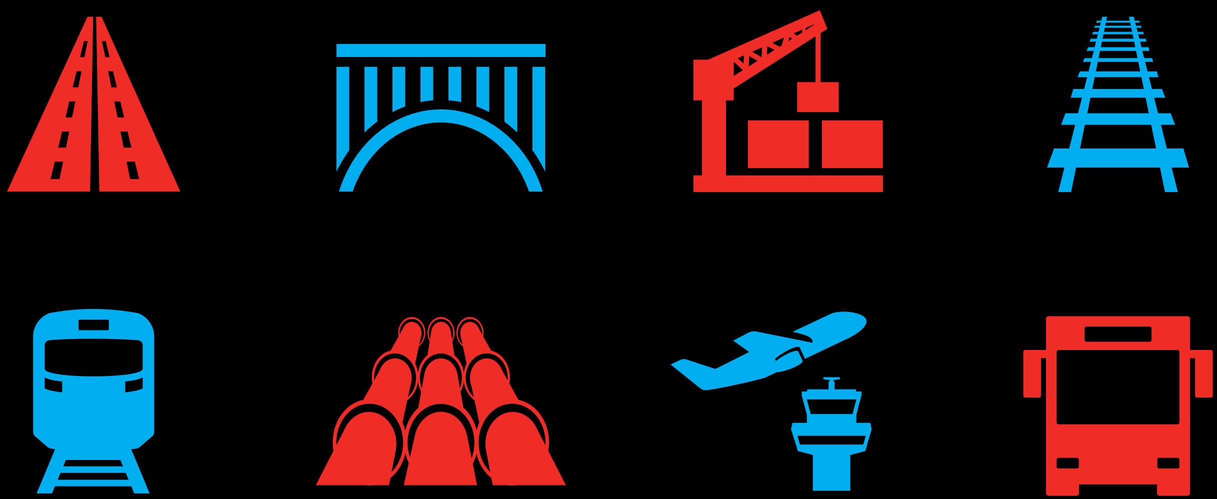
OCTOBER 2014

Infrastructure Investment Creates American Jobs



Duke

CENTER on GLOBALIZATION, GOVERNANCE & COMPETITIVENESS

at the Social Science Research Institute

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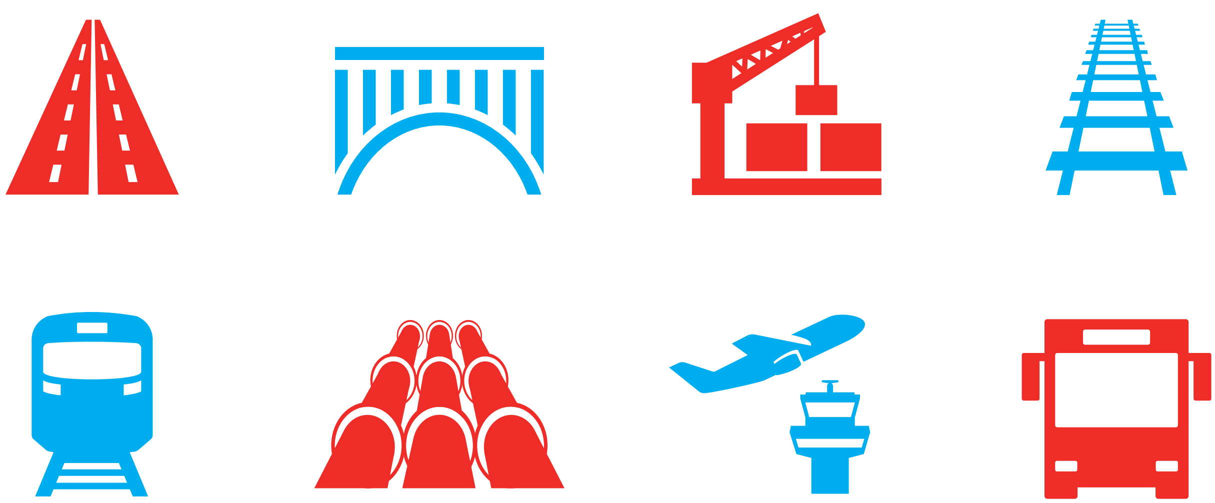

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About the Duke Center on Globalization, Governance & Competitiveness

The Center on Globalization, Governance & Competitiveness (CGGC), an affiliate of the Social Science Research Institute at Duke University, is built around the use of the Global Value Chain (GVC) methodology, developed by the Center's director, Gary Gereffi. The Center uses GVC analysis to study the effects of globalization on various topics of interest, including industrial upgrading, international competitiveness, the environment, global health, engineering and entrepreneurship, and innovation in the global knowledge economy. More information about CGGC is available at www.cggc.duke.edu.

About the Alliance for American Manufacturing

The Alliance for American Manufacturing (AAM) is a non-profit, non-partisan partnership formed in 2007 by some of America's leading manufacturers and the United Steelworkers. Our mission is to strengthen American manufacturing and create new private-sector jobs through smart public policies. We believe that an innovative and growing manufacturing base is vital to America's economic and national security, as well as to providing good jobs for future generations. AAM achieves its mission through research, public education, advocacy, strategic communications, and coalition building around the issues that matter most to America's manufacturers and workers. More information about AAM is available at www.americanmanufacturing.org.

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Acronyms

(AFA)	Airlines for America
(ASLRRA)	American Short Line and Regional Railroad Association
(APTA)	American Public Transportation Association
(ARA)	Association of American Railroads
(ARRA)	American Recovery and Reinvestment Act
(ASCE)	American Society of Civil Engineers
(DBE)	Disadvantaged Business Enterprises
(DOT)	Department of Transportation
(FAA)	Federal Aviation Administration
(FHWA)	Federal Highway Administration
(FRA)	Federal Railroad Administration
(FTA)	Federal Transit Administration
(GAO)	Government Accountability Office
(IMP)	Pipeline Integrity Management Program
(IRI)	International Roughness Index
(NBI)	National Bridge Institute
(NGO)	Non-Governmental Organization
(NHTSA)	National Highway Traffic Safety Administration
(NPIAS)	National Plan of Integrated Airport Systems
(NTS)	National Transportation Statistics
(NYSTA)	New York State Thruway Authority
(OECD)	Organization for Economic Cooperation and Development
(PHMSA)	Pipeline and Hazardous Materials Safety Administration
(PSR)	Present Serviceability Rating
(RITA)	Research and Innovative Technology Administration
(TZC)	Tappan Zee Constructors LLC
(VMT)	Vehicle Miles Traveled
(WEF)	World Economic Forum

Infrastructure Investment Creates American Jobs – Executive Summary

Federal investment in transportation infrastructure can drive employment and boost our national competitiveness. Increased investment in transportation infrastructure will provide jobs in many sectors, including in construction and manufacturing, while addressing the long-term deficiencies in the state of U.S. infrastructure. Businesses depend on a state-of-the-art transportation infrastructure to efficiently transport necessary components and final goods to their destinations. A safe, world-class transportation infrastructure can create new jobs through greater efficiency, increased competitiveness, and more overall demand.

However, Congress and the President continue to delay making long-term, meaningful decisions about investing in our critical infrastructure. In July 2014, Congress approved an $11 billion "patch" to the Highway Trust Fund, effectively postponing any meaningful decisions until May 31, 2015. Unfortunately, this is not a new approach for Congress. After enacting SAFETEA-LU in 2005 (the previous bill authorizing transportation spending), Congress passed nine short-term extensions before finally authorizing MAP-21 in 2012, which budgeted $105 billion for surface transportation investment. That authorization expired in 2014, creating uncertainty for transportation planners and states looking to tackle major projects.

A paucity of new investment and a piecemeal policy approach have led to severe consequences. Our decaying infrastructure is creating a significant drag on the economy: 156,000 deficient bridges, an investment backlog of $85.9 billion for our nation's roads, and $200 billion annually in lost economic activity from inefficient rail transportation.

This report evaluates the cost of inaction through the lenses of international competitiveness and job creation. This report finds:

- Old and broken transportation infrastructure makes the United States less competitive than 15 of our major trading partners and makes manufacturers less efficient in getting goods to market.
- Underinvestment costs the United States over 900,000 jobs, including more than 97,000 American manufacturing jobs.
- Maximizing American-made materials when rebuilding infrastructure has the potential to create even more jobs. Relying on American-made inputs can also mitigate safety concerns related to large-scale outsourcing.

A six-year transportation bill of at least $100 billion annually would support upwards of 2.18 million American jobs and rebuild our underperforming infrastructure. It would also make America more competitive, supporting the basic needs of U.S. businesses and their workers.

Competitiveness

This report compares U.S. transportation infrastructure quality to that of its major trading partners. The United States is well-positioned when it comes to the sheer quantity and complexity of its transportation infrastructure. However, the quality of this infrastructure is inferior to that of its major trading partners.

- The United States boasts the world's largest stock of transportation infrastructure as measured by combined bridges, airports, seaports, and miles of road, rail, pipeline, and inland waterways.
- The United States is not well-positioned compared to its major trading partners in terms of quality of transportation infrastructure. Global assessments of transportation infrastructure place the United States in 16th place out of 144 nations.
- The quality of transportation infrastructure affects the competitiveness of U.S. businesses. In particular, road and bridge quality have affected companies relying on "just-in-time" inventory management.

Job Creation

This report quantifies the number of jobs created by transportation infrastructure investment through an analysis of three investment scenarios: 1) status quo funding; 2) funding consistent with the President's 2015 budget request; 3) expanded infrastructure investment consistent with the U.S. Department of Transportation needs assessment.

- Each $1 billion dollars invested in transportation infrastructure creates 21,671 jobs.
- Every dollar invested in transportation infrastructure returns $3.54 in economic impact.
- Expanding federal funding consistent with U.S. DOT's request to improve conditions and performance of transportation infrastructure ($114.2 billion per year) would result in over 2.47 million jobs, or 58% more jobs than current funding levels, and over $404 billion in total economic impact.

Procurement

This report seeks to understand how preferences for the use of American-made iron, steel, and manufactured goods affect the construction of U.S. transportation infrastructure. Through a case-study of two large-scale infrastructure projects—the San Francisco-Oakland Bay Bridge in California and the Tappan Zee Bridge in New York—the report finds that projects subject to federal Buy America preferences mitigate the safety risks of using potentially inferior-quality foreign inputs while delivering more economic benefits to the U.S. economy than outsourced projects.

- Avoiding Buy America coverage resulted in the outsourcing of 27% of the funds used to build the San Francisco-Oakland Bay Bridge. By contrast, the Tappan Zee Bridge will be 100% American-made, including all of the steel used in its construction.
- Significant unanticipated risks to bridge safety and massive project delays may result from outsourcing large sections of steel fabrication abroad, especially when contractors are not able to execute proper governance.
- The U.S. steel industry and workers have the capacity and capability to competitively deliver on large infrastructure products needing high quality steel and iron.

1 Introduction

The Center on Globalization, Governance & Competitiveness at Duke University was engaged by the Alliance for American Manufacturing (AAM) to conduct an assessment of three major issues related to federal investment in transportation infrastructure. The first issue investigated in this report is the state of U.S. infrastructure in comparison to its major trading partners. As a basic component of a competitive economy, transportation infrastructure moves people and goods to their destinations as efficiently as possible. Underinvestment in transportation infrastructure increases the backlog of infrastructure construction and repair projects and reduces the ability of companies to meet the basic requirements of a "just-in-time" inventory system essential to lean manufacturing in a modern economy.[1]

The second issue examined in this report is the effect of Buy America preferences on the construction of transportation infrastructure. We profile the construction of two recent bridge projects in the United States—the San Francisco-Oakland Bay Bridge in California and the Tappan Zee Bridge in New York—as an entryway to the ongoing discussion about the effects of domestic content preferences on jobs, the economy, and national competitiveness. Our profile of these two bridges illustrates the many ways in which strong Buy America preferences can improve the quality of U.S. transportation infrastructure.

The third issue investigated in this report is the employment impact of transportation infrastructure investment. Investment in infrastructure is not only a requirement for a functioning economy, but it is also beneficial for stimulating employment. This report explores the employment impacts of three different funding scenarios. The first scenario, or base case, is the current infrastructure spending in FY 2014. A second case investigates the employment impact of increased transportation spending proposed for FY 2015 in the President's budget message to Congress. The third case investigates the employment impact of expanded transportation infrastructure investment proposed by the U.S. Department of Transportation (U.S. DOT) in its 2013 *Status of the Nation's Highways, Bridges, and Transit:*

Underinvestment in transportation infrastructure increases the backlog of infrastructure construction and repair projects and reduces the ability of companies to meet the basic requirements of a "just-in-time" inventory system essential to lean manufacturing in a modern economy.

Conditions & Performance ("Conditions & Performance 2013"). We find that for each $1 billion of federal transportation infrastructure investment, the employment effect is 21,761 jobs. This estimate is in close alignment with previous estimates.[2]

1.1 Methodology and Data Sources

Our methodology for the descriptive analysis of U.S. transportation infrastructure uses data from existing U.S. Government publications and from widely-recognized and reputable third party publications. The fourth section of the report, where job impact estimations are included, relied on formal input-output modeling software, specifically IMPLAN (Impact Analysis for Planners 3.0). IMPLAN is a well-known and widely accepted approach to estimating the economic impact of proposed investments, including transportation infrastructure investments. The modeling software captures three types of effects: direct, indirect, and induced, as described below.

- **Direct impacts** are the changes in spending in a given industry that result from the increase in final demand for the products of that industry. Investment in transportation infrastructure affects direct employment impact in construction and maintenance services and manufacturers of vehicles used in mass transit, among others.
- **Indirect impacts** include the impacts created by inter-industry spending. For example, for capital spending, these impacts account for the relationship between transit vehicle manufacturers and steel producers. Indirect impacts are sensitive to the percent of inputs imported from outside the defined geographic area. The greater percentage of imports, the lower the indirect impacts.
- **Induced impacts** are the variations in spending by household consumers resulting from changes in income and population due to new direct and indirect economic activity. Induced impacts model the changes in household spending—typically in retail trade and services—resulting from changes in income.

The output of the investment scenario analysis provides the direct, indirect, and induced jobs for each scenario and geographic region modeled.

Data sources: We relied on official U.S. statistics and reports to the extent possible for our analysis and results, except where noted. The employment impact analysis used IMPLAN data at the national and state level to calculate employment impacts for the funding and Buy America scenarios. The basis for IMPLAN is the U.S. BEA RIMS II model, estimating inter-industry purchasing at the national level.

1.2 Comparison with Previous Studies

This study reviewed the three major economic impact studies previously conducted on transportation infrastructure spending. These studies are the American Public Transportation Association's (APTA) 2014 "Economic Impact of Public Transportation Investment"; the University of Massachusetts – Amherst 2009 (sponsored by AAM) "How Infrastructure Investments Support the U.S. Economy"; and the American Society of Civil Engineers (ASCE) 2011 "Failure to Act: The Economic Impact of Current Investment Trends in Surface Transportation Infrastructure."

The 2014 APTA study examined the economic impact of public transportation investment and estimated that, depending on specific modeling decisions, the jobs impact (direct, indirect, and induced) per $1 billion spent was between 18,983 and 21,830 jobs. The University of Massachusetts–Amherst study investigated the jobs impact of two transportation investment scenarios, and found that a baseline program of $87 billion per year would increase employment by 1.6 million jobs (18,391 per $1 billion), while a high-end program of $148 billion per year would increase employment by 2.6 million jobs (17,568 per $1 billion). The ASCE report cites a 2007 Federal Highway Administration study estimating that for every $1 billion invested in highway construction, the employment effect would be approximately 30,000 jobs, while transit projects generate between 24,000 and 41,000 jobs, depending on the geography and mix of spending between construction, maintenance, and vehicle replacement. Our study finds that for each $1 billion of federal transportation infrastructure investment, the employment effect is 21,761 jobs, which is quite close to previous estimates. As a result, we feel confident that our basic modeling approach and the methodology behind our results is sound.

Our study finds that for each $1 billion of federal transportation infrastructure investment, the employment effect is 21,761 jobs, which is quite close to previous estimates.

1.3 Report Organization

The report is organized into four sections:

- **Introduction:** This section includes an overview, methods, and overall results of the report.
- **Comparative analysis of U.S. transportation infrastructure:** This section provides our analysis of the current stock of transportation infrastructure for the United States and top trading partners (Canada, Mexico, Europe, China). Transportation infrastructure measured includes roads, rail, waterborne shipping, and pipelines (as data availability permitted). We provide examples of how the current stock of transportation infrastructure affects the competitiveness of the U.S. economy, examine how the current underinvestment in transportation infrastructure leads to inefficiencies in the U.S. supply chain, and explain how improvements could be an economic boost to the competitiveness of U.S. manufacturers.
- **Comparative analysis of Buy America provisions in the construction of two bridges:** In this section, we describe two bridge construction projects, one constructed with Buy America preferences and the other without. We describe how Buy America preferences affected budgetary and sourcing decisions for the steel and iron used in each bridge, and draw implications for other large U.S. transportation infrastructure projects.
- **Job creation potential of transportation infrastructure investment:** This section provides our estimates of the job creation potential of three transportation infrastructure investment scenarios: a) current FY 2014 funding (“low scenario”); b) proposed FY 2015 funding (“mid scenario”); and c) funding requested by U.S. DOT to improve the conditions and performance of U.S. transportation infrastructure.

2 Comparative Analysis of U.S. Transportation Infrastructure

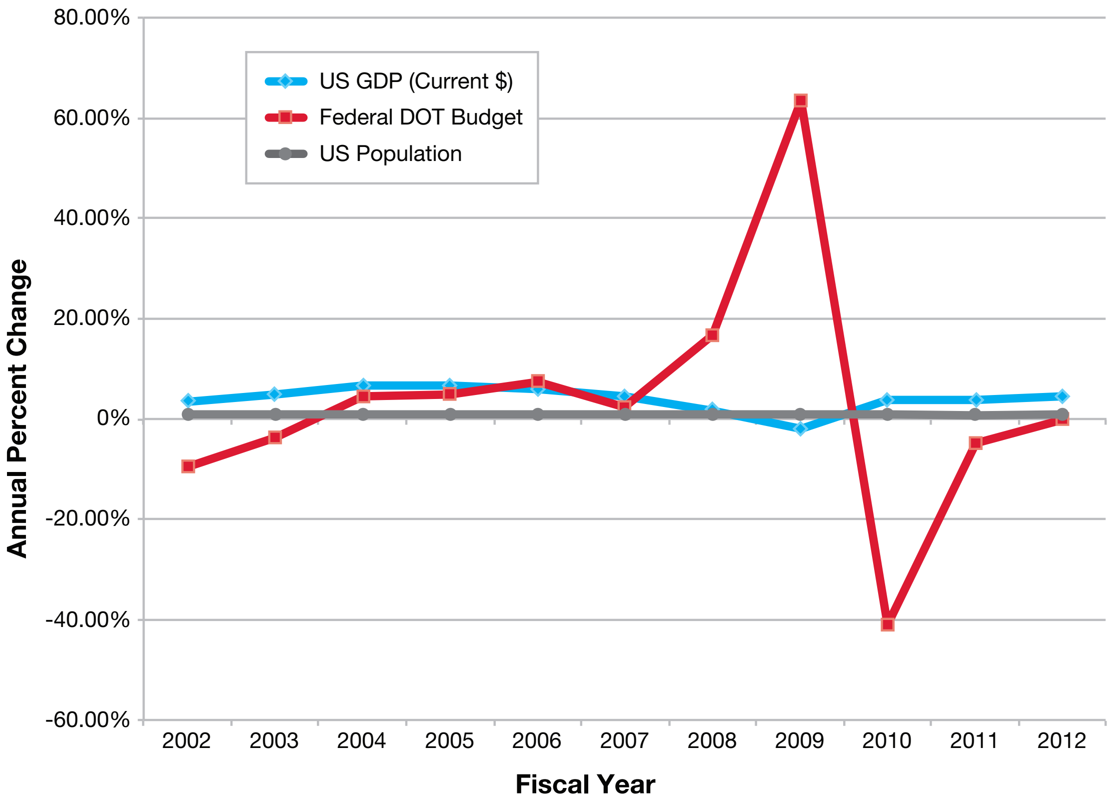
Transportation infrastructure is critical to a well-functioning economy because it is inherently connected to virtually all other segments of the economy. In the United States, geographic disparity and population size generate an extremely high demand for a multifaceted, purposefully linked, and efficient transportation infrastructure to service the numerous needs of U.S. consumers, businesses, and government. The United States has amassed an impressive amount of infrastructure, boasting the largest national stock in the world of transportation infrastructure by measure of combined roads, rails, pipelines, and inland waterway miles, in addition to its number of bridges, airports, and seaports (Table 8, Section 2.2).

However, while stock size may speak to the complexity of the U.S. transportation infrastructure portfolio, it does little to reveal its condition, reliability, and sustainability (OECD 2007). A broad examination of available literatures (including publications from government, non-governmental organizations (NGOs), and academics) reveals a consensus that the U.S. government is vastly underperforming in its ability to effectively and efficiently provide, maintain, and expand its transportation infrastructure (ASCE 2013a; Baum-Snow 2011; Miller 2010; Duranton and Turner 2011; Levinson 2013; U.S. Chamber of Commerce 2011). Such underperformance is routinely associated with negative economic impacts on jobs, productivity, and government deficits—all of which diminishes U.S. global competitiveness.

There are many factors that contribute to underperformance when it comes to U.S. transportation infrastructure, including insufficient investments by the federal government; deterioration levels exceeding maintenance and repairs; severe congestion problems, especially in high traffic arteries; too few transit options for both passengers and freight; and outdated communications technologies. The root cause of these issues is largely suboptimal investments.

As a benchmark, between 2002 and 2012 annual federal funding to the Department of Transportation (DOT)—the primary federal agency responsible for transportation infrastructure—has not kept pace with annual GDP growth (Figure 1). Accounting for population growth over the same period, federal transportation investments per person has only slightly increased, from $202.98 per person in 2002 to $231.18 in 2012. However, when factoring in the current investment backlog of nearly $900 billion for maintenance and repair—$808.2 billion from the Federal Highway Administration (FHWA) (DOT 2013), $86 billion from the Federal Transit Administration (FTA) (DOT 2013), and $4.6 billion from the Federal Aviation Administration (FAA) (GAO 2013a)—actual annual federal

Figure 1. Comparing Annual Percentage Change in DOT Budget, GDP and Population



Sources: World Bank Development 2014a; DOT 2014.
Note: The spike in 2009 funding is attributed to the "American Recovery and Reinvestment Act of 2009."

investments fall far short of the funds needed to rectify the underperforming U.S. transportation infrastructure. The reality behind the investment backlog in the United States is that without addressing current needs, backlogs only serve to "kick the can" of fiscal responsibility further down the road, escalating the national financial burden in years to come.

A critical part of transportation infrastructure performance in the United States is rooted in planning for and addressing fluctuating stress levels placed on each mode. Increased stress levels accelerate deterioration of infrastructure and increase the likelihood of congestion, creating delays and reducing operational efficiencies in the system (GAO 2013b).[3]

The amount of stress placed on the U.S. transportation infrastructure is inextricably linked to changes in freight and passenger volumes, both of which have grown steadily over the last three decades (ASCE 2013b).[3] The DOT projects that both freight and passenger volumes will continue to increase over the next three decades for all modes of travel (roads, rail, air, water, and pipelines). For example, the FHWA anticipates road stress volumes will increase substantially, with a combined tonnage increase of 1.4% for freight shipments and an almost 2% increase in passenger vehicle miles traveled (VMT) annually until 2040 (DOT 2013). Since both of these projected growth rates are above projected population growth rates

> "From our company's perspective, a real transportation and infrastructure bill needs to be passed to adequately address all of the bridges, roads, and waterways. These improvements not only would help the United States with adequate and safe transportation but would create more demand for steel."
>
> — Bill Lowe, Nucor–Yamato Steel

(World Bank 2014a), this means that the U.S. economy is placing greater stress on its road infrastructure as current users increase their per annum consumption. To maintain—and ultimately improve—its transportation infrastructure, a balanced mix of increased investments combined with effective and efficiency-enabling policies is crucial (Winston 2010; Winston 2013).

In an effort to comprehensively assess how the performance of U.S. transportation infrastructure performance impacts its economic competitiveness, the remainder of Section 2 will explore the following: Section 2.1 will dissect the status of transportation infrastructure by mode, identifying key dynamics and explaining how backlogs are critically symptomatic across all modes; Section 2.2 compares the transportation infrastructure in the United States with its top 15 trading partners; and Section 2.3 will assess overall competitiveness by examining the key detriments contributing to lackluster performance in the United States.

Table 1. DOT Budgetary Resources, 2015

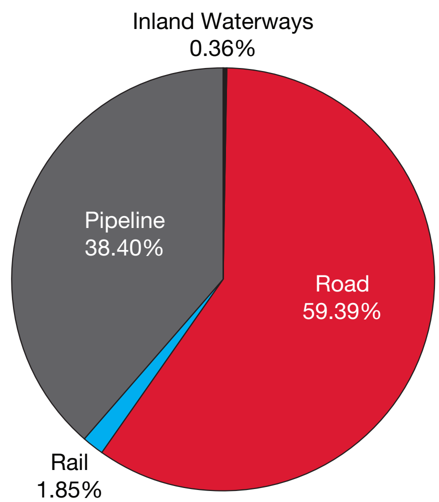
DOT Division	2013 Actual		2014 Estimated		2015 Requested	
	$ Millions	Percent Total	$ Millions	Percent Total	$ Millions	Percent Total
Federal Aviation Administration	$15,236	21.59%	$15,760	21.82%	$15,411	16.95%
Federal Highway Administration	$40,321	57.14%	$40,942	56.67%	$48,562	53.41%
Federal Motor Carrier Safety Administration	$560	0.79%	$585	0.81%	$669	0.74%
Federal Railroad Administration	$1,546	2.19%	$1,610	2.23%	$4,995	5.50%
Federal Transit Administration	$10,597	15.02%	$10,842	15.01%	$17,649	19.41%
Inspector General	$76	0.11%	$86	0.12%	$86	0.09%
Maritime Administration	$327	0.46%	$337	0.47%	$658	0.72%
National Highway Traffic Safety Administration	$801	1.14%	$819	1.13%	$851	0.94%
Office of the Secretary	$855	1.21%	$1,021	1.41%	$1,715	1.89%
Pipeline and Hazardous Materials Safety Administration	$191	0.27%	$210	0.29%	$261	0.29%
St. Lawrence Seaway Development Corp	$31	0.04%	$31	0.04%	$32	0.04%
Surface Transportation Board	$28	0.04%	$31	0.04%	$32	0.04%
TOTAL	$70,568	100%	$72,316	100%	$90,920	100%

Source: Author's recreation of DOT 2015 Budget Highlights (DOT 2014) with own calculations for percent total.

2.1 Status of Transportation Infrastructure in the United States by Mode

To gain a better understanding of how and why the U.S> transportation infrastructure is underperforming, it is instructive to examine the existing stock, current conditions, and investment backlogs of each mode. Section 2.2 looks at roads, bridges, transit, rail, air, and pipelines, which provide the basis this report uses to assess both the overall state of transportation infrastructure in the United States and for competitive comparison to its largest trading partners. To help provide funding context, Table 1 provides DOT funding levels and the percent of total funding for each of DOT's 12 divisions for fiscal years 2013 to 2015.

Figure 2. Percentage Total: U.S. Infrastructure Mileage



Source: Author's own calculations based on NTS 2013.

Roads

By far, roads in the United States comprise the largest number of infrastructure miles and the highest amount of freight tons and value. According to the most current available data, the total stock of U.S. road infrastructure amounts to 4,092,730 miles, or 59.4% of total U.S. infrastructure miles (Figure 2), and over 67% of total tonnage and total value[4] (Table 2). As such, the largest portion of all money invested in U.S. transportation infrastructure is made in roads. In 2013, $40.3 billion—or 57.1% of the entire DOT budget—was allocated to FHWA to support its mission

Table 2. Movement of Goods by Mode, 2007

Mode	Tons (Millions)	Percent	Value (Billions of Dollars)	Percent
Truck	12,778	67.75%	10,780	64.7%
Rail	1,900	10.1%	512	3.1%
Water	941	5.0%	339	2.0%
Air, Air & Truck	13	<0.1%	1,077	6.5%
Multiple Modes & Mail	1,424	7.5%	2,879	17.3%
Pipeline	1,507	8.0%	723	4.3%
Other & Unknown	316	1.7%	341	2.0%
TOTAL	18,879	100%	16,651	100%

Source: (DOT 2013)

of maintaining and investing in U.S. road infrastructure (DOT 2014).

The relative or weighted importance of different roads across the United States, and the ultimate responsibility for maintaining and expanding each road, is determined by its usage and its ownership level—federal, state, or local. The FHWA broadly categorizes different roads by area of function: rural, small urban, and urbanized. In 2012, rural areas contained 72.7% of total road miles, but equated to only 32.9% of VMT; small urban areas, on the other hand, contained 5.2% of total miles and 7.4% of VMT; and urbanized areas contained 22.1% of total miles, commanding the largest amount of VMT traveled at 59.8% (DOT 2012b). In 2012, 3.4% of all U.S. roads were federally owned, 19.1% were owned at the state level, and 77.5% were owned at the local level. Interestingly, federal funding for U.S. roads as channeled through FHWA are, in most cases, required to be applied to federal-aid highways[5] (DOT 2013). The 1,007,777 miles that make up all federal-aid highways amount to roughly 25% of all mileage and over 85% of all VMT (DOT 2013). Thus, federal-aid highways are some of the most crucial roads in the United States when it comes to their effect on national road performance.

To help monitor the performance of federal-aid highways, FHWA employs two rating systems: a quantitative test that indicates smoothness in inches per mile known as the International Roughness Index (IRI), and a subjective test based on a qualitative assessment of a road's general condition known as the Present Serviceability Rating (PSR). Combined, these two measurements provide indicators for managing current operations and making decisions as to which roads require rehabilitation, expansion, or enhancement based on ratings of "good" and "acceptable" (good being above poor, but lower than acceptable) (GAO 2012a; GAO 2012b). As Table A1 in Appendix A shows, between 2000 and 2010, the percent of roads with an "acceptable" rating based on a VMT weighted average decreased from 85% to 82%, meaning that 18% of all roads in the United States remained in poor condition, necessitating some form of rehabilitation. It is worth noting that the percentage of roads in "good" condition (46% lower in IRI score than the needed score for "acceptable") increased from 42.8% to 50.6% during the same period. However, this increase actually reflects a very minor change in the overall number of roads in poor condition; as Table A1 demonstrates, roughly 3% of the 8% increase in roads rated as "good" is actually attributed to a fall from "acceptable" to "good," rather than an improvement from being in poor condition.

Due primarily to insufficient funding (and, to a lesser extent, improper management of funds by all levels of government for road maintenance and rehabilitation, the rate of road deterioration has long exceeded rates of repair, creating a tremendous backlog of needed rehabilitation, expansion, and enhancement (ASCE 2013a; U.S. Chamber of Commerce 2011; Winston 2013). In 2013, the backlog was $541.7 billion for federal-aid highways alone, and another $160.2 billion for all other roads (DOT 2013). The obvious concern with the backlog is that under current investment levels, it will be self-perpetuating and future rehabilitation costs will be compounded, which will have negative economic impacts on consumers, businesses, and government.

Bridges

Bridges are critical to a well-functioning transportation infrastructure. Unfortunately, the 600,000 bridges in the United States are among the nation's oldest and most underperforming infrastructure elements. The average year of construction for all U.S. bridges in 2010 was 1971 and the average bridge is 39 years old—an increase from the 2000 average of 37 years old (DOT 2013). In addition, in 2000 roughly 67.2% of all bridges were more than 25 years old and 26.2% were more than 50 years. By 2010, these numbers had increased to 68.5%

Table 3. Bridge Deficiencies by Age, 2010

Age Range of All Bridges	Bridge Count	Structurally Deficient		Functionally Obsolete		All Deficient	
		Count	Percent	Count	Percent	Count	Percent
0-10 Years	66,877	450	0.7%	6,096	9.1%	6,546	9.8%
11-25 Years	123,231	3,055	2.5%	11,059	9.0%	14,114	11.5%
26-50 Years	228,103	21,508	9.4%	30,671	13.4%	52,179	22.9%
51-75 Years	125,274	25,883	20.7%	24,289	19.4%	50,172	40.0%
76-100	50,525	15,430	30.5%	11,078	21.9%	26,508	52.5%
>100 Years	10,181	4,079	40.1%	2,574	25.3%	6,653	65.3%
Null	294	26	8.8%	90	30.6%	116	39.5%
TOTAL	604,485	70,431	11.7%	85,857	14.2%	156,288	25.9%

Age Range of NHS Bridges	Bridge Count	Structurally Deficient		Functionally Obsolete		All Deficient	
		Count	Percent	Count	Percent	Count	Percent
0-10 Years	11,824	57	0.5%	1,366	11.6%	1,423	12.0%
11-25 Years	18,957	148	0.8%	1,853	9.8%	2,001	10.6%
26-50 Years	61,515	3,221	5.2%	10,019	16.3%	13,240	21.5%
51-75 Years	19,610	1,839	9.4%	4,824	24.6%	6,663	34.0%
76-100	4,506	581	12.9%	910	20.2%	1,491	33.1%
>100 Years	212	54	25.5%	63	29.7%	117	55.2%
Null	45	2	4.4%	26	57.8%	28	62.2%
TOTAL	116,669	5,902	5.1%	19,061	16.3%	24,963	21.4%

Age Range of Interstate Bridges	Bridge Count	Structurally Deficient		Functionally Obsolete		All Deficient	
		Count	Percent	Count	Percent	Count	Percent
0-10 Years	3,637	35	1.0%	654	18.0%	689	18.9%
11-25 Years	5,831	61	1.0%	805	13.8%	866	14.9%
26-50 Years	37,830	2,019	5.3%	6,312	16.7%	8,331	22.0%
51-75 Years	7,810	640	8.2%	2,052	26.3%	2,692	34.5%
76-100	186	19	10.2%	21	11.3%	40	21.5%
>100 Years	6	1	16.7%	1	16.7%	2	33.3%
Null	35	0	0.0%	22	62.9%	22	62.9%
TOTAL	55,335	2,775	5.0%	9,867	17.8%	12,642	22.8%

Source: (DOT 2013)

of bridges more than 25 years old and 30.8% more than 50 years old (DOT 2013). While age is not necessarily indicative of quality, basic correlations can be inferred from actual quality ratings by the FHWA. Table 3 demonstrates that when taking age into consideration, there is a consecutive increase in the rate of deficiency. Not surprisingly, this implies that as bridges age they become both more costly and more difficult to repair. Supporting evidence is the 2012 data from the National Bridge

Bridges are critical to a well-functioning transportation infrastructure. Unfortunately, the 600,000 bridges in the United States are among the nation's oldest and most underperforming infrastructure elements.

Inventory, which finds that on average across all U.S. states, costs for bridge replacement for deficient bridges were 32% higher than costs for rehabilitation (National Bridge Institute 2012). In 2010, when the average age for U.S. bridges was 39 years, the overall rate of bridge deficiency was more than 22% (Table 3).

The FHWA utilizes two primary negative rating classifications for bridges: structurally deficient and functionally obsolete. Structurally deficient implies that, "significant load-carrying elements are found to be in poor or worse condition due to deterioration and or damage," or that the bridge is susceptible to flooding, causing "intolerable traffic delays" (DOT 2013: ES-4). Functionally obsolete implies that bridge design standards do not conform in significant ways with conventional standards (generally related to total width and number of lanes). While symptomatic of the need for rehabilitation, expansion, or enhancement, neither classification implies that a bridge is in imminent danger of collapse. According to the National Bridge Inventory, roughly 12%

Due to funding gaps, policymakers are required to make tough decisions about where to apply available funds—roads versus bridges.

of all bridges are inspected every 12 months, 83% are inspected every 24 months, and 5% are inspected only every 48 months (DOT 2013). Routine inspections are important to maintaining U.S. bridge infrastructure, but if the funds are not available to repair a bridge in need, then inspection becomes a less effective management tool.

Similar to road ownership, all bridges in the United States are associated primarily with federal, state, and local ownership, and responsibility for maintaining a state of good repair is the responsibility of each owner. In 2010, federal ownership was limited to 1.3% of all bridges (mainly for defense purposes), states owned 48.2% of all bridges, and local ownership subsumed 50.2%. Importantly, the share of state bridges also carried 87.5% of all traffic (freight and passenger) (DOT 2013), implying that the greatest amount of performance responsibility falls in the hands of states.

Federal funding for bridges is allocated to states and local entities as part of the FHWA's annual budget, and therefore there is no separate budgetary allocation for bridges alone. This means that, due to funding gaps, policymakers are required to make tough decisions about where to apply available funds—roads versus bridges. A major reason for the funding gap is the outstanding backlog of investments in bridges for rehabilitation, expansion, and enhancement. In 2010, the most recent year on record, the total bridge backlog equaled $106.4 billion, $86.8 billion of which corresponded to bridges eligible for federal funding (DOT 2013). As a result of the maintenance backlog, the rate of deterioration continues to outpace new funding, meaning that even when new funding is allocated to address outstanding needs, the number of existing problems that require even more funding will grow.

Transit

Transit infrastructure is the most complex entity in the U.S. overall transportation infrastructure, as it is comprised of the widest variety of forms of infrastructure, including heavy, light, and commuter rail, busses, vans, trollies, and ferries, and the facilities, stations, and hubs that are the points of call for each. Rail and busses make up the majority share of all transit assets. For example, in 2010 there were 21,062 total rail vehicles, while the stock of busses was 105,579. From 2000 to 2010, vehicle productivity (calculated by annual miles traveled per vehicle) across all transit vehicles steadily increased, while at the same time there was a 14% reduction in the average number of miles between breakdowns (DOT 2013). This implies that over this time period, non-rail transit vehicles were able to capture 14% more usage out of the same fleet while factoring for the addition of new vehicles.

Table 4 provides the annual change in per-vehicle revenue miles for each primary transit mode. Measurement here is important because it is an indicator for growth in demand for transit services by mode. Total rail vehicle revenue miles increased by 22.2% between 2000 and 2010, and total non-rail revenue increased by 20.7%. Supporting the case for increasing demand between these years is the fact that on average, vehicle occupancy rates have not decreased across all modes, meaning that as new services have been offered, occupancy increases have kept pace (FTA 2011; DOT 2013). However, this is not meant to imply that occupancy rates are at full capacity, or that fleet management is necessarily being run efficiently. Section 2.3 addresses in more detail how inefficient service provision creates excessive operational costs and lowers competitiveness.

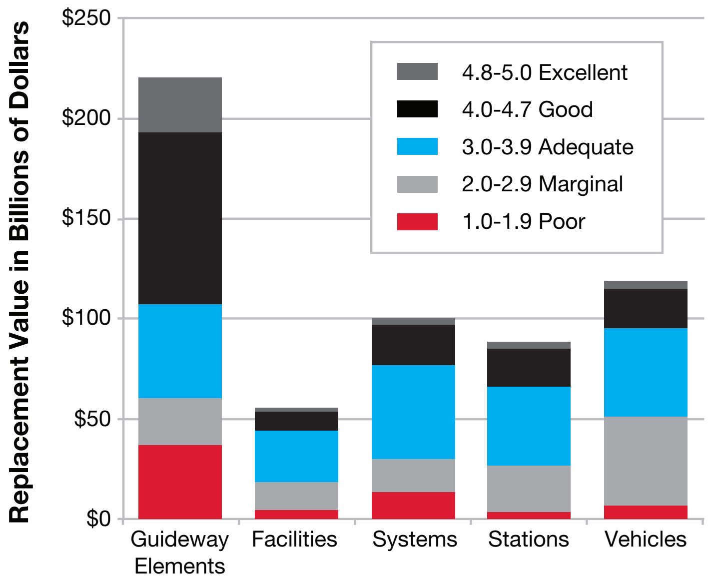
The FTA utilizes a ranking scale from 1 to 5 to assess the quality and condition of all its assets, ordered from “excellent” (4.8-5.0), meaning new or absent of any defects, to “poor” (1.0-1.9), signifying that the asset is in need of immediate repair and cannot reliably handle transit operations (DOT 2013). The FTA uses a rating of 2.5 as a benchmark for a “state of good repair” (a score that implies an asset does not require maintenance or replacement). Figure 3 assesses the stock of all assets managed by the FTA and demonstrates that a significant portion of the entire portfolio falls at or below a 2.5 score. Figure 3 also provides the associated

Table 4. Vehicle Revenue Miles per Active Vehicle by Mode, 2000-2010

	Thousands of Revenue Vehicle Miles						Average Annual Rate of Change
Mode	2000	2002	2004	2006	2008	2010	
Rail							
Heavy Rail	55.6	55.1	57.0	57.2	57.7	56.6	0.2%
Commuter Rail	42.1	43.9	41.1	43.0	45.5	45.1	0.7%
Light Rail	32.5	41.1	39.9	39.9	44.1	42.5	2.7%
Nonrail							
Motor Bus	28.0	29.9	30.2	30.2	30.3	29.7	0.6%
Demand Response	17.9	21.1	20.1	21.7	21.3	20.0	1.1%
Ferryboat	24.1	24.4	24.9	24.8	21.9	24.9	0.3%
Vanpool	12.9	13.6	14.1	13.7	14.3	15.5	1.8%
Trolleybus	18.9	20.3	21.1	19.1	18.7	20.4	0.8%

Source: (DOT 2013)

Figure 3. Asset Physical Condition by FTA Mode



Source: (DOT 2013)

Year-over-year investment shortages will only serve to exacerbate total investment backlogs, which in 2010 the FTA projected would increase to $120.4 billion if federal investment rates were not increased.

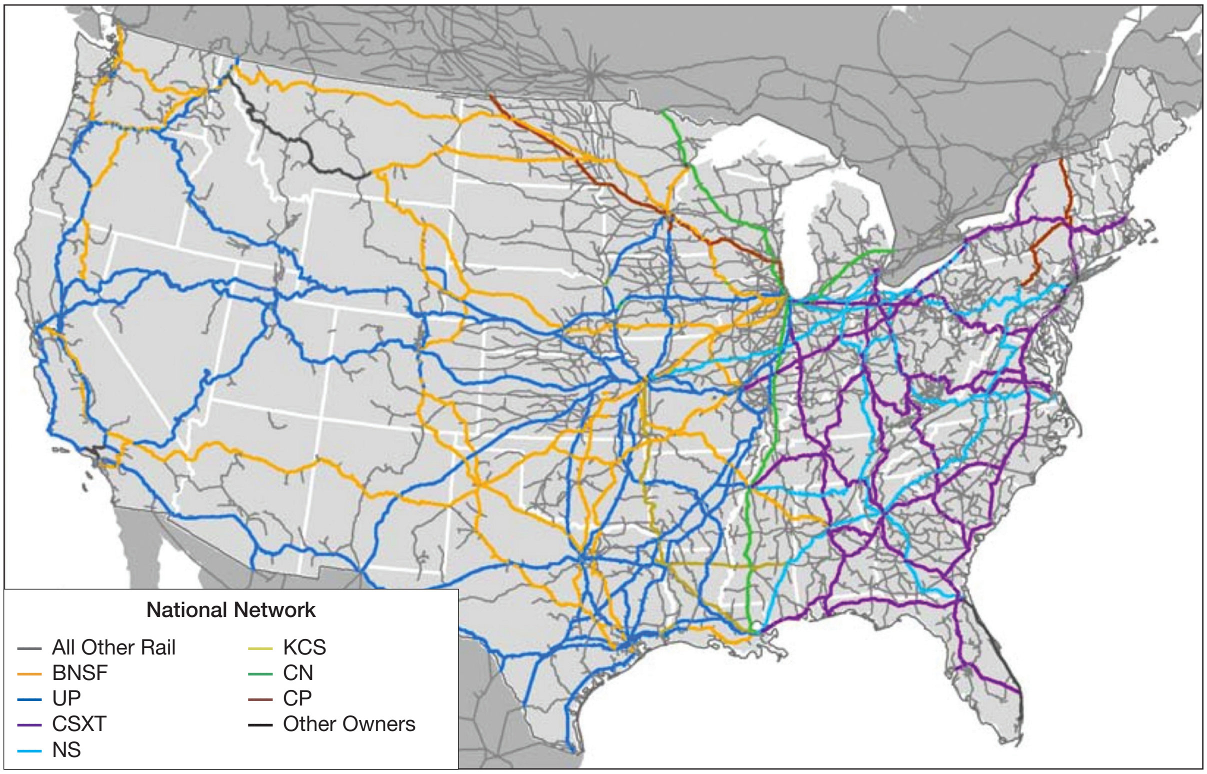
weighted value of each asset (for example, rail cars are more valuable than vans) and shows that the estimated replacement costs for all assets rated “marginal” or below are estimated at $160 billion. More crucially, in 2010 the FTA asserted that its backlog of assets requiring rehabilitation, expansion, or enhancement (assets rated “poor”) was valued at $85.9 billion. As is true with other transportation infrastructure assets, year-over-year investment shortages will only serve to exacerbate total investment backlogs, which in 2010 the FTA projected would increase to $120.4 billion if federal investment rates were not increased.

Rail

The U.S. rail infrastructure—both freight and intercity passenger—is one of the most important links in the nation’s overall transportation infrastructure portfolio. Crucially, it also possesses some of the greatest potential for expansion, routinely attracting high volumes of both freight and passengers away from highways and airports. An average of 36% modal change to rail (freight and passenger) occurred between 2008 and 2013 (Mongelluzzo 2014). Constituting more than 140,000 miles in total length, 76,000 rail bridges, and 800 rail tunnels (ASCE 2013a), U.S. national rail infrastructure is geographically expansive and is the largest national system in world. U.S. rail infrastructure is primarily structured to support freight rail; indeed the United States moves more freight-tons of goods by rail than any other country (measured in billion ton-miles). By comparison: 86% more than the EU-27; 83% more than India; 27% more than Russia; and 22% more than China (FRA 2010; EU Transport Scoreboard 2014). In addition to freight, U.S. rail infrastructure also supports more than 23,000 miles of intercity passenger lines; however, nearly all of these 23,000 miles share the same track as freight and are not to be considered separate. The United States is far less internationally competitive in its passenger rail miles traveled, with only 6.6 billion total miles in 2011. To put U.S. annual passenger-miles into perspective, Japan boasted over 159 billion-passenger miles in 2011; the EU-27, 233 billion; 429 billion in China; and 432 billion passenger miles in India (FRA 2010; RITA 2014).

Similar to pipeline infrastructure, freight rail is essentially entirely owned and operated by private businesses that are fundamentally responsible for investing in, maintaining, and expanding their respective assets (see Figure 4 for U.S. Freight Rail Map). Ownership

Figure 4. U.S. Freight Rail Map with Key Railroad Operators, 2011



Source: (AAR 2011: 4-1)

structures of freight rail can be divided into three primary associations: Class I[6], Regional, and Local (Short Lines)[7]. As Table 5 shows, these classifications are distinguished by the total number of operators, annual revenue, and total number of employees. Class I railroads (RRs) are by far the largest in size, accounting for 95,387 miles (or 69% of total U.S. rail miles) (RITA 2014). Class I RRs are also the most profitable of the three, commanding roughly 94% of the more than $65 billion in total combined 2012 revenue

Table 5. Freight Rail Changes in Operators, Employment, and Miles, 1990-2011

	Class I Railroads Over $433M Revenue		Regional Railroads $40M to $433M Revenue		Local Railroads Under $40M Revenue	
Mode	1990	2011	1990	2011	1990	2011
Number of Operators (RRs)	14	7	30	21	486	539
Employment	209,708	158,623	11,578	5,443	14,257	11,874
Miles	97,817*	95,387*				

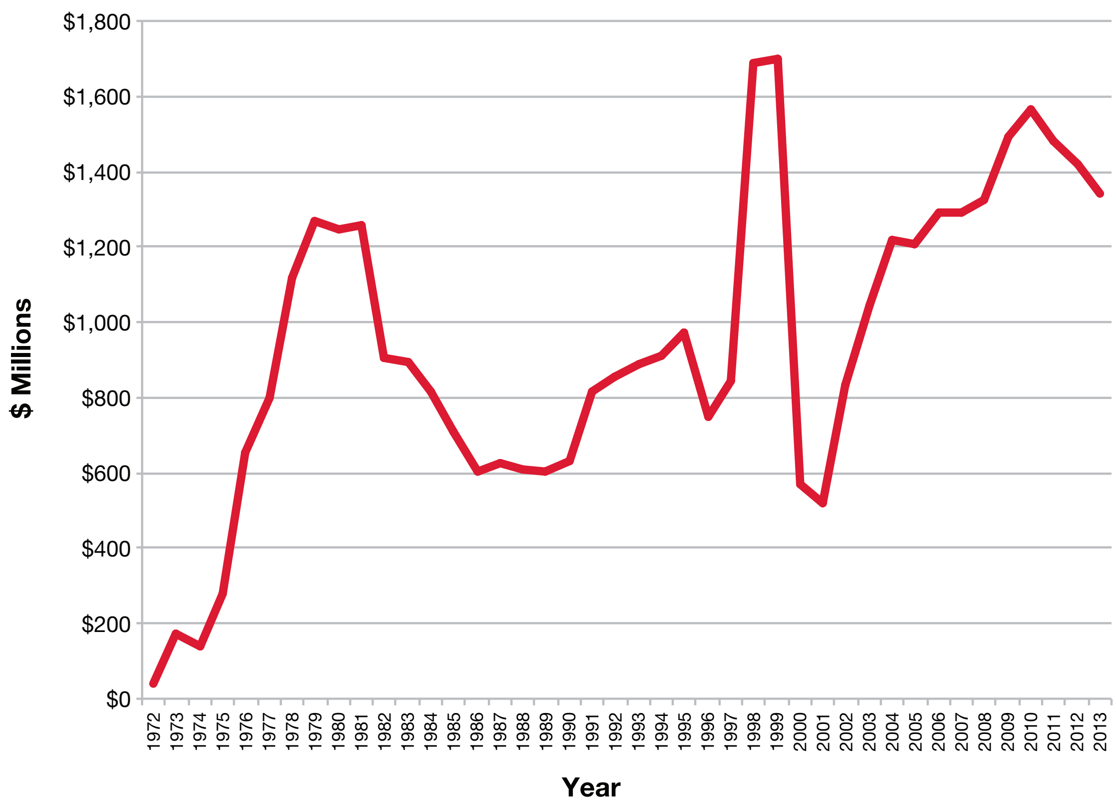
Source: (Palley 2013, RITA 2014*)

generated by all U.S. freight rail operators (AAR 2014a; Palley 2013). Interestingly, between 1990 and 2011, Class I RRs consolidated their numbers of operators from 14 to 7 due to mergers and acquisitions and decreased total employment by more than 24% due to technological advancements (Table 5) (Palley 2013). Operational costs declined while annual freight volumes increased—averaging an 8% return on investment between 1990 and 2011 (Palley 2013). Falling employment has also been a long-term trend for Regional and Local RRs over the same time period, while only Local RRs have increased their number of RR operators (Table 5)—an increase attributable to Local absorption of Class I and Regional RRs decommissioned tracks (FRA 2014a).

Over the last decade, freight rail companies have invested an average of 17% of total revenue on capital expenditures; by comparison, all manufacturing industries only averaged 3% (AAR 2014b). Such investments have principally been made in the procurement of new locomotives. For example, Class I RRs increased their total stock of locomotives from 19,745 in 2001 to 24,250 in 2011 (RITA 2014). However, over the same time period, Class I RRs have reduced their share of freight cars from nearly 500,000 in 2001 to 380,699 in 2011 (RITA 2014). Freight shippers own the majority of all freight cars—806,544 out of a total 1,283,225 (Palley 2013).

An inherent driver for increasing year-over-year investment in new infrastructure by

Figure 5. Annual Federal Funding to Amtrak



Source: Compiled by authors based on (FRA 2014c; DOT 2014) freight rail companies is the fundamental need to accommodate expected growth rates. DOT and FRA have projected that the expected rates of freight rail increases (measured in ton-miles) over the next two to four decades is likely to be 22% by 2035 and up to 35% by 2050 (FRA 2014a). A key 2011 study conducted shortly after these DOT projections were released demonstrated that in spite of the fact that infrastructure-specific investments averaged roughly $1.5 billion per year over the five previous years, the freight rail industry would need to invest at least $4.8 billion per year into infrastructure expansion to meet expected 2035 demand—a $3.3 billion per year shortfall (ARA 2011). Support for the projected growth rate can easily be drawn from the already over-congested, high-traffic intermodal rail yards like Chicago, Houston, and the North East Corridor (NEC). ASCE estimates that efficiency losses due to underinvestment at these key rail yards costs the economy approximately $200 billion per year. To stem lost economic opportunity, and indeed prepare for the future, sizeable infrastructure investments will be essential.

Operation of the U.S. intercity passenger rail network is run almost entirely by the National Passenger Railroad Corporation Amtrak. As a for profit company, Amtrak provides fee-based rail services to the public across 46 states, Washington, and three Canadian provinces. In addition to managing its main operations, Amtrak also acts as a contractor for numerous smaller local lines that have less access to equipment and service capacity (FRA 2014b).

Amtrak services have expanded over the last decade, and in 2013 Amtrak posted a new record for annual ridership—31.6 million passengers (AMTRAK 2013b). Despite this achievement, Amtrak has never reached financial solvency in its more than 30 years of operation. For example, in 2013 Amtrak was only able to cover 89% of total expenses from internally generated revenue, and in 2012 total expenses ($4.04 billion) exceeded total revenue ($2.88) by $1.16 billion (Amtrak 2014). The FRA is the primary agency responsible for issuing grants and other funding mechanisms to Amtrak. Figure 5 charts the annual changes in federal funding levels from FRA since Amtrak's inception in the early 1970s. Important to the FRA-Amtrak relationship is that with continued funding, the FRA retains great influence in the governance and decision-making processes of Amtrak's operations and management. This relationship demonstrates a vested interest by the federal government in the successful development of the U.S. intercity passenger rail infrastructure; however, as Amtrak is technically not part of the government, it also relieves the federal government of direct accountability for actual performance.

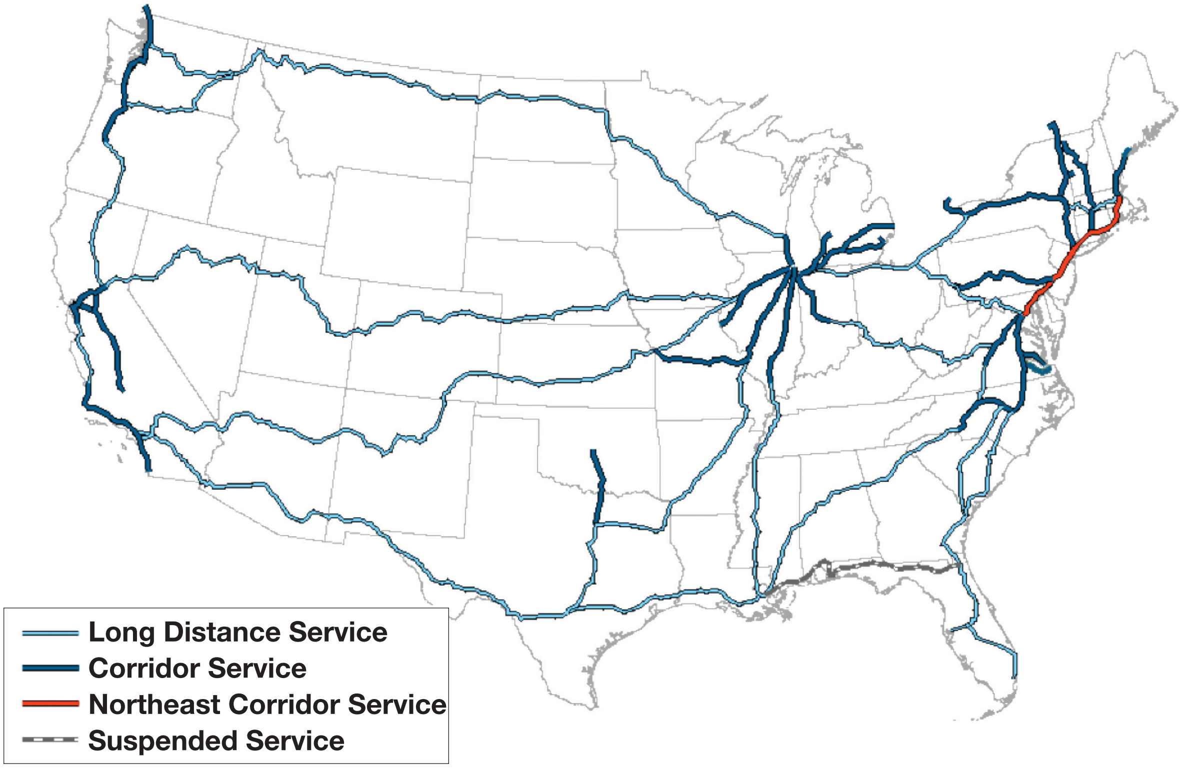
Amtrak currently maintains 517 passenger rail stations across the country (RITA 2014), and over the last decade it has improved its relative levels of operational efficiency, as ridership has increased while large reductions have been made in Amtrak's locomotive and car assets. For example, Table 6 shows how Amtrak lowered combined vehicle inventory by more than

Table 6. Amtrak Changes in Assets and Miles Operated, 2001–2011

	2001	2011	Percent Change
Locomotives	401	287	-28.2%
Cars	2,084	1,301	-37.6%
Vehicle Miles	378 Million	296 Million	-21.7%
Passenger Miles	5.56 Billion	6.67 Billion	20.0%

Source: (RITA 2014)

Figure 6. Map of Amtrak Serviced Track Lines, 2013



Source: (Amtrak 2014)

30%, and as a result, total vehicle miles traveled also fell by over 21%. What makes this data interesting is that while there are fewer trains in operation traveling fewer total miles, the number of passenger miles has increased by 20%. Amtrak's efficiency can also be measured by way of train "on time" performance, whereby Amtrak trains arriving within a predetermined timetable of acceptable variance are considered on time and those exceeding are considered delayed. Figure A4 in Appendix A depicts on time performance for short-distance trains (< 400 miles) and long-distance trains (> 400 miles). Unsurprisingly, short-distance trains—which accounted for roughly 85% of all 2013 ridership—maintain consistently better on time performance than long distance trains (Amtrak 2014).

Since more than 70% of Amtrak's business is serviced on rail lines owned and operated by freight rail companies, Amtrak has to share and coordinate limited track lines with freight trains (see Figure 6, 2013 Map of Amtrak Serviced Lines). While sharing tracks complicates overall operational complexity for both freight and passenger lines, rail bylaws prioritize passenger trains over freight trains, giving Amtrak trains the default right of way (Amtrak 2013a). Of the track lines that Amtrak actually owns and is solely responsible for maintaining, the 363 miles of track in the northeast corridor (NEC) between Washington, New York, and Boston is the most complex and highest-trafficked passenger network in North America (Amtrak 2013a; OIG 2013). These are also arguably Amtrak's most important lines, carrying 11.4 million passengers in 2013—more than one-third of total annual Amtrak passengers (Amtrak 2013a). Crucially, though, due to insufficient funding and management of funds, Amtrak's 2013 backlog for maintaining a state of good repair in NEC exceeds $5.8 billion (Amtrak 2013a). To achieve a state of good repair would require at least $760 million per year for 15 years—$380 million for asset replacement and $380 million for maintenance (Amtrak 2013a; OIG 2013). Additional complications for maintaining a state of good repair beyond financial shortcomings are the average 2,200 trains traveling on NEC lines daily. With such high volumes it is nearly impossible to engage in maintenance activities without adding to congestion and creating traffic bottlenecks. Nevertheless, because current growth projections expect passenger rail traffic to increase by 50% through 2030 and to double by 2050, it is essential that Amtrak maintain this very important network of infrastructure (Amtrak 2013a).

Airports

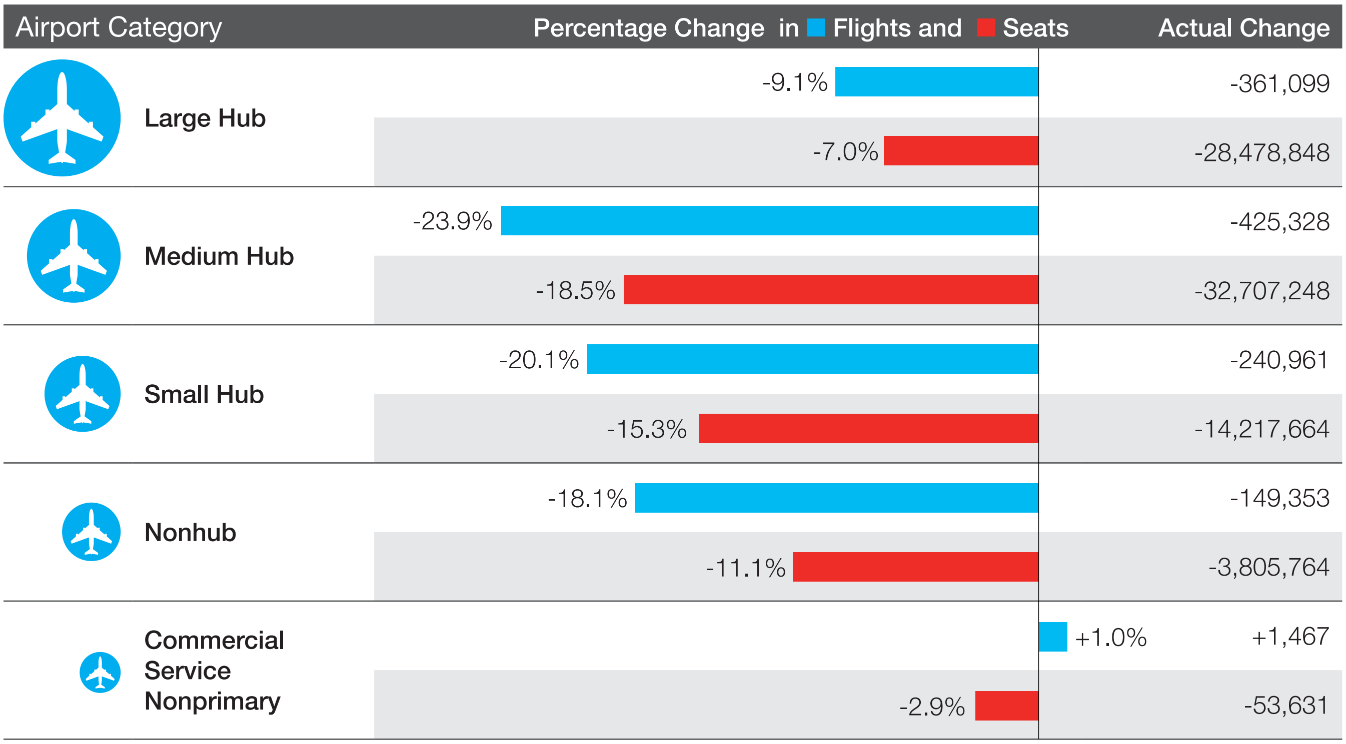
The aviation industry is an important pillar of the U.S. economy, contributing over $1.3 trillion to GDP, more than 10.2 million jobs, and more than $53 billion revenue ton-miles of air cargo in 2011 (FAA 2011). Upholding the aviation industry is the country's airport infrastructure, which—at more than 19,000 airports—is the single largest national network in the world. Of these 19,000 airports, approximately 3,400 are designated as part of the "national airport system," and are overseen by FAA policies and regulations (GAO 2014a). Within the national airport system, there are 389 primary airports that have corresponding large, medium, or small hubs; within this primary network, 62 airports support more than 88% of both freight and passenger traffic (GAO 2014a).

Due to the recent recession and spikes in gas prices, total airport traffic measured by flights, freight, passengers, and size of planes was down between 2007 and 2013 (GAO 2014a). Figure 7 depicts the average decline in passenger traffic for all sizes of airports in the national airport system from 2007 to 2013. It's important to note that much of the federal, state, and local revenue for airport development is tied to the taxes and fees applied on a per flight basis (GAO 2013a; GAO 2014a). Therefore, as airport traffic declined, so too has funding for infrastructure development. This has created a substantial funding problem that exacerbates the estimated $4.6 billion in investment backlog in 2013 for the rehabilitation, expansion, and enhancement needs of all national airport system airports (GAO 2013a; GAO 2014a).

In 2014, the Government Accountability Office warned of the imminent and growing backlog for U.S. airport infrastructure due to unsustainable federal investment shortages in the coming years.

Federal funds for airports are largely reserved for the 3,400 airports in the national airport system and are awarded according to national priorities as outlined by the FAA's National Plan of Integrated Airport Systems (NPIAS) (FAA 2012). Figures A1 and A2 in Appendix A depict the NPIAS's most recent prioritization of development funds based on type of project and type of airport, offering insight into how federal funding is spent on airport infrastructure. On the one hand, 63% of all project funds are reserved for runway/physical rehabilitation and maintaining FAA standards, while 37% of funds are used to accommodate for growth in traffic and travelers (Figure A1, Appendix A). On the other hand, at the airport level, commercial airports equate to 16% of the total airport portfolio and receive 70% of all NPIAS directed funds, with non-commercial airports making up the remaining 84% of all airports and 30% of NPIAS funds (Figure A2, Appendix A) (FAA 2012).

Figure 7. Percent Change in Flights and Seats for Commercial Airlines, 2007-2013



Source: (GAO 2014a)

Other than military and national defense related airports, nearly all airports are owned by state, local, or private entities that are each responsible for managing their own rehabilitation, expansion, and enhancement activities (FAA 2013). Projecting total development needs for 2013 to 2017, NPIAS calculated that $8.5 billion in federal funding would be required per year, totaling $42.5 billion for all five years (FAA 2012). However, the $8.5 billion needed far exceeds the 2013 actual funding to the FAA for "Grants-in-Aid for airports"[8] of only $3.34 billion, the 2014 expected funding of $3.35 billion, and the 2015 requested funding of only $2.9 billion. In 2014, the Government Accountability Office warned of the imminent and growing backlog for U.S. airport infrastructure due to unsustainable federal investment shortages in the coming years (GAO 2014a).

Pipelines

The United States. has the longest pipeline infrastructure in the world. With more than 2.4 million miles of pipelines consisting of two main types—gas and hazardous materials (mainly oil)—its built infrastructure could circle the world roughly 100 times (PHMSA 2014a). With virtually no direct federal ownership of pipelines, the U.S. pipeline networks are operated and managed by close to 3,000 private companies ranging from large national players to small regional firms. Based on data collected from these private operators, the Pipeline & Hazardous Materials Safety Administration (PHMSA)—the division of the DOT that is responsible for collecting data and the primary federal authority for setting regulations on operational use, conditions, and safety—recorded the total stock of pipelines and related transmission facilities to be the following[9]:

- 185,637 miles of hazardous liquid and carbon dioxide pipelines;
- 325,000 miles of onshore and offshore gas transmission and gathering systems pipelines;
- 2,145,000 miles of gas distribution mains and services pipelines; and
- 129 liquid natural gas facilities connected to our gas transmission and distribution systems and propane distribution system pipelines.

Relative to the DOT's annual budget, the $190.8 million given to PHMSA in 2013—and even the $260.5 million requested for 2015—is quite small. Aside from operational costs of $19.3 million in 2013, nearly all of the remaining $171.5 million was used to improve operational standards, implement various safety programs, and conduct nationwide inspections (DOT 2014). For example, in 2011 PHMSA paid for more than 72% of all state pipeline safety programs. In addition, in 2013 alone, PHMSA conducted 2,955 inspections for both gas and hazardous materials pipelines and facilities, issued 484 violations (which generated $9 million in non-compliance fines), and awarded 212 grants across all 50 states (DOT 2014; GAO 2014b). The 36.5% requested increase in the PHMSA's 2015 budget over 2013 levels is directly tied to PHMSA's intent of scaling-out these ongoing initiatives.

The role of PHMSA in championing and promoting improved operations and safety practices is particularly important because over half of the U.S. stock of pipeline infrastructure for both gas and hazardous materials was installed before 1970 when the vast majority of materials used were made of wrought iron and/or bare steel. As outlined in multiple PHMSA "Call to Action Papers" (PHMSA 2011), wrought iron and bare steel are considered the most at-risk materials for corrosion and leakage that could cause an unexpected fault in pipelines, generating a need for policies prioritizing the mitigation of such risks and creating opportunity for businesses capable of replacing old pipelines. The Pipeline Integrity Management Program (IMP), which requires pipeline owners and operators to continuously monitor and evaluate their stock and repair or replace any damaged assets, has been PHMSA's primary means of risk reduction and the main way they hold pipeline companies accountable for public safety (Kishawy and Gabbar 2010). Modern pipelines are usually made of internally and externally coated steel which is designed to better withstand and prevent natural processes of corrosion (Wang, Shan, and Yang 2009). As Table 7 demonstrates, replacement efforts between 2005 and 2012 have reduced the risks from outdated pipelines; however, there is still much more replacement to be completed. Tables A2 and A3 in Appendix A provide the state-level breakdown for number of miles by type of pipeline in service in 2013 that were installed pre-1970.

Table 7. Phase Out of Pre-1970 Pipelines, 2005-2012 and Remaining Pre-1970 Pipelines, 2012

Pipeline Type	Reductions in Pre-1970 Pipelines	Share of Pipelines Installed Pre-1970
Gas Distribution Main Miles	8.4%	38.5%
Gas Distribution Service Count	19.6%	30.1%
Gas Transmission Miles	8.1%	58.5%
Hazardous Liquid Miles	2.0%	52.4%

Source: (PHMSA 2014c)

Interestingly, though perhaps not surprisingly, high concentration in ownership exists for pre-1970 pipelines. For example, the 10 companies in 2013 operating the highest number of pre-1970 gas distribution pipelines owned over 57% of all such pipelines nationally; for gas service lines, concentration of the top 10 companies was 43% (PHMSA 2014b). Similarly, in 2013 the top 10 states with the highest levels of pre-1970 pipelines for gas distribution and gas service lines were responsible for 83% and 98.5% respectively. As the Government Accountability Office (GAO) warns (2013; 2014) and as the “Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011” signed into law by President Obama in 2012 mandates, replacing the outstanding pre-1970 pipelines is a matter of national importance to ensure the safety and the operational efficiency of the U.S. national pipeline infrastructure.

2.2 U.S. Transportation Infrastructure Compared to Top Trading Partners

As reliable and efficient transportation infrastructure is essential for global economic competitiveness in a modern world (OECD 2007), it is instructive to compare the U.S. transportation infrastructure capacities and performance or underperformance with that of its largest trading partners. Meaningful assessments can be drawn from examining the effects the U.S. transportation infrastructure has on its global competitiveness. While this report is not intended to provide a fully comprehensive comparison, this section will use major international indices as well as other comparative measures of levels of infrastructure stock and annual investment levels as the basis for a broad assessment.

To facilitate comparison, the top 15 trading partners based on total average trade levels (combined exports and imports) between 2011 and 2014 were selected from the U.S. Census Bureau’s Foreign Trade database.[10] In 2013, these 15 countries accounted for 72.5% of all U.S. combined trade. For these 15 countries, we compiled an overview of the stock size and overall capacity of their national infrastructure profiles in contrast to the size and capacity found in the United States. Table 8 illustrates the magnitude of the U.S. transportation infrastructure in comparison to its 15 largest trading partners. It demonstrates that the United States has the largest transportation infrastructure in all categories, except total inland waterways (held by China).

There are two primary international rating indices for measuring the competitiveness of national transportation infrastructure systems: the World Economic Forum’s (WEF) Global Competitiveness Index and the World Bank’s Logistics Performance Index. The more established and widely cited of the two is the Global Competitiveness Index. However, the Logistics Performance Index is much more specific because it focuses on transportation infrastructure capacities and logistics industry performance.

The WEF Global Competitiveness Index maintains a transportation infrastructure-specific index that ranks countries by their overall infrastructure rating, which is calculated through a weighted average score of eight infrastructure metrics. For the fields related to this report, Table 9 displays the U.S. ranking according to its comparable ranking with its top 15 trading partners for road, rail, port, and air. These rankings are determined through a survey of more than 15,000 business leaders from 144 countries around the world; answers are ranked on a scale of 1 to 7 (“1 = extremely underdeveloped—among the worst in the world; 7 = extensive and efficient—among the best in the world”) (WEF 2014). As the figure demonstrates, the United States falls roughly in the top 40th percentile

Table 8. Transportation Infrastructure Stock in Miles: United States and Top 15 Trading Partners, 2012

Country	Total Roads	Total Rail	Total Bridges	Inland Waterways	Total Airports	Total Hazardous Material Pipelines	Total Gas Pipelines
United States	4,092,730	140,000	607,380	25,000	19,782	185,637*	2,470,000*
Canada	647,655	29,826	8,929	395	1,889	23,232	48,312
China	2,551,591	41,195	—	112,052	463	26,453	32,000
Mexico	232,555	16,593	—	—	243	3,101	7,400
Japan	210,669	12,514	—	—	142	173	2,768
Germany	143,402	20,864	—	4,802	318	9,694	296,395
Korea, South	65,823	2,269	—	—	71	<200	2,213
United Kingdom	260,745	10,026	—	658	271	6,276	177,464
France	652,513	19,191	—	3,176	294	11,247	143,927
Brazil	982,501	18,527	—	—	698	3,976	8,450
Saudi Arabia	137,555	878	—	—	82	7,789	3,028
India	2,914,444	40,054	—	—	253	14,803	17,782
Taiwan	25,772	981	—	—	35	< 200	< 200
Netherlands	85,558	1,875	—	3,793	23	3,418	84,028
Switzerland	44,399	2,221	—	—	40	125	11,871
Italy	158,702	10,592	—	971	98	6,214	178,136

Source: Compiled by authors from: (RITA 2013; World Bank 2014b; European Commission 2014; Eurostat 2012; Eurogas 2013; ASCE 2013a; CMR-THS 2013; Transport Canada 2014)

Note: Dashes indicate statistics that were not able to be located with reliable results.

* 2013 Data.

compared to its top 15 trading partners. While certainly not uncompetitive, the U.S. overall average is far from what would reasonably be considered world-leading.

The Logistics Performance Index, on the other hand, provides an international benchmark to measure logistics performance based on efficiency and reliability, which are directly correlated to the capabilities and sophistication of each country's transportation infrastructure. The Logistics Performance Index is built around a survey designed by the World Bank, academics, and logistics professionals, and is calculated through a weighted average of responses from over 1,500 logistics service providers operating in nearly every country in the world (World Bank 2014c). Responses for each question are ranked from 1 (low) to 5 (high). Table 10 compares the U.S. ranking to that of its top 15 trading partners. As is evident, the U.S. competitive ranking improves over its ranking in WEF Global Competitiveness Index; however, both Germany and the Netherlands remain more competitive across both indices than the United States. Because the technological and institutional requirements for even minimal levels of transportation efficiency in global logistics are inherently complex, there is a certain bias for more developed countries to

Table 9. WEF Global Competitiveness Index, 2014-2015

Country	Overall	Road	Rail	Port	Air
Switzerland	1	9	2	44	8
Netherlands	6	5	9	1	4
Japan	9	10	1	26	27
France	10	4	6	32	17
Germany	11	13	8	14	13
United States	16	16	15	12	9
Canada	19	23	18	21	16
Korea, Rep.	23	18	10	27	31
Taiwan	24	12	7	25	36
United Kingdom	27	30	16	16	28
Saudi Arabia	29	26	50	40	41
Italy	56	57	29	55	70
China	64	49	17	53	58
Mexico	69	52	64	62	63
India	90	76	27	76	71
Brazil	120	122	95	122	113

Source: Compiled by authors from WEF 2014.

outperform comparatively less developed countries. While the U.S. position of ninth globally is far from uncompetitive, for the country with the largest transportation infrastructure in the world this ranking suggests evident underperformance when compared to reasonable expectations for U.S. competitiveness.

Of the many factors that contribute to the development of these two transportation infrastructure-related performance indices (and indeed, a principle factor for the actual development of national transportation infrastructure), a country's annual investments in transportation infrastructure is one of the most important. Therefore, it is useful to compare investment differences in transportation infrastructure of the United States and some of its more competitive trading partners. For example, in 2011 the U.S. spending on transportation infrastructure for all levels of government was approximately $264.07 billion, equaling roughly 1.7% of total GDP ($15.53 trillion), and corresponding to an average $847.5 per person investment (DOT 2013; World Bank 2014a). Compare that to 2011 investments in transportation infrastructure for all EU-27 countries, which amounted to $1.3 trillion, equaling roughly 7.2% of combined GDP ($17.63 trillion), and corresponding to an average per person investment of $2,589 (Eurostat 2012; EU Transport Scoreboard 2014). Thus, the EU-27 invested over three times more per person than the United States. Table 11 shows a similar breakdown for the EU-27 countries specifically included in this section as top 15 trading partners.[11]

As shown in Table 11, the differences in annual transportation investment levels between the United States and its EU trading partners in both percentage of GDP and

Table 10. World Bank Logistics Performance Index, 2014

Country	Overall Rank	Infrastructure Rank	International Shipments Rank	Logistics Quality and Competence Rank	Timeliness Rank
Germany	1	1	4	3	4
Netherlands	2	3	11	2	6
United Kingdom	4	6	12	5	7
United States	9	5	26	7	14
Japan	10	7	19	11	10
Canada	12	10	23	10	11
France	13	13	7	15	13
Switzerland	14	11	15	16	21
Taiwan	19	4	5	25	25
Italy	20	19	17	23	22
Korea, South	21	18	28	21	28
China	28	23	22	35	36
Saudi Arabia	49	34	70	48	47
Mexico	50	50	46	47	46
India	54	58	44	52	51
Brazil	65	54	81	50	61

Source: (World Bank 2014c)

Note: Overall Rank also includes the following measures not reported here, and thus does not equate to an average of the metrics presented; however overall is still included to give the reader perspective. Excluded metrics are customs; and tracking and tracing.

Table 11. Annual Transportation Investments: Selected EU-27 Countries, 2011

Country	Total Investment	% GDP	Per Person Investment
United States	$264,070,000	1.7%	$848
EU-27 Combined	$1,308,424,937,696	7.2%	$2,589
United Kingdom	$234,358,466,116	8.9%	$3,669
Netherlands	$45,601,736,402	5.6%	$2,717
Italy	$162,151,233,565	7.6%	$2,717
Germany	$267,374,503,644	7.4%	$3,260
France	$207,730,609,827	7.5%	$3,260

Source: (European Commission 2014)

> "I believe our nation's infrastructure is actually declining; we are not even maintaining the status quo. Long term, the United States will become less competitive and our products will be too expensive to get into emerging consumer markets such as China and India. If we do not reverse course soon, we will be disadvantaged in labor, transportation, and energy costs as a nation."
>
> — Dino Kondos, High Company LLC

on a per person basis are dramatic. When factoring in the fact that similar transportation infrastructure investment disparities between EU countries and the United States have remained more or less consistent over the last 50 years (The Economist 2011), the U.S. comparative competitive positioning further pales in comparison. This is not meant to suggest that investment shortages and subsequent investment backlogs for needed rehabilitation, expansion, and enhancement are not an issue in EU countries. In the case of Germany—which, by all measures presented in this section, is more competitive than the United States in its transportation infrastructure performance—national investment backlogs for all modes of transportation infrastructure amounted to $10.33 billion in 2013 (RolandBerger 2013). While not insignificant, when compared to the approximately $900 billion U.S. investment backlog for 2013, Germany's transportation infrastructure portfolio clearly seems more competitive. Similarly, in 2013, the UK government assessed that its investment backlog for roads amounted to slightly more than $17 billion (Office of Chief Secretary to the Treasury 2013)—again, an amount substantially lower than the $808 billion backlog in the United States.

2.3 U.S. Transportation Infrastructure Competitiveness

Transportation infrastructure competitiveness can best be evaluated by the system's ability to maximize its contribution to economic growth (OECD, 2007; Lakshmanan, 2011; Winston, 2014). Likewise, it is essential that a country's transportation infrastructure positively contributes to national economic competitiveness. Indeed the U.S. DOT recognizes this by upholding economic competitiveness as an organizational goal, which aims to "Promote transportation policies and investments that bring lasting and equitable economic benefits to the Nation and its citizens" (DOT 2012a). In light of the fact that the United States possesses the largest stock of infrastructure in the world, a critical component of assessing the U.S. transportation competitiveness is to examine its performance levels.

Two primary concerns emerge from such an examination. The first concern relates to congestion rates across virtually all modes of the U.S. transportation infrastructure, which collectively reduces productivity rates for individuals, businesses, and government and undermines the efficient performance of the country's transportation infrastructure. The second concern is about the effect the U.S. investment backlog has on overall transportation infrastructure performance, especially when considering that addressing the backlog will result in increased congestion due to construction. Additionally, other related concerns are rooted in ongoing operational and managerial issues related to performance management of various infrastructure modes, as well as the ability to effectively and reliably assess when assets need repair.

Congestion is a significant problem across the U.S. transportation infrastructure, affecting the performance of nearly every mode of transport. In 2007, the DOT calculated that congestion across all modes of transport resulted in approximately $200 billion in direct losses to the country's economy (DOT 2007). By many measurements (including the DOT's Urban Congestion Report), congestion across the United States is worsening. In January 2014, U.S. Transportation Secretary Anthony Foxx said, "If you aggregated it, every year Americans spend roughly 600,000 years stuck in traffic" (Foxx 2014).

Congestion negatively affects the U.S. transportation infrastructure in many ways, including through productivity loss, reduced reliability, increased pollution, and excessive wear-and-tear on assets, to name a few. Each of these acts as a deterrent to competitiveness because they decrease efficiency, increase costs, and unnecessarily prevent other forms of economic activity (Sweet 2011; Lakshmanan 2011; Rodrigue, Comtois, and Slack 2013)" The impacts can be seen as threefold: first-ordered impacts are on the infrastructure system and on users; second-ordered impacts are on businesses and residential locations; and third-ordered impacts are on public transportation infrastructure policies (Sweet 2011).

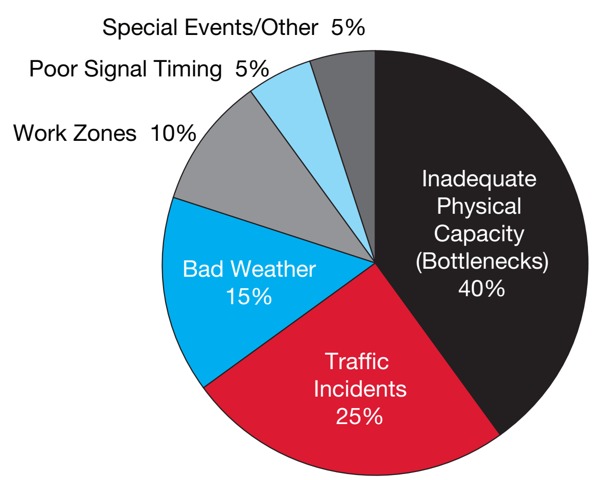
In 2013, the DOT broadly measures congestion by its severity (magnitude of problem), extent (geographic area), and duration (length of time). A look at the Urban Congestion Reports from 2008 through 2013 shows that year-over-year congestion is increasing in its severity, extent, and duration (Table A4, Appendix A). For example, the FHWA, FTA, and FAA have all reported in recent years that they anticipate congestion rates to increase over the next decade. Figure 8 shows the most common sources of congestion for road infrastructure. For transit and air, congestion is commonly measured by wait times, and for each mode average wait times reflect high congestion levels. For example, 26.8% of transit passengers

> **If you aggregated it, every year Americans spend roughly 600,000 years stuck in traffic.**
>
> —U.S. Transportation Secretary Anthony Foxx

wait on average more than 11 minutes per use, with 8% waiting more than 21 minutes per use (NHTS 2009). At airports, wait times have been increasing drastically, and in 2013 passengers collectively waited more than 200 years. Wasted and inefficient time accounts for roughly $8.1 billion in annual losses to the airline industry; broken down to a per-minute cost, every wasted minute costs airline companies $76.22.

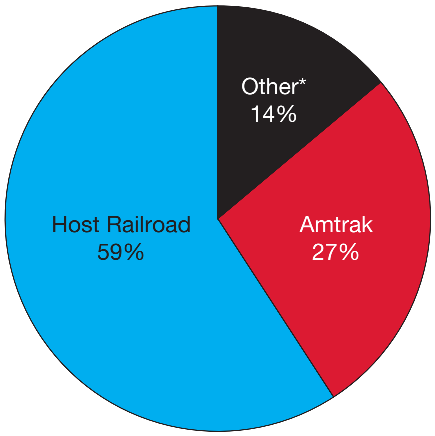
Freight rail is also particularly prone to congestion because operational capacity constraints continue to exceed new track development, which generates routine equipment shortages at key depots and on/off loading delays (Schlake, Barkan, and Edwards 2011). In addition, since freight

Figure 8. Sources of Congestion



Source: (FHWA 2012)

Figure 9. Amtrak Delays by Cause: 2012



Source: (RITA 2014)

*Other represents non-Amtrak delays such as customs and immigration, law enforcement, weather, etc.

railcars and passenger railcars often share the same tracks, and because passenger railcars usually command the right of way, freight train congestion increases with expanding passenger services (Cacchiani and Toth 2012). At the same time, delays in freight rail also exacerbate delays and congestion for passenger trains (Figure 9). In 2011 the Association of American Railroads (ARA) issued a study projecting congestion levels in 2035 compared to conditions in 2005, assuming no substantial changes in capacity growth rates (Figure 10). Similarly,

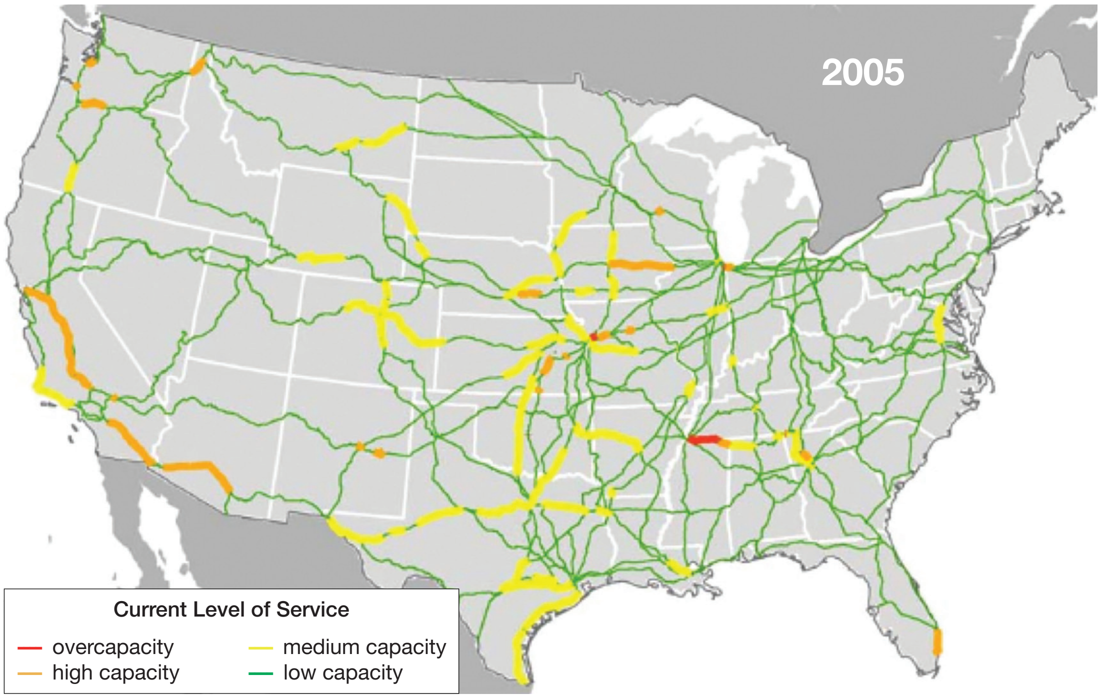
> **"[Rail] definitely is a delay, and we do have to build that into the overall supply timing for incoming materials. Sometimes we add 4+ weeks…[but] it is getting worse."**
>
> **— Brian LaBorde, High Steel Structures**

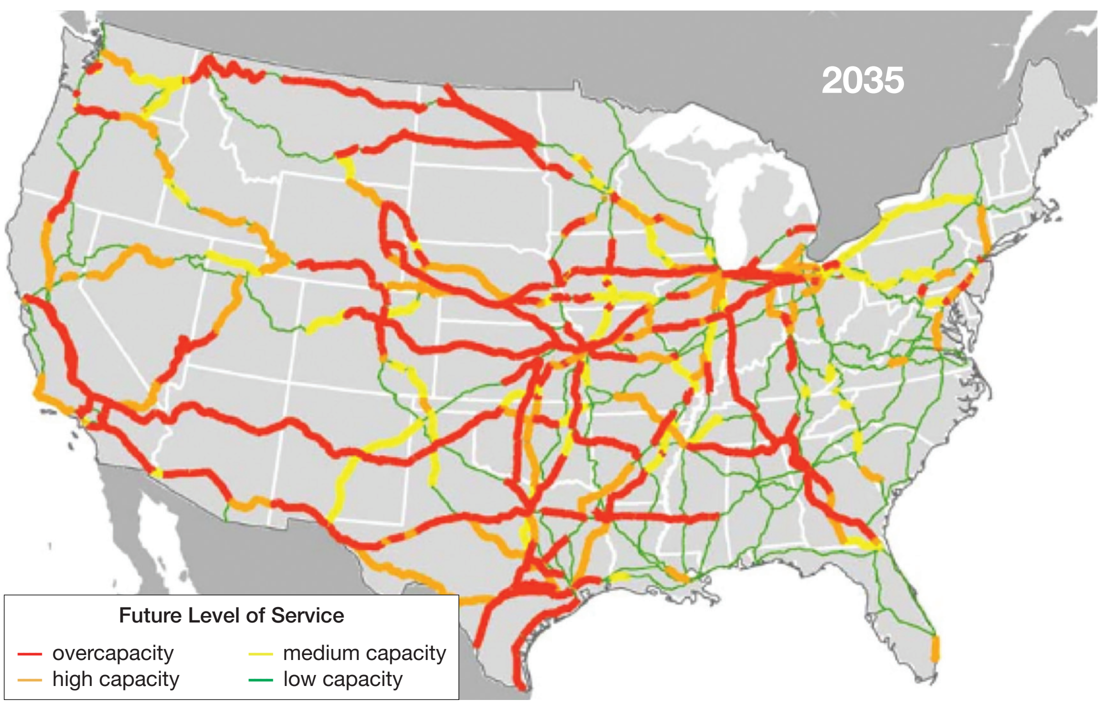
Figure A3 in Appendix A offers a visualization for expected highway congestion for truck freight as projected by the FHWA and DOT.

In light of how vital the U.S. transportation infrastructure is to the nation's economic performance, it is extremely problematic there are approximately $900 billion in backlogs for rehabilitation, expansion, and enhancement needs across every major mode of transportation. Moreover, backlogs are increasing because federal investments are not keeping pace with year-over-year operational demands for maintaining systems in a "state of good repair" (APTA 2012; DOT 2013; ASCE 2013b). The average cost of maintaining assets versus replacing them is often substantially lower. For example, for roads more than 25 years old, the cost of replacement is more than three times the cost of routine maintenance (DOT 2013). In 2013, the American Society of Civil Engineers (ASCE) estimated that the annual collective cost to U.S. automobiles resulting from unrepaired or poor road infrastructure was more than $67 billon (roughly $324 per driver), and that by 2020 poor road infrastructure will create a cost drag to business sales of $1.7 trillion, with a loss of 877,000 jobs (ASCE 2013b). Extrapolating further to include air transportation, by 2020 projected sales losses due to poor airport infrastructure are $580 billion, with a loss of approximately 350,000 jobs (Table 12). For transit, in 2010 the FTA projected that replacement of its assets would cost approximately $678.9 billion. However, the average cost of maintaining, rather than replacing, these assets would be approximately five times less and would extend the expected useful lifespan of each (DOT 2013; NSGR 2011).

The result of the escalating investment backlog in the United States is that it only serves to "kick the can" of fiscal responsibility further down the road, escalating the national financial burden in years to come. In addition, future costs are further exacerbated when factoring in the expected added congestion associated with work required to reduce

Figure 10. Changes in Railroad Congestion and Capacity Levels, 2005-2035





Source: (ARA 2011)

Table 12. Estimated Impacts to National Economy due to Escalating Backlog, 2013

Country	Surface Transportation	Airports	Inland Waterways & Marine Ports
Business Sales			
Through 2020	$1,700	$590	$1,335
2021-2040	$7,062	$2,682	$6,496
GDP			
Through 2020	$897	$313	$697
2021-2040	$1,765	$1,209	$3,278
Jobs			
2020	877,000	350,000	738,000
2040	410,000	358,000	1,384,000
Disposable Income			
Through 2020	$930	$361	$872
2021-2040	$2,205	$1,128	$3,662
Value of Exports			
Through 2020	$114	$54	$270
2021-2040	$1,093	$708	$1,712

Source: (ASCE 2013b)

the backlog. Therefore, the costs are compounded in both dollars and expected performance by an "order of magnitude" for every dollar of backlog left unaddressed, which negatively affects virtually every sector of the U.S. economy (ASCE 2013a; Winston 2010; Winston 2013).

The average cost of maintaining assets versus replacing them is often substantially lower. For example, for roads more than 25 years old, the cost of replacement is more than three times the cost of routine maintenance.

Lastly, another element worth addressing when evaluating competitiveness based on performance—and one that ties into both the congestion and backlog problems in the United States—is the current inability to reliably assess how and when assets are in need of repair. A look at almost any Government Accountability Office (GAO) report from the last five years for each mode covered in this report makes it clear that improving performance management is both complex and a top priority (GAO 2010; GAO 2011; GAO 2012a; GAO 2013b; GAO 2014a; GAO 2014b). While each DOT administration faces its own challenges to creating accurate and reliable performance assessment systems, a fundamental problem is that there is no agreed upon national or government-wide definition for a "state of good repair" (DOT 2013). Since no government standards exist, each administration is left to subjectively determine which assets are in need of repair and when. Concluding evidence from GAO reports routinely raise concerns that because state of good repair standards are not uniform, the actual conditions of assets could be even worse than is being reported by each administration, which would mean a higher backlog cost. A 2014 report on the FAA highlights this point explicitly (GAO 2014a).

While it is clear that rectifying the challenges of congestion, investment backlogs, and standards for a "state of good repair" are far from simple, until they are adequately addressed the U.S. transportation infrastructure will continue to underperform, resulting in significantly increased costs to U.S. consumers, businesses, and government, and a substantial reduction in U.S. competitiveness.

3 A Tale of Two Bridges

To explore the value of federal funding for transportation infrastructure, we examined two projects of similar scale—the $6.5 billion San Francisco-Oakland Bay Bridge and the $3.1 billion (budgeted) Tappan Zee Bridge. One of the primary differences between these two projects is that Tappan Zee received a portion of its funds through the federal government, and was therefore covered by long-standing Buy America preferences for the iron and steel used in the project. Conversely, California authorities avoided federal funding for the San Francisco-Oakland Bay Bridge, resulting in a project unbound by federal Buy America preferences.

We find that more than a quarter of Bay Bridge expenditures were spent outside of the United States. Awarding the most lucrative section of the bridge in dollar value, jobs, and fabricated steel to a Chinese contractor resulted in a significant loss of potential U.S. economic activity.

Our analysis of these two projects attempts to measure the costs and benefits of each approach. We find that more than a quarter of Bay Bridge expenditures were spent outside of the United States. Awarding the most lucrative section of the bridge in dollar value, jobs, and fabricated steel to a Chinese contractor resulted in a significant loss of potential U.S. economic activity. Although a bidding system was used to determine the contract winner, the bid process was found to be biased toward foreign competitors, and the process did not seriously consider U.S. bids. In the end, the production quality in China was low and riddled with faulty welding, cost overruns, and corruption, creating serious safety concerns for the structural integrity of the bridge (which is an issue of ongoing legal hearings).

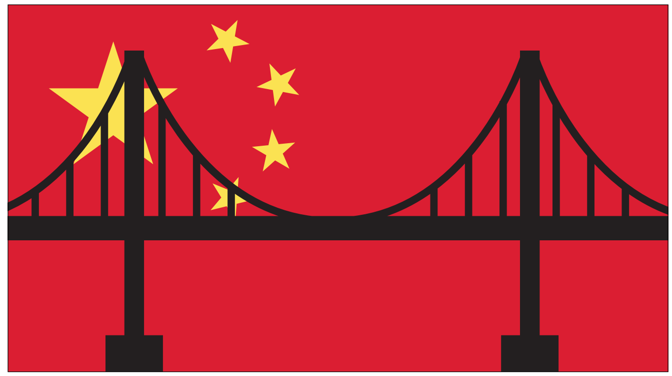
On the other hand, 100% of the Tappan Zee Bridge is being constructed in the United States, including 100% of its steel. Through a bidding process, U.S. firms were found to be the most competitive, and as a result of an innovative "design-build" contract for the bridge, the risk of cost overruns solely rests on the contractor and not on taxpayers. Although construction is still ongoing, the Tappan Zee Bridge is expected to generate 7,728 American jobs, $3.2 billion in economic activity, and $3.7 billion in income. We begin our narrative with the San Francisco-Oakland Bay Bridge.

3.1 San Francisco-Oakland Bay Bridge: Bypassing American Workers

In the late 1990s, state DOT officials in California began taking seriously the need to reconstruct and rebuild the San Francisco-Oakland Bay Bridge. Originally constructed in 1936, the structural integrity of the Bay Bridge was jeopardized after the 1989 Loma Prieta earthquake, which dislodged a 250 ton piece of the bridge's upper deck (Cohn 2012; MacDonald and Nadel 2013). In addition to structural concerns about the bridge's integrity in future earthquakes, the bridge was also in need of significant rehabilitation to restore it to a state of good repair, since the more than 270,000 vehicles that crossed the bridge daily caused a large backlog of maintenance issues (Transportation & Housing Committee 2014). In 1997, the cost of the rehabilitation and reconstruction of 2.2 miles of the Bay Bridge was estimated at $1.7 billion over a five-year timeline (Vorderbrueggen 2013).

No small investment, the Bay Bridge project presented a great infrastructure need and the opportunity to demonstrate, if not rekindle, U.S. prowess in big infrastructure capabilities. However, 17 years and $6.5 billion in expenses later, thousands of potential U.S. manufacturing jobs were offshored and the poor quality of workmanship has caused concern about the structural integrity of the new bridge (Piller 2014a). Although the new Bay Bridge boasts the world's largest single self-suspension mechanism, controversy continues to surround how and where the Bay Bridge was constructed. At the core of much of this controversy lies the issue of state politicians and state transportation officials in California dodging Buy America provisions in order to pursue the lowest cost construction option in China rather than sourcing from producers in the United States (Cohn 2012). As a recent and well-reported-on case (but hardly the only U.S. infrastructure project to bypass Buy America provisions), assessment of the new Bay Bridge project provides important guidance for future U.S. infrastructure investments.

The San Francisco-Oakland Bay Bridge



- Built with Chinese steel.
- $3.9 billion over budget, 12 years late.
- 3,000 Chinese workers hired.
- Under a government safety investigation due to faulty construction.

The bidding process for the new Bay Bridge began in the early 2000s and ended in 2006. The process was rife with delays, indecisiveness, and unnecessary complications. While many of the project

17 years and $6.5 billion in expenses later, thousands of potential U.S. manufacturing jobs were offshored and the poor quality of workmanship has caused concern about the structural integrity of the new bridge.

In total, over 250,000 tons of steel were used in the construction of the new Bay Bridge; as much as 80% of that steel is said to have come from China.

details were unclear during the bidding process (e.g. bridge design, required materials, expected seismic resiliency, level of environmental impact, etc.) the underlying project goals were clear: to build an iconic, highly-fortified bridge that would safely withstand the largest anticipated earthquake and the natural wear-and-tear of high-traffic usage for 150 years (Barboza 2011; Decker and Porterfield 2009). Ultimately, the iconic piece of the new Bay Bridge was to be its central 525-foot tower, supported by a large steel-wire cable, as well as two 1,500 foot steel road decks positioned below the middle of the tower (Barboza 2011; Cohn 2012).

The central tower and the corresponding steel road decks subsequently became the single highest value contract within the entire project and the element that most influenced the decision to turn down federal funding, since it was determined that it would be $400 million cheaper to build this section of the bridge in China rather than in the United States (Cohn 2012).[12] However, considering the fact that total costs for this central section were ultimately more than $1.75 billion (approximately 27% of total budget) and ended up being more than $300 million over budget, the anticipated $400 million in savings over the only U.S. bid received for this section of the project was not a valid reason in choosing to outsource (Cohn 2012). In theory the most important factor in awarding the contract for the project should have been quality and safety, which likely would have warranted predominantly U.S.-based construction. Instead, a survey of available records and interviews with state and transportation officials suggests that the most important factor to the project's bidding process was finding the lowest cost option (Barboza 2011; Cohn 2012; Transportation & Housing Committee 2014; Woodruff 2011).

The deliberate decision to avoid Buy America preferences was made during the bidding process of the Bay Bridge—a decision that U.S. steel professionals claim may have been made long before any bids were even submitted. For example, throughout the entire bidding process only one U.S. steel manufacturer—Oregon Ironworks—was asked by Bay Bridge officials to submit a bid (Barlett and Steele 2011). On the other hand, several East Asian firms were encouraged to submit their bids through formal trips to China by California state officials, including by then-Governor Schwarzenegger (Barboza 2011; Barlett and Steele 2011; Decker and Porterfield 2009). In addition, Bay Bridge officials stated in multiple public announcements, including in congressional testimonies, that the United States simply did not possess the required technical capabilities and that the U.S. steel industry especially did not have the facilities or the manpower to compete with the vast resources of Chinese steel companies (Cohn 2012).

Ironically, Bay Bridge officials said that one of the main deterrents to working with U.S. steel firms was that a new production facility would have to be built before construction could begin. However, as it turned out, the first thing the Chinese manufacturer that was ultimately awarded the contract did was construct a new facility, which delayed the project by nearly a year (Decker and Porterfield 2009; Vorderbrueggen 2013). Furthermore, many accounts of public statements made throughout the bidding process by Bay Bridge officials suggested an almost innate assumption that production would be cheaper in China (Piller 2014a). While indeed the cost difference between Oregon Ironworks' bid and the winning bid was originally $400 million,[12] by 2011 the cost overruns of the project had totaled

$350 million, closing the gap significantly. In addition, the difference between the bids did not account for the additional revenue the state of California would have received from state income taxes by workers employed on the project, as well as the direct, indirect, and induced economic activity that could have been generated by hundreds, if not thousands, of new jobs in the state (Flyvbjerg 2014; Barlett and Steele 2011; Little 2011).

By the time the bidding process was complete, the California Department of Transportation (CalTrans) had issued a total of 16 contracts for various processes and elements related to full bridge construction. From those contracts, the Chinese manufacturer Zhenhua was responsible for constructing a vast majority of the new Bay Bridges' steel components, including the central tower, the steel cable, and 28 bridge decks (large triangular structures that underpin the roadway platform) (Piller 2014b; Cohn 2012; Barboza 2011). In total, over 250,000 tons of steel were used in the construction of the new Bay Bridge; as much as 80% of that steel is said to have come from China (Vorderbrueggen 2013).

The choice of Zhenhua as the manufacturer perplexed some U.S. industry analysts, since prior to being awarded this contract the company specialized in building cranes, and had no prior experience in bridge building (Cohn 2012; Decker and Porterfield 2009). Moreover, Zhenhua had to develop a consortium of partners and subcontractors to deliver their scope of work, while those involved in the Oregon Ironworks bid were discouraged by Bay Bridge officials from developing a similar consortium of U.S. producers (Barlett and Steele 2011; Cohn 2012). After constructing the new facility where most steel parts would be fabricated, Zhenhua hired as many as 3,000 workers (the majority of which were paid between $9 and $12 per day and worked shifts as long as 16 hours) to construct the massive steel sections of the bridge that would be shipped to California for final assembly (Barboza 2011).

From this perspective, one could argue that if the prime contract for the Bay Bridge main tower and associated steel components was subject to a Buy America preference (and therefore sourced and fabricated in the United States), then the end result may have been less expensive and the quality of the steel components more structurally sound.

Perhaps the most important job—and certainly the role that generated the most controversy—was that of the Zhenhua welder. As part of CalTrans' agreement with Zhenhua, welds had to pass independent auditing during the entire construction phase to ensure the quality and integrity of the welds would be able to withstand even the strongest of earthquakes (Piller 2014c). During such audits it became clear that welds were not being produced to code, and hundreds of hairline cracks were discovered on multiple occasions. Numerous reports document that CalTrans responded by firing more than one auditing company, reduced welding standards, and sent as many as 250 U.S. contractors to Zhenua to oversee production (Piller 2014a; Piller 2014b; Piller 2014c; Piller 2014d). Several reports note that welding quality did ultimately improve over the lifecycle of Zhenhua's work (Transportation and Housing Committee 2014); however, many still raised strong concerns about CalTrans officials' decision to knowingly allow imperfect steel components to pass inspection. As the bridge stands today, thousands of cracks or other imperfections have been identified throughout the various sections built by Zhenhua (Barlett and Steele 2011; Piller 2014a; Piller 2014b; Piller 2014c; Piller 2014d).

These findings resulted in serious accusations of foul play and incompetence against CalTrans official. Indeed, California State Senator Mark DeSaulnier called for a full criminal investigation of CalTrans on July 27, 2014. Senator DeSaulnier, who chairs the California Transportation and Housing Committee, has claimed that in the Committee's forthcoming report, there is evidence that CalTrans exhibited gross negligence by knowingly accepting substandard and potentially dangerous work at the expense of California taxpayers (Piller 2014a). With cost overruns of $5 billion and years in delays, Senator DeSaulnier's report argues that the new Bay Bridge's quality and ability to withstand future earthquakes is extremely uncertain, and that substantial repair costs should be expected (Piller 2014a).

While it is not possible to definitively say that these outcomes would have been different if the Bay Bridge was produced with U.S. steel, it is well-known that production quality standards in the U.S. steel fabrication industry are more stringent than in China (Baddoo 2008; Gedge 2008; Davenport 2005). U.S. steel industry analyst Michelle Applebaum has suggested that large U.S. infrastructure projects maintain a better record of avoiding cost overruns and project delays than similarly-sized Chinese projects (Cohn 2012). From this perspective, one could argue that if the prime contract for the Bay Bridge main tower and associated steel components was subject to a Buy America preference (and therefore sourced and fabricated in the United States), then the end result may have been less expensive and the quality of the steel components more structurally sound. Moreover, although no known studies have been conducted on the potential economic impact that Buy America provisions would have had on the state of California, and more broadly across the United States, the impact would certainly have been higher with the provisions than without.

3.2 The Tappan Zee Bridge: A Competitive Case for American-Made Infrastructure Projects

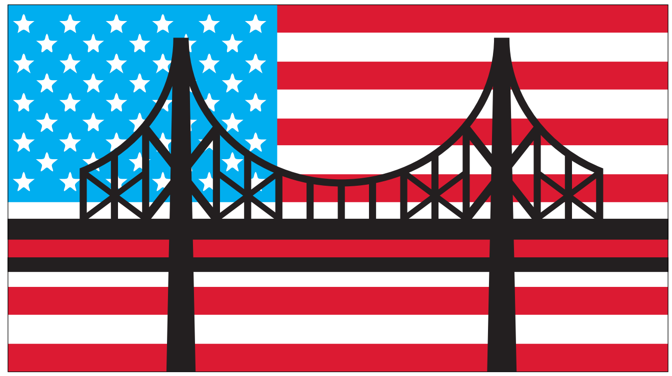
As one of only three infrastructure projects fast-tracked[13] by President Obama in 2011, construction of the new Tappan Zee Bridge in New York state has been identified as both a national and state infrastructure priority (Foxx 2014). Indeed, since 2011 when initial bidding and solicitation for the project formally began, there has been much anticipation about the numerous and expansive economic and social benefits expected for commuters, workers, and state and national DOT authorities (ESD and NYS DOL 2013; DOT/TIFIA 2012). One of the central reasons behind this excitement is that, unlike other recent U.S. bridge projects (such as the Verrazano Bridge in New York and the San Francisco-Oakland Bay Bridge in California) where Buy America preferences were bypassed to import large amounts of steel (Piller 2014; Star-Ledger 2014), the new Tappan Zee Bridge officials found it cost competitive to fabricate all of their required steel inside the United States, bucking the assumption by some policymakers that U.S. steel production is less competitive in cost and capacity than foreign production, particularly in China (Barboza 2011; Barlett and Steele 2011).

What makes the choice to follow Buy America policies even more interesting as a case study is that the U.S. producers selected for the job, Tappan Zee Constructors LLC (TZC), saved more than $1.5 billion and more than two years in construction time from the original NY DOT official estimates for expected costs and time (Berger 2014; FHWA/TIFIA 2014a; Novelli 2013). Moreover, the winning bid also presented the most environmentally innovative designs and the most socially inclusive labor subcontracting schemes (Foxx 2014; Novelli 2013).

Located approximately 20 miles north of New York City along the Hudson River (FHWA/TIFIA 2014a), the Tappan Zee Bridge is the only commuter bridge within 50 miles north and is an essential piece of road infrastructure for the state, servicing an average of 138,000 vehicles per day (Berger 2014; Pete 2014). During the mid-2000s, NY DOT officials concluded that reconstruction of the bridge, rather than rehabilitation or repairs, would be required since the bridge surpassed its expected 50-year lifespan in 2005 (DOT/TIFIA 2012; FHWA/TIFIA 2014a). Besides being old, the bridge was also routinely costing the state more that $700 million annually in repair costs above normal functioning maintenance costs (DOT/TIFIA 2012). In addition, with 40% more daily traffic volume than it was originally designed to handle, the bridge had too few lanes, insufficient width per lane, and minimal shoulders for emergency vehicles. As a result, the old Tappan Zee was rife with accidents and congestion bottlenecks (Novelli 2013; DOT/TIFIA 2012).

To address these constraints, the new bridge designed by TZC, which broke ground in spring 2013, will boast two parallel four-lane cable-styled bridges with two extra-wide emergency shoulders and an extended pedestrian and bike path (FHWA/TIFIA 2014b). During its five year expected construction period, TZC anticipates the use of 110,000 tons of U.S.-made steel and more than 550,000 tons of U.S.-made concrete in the new 3.1-mile long bridge (Novelli 2013). The new Tappan Zee Bridge boasts vastly improved function and design elements and is expected to last 100 years (FHWA/TIFIA 2014b). Additionally, successful delivery of the new bridge relies on innovative public-private funding scheme and large yet nimble consortium of companies that ensures the project will comply that applicable Buy America preferences (DOT/TIFIA 2012; Novelli 2013; NYSTA 2014).

The New York Tappan Zee Bridge



- Built with U.S. steel.
- $3.9 billion total projected cost.
- 7,728 American workers hired.
- Designed to last 100 years without major structural maintenance.

After a well-vetted and competitive bid process, in January 2013 the New York State Thruway Authority (NYSTA) (the primary state body overseeing the project) approved a $3.142 billion design-build contract with TZC. This contract type is growing in popularity for use in public-private infrastructure projects as a way to reduce financial risk and control construction delays; the Tappan Zee Bridge is the first project in the state of New York to utilize such a contract (Berger 2014; NYSTA

During its five year expected construction period, TZC anticipates the use of 110,000 tons of U.S.-made steel and more than 550,000 tons of U.S.-made concrete in the new 3.1-mile long bridge.

2014). In essence, the design-build contract means TZC is committed to their final agreed upon price ($3.142 billion) and project completion time without the possibility for overrun costs for NYSTA, making TZC directly liable for setbacks or financial complications (DOT/TIFIA 2012; Novelli 2013; NYSTA 2014). Tappan Zee officials have mitigated significant cost risks to NY state tax payers, where projects like the San Francisco-Oakland Bay Bridge resulted in hundreds of millions of dollars in additional cost to taxpayers.

In addition to the new design-build contracting mechanism with TZC, another innovative component of the project was the fact that NYSTA secured a $1.6 billion loan from U.S. DOT Transportation Infrastructure Finance and Innovation Act (TIFIA) program—the largest TIFIA funding amount ever granted to a single project to date (FHWA/TIFIA 2014b). TIFIA loans are issued on behalf of U.S. DOT and help provide a firm financial foundation to entice private sector participation in funding transportation projects. The use of TIFIA loans to fund the project triggered federal programmatic requirements to apply Buy America preferences for the iron and steel used throughout the Tappan Zee bridge. These preferences can be waived for undue cost, availability, or public interest (FHWA/TIFIA 2014b). Since the $1.6 billion of federal funding covers only approximately 41% of the total $3.9 billion cost of the new bridge when accounting for non-construction costs such as environmental testing, NYSTA has issued five-year bonds to pay for the $2.3 billion difference. Many questions have been raised about how the state of New York will pay off the $3.9 billion of financed money they are borrowing for this project; however, NYSTA officials insist that state toll fees and the increased toll fees generated from the new Tappan Zee Bridge will ultimately cover the cost (Berger 2014).

TZC is a consortium of core companies working on the Tappan Zee Bridge comprised of Fluor Enterprises, American Bridge Company, Granite Construction Northeast, and Traylor Brothers. This core group of companies specifically partnered together during the bidding process in an effort to leverage their respective complimentary skills and expertise. This enabled the group to provide a more competitive and complete suite of construction services, from design conception to the various component manufacturing and through final assembly (Fluor Enterprises 2014; FHWA/TIFIA 2014a). Of these companies, Fluor Enterprises is the primary entity responsible for fabricating and installing the bridge's various steel components, which were divided into two primary sections: the main approach steel, requiring 100,000 tons of steel, and the main span steel cable, weighing 10,000 tons (ArcelorMittal USA 2014; AISC 2013; Fluor Enterprises 2014). Fluor has subcontracted with ArcelorMittal, Highsteel Structures Inc., and Hirschfield Industries, LP, for the bulk of the needed fabrication; ArcelorMittal will provide all the plate steel that will be process-finished by Highsteel and Hirschfield, respectively (ArcelorMittal USA 2014; AISC 2013). Not only do these companies have the expertise and ability to fulfill the project's requirements, but their manufacturing plants are located near the site of the new Tappan Zee Bridge, which means they are able to quickly and cost-effectively deliver their finished components. Moreover, since all of the steel will be sourced and fabricated within the United States, the project will be Buy America compliant.

In addition to the core group of companies and steel providers working on the Tappan Zee Bridge, as part of their bid to NYSTA TZC committed to a novel subcontracting plan with disadvantaged business enterprises (DBE) (NYSTA 2014). TZC agreed to make a good faith effort to subcontract out 10% of their total contract value (approximately $314 million) to locally-registered DBEs. As of June 2014, 75 DBE-certified firms (most of which were registered locally in New York state or the Hudson Valley) have worked on the Tappan Zee Bridge, with $64.8 million total spent on these DBEs (TZC 2014). While such a plan does not explicitly fall under any Buy America policies, it demonstrates both a concerted effort to promote and develop the skills and the know-how of infrastructure construction in the United States.

As part of the request for financial and construction approval from both the New York state government and the U.S. DOT, an economic impact study was conducted to estimate the project's expected effect on employment, value of goods, GDP growth, and income levels. With calculations for the study based on $3.9 billion in project spending over five years, the primary expected economic effects were found to be the following (when combining their direct, indirect, and induced effects) (ESD & NYS DOL 2013):

- 7,728 unique full time jobs created (or 38,644 job-years);[14]
- $3.2 billion in newly generated GDP;
- $5.6 billion in total value of all goods produced;
- $3.7 billion in new personal income generated; and
- $2.0 billion in real disposable personal income.

While it is too early to confirm whether or not the Tappan Zee project will deliver (or possibly exceed) these projected economic impacts, it is certain that if the Tappan Zee Bridge project was not subject to a Buy America preference, each one of these potential impacts would be considerably lower.

4 Employment Impact of Federal Transportation Investment

The previous sections of the report discussed the performance and condition of U.S. transportation infrastructure and the role of Buy America preferences in the development of a competitive transportation infrastructure in the United States. In this section, we examine the economic effects of transportation infrastructure investments on jobs and the U.S. economy. Our economic impact analysis demonstrates that federally-funded transportation infrastructure investment returns 21,671 jobs for every $1 billion spent and $3.54 for every dollar spent on the U.S. Department of Transportation (DOT) budget.

Our analysis is organized into eight parts:

- Section 4.1 provides an overview of the economic impact study and definitions.
- Section 4.2 discusses the data sources for the economic impact models.
- Section 4.3 provides the funding levels and the mix of capital, administration, and maintenance for each scenario.
- Section 4.4 presents modeling approach and procedure.
- Section 4.5 provides the results of the economic impact analyses at the national level.
- Section 4.6 illustrates the employment impact per $1 billion in spending by industry.
- Section 4.7 presents the results of the economic impact analysis at the state level.
- Section 4.8 concludes.

The discussion in these sections is supplemented by a detailed exploration of additional modeling considerations in Appendix B.

4.1 Modeling Overview and Definitions

The economic impact analysis of federal transportation spending analysis was conducted using IMPLAN 3.0 software and data for the United States. IMPLAN is an industry standard input-output model that can be used to measure broad economic impacts that result for a change in final demand in any given industry sector or household income group.

The primary outcome measures of the analysis are direct, indirect, and induced impacts.

- **Direct impacts** are the changes in spending in a given industry that result from the increase in final demand for the products of that industry. Investment in transportation infrastructure affects direct employment impact in construction and maintenance services and manufacturers of vehicles used in mass transit, among others.
- **Indirect impacts** include the impacts created by inter-industry spending. These impacts account for the capital spending relationship between transit vehicle manufacturers and steel producers. Indirect impacts are sensitive to the percent of inputs imported from outside the geographic area being modeled. A greater percentage of imports, the lower the indirect impacts.
- **Induced impacts** are the changes in spending by consumers as a result of changes in income and population due to the new direct and indirect economic activity. Induced impacts model the changes in household spending—typically in retail trade and services—as a result of changes in income.

The output of the investment scenario analysis provides the direct, indirect, and induced jobs for each scenario and geographic region modeled.

The findings show the estimated change in demand (i.e. spending) that could result from the different infrastructure and labor costs associated with the various U.S. DOT spending levels. These demand changes stimulate activity that is captured in a regional economic multiplier. The basic concept of an economic multiplier is to predict how many additional jobs or dollars will be added to the economy as a result of the jobs or dollars created by the initial event. Note that multipliers do not indicate causation. Rather, the multiplier captures the magnitude of inter-industrial linkages. The multiplier, calculated from the average amount of local spending, represents the ratio between total impacts and direct impacts. The multiplier will be different for each activity. The modeling results include employment figures, labor income, and output (the value of increased economic activity in one year).

4.2 Data Sources

To estimate the economic impact of the funding scenarios, Duke CGGC analysts used a variety of federal budget sources. Three scenarios were modeled at the national level: low, mid, and high. The low scenario utilized the U.S. Department of Transportation's Budget Highlights, FY2015 to model the fiscal year 2014 U.S. DOT expenditures at the federal level. This scenario represents the current level of transportation spending. The mid scenario utilized the same document and modeled the fiscal year 2015 budgetary request, which represented a nearly 26% increase in the transportation budget for the 2015 fiscal year.[15] The high scenario was generated from a U.S. DOT report on the annual fiscal costs of improving the conditions and performance of U.S. transportation infrastructure, the 2013 *Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance*. The low scenario was proportionally increased by roughly 58% to reach the high scenario funding level.

Low, mid, and high scenarios were also modeled for each of the 50 states. The low scenario included 2014 fiscal year obligations to states for Federal Aviation Administration (FAA), Federal Transit Authority (FTA), and Federal Highway Administration (FHWA) documented by the Office of Management and Budget (OMB). The mid scenario included the proposed fiscal year 2015 obligations. The high scenario represents a roughly 58% increase over the low scenario for each state.

Table 13. Data Sources for Transportation Investment Scenarios

Pipeline Type	Low	Mid	High
National level	FY 2014 Budgetary Resources. Source: U.S. Department of Transportation, *Budget Highlights, FY 2015*	FY 2015 Budgetary Resources Request. Source: U.S. Department of Transportation, *Budget Highlights, FY 2015*	"Improve Conditions and Performance" Scenario. Source: U.S. Department of Transportation, *Conditions & Performance, 2013*
U.S. State Level	Estimated FY 2014 obligations to states for Federal Aviation Administration, Federal Transit Authority, and Federal Highway Administration. Source: Office of Management and Budget, *Analytical Perspectives, Budget of the United States Government, Fiscal Year 2015*	Proposed FY 2015 spending for Federal Aviation Administration, Federal Transit Authority, and Federal Highway Administration Source: Office of Management and Budget, *Analytical Perspectives, Budget of the United States Government, Fiscal Year 2015*	Allocation of "Improve Conditions and Performance Scenario" across Federal Aviation Administration, Federal Transit Authority, and Federal Highway Administration. Source: imputed by Duke CGGC, based on FY2014 distribution in U.S. Department of Transportation, *Conditions & Performance, 2013*

4.3 Funding Levels and Spending Mix

The following funding levels were used at the national level. The source of the funding levels for each scenario is described in detail in the previous section (Section 4.2). Additional information about funding levels and spending mix is provided in Appendix B.

Each funding level was modeled using three broad spending categories based on an estimate of the proportion of spending in the U.S. DOT budget: capital expenditures (i.e. construction), administration, and maintenance.

U.S. Funding Level per Scenario	
Low Scenario	$72,316,000,000
Mid Scenario	$90,920,000,000
High Scenario	$114,238,380,907

Budget Breakdown	
Capital Expenditure	49%
Administration	22%
Maintenance	29%

4.4 Modeling Approach and Procedure

We chose to model the effect of transportation infrastructure spending by using an analysis-by-parts technique because it better specifies the spending patterns and more accurately accounts for impacts at the national level (rather than the industry change approach). Under the analysis-by-parts technique, direct impacts are modeled separately from indirect and induced effects. See Appendix B for details on analysis-by-parts results.

Several steps are required to model construction spending using analysis-by-parts. First, the commodity spending pattern for new nonresidential construction was imported into the model. This sector has a factor of 0.59, which means that only 59% of the spending is this industry is comprised of commodity purchases. The remaining 41% is value-added primarily in the form of labor and proprietor income (Day, n.d. p. 206). As such, labor and proprietor income were modeled separately. This commodity purchase model yields only indirect and induced spending effects, since direct effects are modeled separately.[16]

Second, the direct employment and labor income was calculated using IMPLAN Sector 36: Construction of Other New Nonresidential Construction to determine direct employment effects (as suggested by Day, n.d. p. 205). Next, labor income and proprietor income must be calculated separately. IMPLAN Sector 36 demonstrates that of the 40% value added not captured in the commodity purchases, 29% can be attributed to labor income and 8.75% can be attributed to proprietor income. Given the large amount of contractors and subcontractors, it is anticipated that proprietor income is higher during construction modeling.

The same approach was used for maintenance using IMPLAN Sector 39: Maintenance and Repair of New Nonresidential Structures. In this category, the commodity purchases account for 54% of the spending in this area, labor accounts for 34%, and proprietor income nearly 9%. Administration spending was modeled as federal government employee income using IMPLAN Sector 439: Nondefense Federal Employees.

Seven models were required for each funding scenario:

1. **Construction commodity purchases:** Construction commodity purchases represent the 59% of construction or capital expenditure spending that goes toward the purchase of construction commodities. Therefore, only indirect and induced effects are reported.
2. **Construction direct employment and labor income:** Direct employment and labor income from construction work are captured separately, and therefore only direct effects are reported.
3. **Construction labor and proprietor income:** Construction labor and proprietor income represents the 40% of construction spending not captured in the construction commodity purchases, of which 29% can be attributed to labor income and 8.75% can be attributed to proprietor income. Since this only represents income spending, only induced effects are generated. Categories 1, 2, and 3 outlined above are aggregated to generate the total effects of construction or capital expenditure spending by U.S. DOT.
4. **Administration:** Administration spending is modeled as federal government employment income. This generates direct employment (estimate of federal employment) as well as induced employment as federal government workers spend their labor income. Indirect employment is not generated, as there

Our economic impact analysis demonstrates that federally-funded transportation infrastructure investment returns 21,671 jobs for every $1 billion spent on the U.S. Department of Transportation (DOT) budget.

is no supply chain or market relationship with government employment.

5. **Maintenance commodity purchases:** Maintenance commodity purchases represent the 54% of maintenance expenditure spending that goes toward the purchase of maintenance commodities. Therefore, only indirect and induced effects are reported.
6. **Maintenance direct employment and labor income:** Direct employment and labor income from maintenance work is reported separately, therefore only direct effects are reported.
7. **Maintenance labor and proprietor income:** Maintenance labor and proprietor income represents the 46% of maintenance spending not captured in the maintenance commodity purchases, of which labor accounts for 34%, and proprietor income nearly 9%. As this only represents income spending, only induced effects are generated. Categories 5, 6, and 7 outlined above are aggregated to generate the total effects of maintenance spending by U.S. DOT.

In total, 21 models were utilized to construct the impact of U.S. DOT transportation spending at the three funding scenario levels.[17] The construction and maintenance commodity purchases represented the items or bundle of goods purchased in the Other New Nonresidential Construction category. For every dollar spent on construction, roughly 59 cents went toward the purchase of construction related goods (including manufactured goods) and services; for every dollar spent on maintenance, roughly 54 cents went toward the purchase of maintenance related goods (including manufactured goods) and services. Construction and maintenance labor and proprietor income includes the modeling of how proprietors or firm owners and workers spent income from these activities in the broader economy. For example, for every dollar spent on construction, roughly 29 cents went to labor income for construction and related workers and nearly 9 cents as income to proprietors. For every dollar spent on maintenance, roughly 34 cents went to labor income for construction and related workers and nearly 9 cents as income to proprietors. Since construction and maintenance work is often represented by small firms and multiple subcontractors, proprietor income accounts for a larger percentage of spending than in many other industries. Direct labor in construction and maintenance represented the direct employment effects of construction and maintenance workers. Lastly, administration represented the direct employment and labor income spending of federal government workers in the transportation industry.

Table 14. Spending Breakdown for Economic Modeling

	Capital Expenditures	Administration	Maintenance
FAA	39.5%	1%	59.5%
FTA	79.5%	1%	19.5%
FHWA	40%	1%	59%

State Modeling

The state modeling utilized a capital expenditure, administration, and maintenance breakdown for FAA, FTA, and FHWA allocations to the states. These allocations were applied to each type of U.S. DOT funding to generate state-level lump spending in capital expenditures, administration, and maintenance (Table 14). The three broad categories were modeled at the low, mid, and high funding scenarios for each state.
For state level modeling, we elected to utilize the existing construction, maintenance, and administration sectors in IMPLAN rather than utilize an analysis-by-parts approach due to time and budget constraints. (For example, utilizing an analysis-by-parts approach for state level funding scenarios would have required 21 models for each state or 1,050 total models.) Using the broad sectors allowed us to reduce the modeling to nine models per state (450 models total). Furthermore, we conducted a test with four sample states to see if utilizing the existing IMPLAN sectors would yield substantially different results from an analysis-by-parts approach. The results were not substantially different; therefore, we elected to use the simpler, more time- and cost-effective approach.

4.5 National Level Results

The low scenario (Table 15) modeled a total of $72 billion in U.S. DOT spending under the existing 2014 budget. This $72 billion in spending yielded an economic output of $255 billion in the U.S. economy—a multiplier of 3.54. For every dollar spent by U.S. DOT, an additional $2.54 in economic output was created in the U.S. economy. The 446,023 direct jobs resulting from U.S. DOT spending created 232,718 jobs in the supply chain (indirect jobs) and 888,429 induced jobs as a result of labor income spending by direct and indirect employees. This employment multiplier of 3.51 indicates that for every direct job created as a result of U.S. DOT spending, an additional 2.51 jobs were created. For every $1 billion spent by U.S. DOT, a total of 21,671 jobs were created.

The mid scenario (Table 16) modeled a total of $91B in U.S. DOT spending under the 2015 budget request. This $91 billion in spending yielded an economic output of $321 billion in the U.S. economy, a multiplier of 3.54. For every dollar spent by U.S. DOT and additional $2.54 in economic output was created in the U.S. economy. The 560,767 direct jobs resulting from U.S. DOT spending created 292,587 jobs in the supply chain (indirect jobs) and 1,116,986 induced jobs as a result of labor income spending by direct and indirect employees. This employment multiplier of 3.51 indicates that for every direct job created via U.S. DOT spending, an additional 2.51 jobs were created. For every $1billion spent by U.S. DOT a total of 21,671 jobs were created. Fully funding U.S. DOT at the requested levels in the 2015 budget would yield an increase in employment of 403,170 when compared to the low scenario.

The high scenario (Table 17) modeled a total of $114 billion in U.S. DOT spending under the funding levels suggested in the “Improve Conditions and Performance” report. This

$114 billion in spending yielded an economic output of $404 billion in the U.S. economy, a multiplier of 3.54. For every dollar spent by U.S. DOT, an additional $2.54 in economic output was created in the U.S. economy. The 704,588 direct jobs resulting from U.S. DOT spending created 364,627 jobs in the supply chain (indirect jobs) and 1,403,461 induced jobs as a result of labor income spending by direct and indirect employees.

This employment multiplier of 3.51 indicates that for every direct job created as a result of U.S. DOT spending, an additional 2.51 jobs were created. For every $1 billion spent by U.S. DOT a total of 21,671 jobs were created, which is consistent across all three scenarios modeled. Fully funding U.S. DOT at the high scenario would yield an increase in employment of 908,506 when compared to the low scenario.

Table 15. National Economic Impact: Low Scenario

Impact Type	Employment[18]	Labor Income[19]	Value Added[20]	Output[21]
Direct Effect	446,023	$34,264,630,532	$40,567,938,006	$72,315,997,093
Indirect Effect	232,718	$15,502,331,440	$25,172,483,607	$49,376,456,406
Induced Effect	888,429	$47,597,971,360	$80,531,984,523	$134,223,700,375
Total Effect	1,567,170	$97,364,933,332	$146,272,406,136	$255,916,153,875

Source: Calculated from IMPLAN 3.0.

Table 16. National Economic Impact: Mid Scenario

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	560,767	$43,079,542,674	$51,004,437,795	$90,919,996,347
Indirect Effect	292,587	$19,490,458,358	$31,648,352,108	$62,079,034,491
Induced Effect	1,116,986	$59,843,016,351	$101,249,627,424	$168,754,063,801
Total Effect	1,970,340	$122,413,017,382	$183,902,417,327	$321,753,094,636

Source: Calculated from IMPLAN 3.0.

Table 17. National Economic Impact: High Scenario

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	704,588	$54,128,213,873	$64,085,618,046	$114,238,376,315
Indirect Effect	367,627	$24,489,202,335	$39,765,247,377	$78,000,527,644
Induced Effect	1,403,461	$75,191,037,750	$127,217,259,818	$212,034,652,648
Total Effect	2,475,676	$153,808,453,959	$231,068,125,240	$404,273,556,607

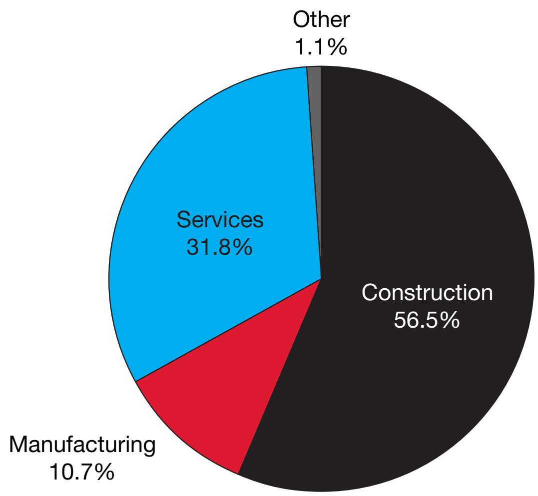
Source: Calculated from IMPLAN 3.0.

4.6 U.S. Results by Sector

We sought to better understand how the employment impacts are divided among the major sectors of the economy. The following chart captures the direct and indirect employment effects on major sectors of the economy per $1 billion invested in transportation infrastructure according to a 2009 study conducted by the University of Massachusetts – Amherst. U.S. transportation spending has the largest impact in the construction sector, accounting for almost 57% of employment. Services account for 32% of the employment associated with transportation spending. Manufacturing accounts for around 11% of the employment associated with transportation spending. Utilities, agriculture, and extractive industries constitute the remaining 1% of employment according to the study (Figure 11).

Applying the share of jobs created per $1 billion for each sector in Table 18, we identified the sector-by-sector employment effect of each funding scenario we modeled. The low scenario would result in over 72,000 manufacturing jobs. The mid scenario would result in over 91,000 jobs. The high scenario would result in over 114,000 manufacturing jobs.

Figure 11: Jobs per $1 Billion of Transportation Infrastructure Investment by Industry



Source: (University of Massachusetts-Amherst 2009)
Note: Direct and indirect employment effects only.

Table 18. Direct and Indirect Employment Impact by Major Sector and Scenario

Scenario	Construction	Manufacturing	Services	Other
Low Scenario	383,193	72,437	215,847	7,265
Mid Scenario	481,773	91,072	271,375	9,133
High Scenario	605,335	114,429	340,975	11,476

Note: Direct and indirect employment effects only.

4.7 State Results

We modeled the economic impact of transportation funding at the state level using OMB's aid to state and local governments found in its *FY 2015 Analytical Perspectives: Budget of the United States*. For the Department of Transportation, the document provides information for the FAA, FTA, and FHWA for each state.

The low scenario (Table 19) by state reveals significant variation in the employment impact of federal transportation obligations, from a low of 2,511 jobs in Hawaii to a high of 82,115 jobs in California. It is important to note that these numbers represent only the effect of federal spending in these states. This spending is likely to be leveraged by states and matched with local and state funding to generate larger impacts. The total employment effect for all states is 698,638 jobs. As a share of 2013 annual employment, this ranges from a low of .35% in Kansas to a high of 2.26% in Alaska.

The mid scenario (Table 20) by state reveals a similar pattern of variation in the employment impact of federal transportation obligations, from a low of 2,642 jobs in Delaware to a high of 77,843 jobs in California. The mid scenario did yield lower employment and economic impact effects for some states since the fiscal year 2015 obligations were lower for some states. The total employment effect for all states is 805,353 jobs. As a share of 2013 annual employment, this ranges from a low of .41% in Kansas to a high of 2.54% in Alaska.

The high scenario (Table 21) by state reveals a similar pattern of variation in the employment impact of federal transportation obligations, from a low of 3,967 jobs in Hawaii to a high of 129,741 jobs in California. The total employment effect for all states is 1,103,848 jobs. As a share of 2013 annual employment, this ranges from a low of .56% in Kansas to a high of 3.57% in Alaska.

Funding U.S. DOT at the fiscal year 2015 budget request would lower the number of unemployed Americans to 9,070,830 and reduce the unemployment rate to 5.8%. The high scenario funding level would reduce the number of unemployed Americans to 8,565,494 and reduce the unemployment rate to 5.5%.

4.8 Conclusion

At the current fiscal year 2014 funding levels, U.S. DOT transportation spending has a significant employment effect, accounting for over 1.5 million jobs in the U.S. economy. Fully funding U.S. DOT at the fiscal year 2015 budget request would add another 403,170 jobs to the U.S. economy, while funding at the high-scenario level would add 908,506 new jobs. Additionally, increasing U.S. DOT funding has the potential to reduce the unemployment rate. In June 2014, the U.S. Bureau of Labor Statistics reported nearly 9.5 million Americans were unemployed, with an unemployment rate of 6.1%. Funding U.S. DOT at the fiscal year 2015 budget request would lower the number of unemployed Americans to 9,070,830 and reduce the unemployment rate to 5.8%. The high scenario funding level would reduce the number of unemployed Americans to 8,565,494 and reduce the unemployment rate to 5.5%.[22]

Table 19. State Economic Impact: Low Scenario

State	Total Employment	Labor Income	Value Added	Output	Share of 2013 Employment*
Alabama	11,235	$567,970,929	$766,072,044	$1,499,781,619	0.61%
Alaska	7,435	$553,566,300	$685,995,562	$1,201,818,779	2.26%
Arizona	13,395	$747,350,716	$1,156,821,585	$1,980,816,083	0.54%
Arkansas	6,709	$307,909,697	$434,428,774	$879,293,400	0.59%
California	82,115	$5,423,237,167	$7,625,044,229	$13,477,747,493	0.53%
Colorado	14,312	$823,678,233	$1,058,800,987	$1,987,263,584	0.61%
Connecticut	11,212	$751,394,109	$920,658,705	$1,641,059,608	0.68%
Delaware	2,569	$149,863,673	$201,350,804	$375,311,237	0.62%
D.C.	3,024	$253,375,139	$293,883,388	$525,168,992	0.42%
Florida	38,029	$1,919,964,116	$2,985,928,057	$5,389,833,827	0.51%
Georgia	22,012	$1,129,959,872	$1,643,204,461	$3,062,845,731	0.56%
Hawaii	2,511	$165,418,816	$241,750,700	$413,130,772	0.41%
Idaho	4,521	$202,447,248	$276,883,207	$569,012,992	0.72%
Illinois	25,917	$1,631,279,084	$2,290,119,908	$4,004,456,922	0.46%
Indiana	14,693	$790,583,480	$1,061,463,291	$2,008,919,587	0.52%
Iowa	7,658	$393,528,704	$500,818,469	$1,032,306,352	0.51%
Kansas	4,701	$247,532,098	$317,374,075	$626,849,807	0.35%
Kentucky	9,200	$438,978,149	$593,152,543	$1,217,272,032	0.52%
Louisiana	10,453	$576,742,958	$785,932,525	$1,491,384,649	0.55%
Maine	3,699	$166,249,737	$215,091,009	$447,786,577	0.63%
Maryland	10,944	$730,253,237	$930,109,918	$1,630,582,728	0.43%
Massachusetts	14,760	$987,748,543	$1,231,424,903	$2,183,815,078	0.45%
Michigan	17,825	$923,945,327	$1,235,045,369	$2,391,087,258	0.44%
Minnesota	11,593	$657,834,600	$961,926,954	$1,724,113,942	0.43%
Mississippi	6,564	$308,298,330	$453,003,690	$886,468,986	0.60%
Missouri	16,265	$874,396,683	$1,107,805,120	$2,143,537,419	0.62%
Montana	6,645	$301,003,248	$405,874,246	$824,333,688	1.52%
Nebraska	4,740	$257,804,131	$325,410,908	$626,584,004	0.51%
Nevada	5,171	$316,233,378	$447,082,908	$776,502,025	0.45%
New Hampshire	3,108	$167,868,769	$195,379,600	$393,634,278	0.50%
New Jersey	17,697	$1,228,174,874	$1,616,632,427	$2,800,443,108	0.46%
New Mexico	4,558	$226,553,247	$313,664,295	$611,188,786	0.58%
New York	45,004	$3,187,539,746	$4,306,810,277	$7,230,473,013	0.52%
North Carolina	17,377	$843,862,092	$1,202,387,754	$2,347,019,684	0.44%
North Dakota	3,359	$203,500,417	$250,573,553	$469,539,532	0.79%
Ohio	22,728	$1,197,952,965	$1,623,248,919	$3,098,301,788	0.44%
Oklahoma	7,182	$356,890,628	$482,371,096	$970,449,329	0.46%
Oregon	9,466	$514,266,590	$704,871,213	$1,313,309,663	0.56%
Pennsylvania	30,732	$1,818,573,912	$2,356,670,224	$4,394,027,801	0.55%
Rhode Island	2,832	$164,813,358	$236,349,363	$416,793,185	0.62%
South Carolina	10,109	$481,103,301	$671,183,356	$1,303,979,610	0.55%
South Dakota	4,259	$195,001,501	$252,328,277	$533,122,848	1.05%
Tennessee	14,692	$775,452,936	$994,277,974	$1,947,069,340	0.55%
Texas	55,923	$3,373,497,562	$4,785,723,580	$8,641,088,126	0.51%
Utah	6,570	$343,653,976	$490,113,268	$913,343,265	0.52%
Vermont	3,545	$160,625,912	$188,505,005	$417,115,287	1.18%
Virginia	15,834	$911,960,651	$1,229,426,416	$2,262,626,002	0.43%
Washington	12,776	$798,546,586	$1,113,460,202	$2,013,345,611	0.43%
West Virginia	4,726	$253,153,634	$325,736,004	$630,027,014	0.67%
Wisconsin	13,163	$699,231,722	$916,430,542	$1,752,981,838	0.48%
Wyoming	3,094	$178,173,110	$219,299,919	$424,186,705	1.11%
Total	**698,638**	**$40,678,945,191**	**$55,627,901,603**	**$101,903,150,984**	**0.51%**

Source: Calculated from IMPLAN 3.0.
Note: Share of 2013 employment calculated from U.S. Bureau of Labor Statistics, Census of Employment and Wages.

Table 20. State Economic Impact: Mid Scenario

State	Total Employment	Labor Income	Value Added	Output	Share of 2013 Employment*
Alabama	12,150	$614,169,799	$828,407,622	$1,620,826,221	0.66%
Alaska	8,363	$622,686,640	$771,789,591	$1,353,610,983	2.54%
Arizona	14,126	$788,126,039	$1,220,007,452	$2,088,409,091	0.57%
Arkansas	7,969	$365,748,102	$516,053,305	$1,045,122,326	0.70%
California	77,853	$5,140,919,148	$7,226,780,808	$12,746,359,903	0.51%
Colorado	15,813	$910,339,402	$1,170,263,052	$2,199,894,469	0.68%
Connecticut	12,454	$834,506,109	$1,022,477,695	$1,821,589,061	0.76%
Delaware	2,642	$154,089,206	$206,957,642	$384,841,710	0.64%
D.C.	2,934	$245,913,857	$285,229,114	$509,136,092	0.41%
Florida	41,025	$2,071,061,624	$3,221,241,098	$5,809,632,350	0.55%
Georgia	25,741	$1,321,504,391	$1,921,732,001	$3,583,385,669	0.66%
Hawaii	2,910	$191,700,123	$280,150,234	$479,158,711	0.47%
Idaho	5,086	$227,735,453	$311,472,838	$639,961,712	0.81%
Illinois	36,975	$2,327,106,640	$3,267,038,695	$5,730,965,503	0.65%
Indiana	17,462	$939,472,853	$1,261,406,068	$2,389,275,063	0.61%
Iowa	8,952	$460,036,310	$585,458,387	$1,206,769,416	0.60%
Kansas	5,484	$288,762,917	$370,236,747	$731,730,097	0.41%
Kentucky	11,124	$530,773,516	$717,181,666	$1,473,974,453	0.63%
Louisiana	11,704	$645,788,972	$879,995,832	$1,669,315,878	0.62%
Maine	4,070	$182,922,355	$236,666,060	$492,451,164	0.69%
Maryland	14,340	$956,945,671	$1,218,959,331	$2,140,499,477	0.57%
Massachusetts	16,621	$1,112,271,757	$1,386,672,445	$2,459,251,509	0.50%
Michigan	21,050	$1,091,186,742	$1,458,635,984	$2,825,620,197	0.52%
Minnesota	14,274	$809,940,251	$1,184,421,537	$2,125,207,014	0.53%
Mississippi	7,243	$340,150,739	$499,838,661	$977,142,588	0.66%
Missouri	19,506	$1,048,687,330	$1,328,672,385	$2,572,935,441	0.74%
Montana	7,680	$347,897,063	$469,115,756	$953,226,743	1.76%
Nebraska	5,263	$286,242,513	$361,298,687	$695,455,781	0.56%
Nevada	6,024	$368,385,018	$520,812,655	$905,028,500	0.52%
New Hampshire	3,483	$188,095,167	$218,915,914	$440,927,843	0.56%
New Jersey	27,990	$1,943,376,012	$2,559,221,972	$4,448,581,643	0.73%
New Mexico	5,642	$280,406,591	$388,231,949	$757,121,655	0.71%
New York	48,821	$3,457,814,268	$4,671,998,640	$7,840,242,416	0.56%
North Carolina	19,679	$955,676,320	$1,361,701,762	$2,657,845,386	0.50%
North Dakota	3,875	$234,742,885	$289,046,415	$541,729,627	0.91%
Ohio	27,500	$1,449,504,774	$1,964,200,461	$3,753,499,203	0.54%
Oklahoma	8,112	$403,108,068	$544,831,120	$1,095,778,474	0.52%
Oregon	12,355	$671,095,456	$919,930,563	$1,718,318,746	0.74%
Pennsylvania	38,403	$2,272,769,627	$2,945,337,425	$5,498,988,892	0.69%
Rhode Island	3,488	$202,969,132	$291,021,217	$513,837,070	0.76%
South Carolina	11,309	$538,160,272	$750,815,306	$1,458,033,121	0.61%
South Dakota	4,964	$227,321,503	$294,160,097	$621,873,036	1.23%
Tennessee	17,321	$914,289,629	$1,172,326,559	$2,296,829,357	0.64%
Texas	64,322	$3,880,223,416	$5,504,610,553	$9,940,083,944	0.58%
Utah	7,461	$390,237,300	$556,549,293	$1,037,381,390	0.59%
Vermont	4,485	$203,318,986	$238,571,312	$529,352,782	1.49%
Virginia	18,187	$1,047,494,038	$1,412,138,752	$2,598,782,742	0.50%
Washington	16,114	$1,007,131,192	$1,404,544,001	$2,544,352,997	0.54%
West Virginia	5,365	$287,397,544	$369,797,251	$715,066,759	0.76%
Wisconsin	16,148	$857,770,467	$1,124,284,380	$2,154,756,472	0.59%
Wyoming	3,493	$201,054,309	$247,467,015	$479,234,984	1.25%
Total	**805,353**	**$46,839,027,496**	**$63,958,675,305**	**$117,273,395,661**	**0.60%**

Source: Calculated from IMPLAN 3.0.
Note: Share of 2013 employment calculated from U.S. Bureau of Labor Statistics, Census of Employment and Wages.

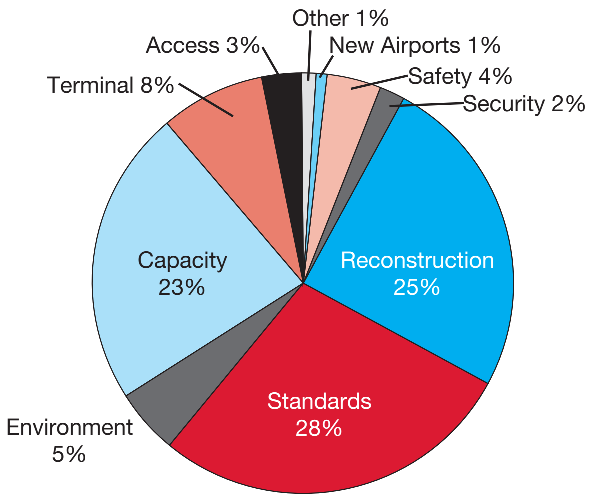
Table 21. State Economic Impact: High Scenario

State	Total Employment	Labor Income	Value Added	Output	Share of 2013 Employment*
Alabama	17,752	$897,394,069	$1,210,393,831	$2,369,654,960	0.96%
Alaska	11,747	$874,634,754	$1,083,872,988	$1,898,873,671	3.57%
Arizona	21,164	$1,180,814,132	$1,827,778,105	$3,129,689,412	0.85%
Arkansas	10,600	$486,497,322	$686,397,464	$1,389,283,572	0.92%
California	129,741	$8,568,714,725	$12,047,569,884	$21,294,841,042	0.84%
Colorado	22,613	$1,301,411,608	$1,672,905,559	$3,139,876,462	0.97%
Connecticut	17,714	$1,187,202,693	$1,454,640,756	$2,592,874,183	1.08%
Delaware	4,060	$236,784,604	$318,134,271	$592,991,755	0.98%
D.C.	4,778	$400,332,719	$464,335,753	$829,767,008	0.66%
Florida	60,085	$3,033,543,302	$4,717,766,329	$8,515,937,444	0.80%
Georgia	34,778	$1,785,336,599	$2,596,263,049	$4,839,296,257	0.89%
Hawaii	3,967	$261,361,730	$381,966,106	$652,746,620	0.64%
Idaho	7,144	$319,866,652	$437,475,467	$899,040,528	1.13%
Illinois	40,949	$2,577,420,953	$3,618,389,455	$6,327,041,937	0.72%
Indiana	23,215	$1,249,121,899	$1,677,112,000	$3,174,092,948	0.81%
Iowa	12,099	$621,775,353	$791,293,181	$1,631,044,036	0.81%
Kansas	7,427	$391,100,715	$501,451,039	$990,422,695	0.56%
Kentucky	14,536	$693,585,476	$937,181,019	$1,923,289,811	0.82%
Louisiana	16,515	$911,253,873	$1,241,773,389	$2,356,387,746	0.87%
Maine	5,844	$262,674,584	$339,843,794	$707,502,792	1.00%
Maryland	17,292	$1,153,800,116	$1,469,573,671	$2,576,320,711	0.68%
Massachusetts	23,321	$1,560,642,699	$1,945,651,346	$3,450,427,823	0.71%
Michigan	28,163	$1,459,833,617	$1,951,371,683	$3,777,917,867	0.70%
Minnesota	18,317	$1,039,378,669	$1,519,844,588	$2,724,100,029	0.68%
Mississippi	10,372	$487,111,362	$715,745,830	$1,400,620,998	0.95%
Missouri	25,699	$1,381,546,760	$1,750,332,089	$3,386,789,122	0.97%
Montana	10,498	$475,585,130	$641,281,308	$1,302,447,224	2.40%
Nebraska	7,490	$407,330,527	$514,149,234	$990,002,727	0.80%
Nevada	8,170	$499,648,737	$706,390,993	$1,226,873,198	0.70%
New Hampshire	4,911	$265,232,655	$308,699,768	$621,942,159	0.79%
New Jersey	27,962	$1,940,516,301	$2,554,279,235	$4,424,700,110	0.73%
New Mexico	7,201	$357,954,130	$495,589,586	$965,678,280	0.91%
New York	71,106	$5,036,312,798	$6,804,760,237	$11,424,147,361	0.82%
North Carolina	27,455	$1,333,302,104	$1,899,772,650	$3,708,291,100	0.69%
North Dakota	5,307	$321,530,659	$395,906,213	$741,872,461	1.24%
Ohio	35,910	$1,892,765,685	$2,564,733,292	$4,895,316,825	0.70%
Oklahoma	11,347	$563,887,193	$762,146,333	$1,533,309,939	0.73%
Oregon	14,956	$812,541,213	$1,113,696,517	$2,075,029,267	0.89%
Pennsylvania	48,556	$2,873,346,781	$3,723,538,954	$6,942,563,925	0.87%
Rhode Island	4,474	$260,405,107	$373,431,994	$658,533,235	0.98%
South Carolina	15,973	$760,143,216	$1,060,469,702	$2,060,287,785	0.87%
South Dakota	6,729	$308,102,372	$398,678,678	$842,334,101	1.66%
Tennessee	23,214	$1,225,215,638	$1,570,959,200	$3,076,369,557	0.86%
Texas	88,359	$5,330,126,148	$7,561,443,256	$13,652,919,240	0.80%
Utah	10,381	$542,973,283	$774,378,964	$1,443,082,360	0.83%
Vermont	5,601	$253,788,941	$297,837,908	$659,042,154	1.86%
Virginia	25,018	$1,440,897,829	$1,942,493,737	$3,574,949,082	0.69%
Washington	20,186	$1,261,703,605	$1,759,267,119	$3,181,086,065	0.68%
West Virginia	7,467	$399,982,742	$514,662,887	$995,442,682	1.06%
Wisconsin	20,798	$1,104,786,121	$1,447,960,256	$2,769,711,304	0.76%
Wyoming	4,889	$281,513,514	$346,493,873	$670,214,996	1.75%
Total	**1,103,848**	**$64,272,733,414**	**$87,892,084,540**	**$161,006,978,566**	**0.81%**

Source: Calculated from IMPLAN 3.0
Note: Share of 2013 employment calculated from U.S. Bureau of Labor Statistics, Census of Employment and Wages.

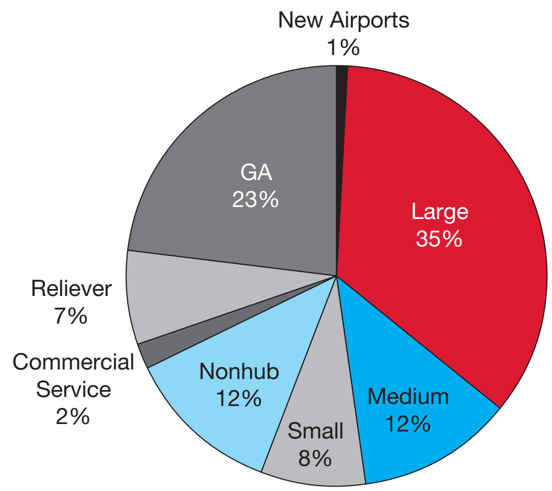
Appendix A: Figures & Tables

Figure A1. NPIAS Priority Funding by Project Type



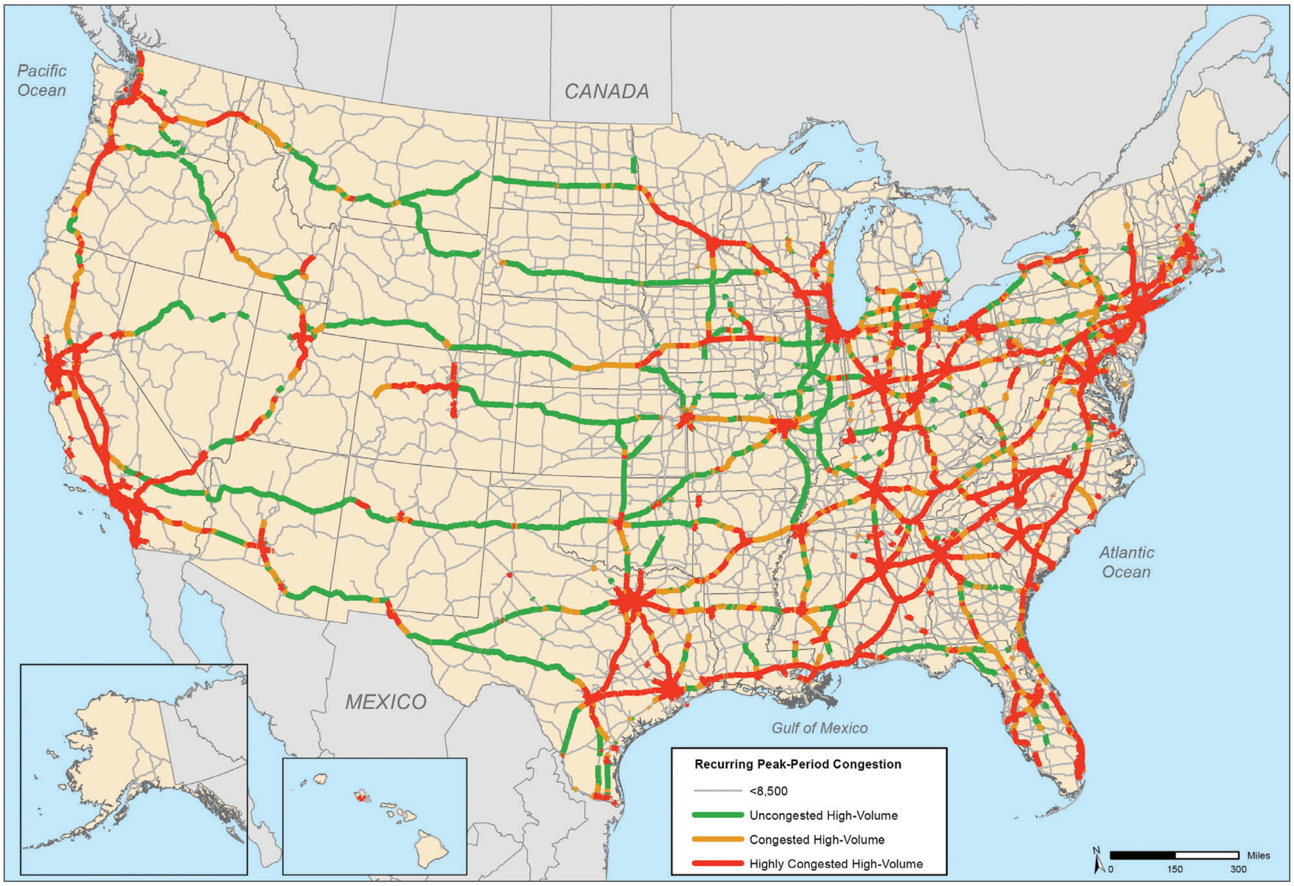
Source: (FAA 2012)

Figure A2. NPIAS Priority Funding by Airport Type



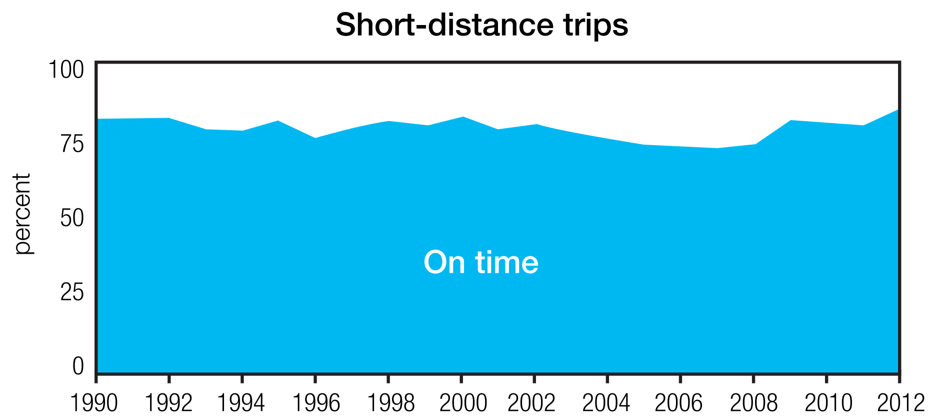
Source: (FAA 2012)

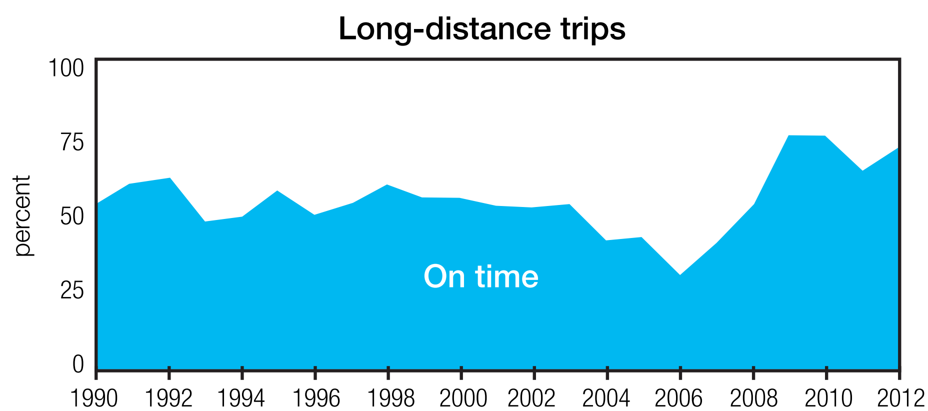
Figure A3. Peak Period Congestion on High-Volume Truck Portions of the National Highway System, 2040



Source: (DOT 2013)

Figure A4. On Time Performance of Amtrak Trains, 2012



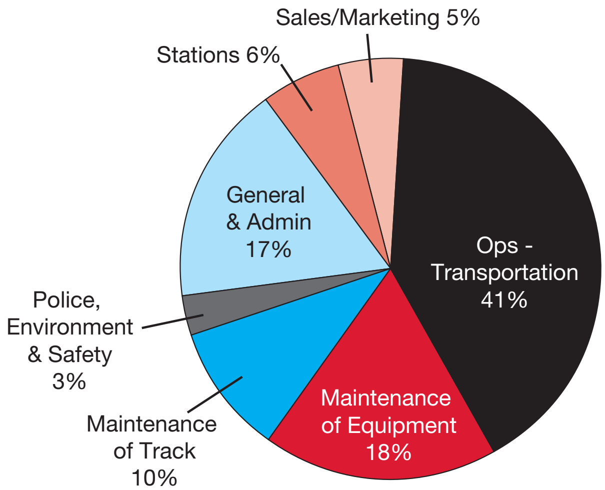


Amtrak Train On-Time Definition

Trip length	Train arrives at endpoint within
0–250 miles	10 minutes
251–350 miles	15 minutes
351–450 miles	20 minutes
451–550 miles	25 minutes
>551 miles	30 minutes

Source: (RITA 2014)

Figure A5. Amtrak Expenses, 2012



Source : (Amtrak 2013a; OIG 2013)

Table A1. Percentage of Roads with Good and Acceptable Ride Quality, 2000-2010

	2000	2002	2004	2006	2008	2010[1]
Functional System			Percent GOOD			
Rural Interstate	69.6%	72.2%	73.7%	78.6%	79.0%	79.1%
Rural Other Freeway & Expressway[2]	—	—	—	—	—	74.3%
Rural Other Principal Arterial[2]	—	—	—	—	—	72.9%
Rural Other Principal Arterial[2]	56.8%	60.2%	61.0%	66.8%	68.4%	—
Rural Minor Arterial	48.9%	51.0%	51.5%	56.3%	56.2%	60.9%
Rural Major Collector	39.9%	42.4%	40.3%	39.8%	39.0%	41.4%
Subtotal Rural	55.2%	58.0%	58.3%	62.2%	62.5%	64.6%
Urban Interstate	43.6%	45.0%	49.4%	54.0%	55.7%	64.6%
Urban Other Freeway & Expressway[2]	32.4%	33.6%	38.8%	45.3%	44.4%	53.3%
Urban Other Principal Arterial	26.9%	25.7%	26.5%	28.8%	26.9%	39.7%
Urban Minor Arterial	34.4%	34.1%	32.3%	33.6%	32.5%	28.8%
Urban Collector[2]	37.9%	35.5%	35.7%	34.1%	31.5%	—
Urban Major Collector[2]	—	—	—	—	—	25.7%
Urban Minor Collector[2]	—	—	—	—	—	8.6%
Subtotal Urban	35.0%	34.9%	36.6%	39.5%	38.9%	44.0%
Total GOOD[3]	42.8%	43.8%	44.2%	47.0%	46.4%	50.6%
Functional System			Percent ACCEPTABLE			
Rural Interstate	97.4%	97.3%	97.8%	98.2%	97.3%	91.1%
Rural Other Freeway & Expressway[2]	—	—	—	—	—	93.7%
Rural Other Principal Arterial[2]	—	—	—	—	—	93.0%
Rural Other Principal Arterial[2]	96.0%	96.2%	96.1%	97.0%	97.6%	—
Rural Minor Arterial	93.1%	93.8%	94.3%	95.1%	94.5%	87.3%
Rural Major Collector	86.9%	87.6%	88.5%	87.8%	88.3%	81.2%
Subtotal Rural	93.8%	94.1%	94.5%	94.9%	94.8%	87.8%
Urban Interstate	91.2%	89.6%	90.3%	92.7%	91.9%	89.8%
Urban Other Freeway & Expressway[2]	87.2%	87.8%	87.7%	92.1%	91.4%	89.2%
Urban Other Principal Arterial	71.0%	71.0%	72.6%	73.8%	72.4%	76.4%
Urban Minor Arterial	76.5%	76.3%	73.8%	75.6%	75.5%	70.6%
Urban Collector[2]	76.1%	74.6%	72.6%	72.6%	72.0%	—
Urban Major Collector[2]	—	—	—	—	—	67.0%
Urban Minor Collector[2]	—	—	—	—	—	26.2%
Subtotal Urban	80.3%	79.8%	79.7%	81.7%	81.0%	79.4%
Total ACCEPTABLE[3]	85.5%	85.3%	84.9%	86.0%	85.4%	82.0%

[1] HMPS pavement reporting requirements were modified in 2009 to include bridges; features such as open grated bridge decks or expansion joints can greatly increase the IRI for a given section.
[2] 2010 data reflects revised HPMS functional classification. Rural Other Freeways and Expressways have been split out of the Rural Other Principal Arterial category, and Urban Collector has been split into Urban Major Collector and Urban Minor Collector.
[3] Totals shown reflect Federal-aid highways only and exclude roads classified as rural minor collector, rural local, or urban local, for which pavement data are not reported in HPMS.

Source: (DOT 2013)

Table A2. Gas Distribution and Transmission Pre-1970 and Unknown Decades, 2013

State	Gas Distribution Main Miles	% Gas Distribution Main Miles	Gas Distribution Number of Services	% Gas Distribution Number of Services	Gas Transmission Miles	% Gas Transmission Miles
Alabama	11205	36.9%	427737	39.8%	3306	45.5%
Alaska	287	9.3%	8015	6.4%	230	29.6%
Arizona	5722	23.6%	159791	12.6%	4776	71.2%
Arkansas	10831	53.2%	393792	58.2%	4680	63.0%
California	40902	38.9%	2800196	32.2%	6638	56.7%
Colorado	20409	58.0%	475481	28.9%	3273	41.8%
Connecticut	3587	45.9%	109801	25.5%	415	70.6%
Delaware	686	23.0%	42500	24.5%	137	40.7%
District of Columbia	737	61.5%	36755	29.8%	8	61.8%
Florida	8358	30.7%	218938	24.9%	2220	41.2%
Georgia	11626	26.6%	512651	25.4%	2513	55.1%
Hawaii	243	40.0%	12495	35.8%	0	0.0%
Idaho	2179	26.9%	60351	14.3%	774	51.5%
Illinois	25719	42.1%	1075700	29.1%	6728	71.3%
Indiana	13050	32.5%	360613	18.2%	3614	65.7%
Iowa	6953	39.0%	278834	29.7%	5910	71.0%
Kansas	8318	37.4%	165186	17.4%	10265	72.7%
Kentucky	7936	44.5%	226721	26.8%	4993	70.8%
Louisiana	12498	47.0%	483103	43.2%	15431	58.2%
Maine	267	28.5%	609	2.2%	45	9.9%
Maryland	5432	37.2%	291820	28.8%	537	54.9%
Massachusetts	9694	45.3%	403673	31.5%	676	59.8%
Michigan	24343	42.8%	1056862	32.7%	5858	64.6%
Minnesota	9899	32.5%	303432	20.5%	3492	63.3%
Mississippi	8169	50.3%	277999	46.5%	7272	69.3%
Missouri	10694	39.4%	275857	18.2%	3083	66.8%
Montana	1975	28.1%	102307	34.8%	2171	54.2%
Nebraska	6275	49.6%	224686	38.5%	3826	64.6%
Nevada	689	7.0%	26579	3.6%	769	38.0%
New Hampshire	475	25.1%	14896	16.6%	53	21.3%
New Jersey	13196	38.7%	845722	36.4%	770	50.4%
New Mexico	3743	27.9%	276824	44.1%	4562	69.8%
New York	22133	46.1%	877068	27.6%	2609	55.9%
North Carolina	8966	30.4%	338626	24.3%	1704	40.4%
North Dakota	1352	41.0%	37278	24.9%	492	20.0%
OCS					258	15.4%
Ohio	26522	46.5%	1353313	38.2%	7037	67.7%
Oklahoma	9152	35.4%	423673	32.5%	4918	40.1%
Oregon	4149	26.8%	161519	24.7%	1152	46.3%
Pennsylvania	19902	41.8%	683241	24.2%	5093	51.5%
Puerto Rico	0	0.0%	0	0.0%	0	0.0%
Rhode Island	1702	53.6%	51696	26.8%	49	51.8%
South Carolina	6337	30.2%	214052	27.8%	1640	59.0%
South Dakota	935	19.9%	33094	16.7%	894	56.9%
Tennessee	9628	25.3%	302635	22.9%	3815	76.4%
Texas	48045	46.9%	1704600	34.4%	24933	51.3%
Utah	2867	17.0%	129410	15.1%	645	20.4%
Vermont	53	7.2%	1657	4.6%	46	64.6%
Virginia	5808	27.7%	369069	30.0%	1841	59.6%
Washington	5241	23.7%	186152	15.2%	1069	56.4%
West Virginia	4998	46.7%	303597	71.6%	1898	47.3%
Wisconsin	9408	24.7%	283045	17.4%	3093	68.9%
Wyoming	2179	42.7%	70818	38.9%	2186	31.4%

Source: (PHMSA 2013)

Table A3. Hazardous Liquid Pre-1970 and Unknown Decades, 2013

	CRUDE OIL		HVL FLAMM TOXIC		REFINED PP	
State	Miles	% Total Miles	Miles	% Total Miles	Miles	% Total Miles
Alabama	68	15.5%	250	70.1%	640	58.1%
Alaska	116	10.4%	0	0.0%	152	26.5%
Arizona			0	0.0%	152	26.5%
Arkansas	518	89.7%	300	52.9%	220	34.4%
California	1,798	56.5%	0	0.0%	1,745	53.4%
Colorado	167	40.6%	245	15.3%	264	25.5%
Connecticuit					72	77.7%
Delaware			1	100.0%	17	41.6%
District of Columbia					4	100.0%
Florida	8	18.1%	0	0.0%	36	10.6%
Georgia			355	98.2%	932	52.9%
Hawaii					53	55.3%
Idaho					598	96.7%
Illinois	1,647	73.7%	555	38.7%	2,932	72.8%
Indiana	295	65.8%	365	49.2%	2,074	76.9%
Iowa	16	6.9%	1,233	52.4%	1,457	86.9%
Kansas	2,108	69.2%	2,207	49.1%	2,083	58.9%
Kentucky	283	51.4%	39	42.2%	141	51.5%
Louisiana	2,294	61.8%	3,189	46.5%	838	46.0%
Maine	143	99.3%			99	78.8%
Maryland					248	77.7%
Massachusetts					91	97.7%
Michigan	805	57.8%	218	39.9%	991	73.9%
Minnesota	904	37.5%	344	42.8%	1,375	79.9%
Mississippi	975	75.8%	121	44.3%	812	52.9%
Missouri	1,111	67.7%	525	40.5%	1,333	68.0%
Montana	1,106	49.0%	0	0.0%	591	67.9%
Nebraska	412	62.5%	514	75.7%	1,246	80.4%
Nevada					124	45.2%
New Hampshire	71	100.0%				
New Jersey			12	100.0%	422	76.0%
New Mexico	853	65.4%	434	23.4%	833	38.4%
New York	25	27.8%	190	94.9%	795	92.7%
North Carolina			75	84.2%	598	57.2%
North Dakota	872	33.9%	0	0.0%	503	64.7%
OCS	212	6.1%				
Ohio	328	59.5%	557	55.9%	1,784	73.1%
Oklahoma	3,264	68.1%	1,085	23.6%	1,071	49.2%
Oregon					316	92.2%
Pennsylvania	14	51.1%	484	66.5%	1,759	84.9%
Puerto Rico					9	89.5%
Rhode Island					13	100.0%
South Carolina			162	71.3%	397	67.9%
South Dakota	0	0.0%			430	86.6%
Tennessee	263	94.8%	8	56.5%	458	52.9%
Texas	10,068	6545.0%	10,004	35.7%	4,575	44.2%
Utah	360	77.3%	0	0.0%	430	51.3%
Vermont	117	100.0%				
Virginia					822	71.7%
Washington	64	92.8%	0	0.8%	588	82.9%
West Virginia	3	60.9%	35	12.8%	4	7.9%
Wisconsin	463	39.3%	235	98.9%	311	29.9%
Wyoming	2,098	61.2%	7	0.5%	908	68.4%

Source: (PHMSA 2013)

Table A4. Urban Congestion Report, March 2013

City	Congested Hours 2013	Congested Hours Change from 2012	Travel Time Index 2013	Travel Time Index Change from 2012	Planning Time Index 2013	Planning Time Index Change from 2012	% Change in VMT	% Usable Data
Atlanta, GA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Boston, MA	4:59	1:20	1.25	7	1.73	25	-6%	99%
Chicago, IL	4:31	1:32	1.2	-6	1.52	-16	-45%	96%
Detroit, MI	3:19	0:45	1.12	4	1.45	17	-4%	99%
Houston, TX	4:21	0:06	1.35	3	1.79	2	0%	92%
Los Angeles, CA	6:01	0:37	1.29	3	1.59	7	0%	100%
Minneapolis - St. Paul, MN	4:13	1:18	1.2	8	1.69	30	-3%	100%
Oklahoma City, OK	1:58	0:01	1.08	2	1.25	6	-1%	99%
Orange County, CA	3:47	0:23	1.22	2	1.46	3	1%	100%
Philadelphia, PA	5:14	1:14	1.28	8	1.66	17	-3%	99%
Phoenix, AZ	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Pittsburgh, PA	5:46	0:23	1.22	0	1.45	-4	-5%	99%
Portland, OR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Providence, RI	3:31	0:37	1.13	4	1.39	13	-1%	99%
Riverside - SanBernardino, CA	2:48	0:10	1.11	1	1.27	1	-1%	100%
Sacramento, CA	1:49	0:03	1.09	1	1.25	0	0%	100%
St. Louis, MO	6:36	0:40	1.06	0	1.23	0	-1%	97%
Salt Lake City, UT	2:37	0:43	1.07	3	1.27	12	0%	85%
San Antonio, TX	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
San Diego, CA	2:21	0:03	1.12	1	1.32	1	-2%	100%
San Francisco, CA	3:17	0:11	1.17	2	1.36	2	0%	100%
Seattle, WA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Tampa, FL	3:39	0:05	1.17	1	1.38	1	-3%	99%

Notes: Green bolded values indicate improving conditions; red italics indicate worsening conditions.Comparison of 2013 to 2012 is for the same three-month Period (January - March)

Source: (FHWA 2013)

Appendix B: IMPLAN Analysis

This appendix provides detailed information on the modeling for each analysis-by-parts component for each funding scenario.

For each funding scenario, the seven models are reported as follows.

- Construction commodity purchases: Construction commodity purchases represent the 59% of construction or capital expenditure spending that goes toward the purchase of construction commodities. Therefore, only indirect and induced effects are reported.
- Construction direct employment and labor income: Direct employment and labor income from construction work are captured separately, and therefore only direct effects are reported.
- Construction labor and proprietor income: Construction labor and proprietor income represents the 40% of construction spending not captured in the construction commodity purchases, of which 29% can be attributed to labor income and 8.75% can be attributed to proprietor income. As this represents just income spending, only induced effects are generated. Categories 1, 2, and 3 outlined above are aggregated to generate the total effects of construction or capital expenditure spending by U.S. DOT.
- Administration: Administration spending is modeled as federal government employment income. This generates direct employment (estimate of federal employment) as well as induced employment as federal government workers spend their labor income. Indirect employment is not generated, as there is no supply chain or market relationship with government employment.
- Maintenance commodity purchases: Maintenance commodity purchases represent the 54% of maintenance expenditure spending that goes toward the purchase of maintenance commodities. Therefore, only indirect and induced effects are reported.
- Maintenance direct employment and labor income: Direct employment and labor income from maintenance work is reported separately, and therefore only direct effects are reported.
- Maintenance labor and proprietor income: Maintenance labor and proprietor income represents the 46% of maintenance spending not captured in the maintenance commodity purchases, of which labor accounts for 34%, and proprietor income nearly 9%. As this represents just income spending, only induced effects are generated. Categories 5, 6, and 7 outlined above are aggregated to generate the total effects of maintenance spending by U.S. DOT.

Analysis-By-Parts: Low Scenario

Construction Commodity Purchases (59%): Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	151,170	$10,190,098,394	$16,361,780,453	$32,127,872,657
Induced Effect	207,954	$11,186,352,333	$18,780,783,632	$31,179,793,423
Total Effect	359,124	$21,376,450,727	$35,142,564,085	$63,307,666,081

Construction Direct Labor: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	216,119	$13,584,450,301	$14,692,255,009	$35,366,359,652
Indirect Effect	0	$0	$0	$0
Induced Effect	0	$0	$0	$0
Total Effect	216,119	$13,584,450,301	$14,692,255,009	$35,366,359,652

Construction Labor and Proprietor Income: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	0	$0	$0	$0
Induced Effect	217,175	$11,597,717,991	$19,722,981,471	$32,958,764,090
Total Effect	217,175	$11,597,717,991	$19,722,981,471	$32,958,764,090

Total All Construction Impacts: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	216,119	$13,584,450,301	$14,692,255,009	$35,366,359,652
Indirect Effect	151,170	$10,190,098,394	$16,361,780,453	$32,127,872,657
Induced Effect	425,129	$22,784,070,324	$38,503,765,103	$64,138,557,513
Total Effect	792,418	$46,558,619,019	$69,557,800,565	$131,632,789,823

Administration: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	87,817	$11,668,247,222	$16,100,839,930	$16,147,846,313
Indirect Effect	0	$0	$0	$0
Induced Effect	207,975	$11,130,087,160	$18,903,244,033	$31,564,413,729
Total Effect	295,792	$22,798,334,382	$35,004,083,963	$47,712,260,042

Maintenance Commodity Purchases (54%): Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	81,548	$5,312,233,046	$8,810,703,154	$17,248,583,749
Induced Effect	111,066	$5,979,309,182	$10,022,311,146	$16,625,164,524
Total Effect	192,613	$11,291,542,228	$18,833,014,300	$33,873,748,273

Maintenance Direct Labor: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	142,087	$9,011,933,009	$9,774,843,067	$20,801,791,128
Indirect Effect	-	$0	$0	$0
Induced Effect	-	$0	$0	$0
Total Effect	142,087	$9,011,933,009	$9,774,843,067	$20,801,791,128

Maintenance Labor and Proprietor Income: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	0	$0	$0	$0
Induced Effect	144,260	$7,704,504,694	$13,102,664,241	$21,895,564,609
Total Effect	144,260	$7,704,504,694	$13,102,664,241	$21,895,564,609

Total All Maintenance Impacts: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	142,087	$9,011,933,009	$9,774,843,067	$20,801,791,128
Indirect Effect	81,548	$5,312,233,046	$8,810,703,154	$17,248,583,749
Induced Effect	255,325	$13,683,813,876	$23,124,975,387	$38,520,729,133
Total Effect	478,960	$28,007,979,931	$41,710,521,608	$76,571,104,010

Total Construction, Administration, & Maintenance: Low Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	446,023	$34,264,630,532	$40,567,938,006	$72,315,997,093
Indirect Effect	232,718	$15,502,331,440	$25,172,483,607	$49,376,456,406
Induced Effect	888,429	$47,597,971,360	$80,531,984,523	$134,223,700,375
Total Effect	1,567,170	$97,364,933,332	$146,272,406,136	$255,916,153,875

Analysis-By-Parts: Mid Scenario

Construction Commodity Purchases (59%): Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	190,060	$12,811,600,750	$20,571,008,308	$40,393,081,746
Induced Effect	261,452	$14,064,150,747	$23,612,323,685	$39,201,099,868
Total Effect	451,512	$26,875,751,496	$44,183,331,993	$79,594,181,613

Construction Direct Labor: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	271,718	$17,079,183,325	$18,471,981,656	$44,464,702,411
Indirect Effect	0	$0	$0	$0
Induced Effect	0	$0	$0	$0
Total Effect	271,718	$17,079,183,325	$18,471,981,656	$44,464,702,411

Construction Labor and Proprietor Income: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	0	$0	$0	$0
Induced Effect	273,045	$14,581,344,650	$24,796,911,822	$41,437,729,285
Total Effect	273,045	$14,581,344,650	$24,796,911,822	$41,437,729,285

Total All Construction Impacts: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	271,718	$17,079,183,325	$18,471,981,656	$44,464,702,411
Indirect Effect	190,060	$12,811,600,750	$20,571,008,308	$40,393,081,746
Induced Effect	534,497	$28,645,495,397	$48,409,235,507	$80,638,829,153
Total Effect	996,275	$58,536,279,471	$87,452,225,471	$165,496,613,309

Administration: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	110,408	$14,670,018,218	$20,242,938,859	$20,302,038,094
Indirect Effect	0	$0	$0	$0
Induced Effect	261,478	$13,993,411,204	$23,766,288,892	$39,684,668,626
Total Effect	371,887	$28,663,429,422	$44,009,227,751	$59,986,706,719

Maintenance Commodity Purchases (54%): Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	102,526	$6,678,857,608	$11,077,343,800	$21,685,952,745
Induced Effect	139,638	$7,517,545,687	$12,600,649,947	$20,902,152,750
Total Effect	242,165	$14,196,403,295	$23,677,993,747	$42,588,105,494

Maintenance Direct Labor: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	178,640	$11,330,341,131	$12,289,517,280	$26,153,255,842
Indirect Effect	0	$0	$0	$0
Induced Effect	0	$0	$0	$0
Total Effect	178,640	$11,330,341,131	$12,289,517,280	$26,153,255,842

Maintenance Labor and Proprietor Income: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	0	$0	$0	$0
Induced Effect	181,372	$9,686,564,063	$16,473,453,078	$27,528,413,272
Total Effect	181,372	$9,686,564,063	$16,473,453,078	$27,528,413,272

Total All Maintenance Impacts: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	178,640	$11,330,341,131	$12,289,517,280	$26,153,255,842
Indirect Effect	102,527	$6,678,857,608	$11,077,343,800	$21,685,952,745
Induced Effect	321,010	$17,204,109,750	$29,074,103,025	$48,430,566,022
Total Effect	602,177	$35,213,308,489	$52,440,964,105	$96,269,774,608

Total Construction, Administration, & Maintenance: Mid Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	560,767	$43,079,542,674	$51,004,437,795	$90,919,996,347
Indirect Effect	292,587	$19,490,458,358	$31,648,352,108	$62,079,034,491
Induced Effect	1,116,986	$59,843,016,351	$101,249,627,424	$168,754,063,801
Total Effect	1,970,340	$122,413,017,382	$183,902,417,327	$321,753,094,636

Analysis-By-Parts: High Scenario

Construction Commodity Purchases (59%): High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	238,805	$16,097,409,405	$25,846,882,765	$50,752,750,315
Induced Effect	328,507	$17,671,202,602	$29,668,208,430	$49,255,059,225
Total Effect	567,312	$33,768,612,007	$55,515,091,194	$100,007,809,540

Construction Direct Labor: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	341,406	$21,459,505,613	$23,209,516,900	$55,868,627,485
Indirect Effect	0	$0	$0	$0
Induced Effect	0	$0	$0	$0
Total Effect	341,406	$21,459,505,613	$23,209,516,900	$55,868,627,485

Construction Labor and Proprietor Income: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	0	$0	$0	$0
Induced Effect	343,073	$18,321,042,722	$31,156,610,845	$52,065,322,283
Total Effect	343,073	$18,321,042,722	$31,156,610,845	$52,065,322,283

Total All Construction Impacts: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	341,406	$21,459,505,613	$23,209,516,900	$55,868,627,485
Indirect Effect	238,805	$16,097,409,405	$25,846,882,765	$50,752,750,315
Induced Effect	671,580	$35,992,245,324	$60,824,819,275	$101,320,381,508
Total Effect	1,251,792	$73,549,160,342	$109,881,218,939	$207,941,759,308

Administration: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	138,726	$18,432,458,525	$25,434,673,999	$25,508,930,498
Indirect Effect	0	$0	$0	$0
Induced Effect	328,541	$17,582,321,153	$29,861,662,596	$49,862,651,679
Total Effect	467,266	$36,014,779,679	$55,296,336,595	$75,371,582,177

Maintenance Commodity Purchases (54%): High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	128,822	$8,391,792,930	$13,918,364,612	$27,247,777,329
Induced Effect	175,452	$9,445,580,434	$15,832,355,073	$26,262,955,127
Total Effect	304,274	$17,837,373,364	$29,750,719,685	$53,510,732,456

Maintenance Direct Labor: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	224,456	$14,236,249,735	$15,441,427,147	$32,860,818,332
Indirect Effect	0	$0	$0	$0
Induced Effect	0	$0	$0	$0
Total Effect	224,456	$14,236,249,735	$15,441,427,147	$32,860,818,332

Maintenance Labor and Proprietor Income: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	0	$0	$0	$0
Induced Effect	227,888	$12,170,890,839	$20,698,422,874	$34,588,664,334
Total Effect	227,888	$12,170,890,839	$20,698,422,874	$34,588,664,334

Total All Maintenance Impacts: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	224,456	$14,236,249,735	$15,441,427,147	$32,860,818,332
Indirect Effect	128,822	$8,391,792,930	$13,918,364,612	$27,247,777,329
Induced Effect	403,340	$21,616,471,273	$36,530,777,947	$60,851,619,461
Total Effect	756,618	$44,244,513,938	$65,890,569,706	$120,960,215,122

Total Construction, Administration, & Maintenance: High Scenario				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	704,588	$54,128,213,873	$64,085,618,046	$114,238,376,315
Indirect Effect	367,627	$24,489,202,335	$39,765,247,377	$78,000,527,644
Induced Effect	1,403,461	$75,191,037,750	$127,217,259,818	$212,034,652,648
Total Effect	2,475,676	$153,808,453,959	$231,068,125,240	$404,273,556,607

Endnotes

1 Just-in-time inventory systems receive goods and inputs only as they are needed, thus minimizing the value of goods held in inventory in an effort to decrease waste and cost.

2 See, for example, American Public Transportation Association (2014) "Economic Impact of Public Transportation Investment"; University of Massachusetts – Amherst (2009) "How Infrastructure Investments Support the U.S. Economy"; and Federal Highway Administration 2007, as cited in American Society of Civil Engineers (2011) "Failure to Act: The Economic Impact of Current Investment Trends in Surface Transportation Infrastructure."

3 Over the 2008-2012 period there has been a decrease in overall VMT traveled, which is largely seen as a reaction to the recession and fluctuating gas prices, but most predict that this is not a long-lasting trend (ASCE 2013a; DOT 2013; Winston 2013).

4 The data for total infrastructure miles is from 2012; tonnage value is from 2007. This is the most up-to-date data containing all available modes as presented in the 2013 "Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance."

5 It is worth noting that in some federal programs—of which there are many different types—federal funds can be used on non-federal-aid highways (see www.fhwa.gov/accelerating/grants).

6 The seven Class I Rail Roads consist of: BNSF Railway Co.; CN; Canadian Pacific; CSX Corp.; Kansas City Southern; Norfolk Southern Railway's; and Union Pacific Corp.

7 Regional RRs/Local/Short Lines are generally represented by the American Short Line and Regional Railroad Association (ASLRRA).

8 The Grants-in-Aid for airports is channeled to states and local entities through the Airport Improvement Program (http://www.faa.gov/airports/aip/)

9 Data available on: http://primis.phmsa.dot.gov/comm/PipelineBasics.htm

10 http://www.census.gov/foreign-trade/index.html

11 As Switzerland is not part of the EU-27 and the dataset containing this information only covers EU-27, it is excluded.

12 A 2013 report by Sacramento Bee (Piller 2014b) states that the difference was actually $250 million and not $400 million.

13 Wherein certain permit concessions were granted to streamline the time it would normally have taken to get from conception to breaking-ground; for example in the case of Tappan Zee Bridge the average time was cut to 1.5 years down from the average 5 years (Foxx 2014).

14 A job-year is a standard measure of the employment impact of a project used by industry and government agencies and is defined as one job held for one year (ESD and NYS DOL 2013).

15 The low and mid- transportation investment scenarios are the "budgetary resources" of the USDOT, which are the funds available to be used in a given fiscal year, including new budget authority, unobligated balances of budget authority, direct spending authority, and obligation limitations (Source: CBO). Budgetary resources rely on appropriations and other revenue sources, including the Highway Trust Fund and user fees, to reach funding levels. Reductions in Highway Trust Fund monies would require an increase in other funding sources or result in a reduction in the budgetary resources available to the USDOT.

16 IMPLAN currently has 440 sectors based on the Bureau of Economic Analysis' Benchmarking Tables. One challenge with the recent benchmarking scheme is the consolidation of construction activities into a larger IMPLAN sector 36: New Nonresidential Construction. This limits the specificity of modeling construction related activities. Yet, it remains the best option for modeling construction related activities such as highway, bridges, roads, passenger rail, freight rail, and other modes of transportation, especially when conducting aggregate level modeling of transportation spending. IMPLAN 3.0 does allow users to import the spending pattern from the IMPLAN 2.0 model for construction and maintenance of highways, bridges, and tunnels. This spending pattern is based on the 2002 BEA benchmark input-output tables. Unfortunately, the commodity spending purchases for these categories are less than those for the existing construction and maintenance category in the model. For example, the construction commodity purchase utilized in the model accounts for nearly 60 cents of each dollar spent, while

highway, bridge, and tunnel construction only accounts for 47 cents of each dollar spent. Several sensitivity analyses were conducted, and the construction and maintenance categories used yielded higher employment and output numbers than the highway, bridges, and tunnels sector, and more accurately captured the employment impact of spending consistent with prior studies. Additionally, the mix of industries stimulated by spending (for example manufacturing, retail trade, service, etc.) was largely consistent across both approaches.

17 As modeled here, manufacturing employment is derived from the indirect and induced effects of construction and maintenance activities stimulated by transportation infrastructure investments.

18 “Employment” is the average total annual jobs and includes all full-time, part-time, seasonal jobs, and self-employed. Full-time/part-time jobs have been averaged over twelve months (Day, n.d., 62).

19 “Labor income” is the total value paid to local workers within a region (Day, n.d., 62).

20 “Value added” is comprised of labor income, indirect business taxes, and other property-type income. This category measures an industry’s value of production over the cost of purchasing the goods and services required to make products. Value added is often referred to as Gross Regional Product (GRP) (Day, n.d., 62).

21 “Output” is the total value of an industry’s production, comprised of the intermediate inputs and value added. In IMPLAN, Output is the value of a change in sales or the value of increased production (Day, n.d., 62).

22 This assumes that the unemployed would have the requisite skill set to fill the new jobs created from U.S. DOT spending or jobs opened up as currently-employed individuals moved from existing jobs to newly created jobs.

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