrastate movements, largely relating to movements from aggregate pits to construction projections, or copper-related product from mine site to mine site, or from mine site to a smelter.

The other two main natural resources sectors in Arizona, agriculture and forestry, account for significantly lower values and volumes of transportation flows. In 2012, the agricultural sector generated $1.8 billion in goods flows to, out of, or within Arizona, equivalent to 1.2 million tons of freight, or less than 1 percent of total freight tonnage in the state. A significant share (46 percent, by volume) was transported to markets outside Arizona, including Canada, California and Mexico.

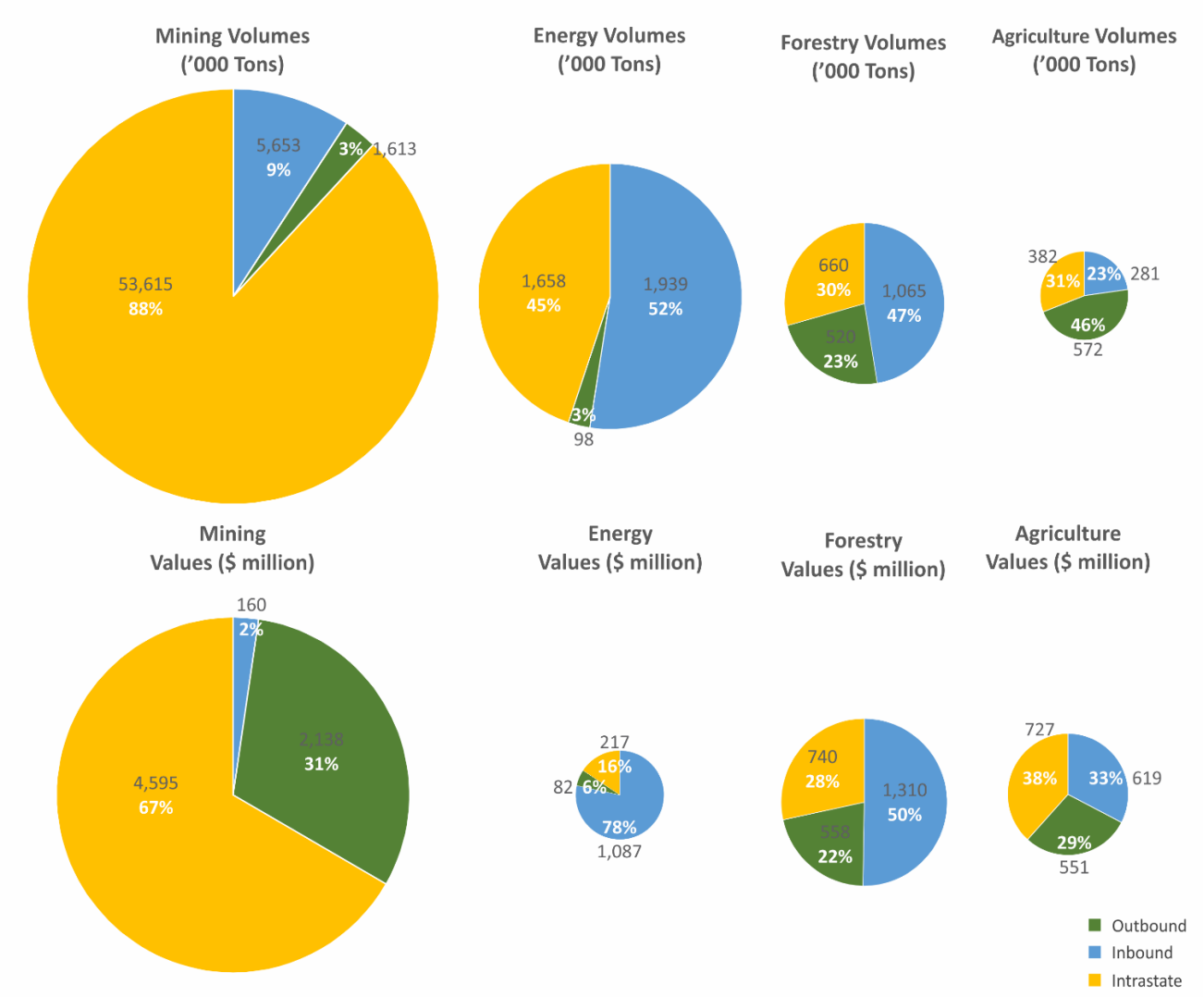
Figure 4-11: Arizona Natural Resources Sectors Inbound-Outbound Tonnages



Source: CPCS analysis of Commodity Flow Survey, 2012. The import/export figures were obtained from Freight Analysis Framework 3 estimates for 2012

The forestry sector, in turn, generated $2.6 billion in goods flows in that same year, equivalent to 2.2 metric tons of freight, representing close to 1.5 percent of total freight flows in the state. Close to half of forestry product flows are inbound (by value and volume), and largely tied to the local housing industry. Canada represents the single largest source of inbound forest products. Mexico and California are the largest outbound markets.

Figure 4-12: Natural Resources Sectors Values ($ billion) and Volumes (tons) of Flows in 2012



Source: CPCS Analysis of 2012 Commodity Flow Survey Data

Copper mining operations in Arizona make extensive use of both road and rail transport. Principal roads used include U.S. Interstate highways I-10 and I-19, U.S. routes 60, 70, 191, and 93 (the latter being in the Northwest) and State routes 77, 79, and 96 (the latter being in the Northwest). Railroads used include two Class I railroads, the Union Pacific (UP) and the Burlington Northern Santa Fe (BNSF), as well as a number of shorelines.

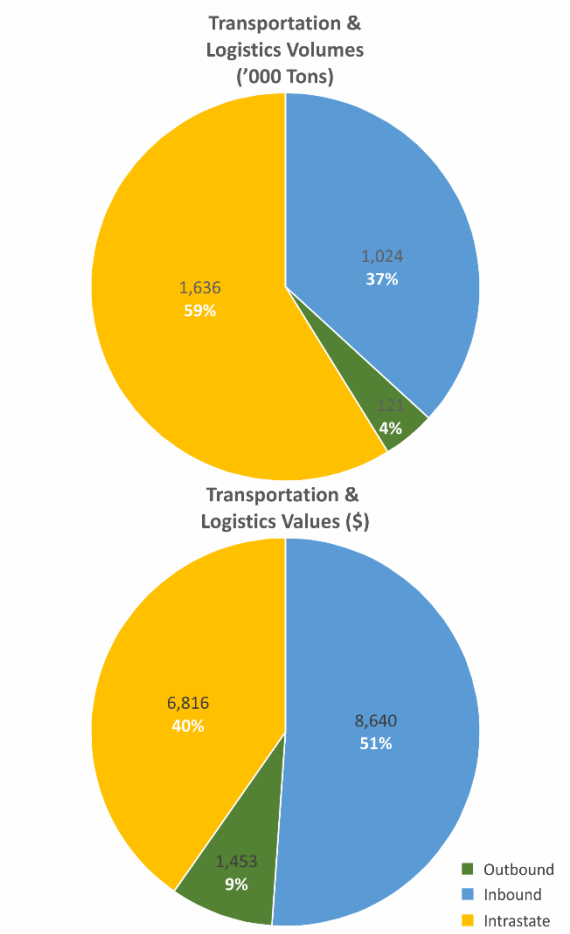
The major corridors used by the agricultural sector are I-10, I-8, I-19 and I-17 leading to I-40 Eastward. The I-10 and connection with I-19 is also heavily used, an indication of Arizona's important export/import of agricultural products to/from Mexico.

The major corridors used by the forestry sector are I-10, I-17 leading to I-40 Eastward and U.S. 89 Northbound. I-10 towards California is most used highway since California is the biggest domestic trading partner of forest products.

4.3.4 Transportation and Logistics

The transportation and logistics sector generates 2.7 Mt of freight in Arizona annually which is just over two percent of the total freight tonnage in the state. A majority of these movements are intrastate (1.6 Mt or 59 percent). Just over one Mt or 37 percent are inbound and .1 Mt, or four percent, are outbound shipments.

Figure 4-13: Transportation and Logistics Volumes (tons) Flows in 2012



Source: CPCS Analysis of 2012 Commodity Flow Survey Data

Transportation and logistics sector freight movements in Arizona are predominantly intrastate, followed by smaller shares of inbound and outbound movements. In terms of inbound shipments, California is the principal domestic source comprising over 90 percent of all inbound tonnages. The other notable source is Texas. The estimated inbound[32] volumes produced by this sector are clustered in Southern part of Phoenix, Tucson, Nogales, Yuma, Sierra Vista, Flagstaff and Lake Havasu City. In Phoenix, the major concentration is at Tolleson as well as near Sky Harbor, Mesa and north of Scottsdale.

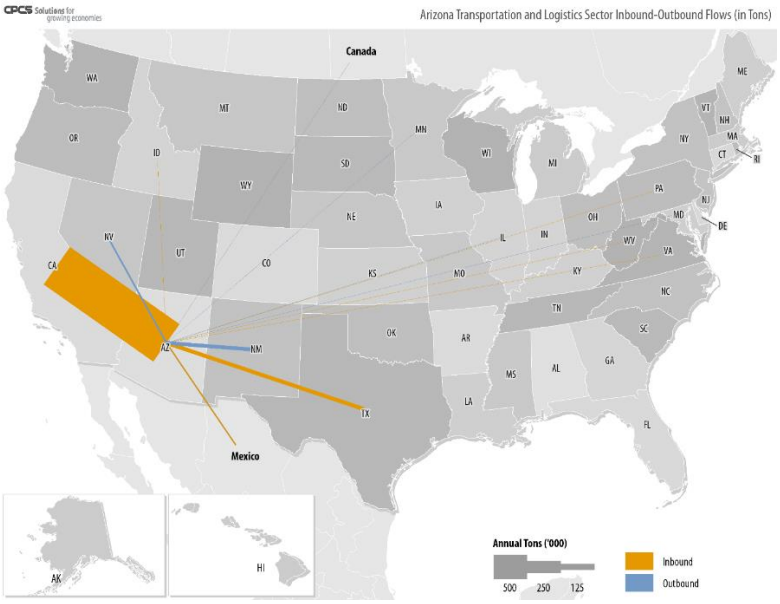
[32] Freight Finder dataset does not have outbound tonnage information for this sector.

In terms of outbound shipments, New Mexico and Nevada are the major destinations for this sector.

Trucking is the primary mode of shipment for all types of movements – inbound, outbound or intrastate.[33] Some four percent of the outbound freight (5,000 tons) is multimodal which is primarily parcel or courier freight shipped by truck and air.

The major corridors used by this sector are I-10, I-8 and I-17 leading to I-40 Eastward. Interstate I-10 is the busiest highway for the sector and reflects California's role as Arizona's largest trading partner for this sector.

Figure 4-14: Arizona Transportation and Logistics Sector Inbound-Outbound Tonnages



Source: CPCS analysis of Commodity Flow Survey, 2012. The import/export figures were obtained from Freight Analysis Framework 3 estimates for 2012

[33] Please note that in CFS dataset, the individual mode volumes do not add up to the aggregate "All Mode" which is due to the data suppression and rounding at detailed mode level.

4.4 Freight Transportation Activity and the Key Commerce Corridors

The overarching goal of the Arizona State Freight Plan is to enhance Arizona's economic competitiveness and growth, including through increased trade. ADOT has already identified Key Commerce Corridors "where improvements to the transportation infrastructure supports the greatest potential commercial and economic benefits".[34]

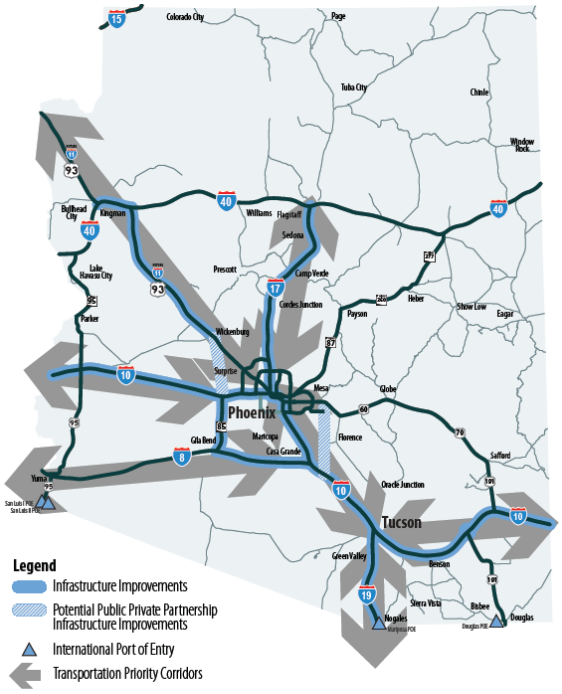
To this end, Strategy No. 3 of the Arizona State Freight Plan (as defined in the Phase 4 Working Paper) is to bolster the performance of Key Commerce Corridors.

Figure 4-15: Arizona Key Commerce Corridors

Transportation Priority Corridors

- **I-19** Nogales to Tucson Corridor
- **I-10/I-8** Tucson to Phoenix Corridor
- **I-11 (US 93)** Phoenix to Las Vegas Corridor
- **I-17** Phoenix to Flagstaff Corridor
- **I-10** California to Phoenix Corridor
- **I-10** Tucson to New Mexico Corridor

Note, although the KCCs are multimodal in nature, they are defined by ADOT as highway corridors.



Source: Arizona's Key Commerce Corridors (March 2014)

Arizona's two largest domestic trading partners are California and Texas, while its largest international trading partner is Mexico. Dominant is Arizona's trade with California. It is noted that while Southern California has grown from approximately 10 million people in 1970 to over 16 million, the basic carrying capacity of I-10 and I-8 has remained virtually unchanged. In addition, Arizona itself has grown from less than 2 million people in 1970 to well over 6 million. Comparable growth has also occurred in Texas along I-10, while the emerging markets of Northwestern Mexico now have more than 10 million consumers.

[34] Arizona Key Commerce Corridors, p. 1, http://azdot.gov/docs/default-source/planning/arizona-key-commerce-corridors-final-report.pdf?sfvrsn=0

Among Arizona's KCCs, the highway corridors experiencing the highest volumes of freight (in tons) for Arizona flows (inbound, outbound, and intra state flows) are, in order of significance:

- **I-10 California to Phoenix Corridor**: Notwithstanding significant volumes of traffic relating to natural resources (likely dominated by aggregate for construction), this corridor is dominated by traffic flows generated by the manufacturing, consumer goods and transportation and logistics sectors, highlighting the importance of trade with California for these sectors. An important share of this traffic is likely originated or destined at POLA/POLB.
- **I-10 Tucson to Phoenix Corridor**: Beyond significant volumes of aggregate for construction, this corridor is heavily used by manufacturing sectors, much more so than the I-10 California to Phoenix Corridor. Consumer goods and transportation and logistics sector flows are also significant, though to a lesser extent that flows generated by these sectors on the I-10 California to Phoenix Corridor.
- **I-10 Tucson to New Mexico Corridor**: Arizona freight traffic flows drop off on the I-10 East of Tucson, but are nevertheless important, particularly for the manufacturing sector, highlighting the importance of manufacturing sector trade with neighboring state to the East, including New Mexico and Texas.

The I-10: the most Important KCC

As the single most important freight transportation facility serving Arizona measured by value of trade, I-10 at the Arizona/California border carries:

- 8,000 trucks each day—or 2.4 million trucks per year.
- These trucks carry nearly $460 million worth of freight each day or $140.6 billion per year—making this route by far the highest value freight corridor in Arizona.

Source: CPCS analysis of IHS Global Insight Transearch Data

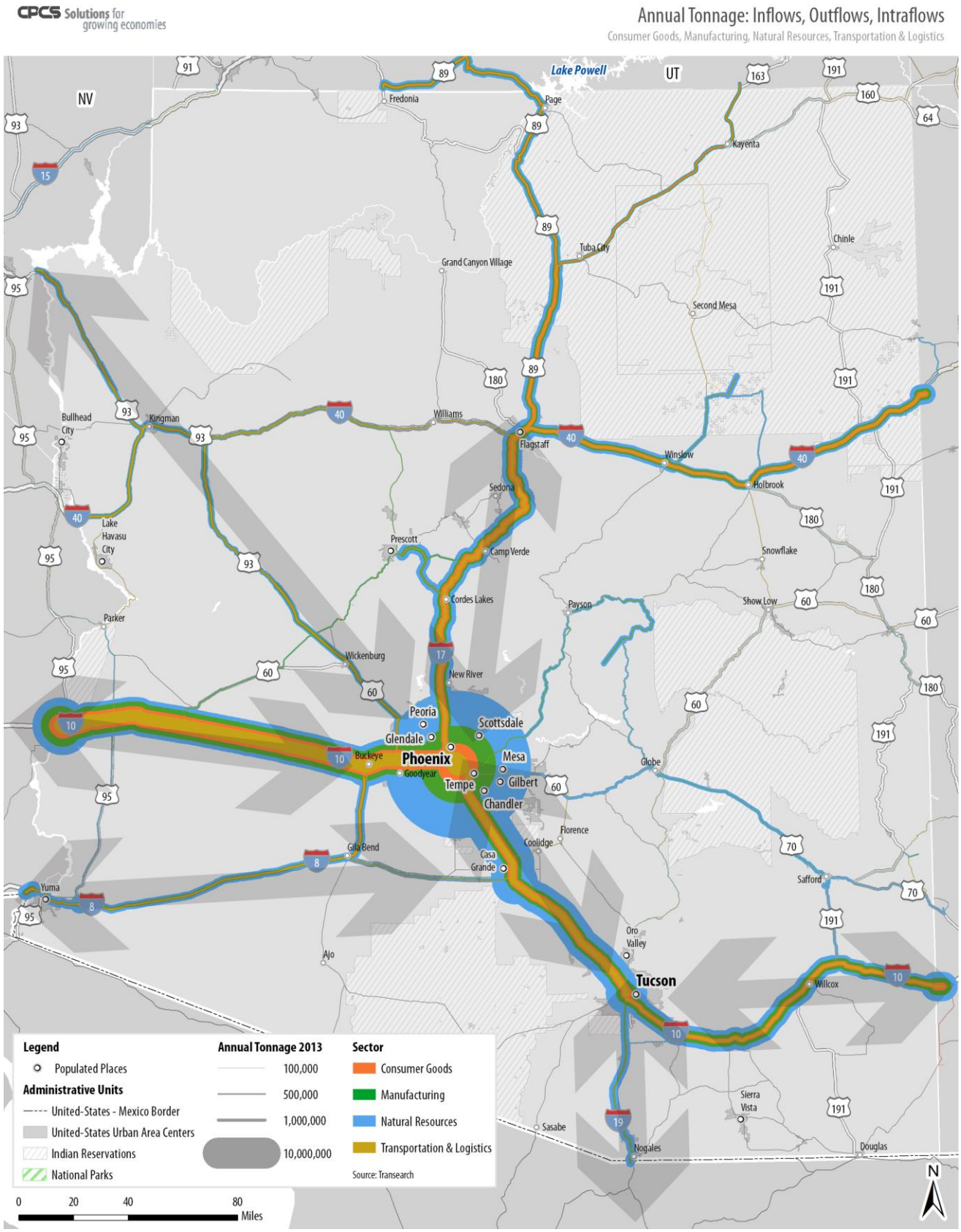
- **I-17 Phoenix to Flagstaff Corridor**: I-17 freight flows between Phoenix and Flagstaff are dominated by manufacturing sector flows, though consumer goods and transportation and logistics sector flows are also important.
- **I-19 Nogales to Tucson Corridor**: Natural resources sector flows dominate freight traffic along the I-19 between Tucson and Nogales, likely representing a combination of agricultural products and mining products. Manufacturing also uses this corridor and is particularly important in terms of the value of flows.

The other two KCCs, (**I-11 /US 93)** Phoenix to Las Vegas Corridor, and the I-8 Tucson to Phoenix Corridor), have relatively low volumes of freight traffic, largely relating to natural resources traffic, and to a lesser extent, consumer goods sector traffic.

The I-10 is the most important KCCs for Arizona trade. But the greatest volume of freight flows are in and around the Phoenix metro area.

These Phoenix-area flows are dominated by the natural resources sector (again, likely dominated by aggregate for regional construction), followed by manufacturing sector flows, consumer goods, and transportation and logistics flows.

Figure 4-16: Sector Group Freight Flows on Arizona's Key Commerce Corridors



4.5 Implications for the Arizona State Freight Plan

Three factors from the above review of freight transportation activity in Arizona have particularly important implications for the Arizona State Freight Plan:

1. Freight activity in Arizona is for the most part clustered around Phoenix and Tucson. This is notably the case for the consumer goods, manufacturing and transportation and logistics sectors. This high concentration of freight activity around major population centers means that freight transportation activity competes for capacity with urban and suburban passenger traffic. It may nevertheless facilitate planning for freight regions and associated freight infrastructure.

2. By volume, construction aggregate places the greatest pressure on the system, though this moves short distances and is tied to regional construction projects. Consumer goods also tend to move short distances, on the whole – much of this relating to last mile transportation. These pressures no doubt contribute to urban congestion, which may have quality of life implications for Arizona residents.

3. Linkages to California, Texas, and Mexico are critical to the movement of Arizona inbound and outbound freight. The I-10 is without question the most important KCC for Arizona trade. The I-10 is particularly important for the consumer goods sector. The I-19 is also an important trade corridor for trade in the natural resources and manufacturing sectors.

5 Freight Sector Transportation Performance Needs and Issues

Key Messages

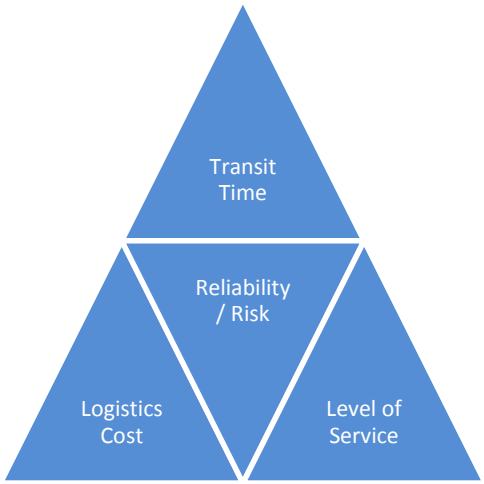
Transit time, reliability and service levels are particularly important to freight sectors moving high value, time-sensitive goods, such as high-tech products, or perishable goods such as beef. Logistics costs are also important, but tend to be the primary focus of sectors moving low value, high volume goods, such as coal, construction aggregate, forestry products or other non-perishable natural resources.

One of the most notable findings in consulting with Arizona freight transportation system stakeholders was that most were largely satisfied with the performance of the transportation system. Certain issues were noted, included recurring congestion and bottlenecks in and around urban centers, particularly Phoenix.

5.1 Transportation Performance Parameters

The transportation performance requirements of Arizona's freight sectors can differ greatly.

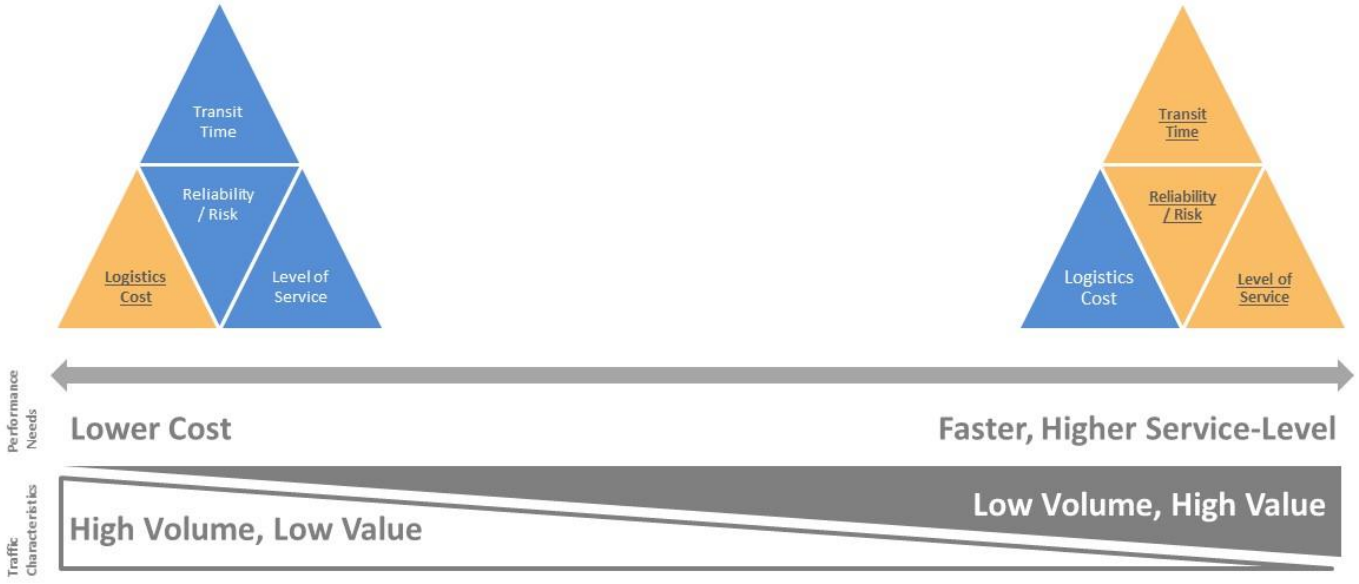
Figure 5-1: Transportation Performance Parameters



Shippers and receivers — i.e., the owners of the freight who are the ultimate users of the freight transportation system — generally characterize transportation performance in terms of some combination of transit time, total logistics costs, service level and reliability. The relative importance of these factors to their competitiveness — and their related trade-offs in transportation decisions — depends on the nature of the sector's market, the products being shipped and their related supply chains. Aerospace manufacturers, for instance, deal in high-value, time-sensitive inputs and outputs and tend to make transportation decisions on the basis of transit time, service level and reliability over logistics cost. Conversely, mining sector operations that generate high volume, low value per ton commodities, such as aggregate, tend to favor low cost transportation services over transit time, as they compete on the basis of cost, often on the basis of prices set on international markets (e.g. copper concentrate).

The following provides a highly simplified representation of the relationship for transportation performance parameters and the volume and value of the freight in question.

Figure 5-2: Simplified Representation of Transportation Performance Tradeoffs (Orange denotes Emphasis)



Source: CPCS

The following provides an overview of the key performance parameters of Arizona's freight sector groups and related most important sub-sectors.

5.1.1 Consumer Goods Sector

For the consumer goods sectors, transit time, logistics cost, level of service, and reliability are all important factors, though to varying degrees depending on the nature of the products being shipped, including their perishability, value, and time-sensitivity.

Grocery store supply chains or perishable food manufacturers are particularly oriented towards service levels and reliability. Cold chain logistics (which requires maintaining specific temperatures, humidity and ventilation controls through a series of transportation and storage links and nodes) can be critical to preventing spoilage, and shippers/receivers pay a premium for this service. Major grocers in the state also typically have one or two DCs supplying retail storefronts with daily product requirements. Realizing economies by holding higher inventory is often not an option, particularly for foods that have a short shelf life (e.g. fruit, meat).

Big-box retail (general merchandise, electronics, clothing, etc.) supply chains are typically configured similarly to the grocery supply chain noted above, without the added complexity of the cold chain. One exception is in healthcare and pharmaceuticals, where certain products require a high degree of precision with respect to temperature control, although the volumes are much smaller than retail grocery volumes.

Other (non-perishable) retail supply chains are more likely to place a greater emphasis on cost (the freight rate) over transit time. Reliability of deliveries is also critical, particularly for retailers that don't hold much inventory on site. High transit time variability also increases the risk of stock-outs, resulting in delayed or lost sales.

Travel time and cost play a larger role in long-term strategic decision making regarding distribution center locations.

Because the consumer goods sector's activity is in large part centered around major population (e.g. consumption) centers, local or regional transportation issues (e.g. from DC to storefront) typically have a significant impact on overall transportation performance.

5.1.2 Manufacturing Sectors

As with the consumer goods sectors, the supply chains of manufacturers are highly diverse.

At one end of the spectrum, cement and concrete supply chains are highly localized, dependent on trucking as a mode of transportation (given the short lengths of haul), and highly cost-sensitive given the low value-to-volume nature of product.

At the other end, the supply chains of high-value products such as high-tech equipment or aerospace technology, are increasingly globalized and rely on both trucking and air (and, as of fairly recently, ocean shipping) to reach markets around the U.S. and internationally. Many rely on highly time-sensitive Just-in-Time (JIT) inventory systems, with many larger companies, expecting products to arrive within a 12-hour window (or less) to hit an assembly line, for example. The cost of transportation services does not appear to be a major transportation performance parameter (relative to reliability and transit time). As a general finding, most high-tech and transportation equipment manufacturers have very well established and sophisticated supply chain processes and practices that are working well.

> The Arizona high-tech companies consulted stressed reliability as the most important transportation parameter. High-tech companies also underscored the importance of transit time given high inventory carrying costs, the risk of depreciation, and obsolescence. The sector is also highly internationally oriented.
>
> The products shipped by the high-tech sector, for example, are high-value and low-density, explaining the dominance of parcel and air modes.

In between are a large array of companies manufacturing parts, components, and equipment – these companies tend to be largely nationally oriented. Other general manufacturers, especially in fabricated metal manufacturing, predominantly serve local customers, such as aerospace companies.

Trucking is the dominant mode by tonnage, but air and "multiple modes" (including small package/parcel) handles a significant share of the total value of manufacturing sectors' transportation flows, particularly for high-tech and transportation equipment manufacturers moving high value goods to markets far and wide. Rail is generally used only on an exceptional basis by Arizona manufacturers.

On the whole, it seems general manufacturers in Arizona are somewhat more removed from transportation issues than companies in other sectors, in large part because of their reliance on third party logistics providers (3PLs) of freight forwarders. Many manufacturers, as well as their customers, appear to be satisfied to outsource transportation and logistics to 3PLs or small package carriers such as UPS and FedEx, and are pleased with the service they receive.

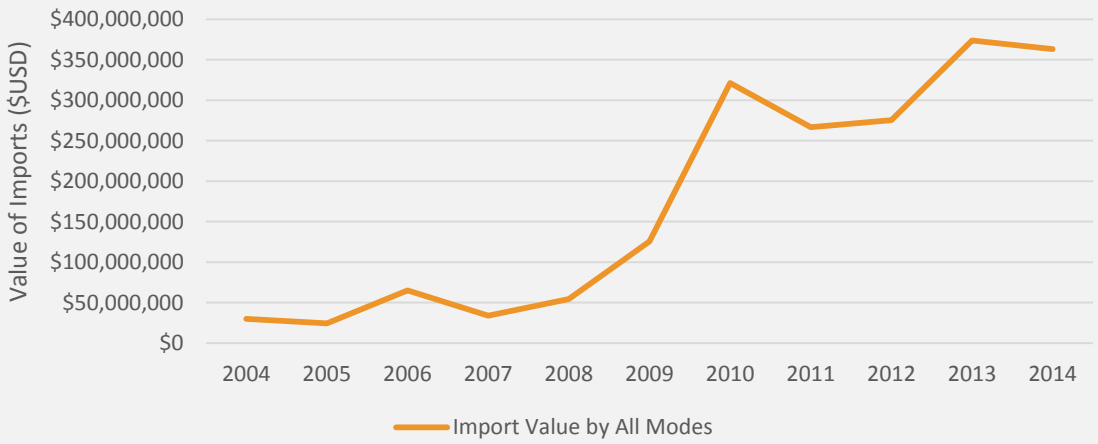
As with the consumer goods sectors, much of the manufacturing activity in Arizona is also clustered in and around major population centers, notably, Phoenix and Tucson, and therefore impacted by urban and sub-urban transportation issues.

Maquiladoras and Arizona's Manufacturing Sector Supply Chains

Mexican *maquiladoras* are producing increasingly higher value and sophisticated products. These maquiladoras stand to become even more important to the sector as U.S. manufacturers (especially in the aerospace sector and other sectors) begin to shift manufacturing production closer to home (nearshoring) in reaction to rising costs in China and higher transportation costs.

For example, imports to Arizona from Mexico for the vehicle commodity sector have grown extremely fast according to the Bureau of Transportation Statistics. This is a reflection of the increase in higher-value manufactured goods that have been imported from Mexico.

Figure 5-3: Arizona Imports in Vehicle Sector (except railway)



Source: CPCS Analysis of USDOT Bureau of Transportation Statistics North American Transborder Freight Data

The maquiladora zone near Tijuana has an estimated 50 firms active in the aerospace and defense industry, and Honeywell Aerospace employs approximately 350 people in the design, engineering and testing of aircraft components in Mexicali.[35]

The maquiladora economy of Nogales, Sonora has an important, and growing role in Arizona manufacturing sector supply chains.

The maquiladora economy in Nogales, which employs 35,000, includes various general manufacturers, but much electronics and parts production/assembly is oriented towards the auto industry and, increasingly, the aerospace industry.[36]

Overall, 6.0% of all maquiladora establishments in Mexico are located in Sonora State, representing the 7th largest number of establishments per state. The preceding top six states where maquiladoras are located, in order were: Baja California (17.6% of all maquiladora establishments), Nuevo Leon (12.3%), Chihuahua (9.0%), Jalisco (6.7%), Tampaulipas (6.7%).

[35] The Economist Magazine. "Mexico's Maquiladoras: Big maq attack", October 26, 2013. http://www.economist.com/news/business/21588370-50-year-old-export-industry-provides-millions-jobs-has-reinvent-itself-quickly

[36] Pavlakovich-Kochi, Vera. "Maquiladora Related Economy of Nogales and Santa Cruz County." University of Arizona Eller. April, 2014.

Mexico's Transportation Equipment Manufacturing Sector

Transportation equipment manufacturing is the most important category of manufactured commodities currently exported from Mexico, accounting for 16 percent of all manufacturing maquiladora establishments, 32 percent of employment, and 44 percent of total revenues.[37] This importance is reflected in the trade flows with Arizona in two areas: aerospace parts and auto manufacturing. Of note, in 2014, Sonora had 45 aerospace manufacturing plants with 7,500 employees, the majority of which are operated by American, French, and British companies. Rolls Royce, General Electric, Honeywell, Pratt & Whitney, Boeing and Airbus are some of the industry leaders that drive demand of aerospace products manufactured in this region.

The auto production industry in Mexico is also growing very quickly; between 2004 and 2014, Mexico's auto production doubled from 1.4 million units to 3.2 million units (while auto production in the U.S. and Canada declined)[38]. Of note, there is a large Ford stamping and assembly plant in Hermosillo (Sonora), producing over 300,000 vehicles per year[39], as well as other auto manufacturing plants across the country, owned by General Motors, Chrysler/Fiat, Honda, Nissan, Toyota and Volkswagen.[40]

5.1.3 Natural Resources Sectors

Arizona's natural resources tend to favor low cost transportation options as the primary driver to transportation performance and mode selection.

In most cases, product is heavy, bulky and low value on a per-ton basis.

For the mining sector – moving copper ores, sulfuric acid, among other inputs and outputs--the choice of mode between road and rail is determined primarily by distance, and more importantly what each location is capable of accepting or by what is practical.

Construction aggregates, ready mix concrete and asphalt generally move by road and tend to move locally - within a 20 to 30 mile radius of source. The shorter the distance to source, generally the better, as transportation can account for 50 percent or more of the total landed cost of the product.[41] There are instances where transit time and reliability are also crucial. For example, certain materials can be rejected by users if they fail to reach the project in time, resulting in perishable load issues (there is a 90-minute-window for concrete).

In the forestry sector, the vast majority of Arizona originated traffic flows are moved by truck, comprising moves of timber from logging (landing) sites, to regional sawmill, biomass power plant and wood pellet plant facilities, typically located within 50 to 100 miles of the landing

[37] "IMMEX – Mexico's http://azeconomy.org/2015/03/featured/immex-mexicos-export-oriented-manufacturing-and-services/

[38] USA Today, "More car manufacturing jobs move south – to Mexico", June 15, 2015. http://www.usatoday.com/story/money/cars/2015/06/15/auto-jobs-mexico/71224972/

[39] InterVISTAS Consulting Group, "Phoenix Regional Air Cargo Planning Study: Final Report", prepared for Phoenix Sky Harbor International Airport, January 2014. https://skyharbor.com/pdf/FinalReportAirCargoPlanningStudy.pdf

[40] Reuters, "Ford to invest $1.3 billion in northern Mexico plant", March 30, 2012. http://www.reuters.com/article/2012/03/30/us-ford-mexico-idUSBRE82T0X220120330

[41] As noted in consultations.

sites. A combination of rail and trucking are used to bring in lumber, wood products and paper products to Arizona from other parts of the country and Canada. For producers of logs and other low value outputs, keeping transportation costs low is paramount. Producers of higher value products (wood products, paper products) place relatively more importance on reliability, service levels and transit time than on transportation costs.

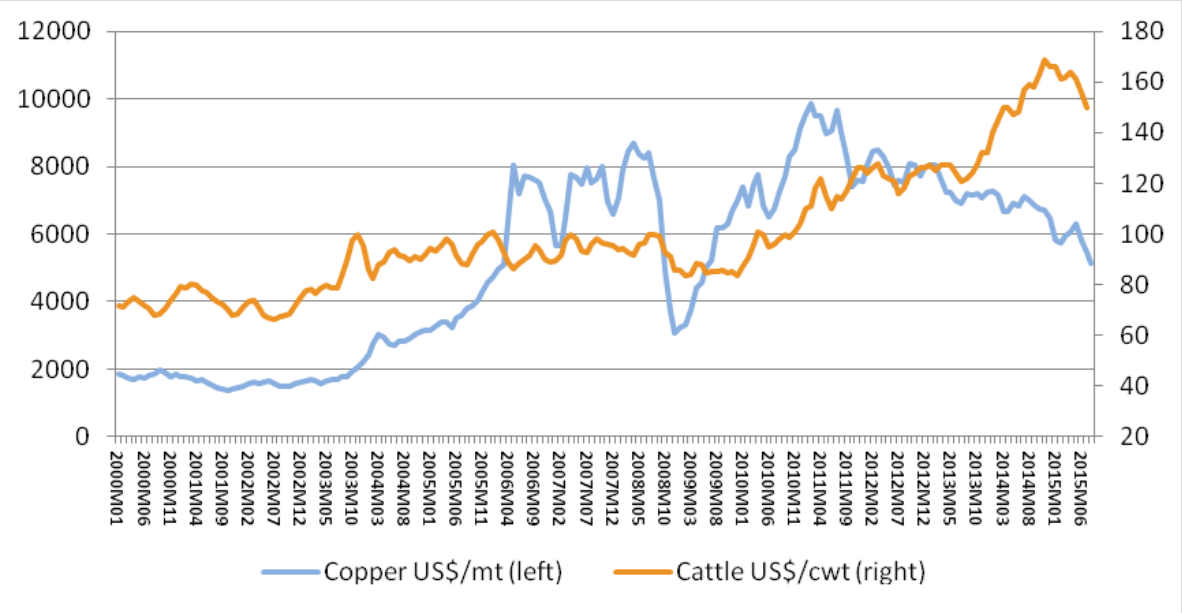
Agriculture is a diverse sector with distinct needs and supply chains depending on the product produced. Agricultural products (e.g. beef, dairy) are often highly perishable or temperature-sensitive. Both travel time and travel reliability are critical factors for the agricultural sector. Travel time is the main factor that led to the switch from rail transportation to truck transportation for most products in the agricultural sector.

Natural Resources Sectors Often Tied to International Commodities Prices

Several of Arizona's natural resources sectors, including mining, agriculture and forestry, produce outputs that consist of, or include among the products, basic commodities. Such prices can be volatile and can have significant implications for production. These price swings are also largely beyond the control of Arizona producers, suggesting that their competitiveness is a function of keeping their costs low.

For example, the monthly prices of two key Arizona commodities — copper and cattle — are shown below for the period January 2000 – July 2015.

Figure 5-4: Selected Commodity Prices, 2000-2015



Sources: World Bank Commodity Price Data (Pink Sheet) [Copper (LME), standard grade A, cathodes and wire bar shapes, physical settlement, US$/mt], and USDA [Cattle, Steers and Heifers, GE 500 lbs – Price Received US$/cwt]

5.1.4 Transportation and Logistics Sector

The transportation and logistics sector serves several key functions, which include:

- **Regional delivery of mixed freight.** This includes mixed freight and intermodal shipments which move with great frequency between Arizona and centers of domestic and international trade outside the state's borders. For example, a domestic container from Southern California is moved by truck to a third-party warehouse and fulfillment center in metropolitan Phoenix where its contents are broken down, repackaged, and delivered via integrated carrier to the homes of customers throughout Arizona.
- **Mail, parcel delivery, and air cargo.** These activities are conducted by the U.S. Postal Service and its contractors, integrated carriers (e.g. UPS, FedEx, DHL, and others), air cargo carriers and drayage companies, respectively.
- **Repositioning of empty equipment**. Given the imbalance of inbound-to-outbound trade, Arizona generates many more empty trailers and containers than it refills. As a consequence, the repositioning of empty trailers and containers is a major activity of the transportation and logistics sector in the state.

The way in which Arizona's transportation and logistics company's measure performance depends on a number of factors, including the type of freight they are handling and their role in the supply chain they are serving. Common performance parameters include:

- **Travel Time and Reliability.** The single most important performance metric of the transportation and logistics sector is travel time. Travel time affects planning and scheduling of freight moves, including the return of empty equipment. The reliability of travel times is a critical factor for planning trips. Reliability is affected by a number of factors including the condition of infrastructure, volumes, congestion, weather, and other variables. Unanticipated delays impact firms' bottom lines.
- **Operating Costs.** For the transportation and logistics sector, operating cost is a key performance parameter because it determines a firm's relative competitiveness in the marketplace against other firms providing transportation or warehousing services. Part of operating cost is determined by travel time reliability. Other major cost categories include labor, physical buildings, inventory carrying costs, and regulatory and tax costs.
- **Safety**. Safety not only includes operation of trucks but management of incidents, including dust and snow storms, as well as flash floods encountered in the Mojave and Sonoran deserts.

Because consumer goods and manufacturing sectors activity is in large part centered around major population centers, the transportation and logistics sector that serves these other sectors is also clustered in the same regions.

As a result, urban transportation issues can have a significant impact on transportation and logistics sector performance. The geographic orientation of this sector also means that space for warehousing and distribution sites - for example, sites with highway, direct rail services, and acreage to support large distribution and fulfillment centers - can be scarce.

5.2 Transportation System Issues Hindering Performance, Competitiveness

One of the most notable findings in consulting with Arizona freight transportation system stakeholders was that most were largely satisfied with the performance of the transportation system.

This is not to suggest that there are no transportation performance issues in Arizona. The transportation performance issues and improvement opportunities identified by those consulted are presented below, organized first by issues common to all or most sectors, and second, by issues that tend to be more specific to individual freight groups.

5.2.1 Freight Transportation Issues Common to Sector Groups

The most often cited Arizona transportation system issues common to all sector groups are:

Recurring congestion and bottlenecks in and around urban centers, particularly Phoenix: Peak congestion and associated bottlenecks were identified by virtually all freight sectors as problematic, and a barrier to transportation system performance and sector competitiveness.

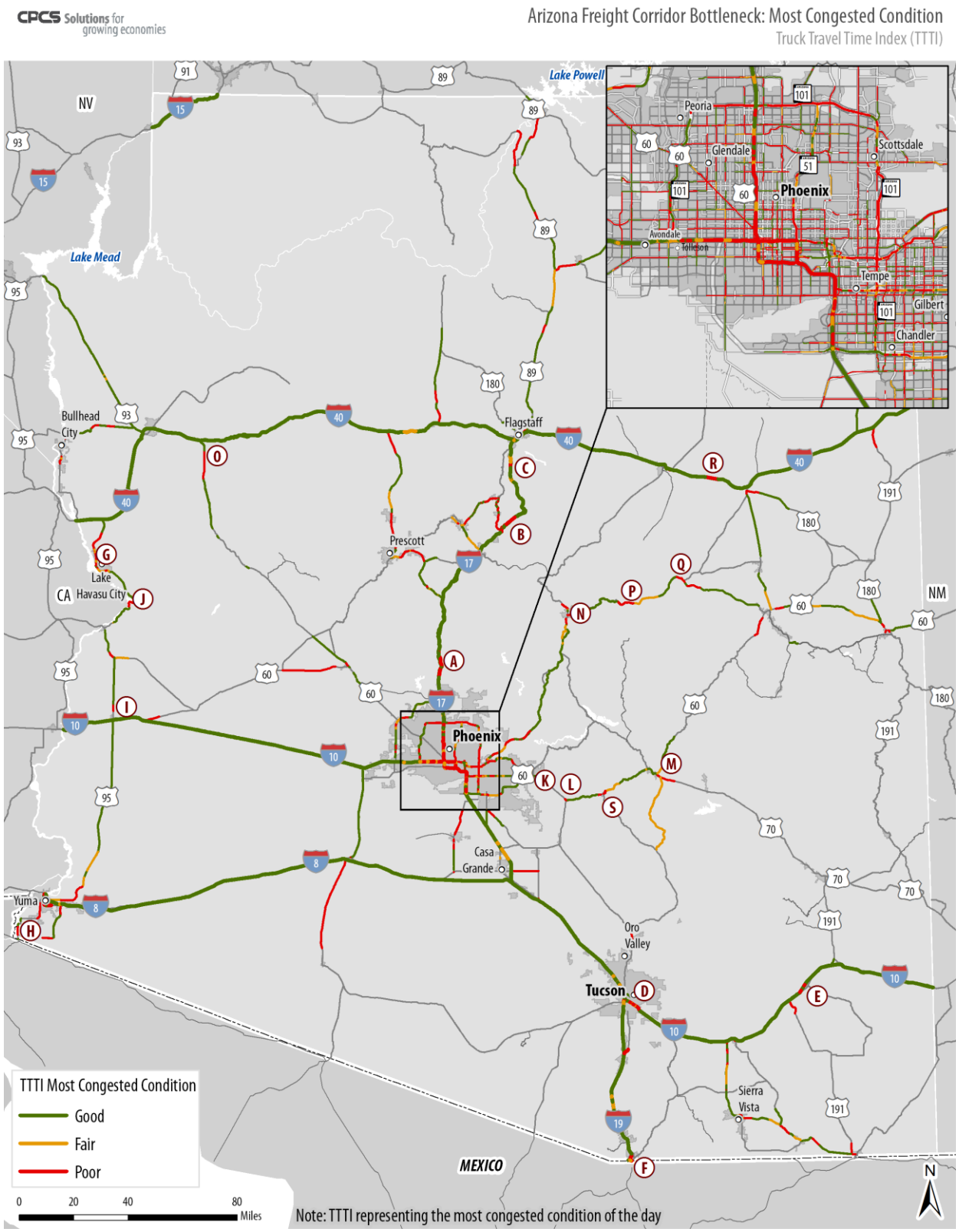
Transportation and logistics sector stakeholders, for instance, noted peak-hour bottlenecks on urban interstates and near major warehousing and terminal clusters as most acute and problematic for their operations. One frequently cited area is the bottleneck near 99th Avenue and I-10 in Phoenix, which is heavily congested during morning peak periods, and similarly on 44th and 55th Avenues. Others noted the I-17 Northbound from Phoenix as heavily congested.

Stakeholders in the consumer goods sectors cited more transportation challenges on the outbound (from the Distribution Centers (DCs) to stores or consumer-facing location) than on the inbound side, in large part due to the limited inventory capacity at consumer locations and the need to frequently replenish store shelves or supplies. This often leaves little choice but to conduct deliveries during peak traffic hours where major highways and arteries are congested. This has the effect of increasing transit time to stores, which in turn ties up more equipment and labor (fewer deliveries per truck, trailer and driver hour). It also has the effect of increasing the variability of delivery times and therefore increasing the chance of stock-outs or spoilage. This is especially a factor in the Phoenix Metropolitan Area for customer locations that are located on the other side of downtown relative to DCs (forcing the route through the downtown core).

The manufacturing sector, notably the high-tech and transportation equipment manufacturers, noted congestion around the outskirts of Phoenix, particularly around Sky Harbor International Airport, as well as on the heavily-travelled highway between Phoenix and Tucson as most problematic. Stakeholders mentioned the need for Highway I-10 to be 3-lanes the whole way between Phoenix and Tucson, as there are many commercial vehicles competing with personal vehicles in the two lane sections.

> Many expect peak-hour congestion to worsen with population and economic growth, particularly in major urban centers – Phoenix in particular.

Figure 5-5: Map of the Major Truck Bottleneck Locations throughout Arizona



Non-recurring congestion and bottlenecks: Although less frequently cited as an issue, several stakeholders – across most sector groups – noted non-recurring congestion and road closures as hindering the reliability of their transportation operations. Cited causes are many and include road construction-related lane closures, crashes, and weather events, including snow related road closures (e.g. in the Northern part of the state), dust storms (notably along the I-10 South of Phoenix), flooding, or other events (e.g. landslides). The 2015 bridge failure and subsequent closure of I-10 at Desert Center, California underscores the high cost of problems along key corridors. Some stakeholders noted concerns about the possibility of similar incidents in Arizona.

One stakeholder noted that there is frequently road work on the I-10 corridor, increasing congestion. Increasing congestion increases travel times and lowers reliability, both of which decrease the productivity of trucks and their drivers (i.e. more trucks and drivers would be required to make the same number of deliveries).

Axle-load restrictions: Several shippers across sectors noted that axle load restrictions in Arizona are low relative to other states that allow gross vehicles weights in excess of 80,000 lbs.[42] This was noted as generating more truck trips for a given amount of freight, contributing to higher transportation costs for carriers and shippers, more trucks on the road exacerbating congestion around urban centers, and compounding the truck driver shortage problem. Axel-load restrictions were most often cited as a top issue for natural resources sector stakeholders.

Truck driver shortage: The shortage of truck drivers is a national phenomenon and is worsening. In Arizona, the driver shortage is aggravated by the improving economy and the tightening labor pool in which trucking companies compete with construction and other trades for talent. It is also likely exacerbated by Hours of Service regulations. The truck driver shortage issue impacts all truck-dependant freight sectors in Arizona, but is notably acute in seasonal sectors, including agriculture and forestry, but is notably acute in seasonal sectors, including agriculture and forestry, where demand is highly peaked for several months per year and an adequate labor pool of drivers is not available.

There is a general concern in the trucking industry that the pipeline of qualified drivers is growing thin and this could have a significant impact on freight movement in the coming decade.

Challenges in securing drivers are particularly acute in certain sectors. In the forestry sector, for example, the work conditions are challenging, hauls are only in one direction, and the value of product is low, meaning shippers cannot pay premiums to carriers.

Funding constraints. Freight transportation stakeholders, and notably those in the transportation and logistics sector, highlighted concerns about the limited funding available to maintain and expand the state's highway network.

[42] ADOT allows motor carriers to operate at FHWA limits

Arizona Transportation Network Investment Needs

The Arizona's 2010 Long Range Transportation Plan estimated that Arizona's bridges required $1.5 billion for replacement, widening, strengthening, maintenance and operations over the 25 year planning horizon.[43] A subsequent study completed in 2014 on Key Commerce Corridors identified 151 bridges (70 on Key Commerce Corridors, 41 on other corridors and 40 others throughout the state) for reconstruction at a cost of $400 million.[44]

With respect to pavement condition, 1,700 directional miles (20 percent) of 8,700 miles of ADOT-owned roadways are in poor condition, with an additional 2,400 miles (28 percent) in fair condition.[45] Improving the condition of these roadways will take considerable investment.

5.2.2 Freight Transportation Issues Related to Individual Sector Groups

Certain freight transportation performance issues were more prominent or specific to individual sector groups. These issues are highlighted below, organized by sector group.

Consumer Goods Sectors

Specific issues noted by the consumer goods sectors include:

Municipal noise ordinances as barrier to off-peak deliveries: City ordinances related to noise were cited by retail sector companies as issues in certain areas of Tucson and Phoenix, particularly where there are strong neighborhood associations that oppose deliveries at off-peak hours. This limits the ability of certain stores to be replenished outside of congested hours.

Location specific truck manoeuvrability issues. Some companies noted challenges in manoeuvring large trucks to and from delivery docks at shopping centers. This is thought to be due to developers thinking primarily of customer traffic needs at the expense of freight needs when designing these centers. In any case, this has led to increased transit time and lower equipment/labor utilization.

California Air Resource Board (CARB) Truck Emissions Regulations: These requirements have cost implications and were noted as particularly affecting the food and beverage sector as are requirements that apply not only to the truck engines, but also the engine that generates power for refrigerated vehicles and trailers.[46]

[43] Ibid.
[44] *Key Commerce Corridors Final Report*. Arizona Department of Transportation, 2014.
[45] ADOT HPMS pavement dataset (2014)
[46] The CARB requirements are described in more detail here: http://www.arb.ca.gov/diesel/tru/tru.htm.

Manufacturing Sectors

Specific issues noted by the manufacturing sectors include:

Dissatisfaction with Air Connections and Service: Improving international air connections at Phoenix Sky Harbor International Airport (PHX), particularly to Asia and Europe, was the most frequently mentioned improvement need by manufacturing sectors. Several manufacturers, especially those moving high value goods, expressed dissatisfaction with the present international offerings at PHX. As of this writing, PHX has 20 international destinations, though all but two are to Canada and Mexico (the other two are London England, and San Jose, Costa Rica). The only non-North American carrier is British Airways. California airports such as LAX are within a day's drive by truck, for which reason the limited offerings at PHX are not necessarily a deal-breaker for Arizona manufacturers. Nonetheless, the minimal service to Europe and Asia results in heightened complexity, risk, and cost for manufacturers. There was also some skepticism expressed about whether there was simply enough industry in Arizona to support expanded cargo service.

Phoenix Sky Harbor International Airport

Phoenix Sky Harbor (PHX) is the major airport serving the Valley. Centrally located, it offers direct service to over 80 locations in the United States, including Alaska and four locations in Hawaii. According to the Federal Aviation Administration, PHX ranks in the Top 20 in cargo landed weight.

Text Source:
https://skyharbor.com ,
http://www.faa.gov
Photo Source: Wikipedia (User ZHoover123)

Limited customs airport services was also mentioned as a challenge. Specifically, coverage is lacking on the weekends and during off-hours, and otherwise is oriented overwhelmingly to passenger operations.

Reliability of the Mexican Border: The unpredictability of crossing times at the Mexican/US border, notably at Nogales (the busiest Port of Entry for the manufacturing sector) was identified by several manufacturers as problematic, although it was recognized that these delays are largely-originated from Mexican customs requirements, as opposed to U.S. Customs and Border Protection (CBP).

Natural Resources Sectors

Specific issues noted by natural resources sectors include:

Axle-load restrictions: As noted, Axel-load restrictions was most often cited as a top issue for natural resources sector stakeholders- particularly for mining and forestry sectors. Higher axle-loads would allow from greater economies of scale in moving product, which would drive down per ton cost, thereby increasing the cost competitiveness of shippers.

Carriers specializing in liquid bulk and other specialized commodities are especially concerned about their ability to compete and have proposed increasing the gross vehicle weight of 5-axle semi-trailer trucks from 80,000 to 86,000 lbs. or changing the regulations to allow for a trailer to be towed behind the main semitrailer. Carriers believe these changes would help alleviate productivity constraints associated with the driver shortage.

ADOT Healthy Forest Initiative

In November 2014, ADOT launched the two-year Healthy Forest Initiative pilot program. The initiative eases weight restrictions on several highways in the White Mountains region of Northeastern Arizona (see map). Under the agreement, the gross weight limit for carriers moving forestry products between landing sites and processing facilities has been increased to 90,800 lbs (from 80,000 lbs). Timber haulers wishing to use the program file an application for a 30-day, $75 per vehicle permit that allows them an unlimited number of loads on designated roads. In the first six months of the program, nearly 800 loads were permitted and hauled, illustrating the significant uptake by industry.

Source: Consultations and ADOT News Release (May 14, 2015)

Truck reliability and availability during peak periods: According to several natural resources sector stakeholders consulted, often transportation equipment (trucks and trailers) can be in high demand during harvest seasons and cause difficulty in scheduling. During these times unexpected delays throughout the supply chain can be particularly costly given the time-sensitivity of bringing perishable products to market. Many echoed the challenges in securing truck transportation in the peak produce season, when many carriers are lured away to haul Mexican produce from the states of Sinaloa and Sonora or border entry points to markets across the Southern U.S.

Transportation and Logistics Sector

Specific issues noted by the transportation and logistics sector include:

Inadequate Truck Parking Facilities: Truck drivers are concerned about the lack of safe truck parking across Arizona, especially on the I-17 corridor between Phoenix and Flagstaff and on I-10 between Tucson and Blythe, California. Carriers expect the truck parking situation to deteriorate further once electronic logs go into full effect, requiring drivers to closely adhere to Federal Hours of Service regulations. Drivers in Arizona are reportedly already spending up to a half-hour to find parking each day. This issue impacts both local and long-haul carriers although larger carriers are less frequently affected, in part because they can accommodate trucks at their terminal facilities. For carriers moving hazardous materials (including gasoline or diesel), the situation is further complicated by the lack of Safe Haven parking near motels.

Other noted transportation issues hindering the performance of Arizona's freight sectors:

Other less often cited, the following are transportation issues noted by freight transportation system stakeholders.

- One stakeholder felt that there was a disproportionate number of trucks being pulled over for inspection by ADOT on the I-10 between Phoenix and Tucson.
- One stakeholder noted that some distributors are using alternative fuel vehicles in the state (e.g. CNG [compressed natural gas]), but there are not enough CNG fueling stations.

- One stakeholder was concerned about the need for and challenges associated with receiving a Commercial Driver License (CDL), suggesting that CDL licensing requirements may be overly onerous, particularly in the food service subsector in which many of the deliveries to food service are short-haul and with smaller trucks. Also, one stakeholder was concerned that the unavailability of testing centers for CDLs may contribute to discouraging new entrants to the industry, particularly in rural areas with longer distances between testing centers.

6 Where to Focus to Enable Arizona's Economic Competitiveness and Growth?

Key Messages

From an economic competitiveness and growth perspective, the Arizona State Freight Plan should give particular weight to the transportation performance issues of Arizona's manufacturing and natural resources sectors, since these sectors are export oriented and compete for markets *outside* Arizona. These sectors also attract direct investment from outside Arizona.

Addressing challenges faced by the consumer goods and transportation and logistics sectors are likely to have quality of life impacts on Arizona residents, since the cost of transportation inefficiencies for these sectors are likely passed on to them.

6.1 Role of Transportation in Arizona's Economic Competitiveness and Growth

The four freight transportation sector groups – consumer goods, manufacturing, natural resources and transportation and logistics sectors - use the transportation system differently and often have different freight transportation performance needs. From a freight planning perspective, it is also important to recognize the different roles that these sectors play in Arizona's economy, and related implications for Arizona's economic competitiveness and growth.

6.1.1 Consumer Goods Sectors

The wholesalers and retailers sector and the food and beverage sector are highly competitive, with many large chains vying for market share through many consumer-facing storefronts or establishments across Arizona. Managing their transportation and logistics supply chains efficiently is one way that companies in these sectors attempt to maintain a competitive advantage.

Competition in consumer goods sectors is largely centered on consumer markets in Arizona.

The cost of inefficiencies in transportation may impact the competitiveness of one company or another in these sectors, but it is ultimately Arizona's end consumers that pay the price of inefficiency, either in the form or higher costs, lower quality products, reduced options, or otherwise.

Put differently, there is a quality of life impact for consumers to inefficiencies in the transportation system, but these inefficiencies may not directly impact Arizona's economic competitiveness and growth per se.

The imperative to address transportation system issues faced by consumer goods sectors is one of quality of life for Arizona residents, rather than Arizona's economic competitiveness and growth, strictly speaking.

Even still, consumer goods use much of the same transportation system that moves other sectors' freight, as well as passenger vehicles. As such, improvements to address transportation issues faced by the consumer goods sectors can have broader impacts on other sectors, Arizona's economy, and quality of life in the state.

6.1.2 Manufacturing Sectors

In contrast to consumer goods sectors, which largely compete for markets *within* Arizona, Arizona's manufacturing sectors, which includes the high-tech, transportation equipment and general manufacturing sectors, are for the most part much more focused on competing for

markets *outside* Arizona. Indeed, the manufacturing sectors generated the largest share of international exports, totalling $14.3 billion, or 77 percent of total Arizona exports, by value (2012). Manufacturing sectors' supply chains are also highly globalized, generating important inbound flows from around the U.S. and the world, including important flow from Mexico.

Transportation performance issues in Arizona can increase the overall cost and decrease the reliability of Arizona's manufacturing sectors' supply chains, which in turn can negatively impact the competitiveness of Arizona's manufacturers in selling into markets outside Arizona vis-à-vis competing U.S. and global jurisdictions.

Put differently, the impact of poor transportation performance for Arizona's manufacturers can contribute to a contraction of Arizona's manufacturing sector, with consequential implications for GDP, employment, and future manufacturing sector direct investment, among other economic and quality of life consequences.

Another notable characteristic of manufacturing sectors is that location and related direct investment decisions are not necessarily tied to a regional market (e.g. as is the case for the consumer goods sectors), or to the location of inputs to the manufacturing process (e.g. as distinct from the mining or forestry sector which locate next to production sites). Put differently, manufacturers have more options for where they choose to locate their production. As such it is not only Arizona's manufacturers that compete; Arizona is also competing to attract manufacturers and related investments. A competitive transportation system is often a prerequisite in any manufacturing sector location or investment decision.

It is also worth reiterating that the manufacturing sector, and the high-tech sector more specifically, have the highest average wage rates among freight sectors. Increasing the competitiveness of manufacturing sectors can help attract higher quality, higher paying jobs to the state.

To be clear, the factors that influence the competitiveness of Arizona's manufacturing sectors, and Arizona as a location for manufacturing more broadly, are not limited to transportation performance. Other factors include the state labor market, the suitability of local conditions (e.g. access to land, electricity prices, access to key inputs, proximity to sector clusters), local fiscal conditions (e.g. tax rates), among a range of other factors familiar to economic development actors. Yet transportation performance does play a role in the competitiveness and growth of Arizona's manufacturing sector.

The transportation issues that hinder the competitiveness of Arizona's manufacturing sectors warrant prioritization in the Arizona State Freight Plan given the critical role of transportation in reaching markets competitively and enhancing the State's economic competitiveness and growth. The relatively higher wage jobs in this sector further justify emphasis on improving the competitiveness of this sector. Transportation improvements should however be undertaken in concert with improving the investment climate for the manufacturing sectors more broadly (i.e. beyond transportation issues).

As with consumer goods sectors, it is also largely the case that manufacturing sectors use much of the same transportation infrastructure used by other freight sectors and passenger vehicles – particularly around Phoenix and Tucson. Addressing the manufacturing sectors' transportation issues can thereby have other positive impacts on other sectors and transportation in Arizona more broadly.

6.1.3 Natural Resources Sectors

Like manufacturing sectors, Arizona's natural resource sectors, including mining, agriculture and forestry sectors, are in many cases also oriented to and compete for markets *outside* Arizona.

The performance of Arizona's transportation system is critically important to the competitiveness and growth of Arizona's natural sectors for at least three reasons.

The cost of transportation as a share of the total landed product cost is typically very high relative to other sectors.

In some cases, transportation costs can account for 50 percent or more of the total cost of the product being shipped (e.g. sulfuric acid used in and derived from mining processes).[47] Second, the price of end products, including all transportation costs, are often set by world markets (e.g. copper concentrate), and so competitiveness is largely a function of cost (as distinct, for example, from differentiated product attributes or branding). In this respect, measures that can reduce transportation costs can have a very significant positive impact on competitiveness of those commodities on the world stage. Third, in many cases, regions rich in natural resources do not have adequate transportation connectivity. In these cases, access, or lack of access, can be the determining factor in whether these resources are exploited, with obvious consequences for economic development.

Also of note, major international resources companies – global mining companies for example – will typically consider project investments from a very long global list of potential project sites

[47] As noted in consultations.

and will invest in only in a small number of these. Decisions to invest in one location or another is based on a long range of factors, but most important, beyond the quality and magnitude of the resource deposit in question, is the overall cost to bring the related product to market. Transportation costs typically have a significant bearing on these considerations.

Opportunities to reduce transportation costs in relation to the Arizona State Freight Plan could have a material impact on enabling the enhanced competitiveness and growth of Arizona's natural resources sectors.

6.1.4 Transportation and Logistics Sector

The transportation and logistics sector is a service sector, rather than a freight generating sector as is the case with consumer goods, manufacturing or natural resources sectors. It competes for shippers' business.

The growth of Arizona's transportation and logistics sector is largely tied to the competitiveness and growth of Arizona freight generating sectors. Put simply, the more goods that are moving to, from and within Arizona, the better for Arizona's transportation and logistics sector.

Yet importantly, a competitive transportation and logistics sector in Arizona can enable the competitiveness of companies in Arizona's freight generating sectors, whether by increasing the efficiency of their supply chains, reducing their transportation costs, or by helping companies in freight generating sectors reach their markets more reliably.

The true cost of transportation performance issues are likely passed on to shippers in freight generating sectors, impacting their competitiveness and growth. Some of these costs will also be passed on to end consumers.

The transportation and logistics sector provides a good proxy for identifying broad transportation performance issues in Arizona. Addressing these issues through the Arizona State Freight Plan can have far reaching impacts, given that the transportation and logistics sector serves many freight generating sectors in Arizona's economy.

6.2 Implications for the Arizona State Freight Plan

To most effectively contribute to enhancing Arizona's economic competitiveness and quality growth, the Arizona State Freight Plan should be oriented to addressing the needs of the sectors of the economy that:

- **Compete for markets *outside* Arizona**. The exports generated by these sectors bring dollars to Arizona, which in turn can stimulate employment and economic activity in the State.

- **Can attract investment to Arizona**. Direct investment, and in particular investment coming from outside the State, will directly contribute to Arizona's gross domestic product (GDP), employment in the state, and taxes, which in turn can be used to reinvest in the State's future growth and prosperity.

The manufacturing and natural resources sectors both meet these criteria, though they are not the largest sectors in Arizona's freight economy.

Consumer goods and transportation and logistics sectors, though larger, are much more oriented towards markets in Arizona. The growth of these markets is tied largely to local consumption, suggesting that the growth of these sectors is perhaps more constrained than those selling outside Arizona.

A related consideration is that the consumer goods and transportation and logistics sectors for the most part ultimately serve consumers in Arizona, meaning that the cost of inefficiencies in the transportation system are ultimately passed onto Arizona residents, in one form or another.

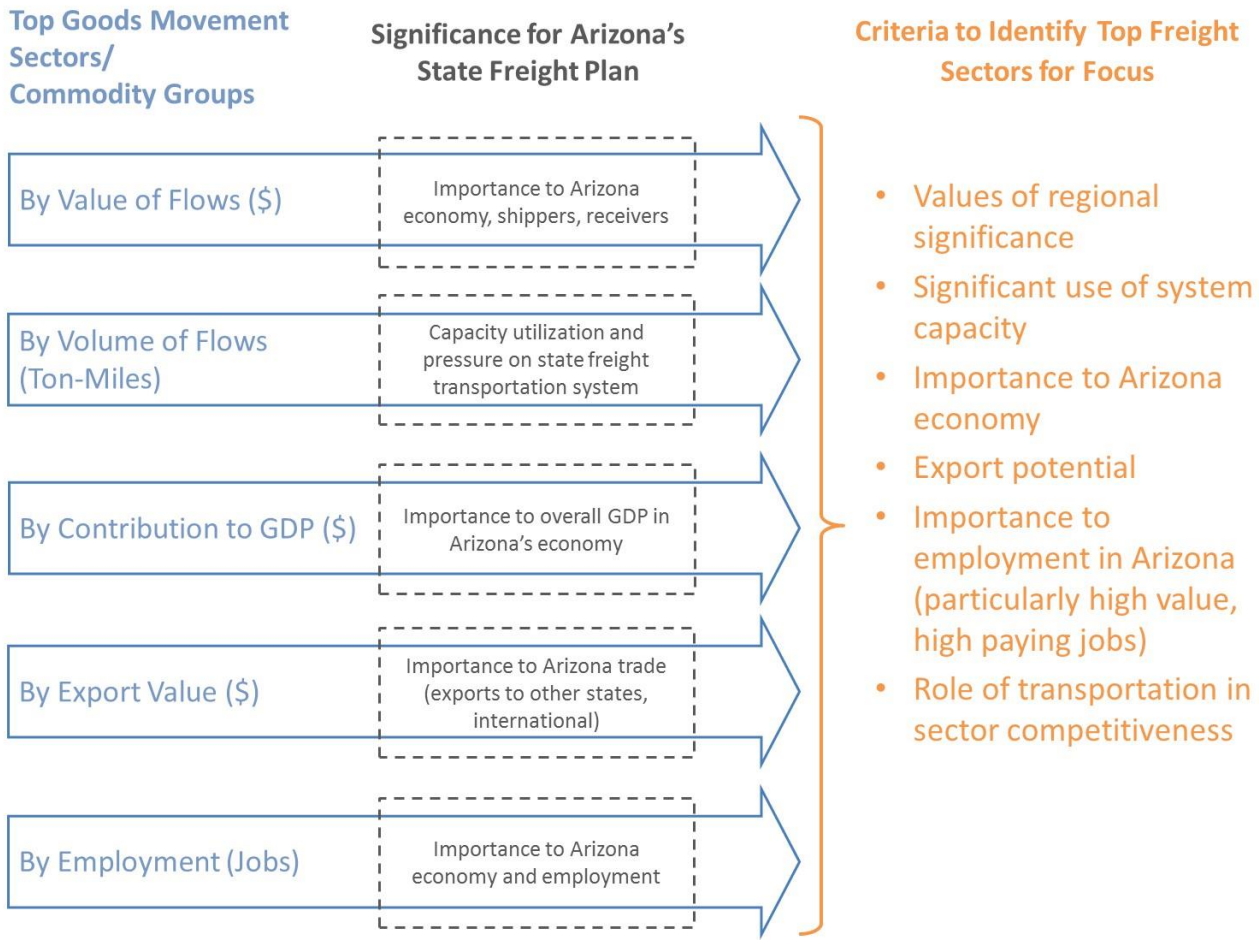
To the extent that the Arizona State Freight Plan can address the transportation issues faced by the consumer goods and transportation and logistics sectors, there could be a clear quality of life benefit for Arizona residents.

Also of critical importance to the State Freight Plan is the fact that many freight sector groups use the same transportation infrastructure and also share this infrastructure with passenger vehicles – for instance the interstate highways system in and around the Phoenix and Tucson areas. Addressing common freight sector transportation challenges can go a long way to both enhance economic competitiveness and growth, and improve the quality of life of Arizona residents.

Appendix A: Criteria Used to Identify Top 10 Freight Sectors for Focus

Arizona's "top 10" freight sectors were identified based on an assessment of top goods movement sectors in terms of volumes and values of traffic, contribution to GDP, trade and employment, and based on criteria informed by the economic competitiveness goals and objectives of the Arizona State Freight Plan, summarized in the figure below.

Figure 6-1: Identifying "Top 10" Economic Sectors for Focus



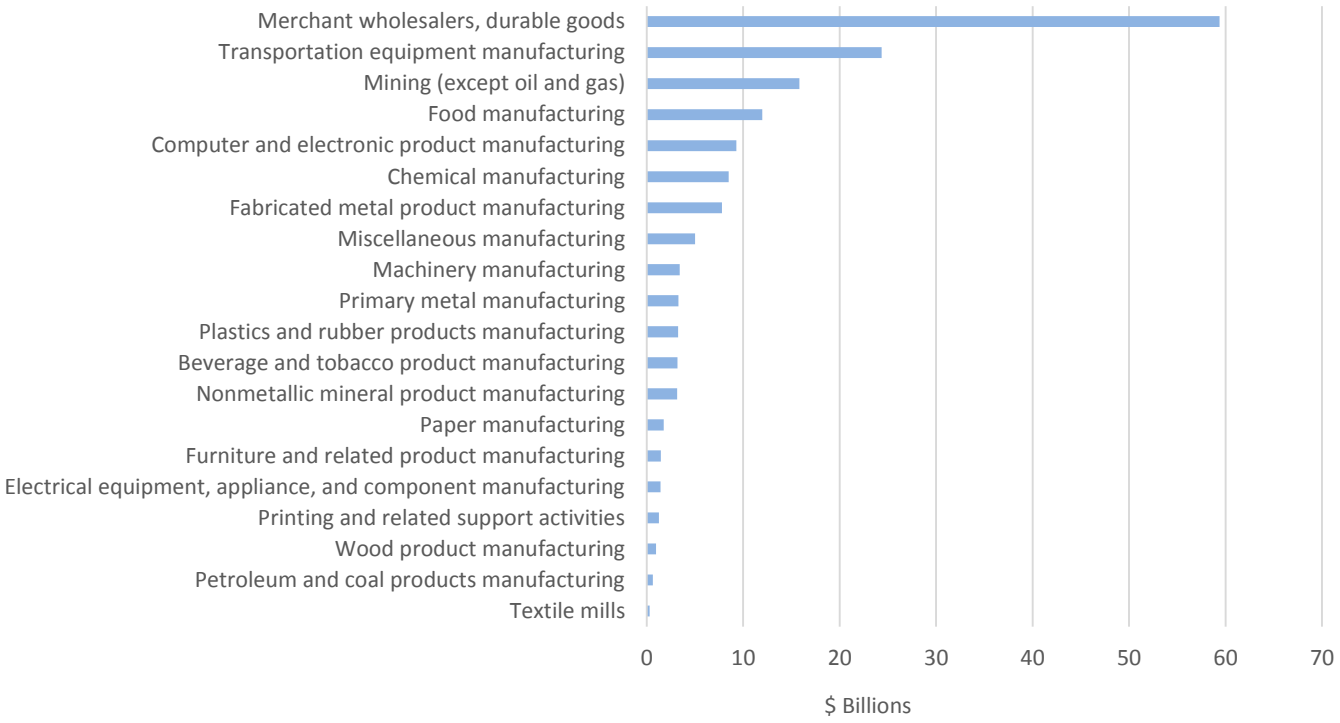
Source: CPCS

Appendix B: "Top" Goods Movement Sectors, by Different Metrics

B-1: Value of Flows ($)

Manufacturing sectors comprise the most significant values of freight flows in Arizona.

Figure 6-2: Value of Commodities Shipped by Industry (2012)



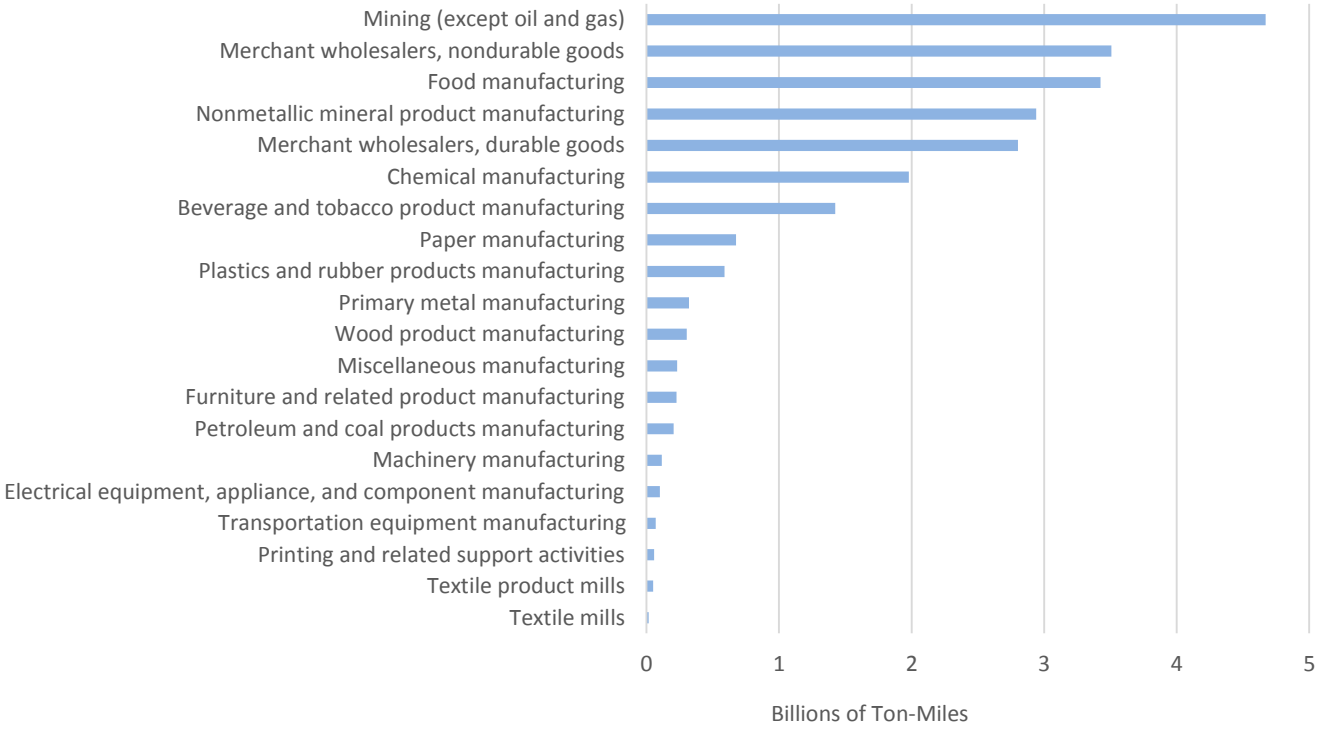
NAICS Code	Industry Name
316	Merchant wholesalers, nondurable goods
315	Merchant wholesalers, durable goods
314	Transportation equipment manufacturing
313	Mining (except oil and gas)
324	Food manufacturing
321	Computer and electronic product manufacturing
323	Chemical manufacturing
335	Fabricated metal product manufacturing
337	Miscellaneous manufacturing
322	Machinery manufacturing
327	Primary metal manufacturing
312	Plastics and rubber products manufacturing
326	Beverage and tobacco product manufacturing
331	Nonmetallic mineral product manufacturing
333	Paper manufacturing
339	Furniture and related product manufacturing
332	Electrical equipment, appliance, and component manufacturing
325	Printing and related support activities
334	Wood product manufacturing
311	Petroleum and coal products manufacturing

Source: CPCS analysis if United States Census Bureau. 2012 Commodity Flow Survey.

B-2: Volume of Flows (Ton-Miles)

The mining sector, followed by wholesalers and manufacturing, comprise the sectors that generate the largest volume of freight flows over Arizona's transportation system.

Figure 6-3: Ton-Miles of Commodities Shipped by Industry (2012)



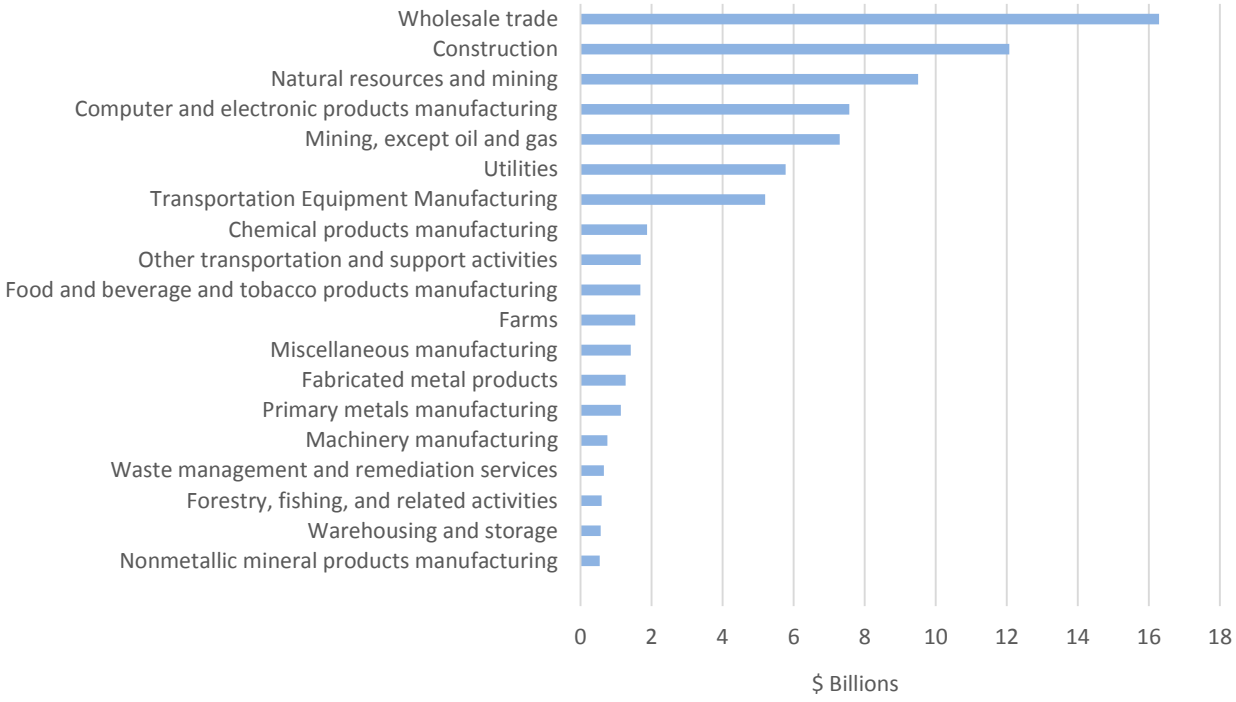
NAICS Code	Industry
315	Mining (except oil and gas)
316	Merchant wholesalers, nondurable goods
334	Food manufacturing
332	Nonmetallic mineral product manufacturing
313	Merchant wholesalers, durable goods
314	Chemical manufacturing
323	Beverage and tobacco product manufacturing
336	Paper manufacturing
335	Plastics and rubber products manufacturing
333	Primary metal manufacturing
324	Wood product manufacturing
337	Miscellaneous manufacturing
339	Furniture and related product manufacturing
321	Petroleum and coal products manufacturing
331	Machinery manufacturing
326	Electrical equipment, appliance, and component manufacturing
322	Transportation equipment manufacturing
312	Printing and related support activities
325	Textile product mills
423	Textile mills

Source: CPCS Analysis of United States Census Bureau. 2012 Commodity Flow Survey

B-3: Contribution to Arizona's GDP

Among freight sectors, retail trade and wholesale trade are the two most significant contributors to Arizona's GDP. Construction, mining, and computer electronics products are also significant contributors to Arizona's GDP.

Figure 6-4: Contribution to Arizona's GDP by Industry (2012)



Note: Only those sectors that generate freight traffic are analyzed here (for example, the financial services sector is excluded from analysis).

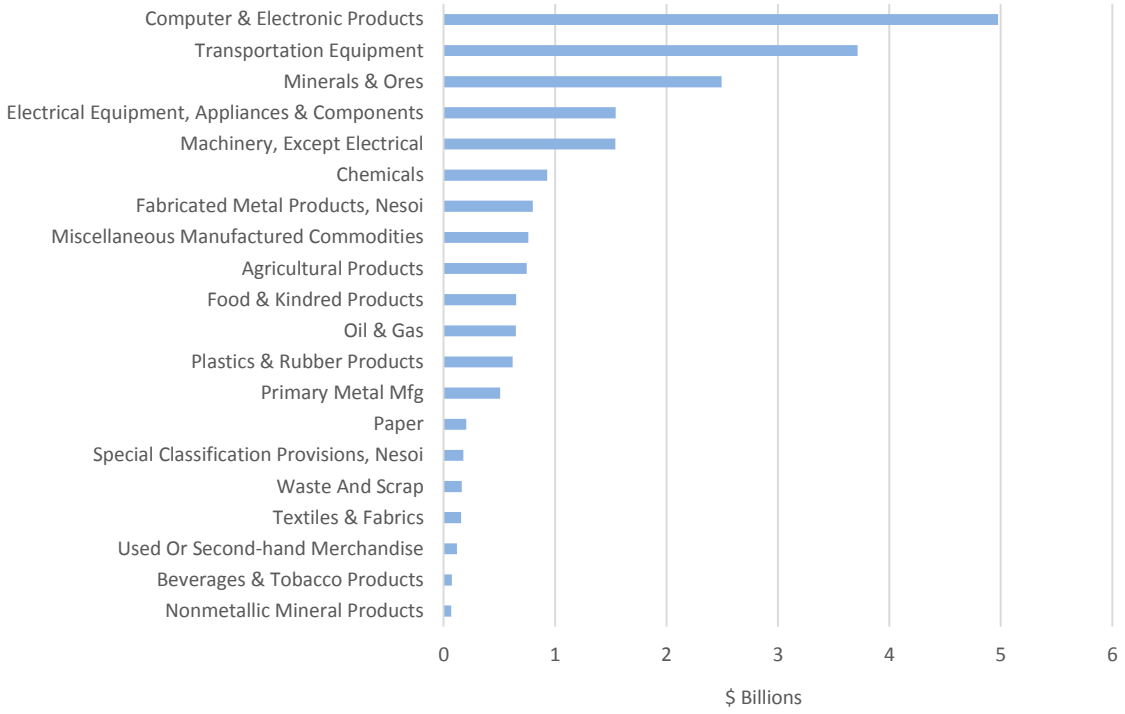
NAICS Code	Industry
44-45	Retail trade
42	Wholesale trade
23	Construction
11, 21	Natural resources and mining
334	Computer and electronic products manufacturing
212	Mining, except oil and gas
22	Utilities
336	Transportation Equipment Manufacturing
325	Chemical products manufacturing
487-488, 492	Other transportation and support activities
311-312	Food and beverage and tobacco products manufacturing
111-112	Farms
339	Miscellaneous manufacturing
332	Fabricated metal products
331	Primary metals manufacturing
333	Machinery manufacturing
562	Waste management and remediation services
113-115	Forestry, fishing, and related activities
493	Warehousing and storage
327	Nonmetallic mineral products manufacturing

Source: CPCS analysis of Bureau of Economic Analysis

B-4: Exports Value ($)

Transportation equipment, computers and electronics, machinery, energy and agricultural products make up the largest sectors in terms of value of exports.

Figure 6-5: Value of Arizona Exports by Sector (2012)



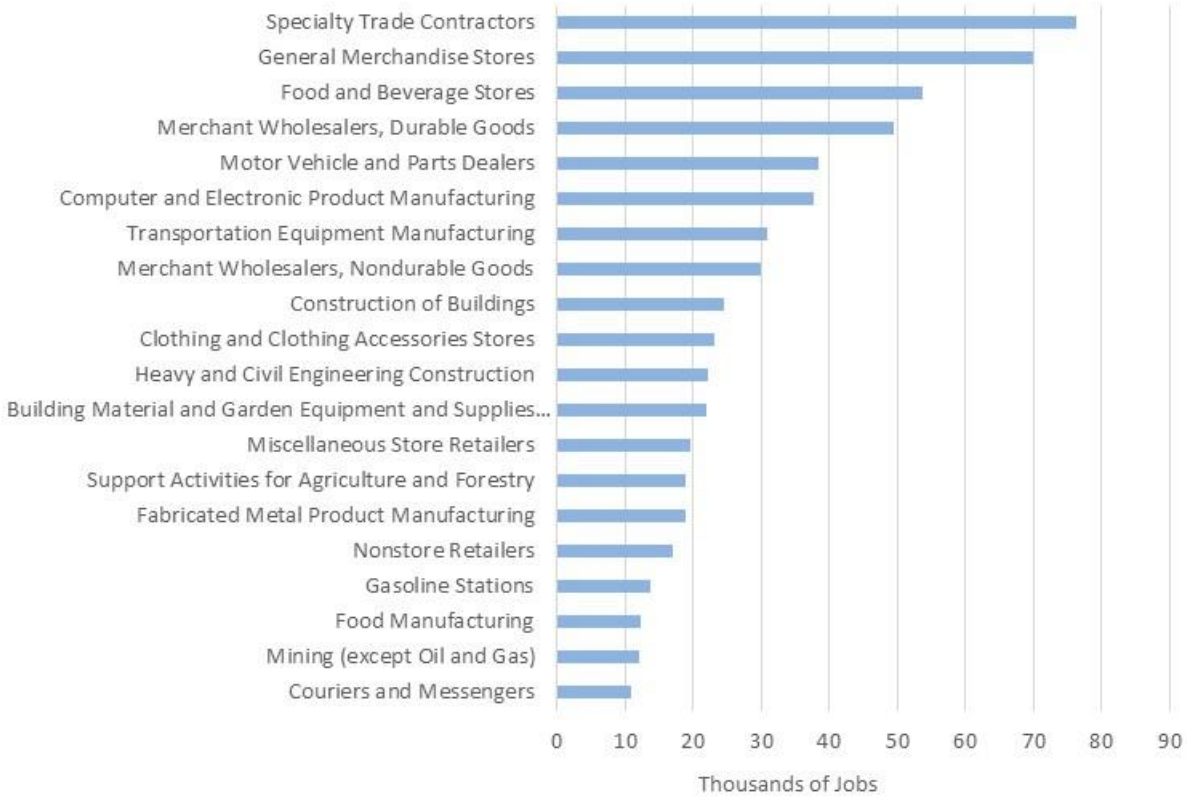
NAICS Code	Industry
334	Computer & Electronic Products
336	Transportation Equipment
212	Minerals & Ores
335	Electrical Equipment, Appliances & Components
333	Machinery, Except Electrical
325	Chemicals
332	Fabricated Metal Products
339	Miscellaneous Manufactured Commodities
111	Agricultural Products
311	Food & Kindred Products
211	Oil & Gas
326	Plastics & Rubber Products
331	Primary Metal Mfg
322	Paper
990	Special Classification Provisions
910	Waste And Scrap
313	Textiles & Fabrics
930	Used Or Second-hand Merchandise
312	Beverages & Tobacco Products
327	Nonmetallic Mineral Products

Source: CPCS analysis of United States Trade Data Online

B-5: Employment (Jobs)

Contractors, retail, food and beverage, wholesalers and vehicle and electronic manufacturing make up some of the largest employers, among freight generating sectors, in Arizona.

Figure 6-6: Employment in Arizona by Industry (2014)



NAICS Code	Industry
238	Specialty Trade Contractors
452	General Merchandise Stores
445	Food and Beverage Stores
423	Merchant Wholesalers, Durable Goods
441	Motor Vehicle and Parts Dealers
334	Computer and Electronic Product Manufacturing
336	Transportation Equipment Manufacturing
424	Merchant Wholesalers, Nondurable Goods
236	Construction of Buildings
448	Clothing and Clothing Accessories Stores
237	Heavy and Civil Engineering Construction
444	Building Material and Garden Equipment and Supplies Dealers
453	Miscellaneous Store Retailers
115	Support Activities for Agriculture and Forestry
332	Fabricated Metal Product Manufacturing
454	Nonstore Retailers
447	Gasoline Stations
331	Food Manufacturing
212	Mining (except Oil and Gas)
492	Couriers and Messengers

Source: CPCS analysis of United States Census

Appendix C: Summary of Top 10 Freight Sectors

Summary of Impact of Top 10 Freight Sectors on GDP, Jobs and Transportation in Arizona

	Economy		Jobs		Transportation					
	GDP 2013 ($ million)	GDP Annualized Growth 1997-2013	Employment (2013)	Compensation per Employee ($,000)	Total 2012 Commodity Flows ($ million)	Total 2012 Commodity Flows (Mt)	Top 2012 Origin (Mt)	Top 2012 Destination (Mt)	2012 Intrastate Flows (Mt)	% Truck (2012)
Wholesale and Retail Sector	$36,537	4.4%	401,994	$46,381	$96,196	28.24	California (3.3 Mt)	California (1.4 Mt)	20.26	97.30%
Food and Beverage Sector	$8,058	5.6%	212,004	$23,135	$12,958	10.5	California (2.4 Mt)	California (1.2 Mt)	2.9	96.20%
Transportation and Logistics	$88,162	5.1%	92,137	$59,619	$17,209	2.78	California (0.9 Mt)	New Mexico (0.1 Mt)	1.64	99.10%
High-Tech Manufacturing Sector	$8,414	-2.1%	39,167	$121,004	$11,766	0.06	Texas (0.01 Mt)	Mexico (0.4 Mt)	0	86.20%
General Manufacturing Sector	$7,116	2.0%	53,576	$64,574	$28,975	28.03	California (1.6 Mt)	California (1.2 Mt)	20.64	90.40%
Mining Sector	$6,108	8.7%	12,019	$93,494	$6,893	60.88	Wyoming (4.3 Mt)	Mexico (3.3 Mt)	53.62	78.40%
Transportation Equipment Sector	$5,010	2.9%	29,944	$114,095	$7,647	0.16	Virginia (0.1 Mt)	Mexico (0.04 Mt)	0.01	97.10%
Agriculture Sector	$1,687	2.3%	25,728	$37,595	$1,897	1.2	Mexico (2.4Mt)	Canada (.5 Mt)	0.38	99.80%
Forestry Sector	$397	-1.6%	5,702	$50,687	$2,608	2.25	Canada (0.7 Mt)	California (0.3 Mt)	0.66	78.20%
Energy	$69	8%	322	$84,413	$1,386	3.7	New Mexico (1.5 Mt)	California (0.1 Mt)	1.66	99.50%
Arizona State Total/Average	**$274,734**	**4.90%**	**2,619,055**	**$57,393**	**$190,617**	**138.2**	**California (9.5 Mt)**	**Mexico (5.6 Mt)**	**101.8**	**87.20%**

Source: CPCS Analysis of data from Bureau of Economic Analysis (2013) and 2012 Commodity Flow Survey

Note: GDP, Employment and Compensation Data based on CPCS Analysis of the Bureau of Economic Analysis Regional State Accounts data. Transportation data is based on CPCS analysis of the 2012 Commodity Flow Survey. GDP for the Forestry sector includes logging, which is not reported independently. Annualized growth is calculated over the period 1997-2013