



Northeastern University  
*Kitty and Michael Dukakis Center  
for Urban and Regional Policy*

# Reviving the U.S. Rail and Transit Industry: Investments and Job Creation

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Joan Fitzgerald   Lisa Granquist   Ishwar Khatiwada  
Joe McLaughlin   Michael Renner   Andrew Sum

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## About the Authors

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**Joan Fitzgerald** is professor and director of the graduate program in Law, Policy and Society and a Senior Research Fellow at the Kitty and Michael Dukakis Center for Urban and Regional Policy at Northeastern University. Her third book, *Emerald Cities: Urban Sustainability and Economic Development*, examines how cities are creating economic development opportunities in several green sectors and discusses the state and national policy needed to support these efforts. *Emerald Cities* builds on her 2002 book, *Economic Revitalization: Strategies and Cases for City and Suburb*, which identifies strategies for incorporating sustainability and social justice goals into urban economic development planning. Her 2006 book, *Moving Up in the New Economy*, focuses on how to build career ladders for low-income workers. Fitzgerald has published in journals such as *Economic Development Quarterly*, *Urban Affairs Quarterly*, *Urban Affairs*, and *The American Prospect*. Her academic and consulting work has been supported by the John D. and Catherine T. MacArthur, Annie E. Casey, Rockefeller Brothers, Rockefeller, Surdna, Century, and Robert Wood Johnson Foundations. She has also conducted research for the U.S. Department of Labor, the Massachusetts Technology Collaborative, the Boston Housing Authority, and other government agencies.

**Lisa Granquist** is a Ph.D. student in the Law, Policy and Society Program in the School of Public Policy and Urban Affairs at Northeastern University. She has worked in the manufacturing and nonprofit sectors and in business development of new technologies. Her current research focuses on climate adaptation solutions for coastal areas.

**Ishwar Khatiwada** is a Senior Research Associate at the Center for Labor Market Studies at Northeastern University. He has authored or co-authored numerous journal articles, monographs, and research reports on labor market information at the national and local level.

**Joseph McLaughlin** is a Senior Research Associate at the Center for Labor Market Studies at Northeastern University. He has worked on numerous youth labor market research and program evaluations including a longitudinal tracking study of the college persistence rates and college graduation rates of graduates from Boston Public Schools' Class of 2000, the education and employment outcomes for recent graduates from the Boston Public School system, and the education and employment outcomes of Jobs for America's Graduates program participants.

**Michael Renner** is a Senior Researcher at the Worldwatch Institute. His work has focused on a variety of linkages between the environment and other global concerns, with particular focus on transportation issues and the connections between environment and employment. With colleagues at the Global Labor Institute (Cornell University), Michael authored *Green Jobs: Toward Decent Work in a Sustainable, Low-Carbon Economy*, published by the United Nations Environment Programme in 2008. He has also collaborated with a broad variety of other organizations on this topic, including WWF, the Friedrich Ebert Foundation (Germany), Carbon Forum Asia, the Workplace Research Centre at the University of Sydney, and the Political Economy Research Institute (PERI) at the University of Massachusetts.

**Andrew M. Sum** is Professor of Economics and Director of the Center for Labor Market Studies at Northeastern University. For the past 35 years, he has conducted research at the national, state, and local levels on a wide array of labor market and workforce development topics, including the educational and labor market experiences of teens and young adults. Among his recent research studies are: *On-Time High School Graduation Rates and College Enrollment Rates for Massachusetts High School Graduates, Class of 2006 and 2007: The Existence of Large Disparities Between Affluent Suburban and Central City School Districts Across the Commonwealth* (May 2008); *Declining Teen Employment Prospects in Massachusetts and the U.S.: The Case for An Immediate Youth Jobs Stimulus Program in the Nation and State* (February 2008); *The Collapse of the National Teen Job Market and the Case for An Immediate Youth Jobs Creation Program* (February 2008); and *An Assessment of the Labor Market, Income, Social, Health, Civic, Incarceration, and Fiscal Consequences of Dropping Out of High School: Findings for Michigan Adults in the 21st Century* (January 2008).

## The Apollo Transportation Manufacturing Initiative

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With support from the Rockefeller and Surdna Foundations, the Apollo Alliance partnered with Northeastern University, the Worldwatch Institute, and the Duke University Center on Globalization, Governance & Competitiveness to conduct research, engage stakeholders, and develop policy recommendations to inform the emergence of a comprehensive strategy to create good American jobs by bolstering the domestic manufacture of advanced rail and transit vehicles systems and component parts. Over the course of 2010, the initiative culminated in the release of four separate reports:

***U.S. Manufacture of Rail Vehicles for Intercity Passenger Rail and Urban Transit,***

Duke University Center on Globalization, Governance & Competitiveness

Modeled on its previous analyses of the hybrid truck and public transit bus supply chains, the Center on Globalization, Governance & Competitiveness mapped the supply chain for the U.S. passenger railcar industry. The study details nearly 250 existing manufacturing locations in 35 states that are currently producing rail vehicles or component parts. While domestic manufacturers exist in many of the industry subsectors, the U.S. supply chain has several gaps, and many higher-value added activities are still performed abroad. The U.S. passenger and transit rail supply chain currently supports between 10,000 and 14,000 employees, numbers that could grow with scaled-up U.S. investments in public transit and intercity rail.

***Global Competitiveness in the Rail and Transit Industry,***

Worldwatch Institute

To inform ongoing discussions at the U.S. federal, state, and local levels regarding public investments in rail and urban transit, the Worldwatch Institute analyzed global rail industry trends and profiled four countries—Germany, Spain, Japan, and China—that have made major commitments to public transportation and that offer important lessons for the United States. The report finds that at least half a million people in total are directly employed in rail vehicle manufacturing in these countries. The creation of strong rail manufacturing industries has depended to a significant degree on steady domestic markets for these products, driven by substantial and sustained investments in rail and transit infrastructure.

***Reviving the U.S. Rail and Transit Industry: Investments and Job Creation,***

Northeastern University & Worldwatch Institute

Northeastern University and the Worldwatch Institute estimated potential manufacturing job creation in the transit bus and passenger railcar supply chains under different scenarios of federal investment: the current funding levels, increased domestic investment, and international comparative investment. Building on the supply chain analyses conducted by Duke University, the study finds that the United States could gain over 79,000 jobs in rail and bus manufacturing and related industries if public transit were funded at a level that would double transit ridership in 20 years, and more than 250,000 jobs if the country were to invest as much



in transit as China does. Employment gains across both rail and bus supply chains could increase by up to 30 percent if stronger domestic supply chains allowed for greater domestic content. The authors conclude that the United States needs a more coherent industrial policy to link public transportation and manufacturing goals.

*Make It in America: The Apollo Clean Transportation Manufacturing Action Plan,*  
Apollo Alliance

Based on the successful GreenMAP initiative, which developed a comprehensive strategy for expanding the U.S. clean energy manufacturing sector, the Apollo Alliance convened a diverse set of political stakeholders, including labor and business leaders, transportation, economic development, and environmental policy experts, to identify the policy needed to expand the domestic manufacture of advanced bus and rail transit systems, clean freight technologies, and their component parts. The resulting policy recommendations call for expanded investment in clean transportation options and for a comprehensive manufacturing strategy to create good American jobs by providing the supports needed to ensure that expanded demand for an advanced transportation system is met by U.S. manufacturers.

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*For copies of the reports and more information about the Apollo Transportation Manufacturing Initiative, please visit [www.apolloalliance.org/programs/tmap](http://www.apolloalliance.org/programs/tmap).*

## Summary

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With the federal transportation bill up for renewal, the United States has an opportunity to invest in public transportation and renew its manufacturing base. This report reveals that the country could gain more than 79,000 jobs in rail and bus manufacturing and related industries under an investment scenario sufficient to double transit ridership in 20 years. If the United States were to invest at even higher levels—similar to those of China—this would yield more than a quarter million jobs.

The United States needs urgently to revive its rail and transit industry. The nation's manufacturing sector accounts for over 10 percent of GDP, but manufacturing has seen job losses in the millions in recent years. And the U.S. trade deficit continues to rise. The country needs new manufacturing jobs now to address the trade deficit and to put unemployed Americans back in well-paying jobs.

While the United States has lost its competitive edge in producing many high-tech goods, it is not too late to follow the strategy of European nations and China in building a strong transit vehicle industry. Spain has consistently invested \$10 billion per year on average in its high-speed passenger rail system since 1992, and France is rapidly expanding its already well-developed rail transit network, in part to help meet greenhouse gas emissions reduction goals. Both countries have mature rail manufacturing sectors, and one of the world's largest rail vehicle manufacturers, Bombardier, is a French firm.

The lessons of Europe have not been lost on China, which plans to spend nearly \$293 billion to meet its 2012 goals for high-speed rail and other rail and transit expansion. In addition to a world-class train network, China is using the initiative as a vehicle to create 6 million jobs and to generate demand for 20 million tons of domestic steel.

The United States, for the most part, has abandoned its domestic passenger rail and transit bus industries. The loss of these industries in the 1970s and 80s was largely a function of unstable demand rather than of high labor costs. As domestic demand for transit vehicles waned, U.S. companies did not keep up with state-of-the-art transit technologies. To retain some degree of local production, Congress adopted "Buy America" legislation that requires that 60 percent of the value of subcomponents of transit vehicles and equipment be produced domestically, and that final assembly also occur in the country. This stipulation motivated foreign suppliers to enter the U.S. market to supplement the more stable demand for equipment in their own countries.

The American Recovery and Reinvestment Act of 2009 (ARRA) has made a down payment on rebuilding the U.S. transit infrastructure. Under ARRA, the federal government committed an initial \$1.3 billion for the rail operator Amtrak in addition to the \$8 billion for new high-speed rail corridors and intercity passenger rail service. Many cities and states are advocating that the government commit further funds so that they can upgrade and expand their transit systems.

However, a much larger investment is needed to create the stable demand for bus and rail vehicles that will motivate U.S. and foreign firms to expand their U.S. manufacturing operations and workforces. If more stimulus funds are directed to rail infrastructure, and if the next federal transportation bill makes a significant investment in public transit, the United States could develop world-class public transportation and create highly needed

jobs while helping to reduce urban traffic congestion and greenhouse gas emissions in the nation's cities.

This report uses three scenarios to estimate the job creation potential from increased federal investment in rail and transit. A "Business-as-Usual" scenario would invest \$2.7 billion in rail vehicles and \$2.8 billion in bus purchases. An "Increased Domestic Investment" scenario would invest \$7.2 billion and \$4.8 billion, respectively, toward these purchases. And an "International Competitiveness" scenario would invest \$24.4 billion and \$12.8 billion, respectively—a level that is comparable to China's investment in rail and bus vehicles.

The "Business-as-Usual" scenario yields 34,563 jobs in U.S. rail car and bus manufacturing and their supplier industries. The "Increased Domestic Investment" scenario would support 79,343 jobs, and the "International Competitiveness" scenario would yield 252,213 jobs. The number of jobs would increase significantly if more than the required 60 percent of inputs (as specified by the Buy America provision) were produced domestically. These jobs would stimulate thousands more jobs in other sectors of the economy.

Such analysis does not apply just to transit vehicles, but also to other clean-technology industries that will be growing dramatically over the coming decades. If U.S. manufacturing is to experience a serious revival that produces more than fragmented showcase projects and scattered jobs, the federal government needs to take much bolder policy action that creates demand and supports research and development in key industries.

## Linking U.S. Manufacturing and Transportation

*“U.S. manufacturers are not likely to decide to reenter the market and manufacture railcars unless the U.S. Government (like other major Western countries and Japan) assures a stable, predictable, and planned rail equipment market that spreads orders out more or less evenly and in manageable sizes.”<sup>1</sup>*

—U.S. Congress, Office of Technology Assessment, 1983

In announcing the \$8 billion federal investment in high-speed rail in 2008, U.S. President Barack Obama observed: “I don’t want to see the fastest train in the world built halfway around the world in Shanghai. I want to see it built right here in the United States of America.”<sup>2\*</sup>† Unfortunately, the United States lags behind China and many other countries both in maintaining and expanding its public transit infrastructure and in creating the high-paying manufacturing jobs that can go along with this investment.

The American Recovery and Reinvestment Act of 2009 (ARRA) made a small start toward putting the country back on track. Under ARRA, the federal government committed an initial \$1.3 billion for the rail operator Amtrak in addition to the \$8 billion for new high-speed rail corridors and intercity passenger rail service. Many cities and states are advocating that the government commit further funds. U.S. cities are eager to upgrade and expand their transit systems to meet rising public demand for cost-effective, clean, and convenient bus and rail service.<sup>‡</sup> Currently, there are proposals for new streetcars in more than 30 cities; some 400 light-rail projects in 78 metropolitan areas

in 37 states; and subway expansions in several cities.

With the federal transportation bill up for renewal, the United States has an opportunity to invest in public transportation and renew its manufacturing base. Manufacturing is essential to the U.S. economy. In 2008, it accounted for \$1.6 trillion, or 12 percent, of gross domestic product (GDP)—more than real estate, finance and insurance, or health care. Manufacturing accounts for 60 percent of U.S. exports and 70 percent of private sector research and development (R&D) funding.<sup>3</sup> Yet the U.S. goods deficit in 2008 exceeded \$836 billion; the annual trade deficit with China alone that year was \$266 billion, about 75 percent of the manufactured goods deficit.



*A station of the LYNX light rail system in Charlotte, North Carolina.*

Payton Chung

The United States cannot prosper with ongoing large trade deficits. Nor can it prosper while losing millions of well-paying manufacturing jobs. In just the past two years, U.S. manufacturing lost 2.1 million jobs. Blue-collar workers accounted for 74 percent of

\* Endnotes are grouped by section and begin on page 36.

† All dollar amounts are expressed in U.S. dollars.

‡ Throughout this report, “rail and transit” refers to intercity passenger rail (including high-speed rail) and all forms of urban mass transit. The latter includes trams, light rail systems, subways, and bus lines.

job losses between the onset of the economic recession in September 2008 and November 2009. For experienced production workers, the unemployment rate in 2009 was 14 percent.<sup>4</sup>

The United States needs to revitalize manufacturing to put people back to work, but also to stem the country's declining position in the world economic order. Conventional wisdom says that the nation has transitioned from a goods-producing economy to a knowledge- and innovation-based economy. But the two are intricately related. An innovation-based economy relies on R&D that is connected to manufacturing high-technology goods.<sup>5</sup> Such goods are typically considered to be products like computers, lithium-ion batteries, and jumbo jets; however, passenger rail cars and buses also rely on high-technology systems. There is significant innovation occurring in both the bus and

rail production industries.

Other developed and industrializing countries have deliberate policies to link innovation to manufacturing advantage—commercializing the products resulting from R&D programs, investing in the education of skilled workers, and linking goals in other policy areas (such as transportation and energy) to develop export industries and create domestic jobs.<sup>6</sup> Germany has invested heavily in wind and solar over the past 20 years and used demand-creation policies to gain technological leadership, employ skilled manufacturing workers, and become an export leader.<sup>7</sup> France, Germany, Spain, and other countries have also built strong railcar manufacturing industries by aggressively expanding rail lines domestically and then moving into exports. Even relatively new entrants such as China are successfully following this model. The United States can do so as well.

## U.S. Rail and Transit Today

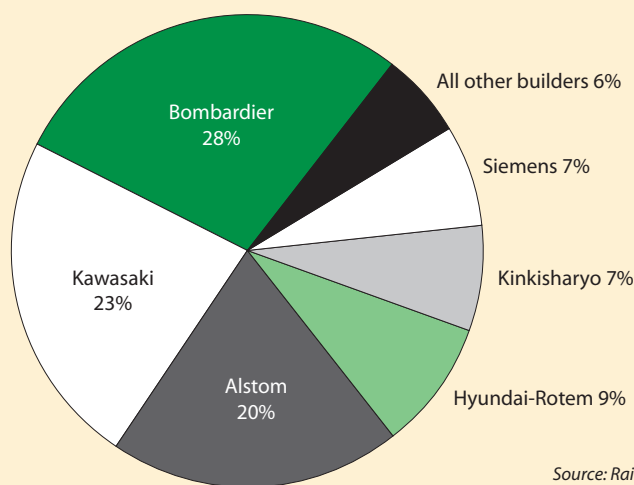
The United States once produced a wide range of transit vehicles, including subways, light and heavy railcars, and streetcars. The last U.S. subway car producer, Budd Company, stopped production in 1987. The last three streetcar builders closed down by 1970. The reason for the loss of the U.S. industry was not high labor costs—most of the countries that dominate the industry today have wages comparable to the United States. Rather, Rutgers transportation engineer Thomas Boucher identifies unstable demand as a key factor in the demise of the U.S. railcar industry, noting that during the 1970s annual domestic demand and production of the cars bounced between 268 and 1,067 units: “Instead of a series of steady orders for cars every year, the pattern of demand absorbed capacity for one or two years and left the industry with little work in other years.” As the U.S. Office of Technology Assessment observed in 1983, maintaining a domestic railcar industry requires a stable, predictable, and planned rail equipment market.<sup>1</sup>

As domestic demand for transit vehicles waned, U.S. companies did not keep up with state-of-the-art technology as subway and other railcars became more sophisticated.<sup>2</sup> Companies such as Pullman began subcontracting out more complex electronics systems but were not able to manage suppliers, leading to quality problems. The other domestic subway car producers simply moved into other industries.<sup>3</sup>

As the U.S. rail manufacturing industry crumbled, Congress passed a “Buy America” provision requiring that 60 percent of the value of the subcomponents of transit vehicles and equipment be produced domestically, and that final assembly also occur in the country.\* Foreign suppliers entered the U.S. market to supplement the stable internal demand for equipment in their own countries, the result of significant investment in rail systems.<sup>4</sup> These leading railcar manufacturers include Bombardier (Canada), Kawasaki (Japan), Alstom

(France), Hyundai-Rotem (South Korea), Kinkisharyo (Japan), and Siemens (Germany).<sup>5</sup> (See Figure 1.) Part of the reason they were able to succeed in the United States is that they could establish low-cost assembly operations to fill large orders, and then close them when the orders were filled. Because these companies generally had business far broader than the U.S. market, they could ride out years with low U.S. demand.

**Figure 1. Top Manufacturers of U.S. Railcars, by Market Share, Recent Years**



Source: *Railway Age Magazine*

Note: Figure includes regional rail, subways, light rail, and streetcars. Shares are based on the number of railcars delivered in 2006–09 and undelivered cars in progress as of January 1, 2010.

To meet Buy America requirements, some suppliers of parts and component systems have established permanent U.S. facilities, while others make temporary use of local subcontractors. According to a supply chain

\*The Buy America provisions have a complicated history. The original Buy America Act was passed in 1933, and the first Buy America provision to apply directly to transit was the Urban Mass Transportation Act of 1964. The provisions were revised in the Surface Transportation Assistance Acts of 1978 and 1982. See U.S. Federal Transit Administration, “Federal Register: Selected Buy America Rulemaking Documents (1981–Present),” [www.fta.dot.gov/printer\\_friendly/leg\\_reg\\_557.html](http://www.fta.dot.gov/printer_friendly/leg_reg_557.html).

study by Duke University's Center on Globalization, Governance & Competitiveness, an estimated 86 percent of the 153 firms identified as parts and component systems suppliers have their global headquarters in the United States; 128 of these are U.S. firms. Like the major equipment manufacturers, these parts and components firms perform their high-value engineering in their home countries. Only 22 firms had non-U.S. headquarters, primarily in France and Germany.<sup>6</sup>

Countries that have made significant investments in building their rail systems, such as France and Spain, have strong rail manufacturing industries as well.<sup>7</sup> President Obama has cited Spain as an example of how to develop high-speed rail in the United States. The country's high-speed AVE (Alta Velocidad Española) line between Barcelona and Madrid covers 324 miles in 150 minutes and has reduced air traffic between the two cities by half.\* Spain has been building high-speed rail lines since 1992 and plans to add 6,000 more miles by 2020 to network the entire country.<sup>8</sup> Spain invested \$130 billion in high-speed rail between 1992 and 2010 and plans to spend \$100 billion more over the next decade.<sup>9</sup> (See Table 1.)

**Table 1. Investment in Passenger Rail in Selected Countries, Recent Years**

Country	Pre-2011	2011 to 2015	Country Total
		<i>billion dollars</i>	
China	\$89 (2004–08) \$88 (2009) \$120 (2010)	\$61–750*	\$358–1,047*
Spain	\$130 (1992–10)	\$100	\$260
France (fixed guideway project only)		\$73 (2009–12)	\$73
United States	\$8 (1998–2002) \$8.2 (2008) \$10.3 (2009) \$3.5 (2010)	\$2.1	\$32

\*Range varies by source.  
Source: See Endnote 14 for this section.

France's government recently announced a transportation plan aimed at reducing greenhouse gas emissions 20 percent by 2020. Achieving this goal requires limiting the construction of new highways, expanding a well-developed passenger rail system (adding 1,429 miles of high-speed rail by 2020), and creating two

new freight-rail corridors. The country will also dedicate an additional \$73 billion to new public fixed-guideway transportation systems.<sup>10</sup>

Recognizing the link between developing rail lines and manufacturing, China has rapidly ramped up its spending on rail infrastructure projects. In 2001, it began a \$132 billion project to build 1,062 miles of rail, to be completed in 2012.<sup>11</sup> By comparison, the last two U.S. transportation bills appropriated only \$19 billion for rail construction over approximately the same period.<sup>12</sup> As part of its recession recovery package, China committed \$88 billion in 2009 to railway infrastructure (doubling its 2008 investment), with the goal of establishing much-needed transportation links, creating 6 million jobs, and generating demand for 20 million tons of domestic steel.<sup>13</sup> China plans to spend \$293 billion to meet its 2012 target of 1.1 million kilometers of railroad, of which 13,000 kilometers is to be high-speed rail.<sup>14</sup>

Several countries have used rail investment to support other domestic industries as well. The European Union excludes procurement activity related to rail from World Trade Organization (WTO) rules, and Canada applies the same exclusions to both the WTO and NAFTA (the North American Free Trade Agreement) and also excludes the iron and steel used in rail projects. China requires the use of 70 percent domestic content in all public transit equipment, as well as the signing of technology-transfer agreements between foreign-owned companies and domestic firms for all nationally funded transportation investments.<sup>15</sup> Similarly, the United States will need to adopt stronger measures than the current Buy America provisions to support a domestic railcar production industry that is engaged in R&D on the latest train technologies.

As detailed in the Apollo Alliance report *Make It In America: The Apollo Clean Transportation Manufacturing Action Plan*, much could be done to strengthen existing U.S. domestic content standards. While the Buy America provisions have helped the United States retain a portion of its rail and bus manufacturing industries, the country needs a strategy that links domestic transportation investments to greater industry growth by increasing the transparency and accountability of existing domestic content requirements. Among other steps, this means introducing incentives to go beyond minimally required domestic content and making tar-

\* Units of measure throughout this report are expressed in miles.

geted investments to expand the U.S. role in high-value-added research and manufacturing within the transit industry.

The story of the transit bus industry is similar to that of rail. Starting in the 1930s, General Motors and Flxible were the only two U.S. transit bus manufacturers until the 1970s. The Canadian company New Flyer entered the U.S. market in the early 1970s, followed in the early 1980s by European producers such as Volvo and Scania, who were lured by the U.S. government to help meet the anticipated rise in demand for buses due to the oil crisis. This demand did not materialize, and, after several rounds of mergers and acquisitions, most of the players closed by the end of the 1980s.

Today, only five companies produce 98 percent of U.S. transit buses.<sup>16</sup> (See Table 2.) Only one of the five, Gillig, does all of its product development and vehicle manufacturing exclusively in the United States; the others produce domestically only roughly what is required under the Buy America provisions. According to the Duke University study, these five bus manufacturers employ 2,482 people in North America (although estimates vary), and total employment in the global supply chain is between 25,000 and 33,000 jobs.<sup>17</sup>

The recent economic recession as well as funding crises at local U.S. transit agencies have taken a toll on related employment. In 2008, New Flyer had a large backlog of new bus orders from U.S. cities, including Seattle, Portland, Phoenix, Cleveland, and Washington, D.C. But these and other cities delayed or cancelled orders when the recession hit. As a result, New Flyer laid off 13 percent of its workforce in 2009.<sup>18</sup> Three other U.S. bus manufacturers have also laid off workers, and Nova, a subsidiary of Volvo that opened its first U.S. facility in 2008, is gearing up more slowly than planned.

The Duke University analysis identifies at least 76 U.S. companies that manufacture inputs to buses. But there has been recent consolidation in the U.S. supply chain for major component systems. Of the 10 transmission suppliers listed in the Duke study, for example, only one, Allison Transmissions (formerly owned by General Motors), is a major supplier for transit buses.<sup>19</sup> The supply chain for transit bus axle systems also has only one U.S. manufacturer, ArvinMeritor. Due to this limited production, if U.S. transit funding were to increase it would be difficult for bus manufacturers to

**Table 2. U.S. Transit Bus Manufacturers, Facts and Figures**

Manufacturer	Final Assembly Location	Employment	2009 U.S. Transit Bus Sales	Market Share
			<i>(million dollars)</i>	<i>(percent)</i>
New Flyer	St. Cloud and Crookston, MN	2,226 (U.S. and Canada)	850 (U.S. only)	38
Gillig	San Francisco, CA	n.a.	563 (est.)	25
Orion (Daimler)	Oriskany, NY	585 (1,324 all locations)	566 (in 2008)	25
Nova (Volvo)	Plattsburg, NY	250	135	6
NABI	Anniston, AL	n.a.	90	4
Other			45	2

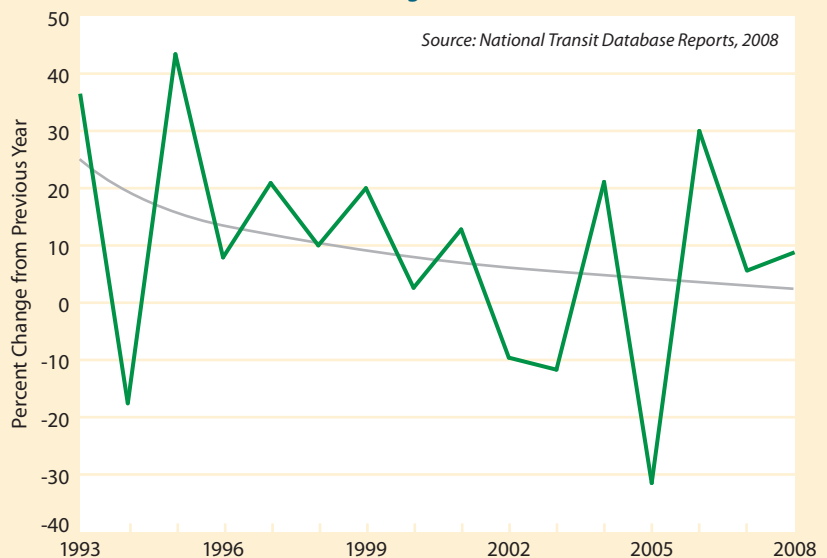
Source: See Endnote 16 for this section.

expand domestic sourcing of these critical components and systems.

As with passenger rail cars, the unpredictability of demand is a key factor in the contraction of the U.S. bus industry and provides a disincentive for manufacturers to invest in facilities, equipment, and R&D.<sup>20</sup> Most transit agencies do not have a regular schedule of bus replacement or refurbishing that would allow manufacturers to predict order streams over a longer period. Spending on new bus vehicles (i.e., rolling stock) has been irregular, making it difficult for manufacturers to anticipate demand.<sup>21</sup> (See Figure 2).

Facing shrinking budgets, many transit agencies

**Figure 2. U.S. Capital Expenditures on Transit Bus Rolling Stock, Percent Change, 1993–2008**





have had to shift funds to preventive maintenance or other critical capital investments rather than purchasing new buses and railcars. As a result, at least 41 percent of U.S. transit buses are in poor or marginal condition, and more than half of the rail vehicles in service need to be replaced within six years.<sup>22</sup> At this point, even funding U.S. transit systems just to maintain them at acceptable operating standards would achieve long-term, predictable order streams.

The Federal Transportation Administration's *2010 National State of Good Repair Assessment* estimates that \$13.5 billion is needed to replace U.S. buses and \$16.2 billion to replace U.S. railcars that have exceeded their useful life or whose conditions fall below the acceptable minimum threshold.<sup>23</sup> To remedy the bus backlog and maintain the existing fleet, annual investments of \$6.8 billion over six years would be needed, or a total of almost \$41 billion. For rail, remedying the backlog and maintaining the existing fleet would require \$5.8 billion annually over six years, or almost \$35 billion. This combined investment of \$76 billion would do nothing to actually expand bus and rail and meet the pent up demand for additional transit services. Addressing the needs for both maintenance and expanded service would require even further investments.

Substantial and sustained investment is needed to support safe transit and manufacturing jobs in the United States. Although bus and railcar manufacturers have welcomed the uptick in orders created by economic stimulus funds, company representatives emphasize that short-term funding will not maintain enough demand to support the industry.<sup>24</sup> The same is true for suppliers. The Duke University analysis notes that although bus manufacturers depend heavily on suppliers of key components such as engines and transmissions, the bus industry is of low importance to many suppliers because most of their orders come from other industries. If the increased demand from bus manufacturers

is viewed as temporary, suppliers will not increase their capacity to meet it. Similar patterns are evident in the rail industry supply chain.

Another challenge for producers of both buses and passenger railcars is that most transit agencies specify customized features on their orders. Customization can increase production costs 20–30 percent, as it requires more engineering work and changes on the assembly line. In both the bus and rail industries, component suppliers typically solicit transit agencies directly to promote their products, and the agencies then request the specific components. This highly customized ordering process results in more expense per unit at all procurement levels; more time needed for funding agencies to review proposals and approve funding; more time needed for manufacturers to produce the items; and increased delivery times. If a transit agency requests an item (such as an electronic component) that is not a proven technology, warranty costs increase as well.

The challenges of both over-customization and the unpredictability of demand can be addressed in the context of the U.S. transportation bill now up for review. What the United States needs to decide is whether it has the political will to follow the path of other rail and transit leaders—countries that have realized the relationship between investment in infrastructure, manufacturing, and leading the market in the associated technologies. The failure to make this investment has put the United States behind.

But it is not too late to revitalize the nation's rail and bus manufacturing capacity. If the United States were to dramatically increase its investment in public transit, this would not only spur greater production of railcars and buses, but it would also lead to significant job creation in these industries. It is high time for the U.S. government to consider the critical links between manufacturing and transportation nationwide.

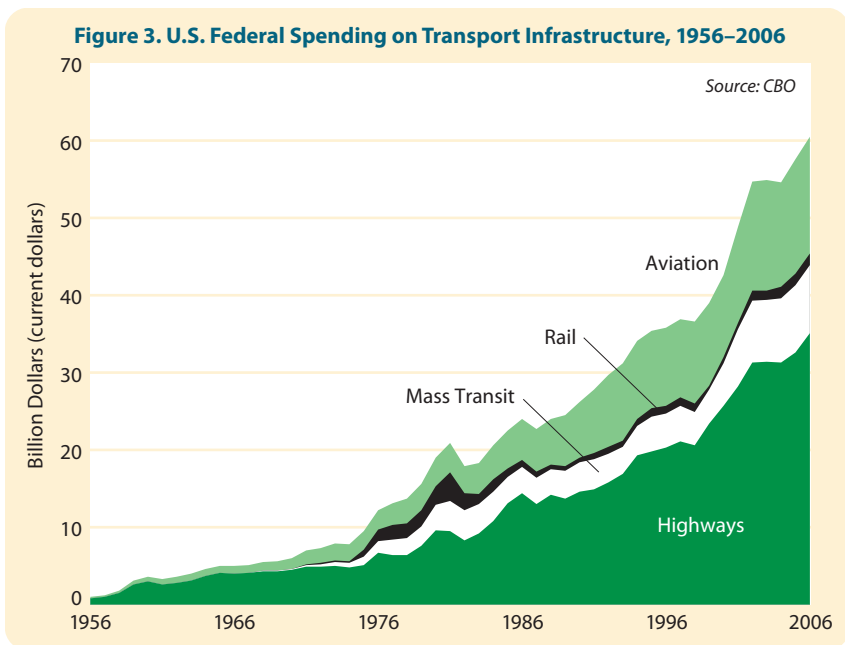
## Scenarios for U.S. Rail and Transit Investment

### Setting the Context: Past and Current Spending

Over the past half-century, U.S. funding priorities for transport infrastructure have been extremely lopsided.<sup>1</sup> (See Figure 3.) Starting in the 1950s, the federal government undertook massive public investments and subsidies to build the nation’s interstate highway system. According to a recent report by the U.S. Public Interest Research Group (PIRG), federal highway investments over three decades totaled \$425 billion. Aviation has also received significant federal support. Between 1956 and 2006, PIRG notes, “the nation invested \$16 in the highway system and \$6 in aviation for every dollar invested in rail.”<sup>2</sup>

From 1990 to 2008, U.S. mass transit funding for capital projects and operations grew from \$21 billion to \$55 billion.<sup>3</sup> (See Table 3.) Of this total, capital expenditures at all levels of government grew from \$5 billion to \$17 billion. But the federal government’s share of capital funding declined from 59 percent to 40 percent.

Intercity rail funding has been meager and relatively



stagnant. The Amtrak Reform and Accountability Act of 1997–2002, passed in 1997, authorized appropriations for Amtrak totaling \$5.2 billion for 1998 through

**Table 3. U.S. Mass Transit Funding, Total versus Federal Share, 1990 and 2000–08**

Year	Capital Funding	Operations Funding	Total Funding	Share of Capital Spending in Total Government Spending	Federal Capital Assistance	Federal Share of All Capital Funding
	<i>billion dollars (current dollars)</i>			<i>percent</i>	<i>billion dollars (current dollars)</i>	<i>percent</i>
1990	16.1	4.9	21.0	23	2.9	59
2000	24.2	9.6	33.8	28	4.5	47
2001	25.3	11.4	36.7	31	5.8	51
2002	26.6	12.8	39.5	33	5.2	41
2003	28.0	13.2	41.3	32	5.3	40
2004	29.7	13.2	43.0	31	5.2	39
2005	31.7	12.4	44.1	28	4.8	39
2006	33.7	13.3	47.1	28	5.8	44
2007	35.5	14.3	49.9	29	5.9	41
2008	38.0	17.4	55.4	31	7.0	40

Source: See Endnote 3 for this section.

2002, or about \$1 billion annually. (The Act also gave access to some \$2 billion from the Taxpayer Relief Act of 1997.) Since then, however, no new multi-year appropriations legislation for Amtrak has been passed; instead, the rail operator has received only year-to-year grants from the Federal Railroad Administration.

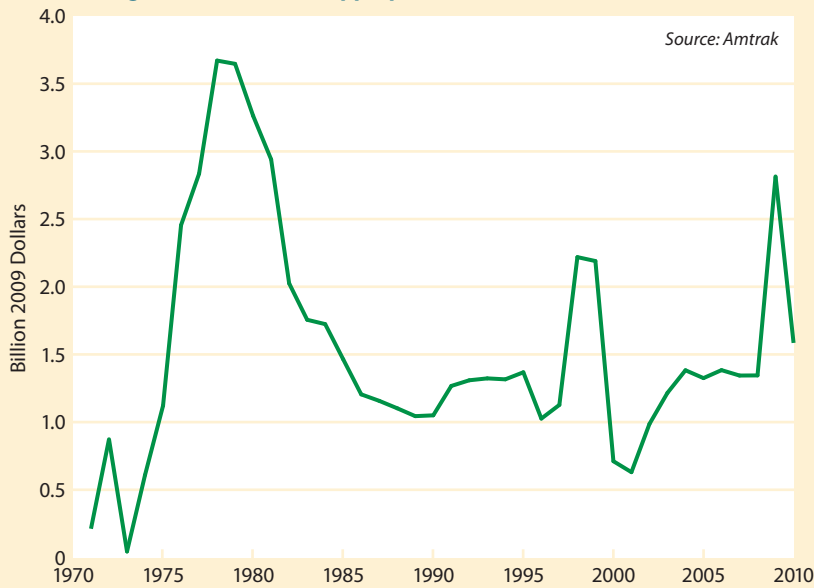
These FRA grants increased from \$1.05 billion in Fiscal Year 2003 to \$1.35 billion in FY2006 and \$1.33 billion in FY2008. Other federal programs also include small amounts of rail-related funding.<sup>4</sup> Except for a handful of peaks, federal funding for Amtrak intercity rail since the early 1970s (expressed in 2009 dollars) has never exceeded \$3.7 billion in any year.<sup>5</sup> (See Figure 4.) Amtrak capital funds have fluctuated from \$609 million in FY1999, to only \$213 million in FY2003, to a more substantial \$738 million in FY2010.<sup>6</sup>

**Table 4. Share of U.S. Urban Transit Spending, by Category, 2008**

Category	Share of Capital Spending	Share of Total Spending
	<i>percent</i>	
Capital Spending	100	31
Purchase of buses	16	5
Purchase of rail vehicles	14	4
Purchase of supporting equipment	11	4
Construction of rail lines/busways	33	11
Construction of buildings/facilities	26	8
Operations and Maintenance	—	69
<b>Total Urban Transit Spending</b>	<b>—</b>	<b>100</b>

Source: See Endnote 7 for this section.

**Figure 4. U.S. Federal Appropriations for Amtrak, 1971–2010**



Not all spending on transit goes directly to purchasing vehicles. However, in order to develop scenarios for job creation in U.S. bus and rail manufacturing\*, it is necessary to estimate how much federal investment goes directly to purchases of rolling stock (railcars and buses). In 2008, 59 percent of U.S. transit capital spending went to infrastructure and facilities, 30 percent to rolling stock, and 11 percent to other purchases.<sup>7</sup> (See Table 4.) Rolling stock purchases grew from \$1.3 billion in 1992 to \$4.4 billion in 2002, but then declined. Only in 2008 did funding again increase, to \$5.3 billion.<sup>8</sup>

**Enter ARRA**

The United States is finally getting serious about public transit, but so far the level of investment pales in comparison to many European and Asian nations.<sup>9</sup> The American Recovery and Reinvestment Act of 2009 (ARRA) represents a significant one-time boost to U.S. public transportation funding. For transit and intercity rail programs combined, the act provides a total of \$17.7 billion, out of \$48.1 billion overall for transportation.<sup>10</sup>

For urban transit (both bus service and intracity rail), ARRA includes \$8.4 billion for three major programs: \$6.9 billion for the Transit Capital Assistance Program, \$750 million for the Fixed Guideway Infrastructure Investment Program, and another \$750 million for Capital Investment Grants.<sup>11</sup> Some \$2.4 billion of these funds has gone to the purchase or rehabilitation of 12,136 buses, railcars, and paratransit† vans.<sup>12</sup>

On the intercity rail side, ARRA includes \$1.3 billion for Amtrak (so far, no new rolling stock has been purchased, but 96 locomotives and coaches and Amtrak facilities have been reconditioned) and \$8 billion for capital grants for new high-speed rail (HSR) corridors and intercity passenger rail service.<sup>13</sup> The ARRA funds

\* Although increased investment in transit will create many jobs in operations and maintenance in addition to jobs created from capital investments, the focus of this report is only on manufacturing.

† Paratransit systems supplement regular transit systems and are usually vans that run on a regular schedule for routes not served by the system—sometimes on demand and sometimes for riders with special needs.

represent a welcome initial boost for efforts to create an HSR network.

Table 5 summarizes U.S. federal funding for intercity rail in recent years, including ARRA as well as the Obama administration’s request for FY2011.<sup>14</sup> Funding for high-speed rail pushes overall budgets in FY2009 and 2010 to unprecedented levels. The request for FY2011 is much smaller but nonetheless provides capital funding at more than triple the level in the years before ARRA; meanwhile, operating funds are somewhat higher than in earlier years.<sup>15</sup> In July 2010, the Senate Appropriations Committee voted to provide Amtrak with \$1.96 billion, \$196.5 million more than the House of Representatives’ proposed appropriation and \$363 million more than the Obama administration’s request.<sup>16</sup>

As welcome as ARRA’s funding for high-speed rail is, it provides only a down payment for enormous pent-up demand. Pre-applications filed by 40 states and the District of Columbia for HSR funding under ARRA totaled \$102 billion for 278 proposed projects, outstripping the available sum by a factor of 12. Even after the states subsequently narrowed their requests to \$57 billion in the final round of applications, this was still seven times the amount of money available.<sup>17</sup>

Beyond ARRA, it remains unclear how much in regular annual appropriations will be made available in coming years, and whether the crunch in transit agencies’ operating funds can be relieved. On the capital investment side, available funding vehicles include the Transportation Infrastructure Finance and Innovation Act (TIFIA), the Transportation Innovation Generating Economic Recovery program (TIGER), and the Transportation Investments Generating Greenhouse Gas Emissions Reductions program (TIGGER).

Yet these measures are not sufficient to ensure sustained growth in the U.S. bus and rail industries. Passing new comprehensive surface transportation legislation and laying out a strong long-term vision will be essential for creating more manufacturing jobs in these industries.

### Reviving U.S. Rail and Transit: Three Investment Scenarios

Numerous reports in recent years have assessed the condition of U.S. transit and intercity rail systems, as well as the need for replacement, modernization, and

**Table 5. U.S. Federal Funding for Intercity Rail, Fiscal Years 2008–11**

Category	FY2007	FY2008	FY2009	FY2010	FY2011 Request
	<i>million dollars</i>				
Capital and Debt Service Funding	772	880	10,330	3,502	2,052
Amtrak capital and debt service	772	850	940	1,002	1,052
Amtrak capital grants	—	—	1,300*	—	—
Intercity Passenger Rail Grant Program	—	30	90	—	—
Capital assistance to states for intercity passenger rail (high-speed rail)	—	—	8,000*	2,500	1,000 <sup>†</sup>
Amtrak Operating Grants	490	475	550	563	563
<b>Total Funding</b>	<b>1,262</b>	<b>1,355</b>	<b>10,880</b>	<b>4,065</b>	<b>2,615</b>

\* ARRA funds.  
<sup>†</sup> In July 2010, the House Appropriations Transportation, Housing and Urban Development Subcommittee approved \$1.4 billion—more than the administration’s request, but far less than the \$4 billion sought in May by high-speed rail advocacy groups. The administration has indicated that it will ask for a total of \$5 billion over five years.  
 Source: See Endnote 14 for this section.

expansion.<sup>18</sup> (See Table 6.) Their findings and recommendations have varied widely, as have their estimates of future funding needs. It is beyond question, however, that major investments that are orders of magnitude higher than current spending, and carried out over several decades, will be required to rise to the task.

The United States needs to dramatically increase its investment in public transit infrastructure in order to build a system that boosts ridership and thereby helps to reduce congestion in metropolitan areas, lower greenhouse gas emissions, and create much-needed manufacturing jobs. The current level of federal spending—the so-called “Business-as-Usual” scenario—is unlikely to get us there. However, two other investment scenarios over and above current spending can be useful to guide estimates of potential job creation in rail and bus manufacturing. These are: a scenario of increased domestic investment, and a scenario of international competitiveness.

#### Increased Domestic Investment Scenario

Under this second scenario, the goal is to double U.S. transit ridership in 20 years. To do this, the consulting firm Cambridge Systematics estimates that the U.S. government (at all levels—federal, state, and local) would need to invest \$60 billion annually.<sup>19</sup> The federal government would need to increase its share of transit capital investments from 40 percent in 2008 to 50 percent, for an annual investment of \$30 billion—a level that is consistent with the upper end of the

**Table 6. Recent U.S. Transit and Intercity Rail Studies: Summary of Funding Recommendations**

Report/Source	Observation/Recommendation	Estimates for Required Funding
<b>URBAN TRANSIT</b>		
Reconnecting America, October 2008	78 regions in 37 states have proposed 400 projects worth \$248 billion. This is 35 times the annual federal transit investment (2008), or 15 times the annual total amount. (Study focused on fixed guideways only.)	\$248 billion total, or \$41 billion/year
National Surface Transportation and Revenue Study Commission, December 2007	a) "Medium" capital investment to maintain transit conditions (i.e., roughly equivalent to current spending), 2005–20 b) "High" investments to bring conditions up to "Good," 2005–20 (adding a cumulative 51,000–96,000 new vehicles) c) "High" investments, but for longer timeframe, 2005–55	In 2006 dollars: a) \$14–18 billion/year b) \$21–32 billion/year c) \$26–46 billion/year
National Surface Transportation Infrastructure Financing Commission, February 2009	A base-case needs forecast offers spending levels required to sustain a business-as-usual approach to federal surface transportation investment. In estimating future needs, the Commission relied on a Transit Cooperative Research Program (TCRP) study that used a 2.4 percent annual growth in ridership figure (i.e., actual 1995–2007 average).	In 2008 dollars: Needed to maintain: \$42 billion/year (\$19 billion federal share) Needed to improve: \$49 billion/year (\$22 billion federal share)
APTA/AASHTO, September 2008	Projected investment needs were calculated assuming a range of average annual ridership growth rates for urbanized areas: a) 2.4 percent (the average annual growth in 1995–2007) b) 3.52 percent (needed to double ridership over 20 years) c) 4.63 percent	In 2006 dollars: a) \$46.1 billion/year b) \$59.2 billion/year c) \$75.2 billion/year
Federal Railway Administration, April 2009	Assessed condition of 26,654 vehicles. Capital investment required to attain and maintain a state of good repair for the seven largest rail transit agencies (eliminating backlog of \$50 billion, plus annual normal replacement). Actual investment level was \$5.4 billion in 2006.	In 2008 dollars: \$14.3 billion/year (over six years)
Federal Transit Administration, National State of Good Repair Assessment Study, June 2010	Assessed condition of 111,945 vehicles. Eliminating backlog of repairs to bring the nation's transit systems up to a state of good repair: \$77.7 billion (\$59.2 billion for rail; \$18.4 billion for bus). Beyond the backlog, regular annual maintenance needed is \$14.4 billion (actual spending is \$12–13 billion).	Combined annual need: \$27.3 billion/year over six years \$20.9 billion/year over 12 years \$18.3 billion/year over 20 years
<b>INTERCITY AND HIGH-SPEED RAIL</b>		
National Surface Transportation and Revenue Study Commission, December 2007	Maintaining Amtrak operations, upgrading passenger rail service, and providing new routes requires \$357 billion of investments over a 44-year period. (Accommodate expansion in intercity passenger rail use of 8–9 times above the current level of 5.5 billion annual passenger-miles.)	\$357 billion total —\$66 billion (\$7.4 billion/year) needed to 2020 —\$225 billion (\$9.4 billion/year) needed to 2035
Amtrak, September 2009	Total investment in rolling stock for FY 2010–14.	\$2.5 billion over five years
Amtrak, February 2010	To modernize its existing fleet and manage 2 percent annual growth, Amtrak will need \$11 billion over 14 years, including 25 high-speed trainsets, 334 locomotives, and 1,200 railcars. Amtrak currently has some 1,800 railcars, trainsets, and locomotives.	Cumulative, in 2009 dollars: —\$9 billion by 2020 —\$15.6 billion by 2030 —\$23 billion by 2040
AASHTO, May 2008	2008 Update to AASHTO's Intercity Passenger Rail Transportation Report: need for capital investments through 2021.	\$71.3 billion, or \$4.8 billion/year
Senate Committee on Commerce, Science and Transportation, May 2007	Investment needed to fund deferred maintenance and capital backlog projects to return the Northeast Corridor to a "state of good repair," under which only routine maintenance would be needed.	\$5 billion total

Source: See Endnote 18 for this section.

\$21–\$32 billion range of federal spending recommended in the studies summarized in Table 6.

Federal spending at this level would allow for a clearing of the investment backlog identified earlier as well as an expansion of transit services. Spending \$30 billion annually on transit capital programs yields a

federal budget of \$180 billion over six years. Table 7 shows the outcome of applying the 2008 breakdown of transit capital spending provided in Table 4 to this \$180 billion figure.

Assuming that federal funding for capital projects covers 50 percent of total U.S. mass transit spending,

the figures presented in Table 7 can roughly be doubled, so that total (federal, state, and local) mass transit capital spending over six years would be \$360 billion, or an average of \$60 billion per year.

For intercity and high-speed rail, we propose spending \$10 billion annually. This is slightly more than the \$8.1 billion recommended by the Passenger Rail Working Group in 2007, but their lower estimate included the development of only one new HSR line.<sup>20</sup> The federal government is the principal funder of intercity passenger rail.<sup>21</sup> Assuming an 80:20 federal and state match implies federal funds of \$10 billion and additional state funds of \$2.5 billion. This results in a combined total annual investment of \$12.5 billion under the Increased Domestic Investment scenario.

### International Competitiveness Scenario

The third scenario is highly ambitious and is intended to close the large gap in rail and transit manufacturing between the United States and countries in Europe and Asia that are more competitive internationally in these two industries.<sup>22</sup> European countries demonstrate what well-developed rail and transit systems look like and offer important lessons; however, they may not offer the best comparative experience for the United States, since the main challenge for these countries is to maintain mature systems, keep up with ridership, and upgrade where needed. The United States, by contrast, needs to undertake a major expansion of its rail and transit systems.

China’s experience therefore comes closer to the U.S. situation. Until recently, China’s rail and transit systems were seriously outdated and overstretched. But the country has committed to a major investment program. China is also more similar to the United States with respect to geographic size and thus the travel distances to be bridged. *TheTransportPolitic* blogger Yonah Freemark has commented that, “China’s example...demonstrates how an efficient and useful high-speed rail system can be implemented in a very large country such as the United States.”<sup>23</sup>

An analysis of key Chinese rail and transit investment figures helps paint a rough picture of what a far more ambitious scenario for the United States might entail.<sup>24</sup> (See Table 8.) Although official Chinese spending figures at times diverge, and precise methodologies are not always available, it is clear from the existing data that even the above proposal for “increased domestic

**Table 7. U.S. Urban Transit Capital Spending Under the Increased Domestic Investment Scenario**

Expenditure	Share of Capital Spending	Capital Spending over Six Years	Average Annual Capital Spending
	<i>percent</i>	<i>billion dollars</i>	
Purchase of buses	16	28.8	4.8
Purchase of rail vehicles	14	25.2	4.2
Purchase of supporting equipment	11	19.8	3.3
Construction of rail lines/busways	33	59.4	9.9
Construction of buildings/facilities	26	46.8	7.8
<b>Total</b>	<b>100</b>	<b>180.0</b>	<b>30.0</b>

**Table 8. Chinese Public Investment in Intercity Rail and Transit, Recent Years and Projections**

Type of Investment	Year(s)	Annual Amount
		<i>billion dollars</i>
Urban rail infrastructure/construction	2001–10	29
	2011–15	37
Passenger intercity rail infrastructure	2009	44
Rolling stock purchases (intercity rail and urban metro systems)*	2009–10	22
	2011–15	24

*Note: Chinese currency investment figures are converted to dollars at the rate 6.83 RMB = 1 U.S. dollar.  
\* Unclear whether light rail systems are included.  
Source: See Endnote 24 for this section.*

investment” in the United States is still quite modest relative to the need to create a capable and attractive modern public transportation system.

Table 9 shows the outcome of applying the 2008 breakdown of transit capital spending provided in Table 4 to this International Competitiveness scenario. Because the spending categories used in China (see Table 8) are somewhat different from those used in the United States, Table 9 applies the following adjustments to enable comparison:

- The \$37 billion for urban rail infrastructure is applied to the following U.S. transit capital spending categories used in Table 4: purchase of supporting equipment, construction of rail lines and busways, and construction of buildings and facilities. The funds are divided among the three categories to mirror the apportionment in Table 4. (For example, 47 percent of the \$21 billion in Table 4 equals \$9.9 billion for construction of rail lines/busways; thus, in Table 9, 47 percent of the \$37 billion equals \$17.4 billion.)
- The \$24 billion for rolling stock purchases is applied to urban rail *and* bus purchases. Again, this mirrors the apportionment in Table 4.

- \$44 billion is allocated to intercity and high-speed passenger rail.

**Table 9. U.S. Urban Transit Capital Spending Under the Increased Domestic Investment and International Competitiveness Scenarios**

	Average Annual Capital Spending	
	Increased Domestic Investment Scenario	International Competitiveness Scenario
	<i>billion dollars</i>	
Purchase of buses	4.8	12.8
Purchase of rail vehicles	4.2	11.2
Purchase of supporting equipment	3.3	5.8
Construction of rail lines/busways	9.9	17.4
Construction of buildings/facilities	7.8	13.7
<b>Total transit capital spending</b>	<b>30.0</b>	<b>61.0</b>
<b>Intercity and high-speed rail</b>	<b>10.0</b>	<b>44.0</b>

**Table 10. U.S. Annual Urban Transit Capital Spending: A Summary of the Three Scenarios**

Expenditure	Business-as-Usual Scenario (2008)	Increased Domestic Investment Scenario	International Competitiveness Scenario
	<i>billion dollars</i>		
<b>Transit Capital Investments</b>			
Federal Investment, of which:	7.0	30.0	61.0
<i>Purchase of buses</i>	2.8	4.8	12.8
<i>Purchase of rail vehicles</i>	2.4	4.2	11.2
All Levels of Government	17.4	60.0	122.0
<b>Intercity and High-Speed Rail Capital Investments</b>			
Federal Investment	0.9	10.0	44.0
<i>Purchase of rail vehicles</i>		3.0	
All Levels of Government	0.9	12.5	55.0

How do these figures compare to the investment needs projections that were presented in the studies summarized in Table 6? For intercity rail, the National Surface Transportation and Revenue Study Commission's recommended annual figure of \$7.4 billion (rising to \$9.4 billion in later years) for intercity passenger rail, plus the U.S. High-Speed Rail Association's audacious plan for investing \$30 billion annually in HSR over two decades, come to a combined \$37.4–\$39.4 billion. The International Competitiveness scenario's figure of \$44 billion for all intercity rail purposes is somewhat more generous and would allow for a major renewal and expansion of U.S. rail systems.<sup>25</sup>

### Summary

Table 10 provides a summary of key figures from the three scenarios discussed above: the Business-as-Usual scenario that relates to actual spending in FY2008 prior to ARRA, the Increased Domestic Investment scenario, and the far more ambitious International Competitiveness scenario.

Under these scenarios, the spending on purchases of rail vehicles amounts to \$2.4 billion, \$4.2 billion, and \$11.2 billion, respectively. Assuming that another 30 percent of "Intercity and High-Speed Rail Capital Investments" would be allocated to rail vehicle purchases, this results in total expenditures of \$2.7 billion, \$7.2 billion, and \$24.4 billion for the three scenarios. For bus purchases, the investments amount to \$2.8 billion, \$4.8 billion, and \$12.8 billion, respectively, for the three scenarios.

## Scenarios for U.S. Rail and Transit Employment

What impacts would significant increases in U.S. rail and transit manufacturing have on job creation and the wider economy? In this section, input-output analysis is used to estimate the employment impact of increased rail and bus production under the three scenarios presented above.<sup>1</sup> In addition, the analysis considers the employment impacts of manufacturing a larger share of the inputs to these industries within the United States than is currently the case.

The economic and labor-market impacts of an industry often go well beyond their *direct* effects on output, earnings, and employment in the region, state, or local economy in which they are located. Industries, especially those that export their goods or services outside of their home state, can generate important multiplier effects on the rest of the state economy. These effects can include *indirect* effects on other state industries as an exporting firm buys inputs from other state firms, as well as the *induced*\* effects on other industries from the local spending of workers and owners in the exporting industries. Knowledge of the magnitude of the multiplier effects of individual industries allows us to evaluate their overall contributions to the state and national economy.

### Potential Employment Impacts of Increased U.S. Passenger Railcar Manufacturing

A substantial increase in U.S. investment in new passenger rail vehicles would primarily affect the railroad rolling stock manufacturing industry (NAICS 3365). Table 11 illustrates the direct and indirect impacts<sup>†</sup> on industry employment under the three investment scenarios described above, using two different estimates of employment.<sup>2</sup> The estimate “with current domestic content” does not count the jobs used to make inputs that are imported into the United States. The estimate “with full domestic content,” in contrast, shows the

**Table 11. Direct and Indirect Job Creation in U.S. Railcar Manufacturing Under the Three Investment Scenarios**

	Employment Multiplier	Business-as-Usual Scenario (\$2.7 billion)	Increased Domestic Investment Scenario (\$7.2 billion)	International Competitiveness Scenario (\$24.4 billion)
<i>number of jobs</i>				
<b>Employment with Current Domestic Content*</b>				
Total Direct and Indirect Jobs	7.814	21,098	56,260	190,660
<i>Direct jobs</i>	4.400	11,880	31,681	107,362
<i>Indirect jobs</i>	3.814	9,217	24,580	83,298
<b>Employment with Full Domestic Content*</b>				
Total Direct and Indirect Jobs	9.233	24,930	66,481	225,296
<i>Direct jobs</i>	4.438	11,982	31,951	108,278
<i>Indirect jobs</i>	4.795	12,949	34,530	117,017
<b>Net Gain from Full Domestic Content</b>				
Total Direct and Indirect Jobs		3,832	10,221	34,636
<i>Direct jobs</i>		102	270	916
<i>Indirect jobs</i>		3,732	9,950	33,719

\* In current dollars.  
Source: See Endnote 2 for this section.

jobs that would be needed to produce all inputs domestically in the United States.

Under the Business-as-Usual scenario of \$2.7 billion in expenditures, the “current domestic content” estimate yields 21,098 jobs. A slight majority (56 percent) of the jobs are created directly in the railroad rolling stock industry, and another 9,217 are indirect jobs in other industries. About 70 percent of all jobs created by this investment would be in manufacturing.

At the two higher levels of investment, the employment estimates increase substantially. The Increased

\* Induced jobs are those created elsewhere in the economy as incomes earned by employees in transit equipment manufacturing and in the transit sector are spent on goods and services.

† Since the U.S. railcar production industry is fairly geographically dispersed, this analysis uses U.S. Bureau of Labor Statistics (BLS) national multipliers; however, these multipliers allow for estimation only of direct and indirect employment, not induced jobs. (For more on the methodology used in this study, see Appendix on page 33.)



Domestic Investment scenario would support nearly 56,260 jobs, and the International Competitiveness scenario would support more than 190,600 jobs. These estimates would increase even further if the industry were 100-percent domestically produced. Almost all of the additional jobs gained under a 100-percent domestic production scenario would be in firms that supply the railroad rolling stock manufacturing industry. Under the two higher investment scenarios, the United States would gain an additional 10,221 and 34,636 jobs, respectively, if all inputs were domestically produced.

The U.S. Bureau of Labor Statistics (BLS) provides an industry-by-industry breakdown of the indirect jobs that would be created from increased sales in the railroad rolling stock manufacturing industry. Based on these data, Table 12 illustrates the 10 manufacturing industries that would gain the largest number of jobs as a result of increased U.S. expenditures on railcars.<sup>3</sup> These 10 industries account for 68 percent of the total direct and indirect jobs supported by each of the three investment scenarios. Other non-manufacturing industries and firms that would gain a substantive share of indirect jobs created are wholesale trade, employment services firms, and professional and technical (engineering, law, and consulting) firms.

Since BLS data do not provide estimates for induced job creation, the figures in Table 12 understate the total economic benefit and job creation impact from

increased purchases of rail vehicles. The underestimation can be very substantial. Economic models suggest that the industry's effect on induced job creation is about 60 percent larger than the combined effect on direct and indirect job creation.\* Thus, the total employment impact—direct, indirect, and induced—per year of investment would range from 33,757 jobs at current levels of spending (the Business-as-Usual scenario), to 90,016 jobs under the Increased Domestic Investment scenario, to a high of 305,056 jobs under the International Competitiveness scenario.

Where would the workers in the U.S. railroad rolling stock manufacturing industry be located? Currently, the distribution of workers varies widely by geographic division. Due to high levels of employment in New York and Pennsylvania, the Mid-Atlantic region had the highest number of workers in 2006–08, followed by the East North Central (or industrial Midwest), West South Central, and South Atlantic divisions.<sup>4</sup> (See Table 13.)

### Potential Employment Impacts of Increased U.S. Bus Manufacturing

The analysis of employment in U.S. bus manufacturing requires a slightly different approach than that for railcar manufacturing because the bus industry is concentrated in five states rather than being more geographically dispersed. The U.S. Bureau of Economic Analysis (BEA) produces economic multipliers for output, employment, earnings, and value added for various industries using a Regional Input-Output Modeling System.<sup>5</sup> The BEA produces only state multipliers; however, unlike the BLS multipliers, it allows for estimation of induced as well as direct and indirect employment.<sup>†</sup>

This analysis focuses on the states in which the five U.S. bus manufacturers are located because BEA data do not capture out-of-state suppliers of components. Excluding these suppliers results in artificially low estimates of the employment impact from increased orders of new buses. This shortcoming can be addressed by using a BLS employment requirements matrix to conduct a national simulation of the direct and indirect jobs

\* This induced effect estimate is conservative since it is confined to those effects within the state. Spillover effects on other states are excluded. Since multipliers are greater for the nation than for any individual state, the induced effect nationally would likely be greater.

† The BEA's economic model provides six types of multipliers: final demand multipliers for output, employment, earnings, and value added and direct effect multipliers for employment and earnings.

**Table 12. The 10 Manufacturing Subsectors that Would Gain the Most Jobs from Increased U.S. Railcar Purchases, Under the Three Investment Scenarios**

Manufacturing Industry	Business-as-Usual Scenario	Increased Domestic Investment Scenario	International Competitiveness Scenario
<i>number of jobs</i>			
Railroad rolling stock (direct jobs)	11,880	31,681	107,362
Architectural and structural metals	835	2,225	7,542
Electrical equipment	462	1,232	4,176
Machine shops; turned product; and screw, nut, and bolt	252	671	2,274
Aerospace product and parts	183	489	1,656
Spring and wire product	146	389	1,320
Motor vehicle parts	145	386	1,308
Foundries	144	384	1,300
Forging and stamping	138	368	1,246
Iron and steel mills and ferroalloy	121	323	1,096
<b>Top 10 Manufacturing Industries</b>	<b>14,306</b>	<b>38,148</b>	<b>129,279</b>
<b>All Manufacturing Industries</b>	<b>21,098</b>	<b>56,260</b>	<b>190,660</b>

Source: See Endnote 3 for this section.

created under the three investment scenarios. The BLS matrix provides more detail on the industries that will gain the highest shares of indirect jobs.

Based on the BEA tables, we allocated funding to the industry subsections that are most directly related to the manufacturing of buses and component parts.\* First, expenditures were allocated for each of the five bus manufacturers as well as the engine manufacturer Cummins, according to their current shares of production. (See Table 14.) (The cost of a bus engine is about 10 percent of the selling price, between \$40,000 and \$50,000, so 10 percent of the expenditures are allocated directly to Cummins.†) The Increased Domestic Investment scenario would lead to approximately a 70-percent increase in the value of orders received by each company and state. The International Competitiveness scenario would produce a nearly fivefold increase in annual bus expenditures from the current level.

Next, the BEA multipliers were applied to identify the employment impact of increased spending on new buses. The multipliers estimate the total number of jobs created in each state as a result of a \$1 million increase in sales in the heavy truck manufacturing industry. The current analysis uses two different multipliers: the “final-demand multiplier,” which includes the direct, indirect, and induced employment effects of each \$1 million increase in sales (or output), and the “direct-effect multiplier,” which estimates the number of indirect and induced job created per direct job in a given industry.‡

The final-demand multiplier ranges from lows of 6.7 in New York to a high of 13.2 in North Carolina. A final-demand multiplier of 13.2 means that about 13 jobs will be created in North Carolina from a \$1 million dollar increase in sales in that state’s motor vehi-

\* Three U.S. industries contain firms that are engaged in either the assembly of buses and/or the making of components for bus manufacturers: Heavy Duty Truck Manufacturing (NAICS 336120); Motor Vehicle Body Manufacturing (NAICS 336211); and Motor Vehicle Parts Manufacturing (NAICS 3363). Since the originating order for a bus would typically go to a firm classified in NAICS 336120, this analysis focuses on this industry. The one exception is engine maker Cummins, which is the only supplier of this important and costly input; thus, the engine component of the bus order is treated as a final order and is captured in the multipliers for NAICS 3363.

† Since the BEA multipliers exclude out-of-state and out-of-region purchases, this analysis treats the purchase of bus engines separately and estimates the multiplier effect of these orders in North Carolina. The full value of the orders will still go to the original equipment manufacturers.

**Table 13. Employment in the U.S. Railroad Rolling Stock Manufacturing Industry, by Geographic Division, 2006–08**

Geographic Division*	States	Employment
Middle Atlantic	NY, NJ, PA	10,350
East North Central	IL, IN, MI, WI, OH	6,812
West North Central	IA, KS, MN, MO, NE, ND, SD	2,091
South Atlantic	DE, FL, GA, MD, NC, SC, VA, WV	3,348
East South Central	AL, KY, MS, TN	1,513
West South Central	AR, LA, TX, OK	5,671
Mountain	AZ, ID, CO, MT, NV, NM, UT, WY	1,333
Pacific	CA, WA, OR, AK, HI	1,576
New England	ME, VT, NH, MA, CT, RI	—†
<b>U.S. Total</b>		<b>32,722</b>

\* Based on U.S. Census Bureau geographic divisions

† Less than 30 adults were employed in this industry in New England. The total at the bottom of the table includes some New England workers.

Source: See Endnote 4 for this section.

**Table 14. Estimated Distribution of Expenditures Across the Five U.S. Bus Manufacturers and Cummins, Under the Three Investment Scenarios**

Company, State	Business-as-Usual Scenario (\$2.8 billion)	Increased Domestic Investment Scenario (\$4.8 billion)	International Competitiveness Scenario (\$12.8 billion)
	<i>million dollars</i>		
New Flyer, MN	1,075	1,843	4,915
Gillig, CA	767	1,315	3,507
Orion, NY	515	883	2,355
Nova, NY	263	451	1,203
NABI, AL	179	307	819
Cummins, Inc., NC	280	480	1,280
<b>Total</b>	<b>2,800</b>	<b>4,800</b>	<b>12,800</b>

cle parts manufacturing industry. The direct-effect multiplier ranges from a low of 2.6 in New York to a high of 5.4 in Alabama. This means that 5.4 jobs are created in Alabama’s economy for every one job created in the heavy truck manufacturing industry.<sup>76</sup>

The values of the multipliers vary across states depending on the relative intensity of the use of in-state versus out-of-state suppliers and the level of wages paid to employees in the state. For example, if New York’s heavy truck manufacturing industry uses a lot of suppliers from other states, then the in-state indirect and induced job creation effect will be smaller than in states

‡ The final-demand employment and direct-effect employment multipliers, respectively, for each state are: Alabama, 11.7, 5.4; California, 6.8, 3.5; Minnesota, 8.1, 2.9; New York, 6.7, 2.6; North Carolina 13.2, 3.5. The multipliers for the first four states are based on the heavy truck manufacturing industry. The multipliers for North Carolina are for the motor vehicle parts manufacturing industry.

where firms use more in-state suppliers. In addition, states with higher wages and benefits per worker will create fewer direct jobs per \$1 million increase in sales than states with lower labor costs, but these higher wages will lead to more induced spending in other sectors.



A New Flyer BRT model.  
Courtesy New Flyer

Applying these multipliers to the three investment scenarios by company/state reveals that the Business-as-Usual level of spending on new buses supports nearly 25,000 jobs across the five states. (See Table 15.) Of this total, roughly 8,000 jobs are in the heavy truck manufacturing and motor vehicle parts manufacturing industries, and nearly 17,000 indirect and induced jobs are created in the five states. Given their higher levels of market share, Minnesota, New York,

and California generate slightly over 75 percent of these jobs.

The potential employment impact of the Increased Domestic Investment scenario is quite substantial. Increasing the value of bus purchases from \$2.8 billion to \$4.8 billion per year would support a total of 42,800 jobs across the five states, with nearly 14,000 of these jobs being in the heavy truck manufacturing or motor vehicle parts industries. Expanding bus production under the Increased Domestic Investment proposal would lead to an additional 17,800 jobs above current levels. Assuming a consistent market share, the percentage share of jobs across states does not change.

The International Competitiveness investment scenario would lead to a 5–6 times increase over the Business-as-Usual scenario, and could produce more than 90,000 jobs in the five states. However, the magnitude of this investment scenario would likely lead to substantial restructuring in the U.S. bus manufacturing industries. This type of change might alter the values of the employment multipliers, which are based on the much smaller set of industries that currently exists in the country. Thus, the estimated employment impact of this third scenario should be viewed with some skepticism.

A very high share of jobs in each state would be in manufacturing. (See Table 16.) The percentage share of manufacturing jobs in each state ranges from a low of 41 percent in California to a high of 56 percent in New York. States with a higher share of manufacturing

**Table 15. Employment Impacts of New U.S. Bus Production, Under the Three Investment Scenarios**

Scenario	Alaska	California	Minnesota	New York	North Carolina	Five States Total
	<i>number of jobs</i>					
<b>Business-as-Usual Scenario (\$2.8 Billion)</b>						
Final-demand employment	2,104	5,212	8,723	5,239	3,688	24,966
Direct-effect employment	390	1,474	3,047	2,029	1,063	8,003
Indirect and induced employment	1,714	3,738	5,676	3,210	2,625	16,963
<b>Increased Domestic Investment Scenario (\$4.8 Billion)</b>						
Final-demand employment	3,606	8,935	14,954	8,981	6,323	42,798
Direct-effect employment	668	2,527	5,223	3,478	1,823	13,719
Indirect and induced employment	2,938	6,408	9,731	5,503	4,500	29,079
<b>International Competitiveness Scenario (\$12.8 Billion)</b>						
Final-demand employment	9,616	23,828	39,876	23,948	16,862	114,128
Direct-effect employment	1,782	6,739	13,927	9,274	4,862	36,583
Indirect and induced employment	7,834	17,089	25,949	14,674	12,000	77,545

**Table 16. Distribution of Employment Impacts, by Industry, Under the Three Investment Scenarios**

Industry	Alaska	California	Minnesota	New York	North Carolina	Five States Total
	<i>percent</i>					
Manufacturing	46.2	41.4	48.9	55.9	43.6	47.7
Retail trade	7.6	7.4	6.3	5.1	8.1	6.7
Wholesale trade	6.8	7.5	6.4	5.7	4.5	6.2
Health care and social assistance	6.4	5.6	6.2	5.6	6.6	6.0
Administrative and waste management services	5.3	5.7	4.1	4.0	5.8	4.8
Food services and drinking places	4.7	4.3	3.7	3.0	4.8	3.9
Professional, scientific, and technical services	2.9	4.0	3.1	3.2	3.7	3.4
Other services*	3.4	3.2	2.9	2.6	3.3	3.0
Real estate and rental and leasing	2.5	3.4	2.8	2.5	3.2	2.9
Management of companies and enterprises	2.1	3.1	2.7	2.3	4.1	2.9
Transportation and warehousing*	3.3	3.1	2.8	2.0	3.2	2.8
Finance and insurance	2.5	3.1	3.0	2.5	2.5	2.8
Information	1.1	2.2	1.7	1.4	1.3	1.6
Arts, entertainment, and recreation	0.6	1.5	1.3	1.0	1.1	1.2
Educational services	1.3	1.2	1.1	1.0	1.1	1.1
Construction	1.0	0.8	0.6	0.5	0.9	0.7
Accommodation	0.5	0.8	0.7	0.5	0.7	0.7
Households	0.5	0.6	0.7	0.5	0.8	0.6
Utilities*	0.7	0.5	0.5	0.5	0.4	0.5
Agriculture, forestry, fishing, and hunting	0.5	0.3	0.5	0.1	0.5	0.4
Mining	0.1	0.1	0.0	0.0	0.0	0.0
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

\*The industry used for North Carolina is Motor Vehicle Parts Manufacturing.

jobs in motor vehicle-related industries have stronger in-state manufacturing bases that will supply the original equipment manufacturers.

So far, this analysis has focused on the employment impact in the five states with bus manufacturers, since the BEA provides only state multipliers. Using additional data from the BLS, however, allows for further detail on the potential for U.S. direct and indirect employment—both to estimate employment in a scenario in which domestic manufacturers fully supply all components, as well as to provide occupational data on the types of jobs created. As noted earlier, the trade-off is that BEA multipliers allow for estimates of the induced employment effect, but not at a national level, whereas the BLS multipliers allow for national estimates, but only for direct and indirect jobs.

The national employment estimates generated from the BLS multipliers are considerably lower than the state-based estimates. (See Table 17.) This indicates that investments in bus manufacturing, which support relatively higher-wage jobs, will generate sig-

**Table 17. Estimated Employment in Motor Vehicles Manufacturing Industries, with Current versus Fully Domestic Component Content, Under the Three Investment Scenarios**

	Employment Multiplier	Business-as-Usual Scenario (\$2.8 billion)	Increased Domestic Investment Scenario (\$4.8 billion)	International Competitiveness Scenario (\$12.8 billion)
<i>number of jobs</i>				
<b>Current Domestic Component Content</b>				
Total direct and indirect jobs	4.8	13,465	23,082	61,553
<i>Total direct jobs</i>	<i>0.8</i>	<i>2,357</i>	<i>4,041</i>	<i>10,777</i>
<i>Total indirect jobs</i>		<i>11,107</i>	<i>19,041</i>	<i>50,776</i>
<b>Full Domestic Content</b>				
Total direct and indirect jobs	7.8	21,922	37,581	100,216
<i>Total direct jobs</i>	<i>0.9</i>	<i>2,431</i>	<i>4,167</i>	<i>11,111</i>
<i>Total indirect jobs</i>		<i>19,492</i>	<i>33,414</i>	<i>89,104</i>

nificant numbers of induced jobs.

The BLS does not provide separate estimates for the heavy truck versus auto and light truck industries. The employment multipliers used are thus for the entire U.S. Motor Vehicle Manufacturing industry

**Table 18. Estimated Distribution of Jobs in Top 10 Industries Created from Investment in the U.S. Motor Vehicles Manufacturing Industry, 2008**

Industry	Share of Jobs	Industry	Share of Jobs
		<i>percent</i>	
<b>Current Domestic Component Content</b>		<b>Full Domestic Content</b>	
Motor vehicle parts manufacturing	17.5	Motor vehicle manufacturing	17.5
Motor vehicle manufacturing	10.4	Motor vehicle parts manufacturing	16.3
Wholesale trade	6.5	Wholesale trade	11.1
Management of companies and enterprises	4.9	Management of companies and enterprises	4.6
Machine shops; turned products; and screw, nut, and bolt manufacturing	3.1	Motor vehicle body and trailer manufacturing	4.1
Motor vehicle body and trailer manufacturing	2.4	Machine shops; turned product; and screw, nut, and bolt manufacturing	2.7
Truck transportation	2.2	Truck transportation	2.0
Foundries	2.1	Employment services	1.7
Employment services	1.9	Plastics product manufacturing	1.6
Services to buildings and dwellings	1.9	Foundries	1.6
<b>Total Top 10 Industries</b>	<b>52.9</b>	<b>Total Top 10 Industries</b>	<b>63.4</b>

**Table 19. Number and Gender Distribution of Employment in U.S. Railroad Rolling Stock, Motor Vehicle and Motor Equipment Manufacturing, and All Industries, 2006–08**

Category	Railroad Rolling Stock Manufacturing		Motor Vehicle and Motor Equipment Manufacturing		Share of Employment in All U.S. Industries
	Jobs	Share of Employment	Jobs	Share of Employment	
	<i>number of jobs</i>	<i>percent</i>	<i>number of jobs</i>	<i>percent</i>	<i>percent</i>
All Employed	32,722	100.0	1,338,178	100.0	100.0
Male	27,996	85.6	991,890	74.1	53.5
Female	4,726	14.4	346,288	25.9	46.5

Source: See Endnote 6 for this section.

(NAICS 3361).<sup>\*</sup> The size of the total job multiplier<sup>†</sup> for this industry, excluding imports, was 4.8, suggesting that \$1 million of output (in current dollars) would support an average of 4.8 jobs across all industries in the country. If stronger domestic supply chains allowed the bus industry to be 100-percent domestically supported, the size of the total jobs multiplier increases to 7.8. The size of the direct job multiplier in the motor vehicle manufacturing industry was only 0.9 and 0.8, including and excluding imports, respectively. As indicated in Table 17, 37,581 more jobs would be generated under the Increased Domestic Investment scenario,

<sup>\*</sup> The Heavy Truck Manufacturing industry (NAICS 336120) is a subset of the Motor Vehicle Manufacturing industry (NAICS 3361). This analysis uses NAICS 3361 because the BLS data are not available for sub-industries within NAICS 3361.

<sup>†</sup> The BLS total employment multipliers capture only direct and indirect effects, not induced effects.

and 100,216 more jobs under the International Competitiveness scenario, if the industry were 100-percent domestically supplied.

For the Increased Domestic Investment scenario, a 100-percent domestically supplied industry would create nearly 14,500 more jobs (37 percent) nationally. Nearly all of them are indirect jobs in the supply chain.

The new jobs created from investments in motor vehicle manufacturing would be spread across many industries, as indicated in Table 18. The left column provides job estimates for the industry with current suppliers, and the right column shows what the jobs distribution would be if the industry used 100-percent domestic suppliers.

### **Characteristics of Workers in the Motor Vehicle Manufacturing and Railroad Rolling Stock Manufacturing Industries**

An analysis of worker characteristics reveals that both the U.S. motor vehicle manufacturing and railroad rolling stock manufacturing industries employ groups of workers that have not fared well in the U.S. economy in recent years.<sup>8</sup> Males, production workers, and workers without post-secondary degrees have lost a disproportionate share of jobs during the recent economic recession.<sup>80</sup> Creating well-paying jobs in the two industries would help put these workers back in jobs.

Employment in both of these industries is heavily dominated by males. (See Table 19.) The male share of

employment—86 percent in railroad manufacturing and 74 percent in motor vehicle manufacturing—is considerably higher than in all U.S. industries combined (53.5 percent).

Workers in the two industries also have less education than U.S. workers as a whole. Both industries employed a much higher share of adults with only a high-school diploma or GED than the national average. (See Table 20.) High-school graduates and GED holders accounted for 39–40 percent of the employed in the two industries, compared to only 28 percent of the total employed nationwide. Adults with only a high-school education have fared very poorly in the labor market over the past decade.

The median annual earnings of railroad rolling stock manufacturing workers exceeded the median annual earnings of all U.S. workers by slightly more than \$9,215, or 28 percent. (See Table 21.) Median annual earnings of motor vehicle manufacturing employees exceeded those of all U.S. workers by approximately \$10,850, or 33 percent. These manufacturing jobs provide good wages for workers with less than four-year college degrees.

**Table 20. Share of Employment in U.S. Railroad Rolling Stock, Motor Vehicle Manufacturing, and All Industries, by Education Level, 2006–08**

Educational Attainment	Railroad Rolling Stock Manufacturing	Motor Vehicle and Motor Equipment Manufacturing	Distribution of Employed All U.S. Industries
<i>share of employment (percent)</i>			
Below or through grade 12, No high-school diploma	13.1	10.2	11.4
High-school diploma/GED	40.1	38.9	27.6
Some college	28.6	31.2	31.3
Bachelor's degree	13.4	13.6	19.1
Master's or higher degree	4.8	6.1	10.6

Source: See Endnote 6 for this section.

**Table 21. Median Annual Earnings of Workers in U.S. Railroad Rolling Stock, Motor Vehicle Manufacturing, and All Industries, by Gender, 2006–08**

Category	Railroad Rolling Stock Manufacturing	Motor Vehicle and Motor Equipment Manufacturing	All U.S. Industries
<i>annual earnings (dollars)</i>			
All Employed	41,754	43,385	32,539
Male	42,234	48,808	38,179
Female	38,504	32,539	26,478

Source: See Endnote 6 for this section.

## Key Assumptions About the Investment Scenarios and Realizing Their Employment Impact

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Any economic-impact analysis is based on a variety of economic and political assumptions. In this report, for example, the substantial increase in U.S. production of passenger rail cars and buses that is proposed in the Increased Domestic Investment scenario requires that manufacturers have unutilized capacity to meet this hypothetical demand (or that new companies will be created). Interviews with key manufacturers indicate that several of them have been operating below full capacity, and that if demand increased, they could fill it. While calling back laid-off workers and increasing hours will help companies meet demand and boost workforce earnings, it may also lower the true employment impact estimated in this analysis.

With regard to bus manufacturing, another key assumption of this analysis is that substantially increasing bus orders will not alter the current market shares of the five U.S. manufacturers, which is unlikely to be the case if the industry expands rapidly. The employment impact across states will vary considerably depending on which companies win contracts for new buses. Two of the companies, New Flyer and Orion, have very substantial Canadian manufacturing operations. If these companies manufacture bus parts and components in Canada rather than in the United States, then the true domestic employment impact could be overstated. This concern could become greater if their U.S. facilities reach full capacity. However, the Buy America provisions will prevent them from importing more than 40 percent of the parts and components of the buses purchased in the United States with federal monies.

The analysis of job creation under full domestic content assumes that it is both feasible and desirable to increase the domestic content for rail and buses far above and beyond their current levels. Manufacturing

advocates support increasing the Buy America provision to higher than 60 percent, and the Obama administration has announced support for enforcing domestic purchasing preferences on high-speed rail projects funded with the initial \$8 billion of HSR grants that were part of the economic stimulus package. The estimates provided in this report reveal that full domestic sourcing would dramatically increase employment.

Yet interviews with industry representatives suggest that increasing the share of domestic sourcing may present practical challenges on the ground. Supply chains have been developed around the 60 percent requirement, and, already, suppliers of some key components of transit vehicles have near-monopoly power. Transit vehicle producers fear that increasing the percentage could also increase the cost of several key inputs. Moreover, the United States no longer produces some key components, so waiting for U.S. manufacturers to gear up would slow down infrastructure development. If the country is serious about achieving a goal of greater domestic content, it must be equally serious about developing the necessary supply chain and ensuring markets for suppliers.

As noted in the Duke University report *U.S. Manufacturing of Rail Vehicles for Intercity Passenger Rail and Urban Transit*, the current U.S. rail market has not been large enough to support the comprehensive supplier industry needed to move to full domestic supply:

The U.S. value chain includes several gaps—specific manufacturing activities that are not typically performed in the United States. These gaps vary among the six target rail types. For example, a high-speed rail component may currently be manufactured exclusively overseas, while the equivalent component for regional rail is made domestically by several firms. Depending on the

rail category, activities often performed outside the United States may include propulsion systems, fabricated trucks, electronic systems, and doors. Often these gap categories require complex machinery and special skills, so companies typically invest in them only in overseas locations where there is a stronger market.<sup>1</sup>

In essence, there is a chicken-and-egg problem. Increased domestic content requires more complete domestic supply chains, but unless there is enlarged demand it will be difficult to call forth the supply. Raising the Buy America provision to 100 percent presents special challenges. U.S. manufacturers of systems and component parts have established cost-efficient partnerships with manufacturers and suppliers of sub-components in other regions of the world.<sup>2</sup> In the bus industry, these out-of-country suppliers generally provide lower-technology subcomponent parts such as wheels and fasteners that have less complex manufacturing processes than parts manufactured in the United States. These parts are ubiquitous in the global marketplace, so firms often source them from regions that have less technologically advanced manufacturing industries and the lowest production costs, while firms in regions with more skilled and technologically advanced manufacturing industries expand their capacity to produce components that have a higher value-added in the product stream.<sup>3</sup>

For example, in 2009, ArvinMeritor, a U.S. company that is the sole supplier of transit bus and rail axle systems, divested its wheel business to Iochpe-Maxion, S.A., a Brazilian company that produces wheels, frames, and castings for commercial vehicles and rail cars.<sup>4</sup> The wheels are made in China by Iochpe-Maxion's wholly owned subsidiary, Maxion (Nantong) Wheels Co. Ltd.<sup>5</sup> Divesting low-margin manufacturing activities can help make U.S. firms stronger interna-



tional competitors, and, by increasing firms' bottom lines, it can contribute to creating and retaining more higher technology living-wage jobs in the United States.

Finally, some critics have contended that other countries might retaliate by restricting U.S. imports, so industrial goals would need to be reconciled with trade policy.<sup>6</sup> In fact, many of the same countries that object to U.S. domestic content are far more strategic in developing their own industries. If there is to be a level playing field in international trade and industrial policy, then more strategic coherence is required on the U.S. side.

*This AC Transit bus in Oakland, California, was built by Van Hool with a Cummins engine. Courtesy AC Transit*



## Conclusion

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The bottom line is that the United States needs to focus on high-end manufacturing. A strategy for doing so is to link manufacturing to other policy goals. Countries in both Europe and Asia have successfully linked the development of state-of-the-art public transit systems to manufacturing. These countries are now exporting or producing technologically sophisticated transit vehicles around the world. It is time for the United States to become a producer, rather than a consumer, of transit vehicles. But no single industry will save U.S. manufacturing—the country needs a coherent industrial policy.

In reports such as this one, the authors are constrained by the boundaries of current policy debate if

they expect to be taken seriously. As a result, even though the above analysis indicates that the level of funding proposed under the International Competitiveness scenario would most forcefully accelerate the development of a strong U.S. transit industry, the less-ambitious Increased Domestic Investment level is recommended here—and even this is an aggressive funding scenario given the current political climate. Nevertheless, the analysis in this report plainly suggests that if U.S. manufacturing is to experience a serious revival that produces more than fragmented showcase projects and scattered jobs, public policy needs to think much bigger and more boldly than it currently does.

## Appendix: Methodology for Employment Projections

### Input-Output Models and the RIMS Models of the U.S. Bureau of Economic Analysis

Input-output models provide a statistical depiction of the inter-industry linkages within a national or state economy.<sup>1</sup> The national or state economy is divided into a set of industries. Each industry's output is allocated to either other industries in the state economy or to final sales (consumption goods and services to households, capital goods purchases by industries, government purchases, or exports to other states/nations).<sup>\*</sup> Linkages created by sales to other industries in the state are referred to as *forward linkages*. Purchases of each state industry from other industries in the state are referred to as *backward linkages*.

The data on the gross outputs of industries and these inter-industry linkages are used to calculate a matrix of input-output coefficients (or technical coefficients). This set of data on gross outputs, final demand sales, and technical coefficients is used with a set of matrix algebra calculations to calculate the *direct and indirect output requirements* from each industry of the state to produce a dollar of final sales from each industry. By incorporating the economic links between households and each industry into the input-output model, we can also calculate the *induced effects* of an expansion of final sales from each industry.<sup>†</sup> These induced effects are brought about by the spending of workers in the industry on the goods and services produced by other industries across the state. For example, a production worker in a bus manufacturing firm uses his salary to buy locally produced goods and services.

During the 1970s, the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) developed a statistical methodology, known as the Regional Industrial Multiplier System (RIMS), to estimate regional Input-Output (I-O) multipliers. In the 1980s, the BEA enhanced this methodology, and it became known as the Regional Input-Output Modeling System II (RIMS II). The multipliers for industries are based on a complex set of I-O tables originally developed by Wassily Leontief, a contribution for which he was awarded the Nobel Prize in Economics in 1973. For each industry, the I-O table shows the value of the inputs it purchased from other industries, the outputs it sold to other industries, and final demand. In this analysis, we primarily rely on BEA multipliers at the state level.

Input-output studies are commonly used to assess the economic impact of specific industries on regions, states, or the nation. These include studies on the economic impacts of hospitals, colleges, pharmaceuticals, aviation, sports teams, tourism, transportation, health care, biotechnology, and venture capital.<sup>2</sup>

Several types of multipliers can be generated by input-output models. The first category is Type I and Type II multipliers. Type I multipliers capture only the direct and indirect effects of a change in final demand sales, earnings, or employment in a given industry. For example, a Type I final demand output multiplier would capture the direct effect of an expansion in final demand sales of industry "i" plus all the indirect effects via the changes in the outputs of all other industries in the state brought about by industry i's purchases from other industries.

As the bus manufacturing industry increases its sales to transit agencies in the state or to agencies in other states and countries,<sup>‡</sup> the industry will directly pur-

<sup>\*</sup> Annual gross output is the value of all revenues received from sales of the product or services plus the change in inventories. Output produced but not sold is part of the gross output of the industry.

<sup>†</sup> Households provide both labor and capital services (cash, bonds, stocks, land) to an industry for which they receive a stream of income, and they purchase goods and services from industries.

<sup>‡</sup> In a state input-output model, sales to consumers within the state are treated as consumption expenditures under the final demand matrix, whereas sales to consumers in other states and countries would be classified as export sales under the final demand matrix.

chase inputs of goods and services from other state industries, including itself. These industries in turn will buy goods and services from other state industries to produce additional inputs, which will then initiate another cycle of inter-industry spending of increasingly smaller sizes.\* The combined effects of these second and third round and additional rounds of spending are the indirect effects of the increase in final demand sales of industry *i*. The higher the purchases by industry *i* from other state industries (i.e., these inter-industry backward linkages), the higher will be the size of these indirect effects. The value of the Type I multiplier for a given industry is calculated by dividing the sum of the direct and indirect effects by the direct effects. (See table here.)

#### Formulas for the Two Types of Multipliers in Input-Output Analysis

$$\text{Type I Multiplier} = \frac{\text{Direct} + \text{Indirect Effects}}{\text{Direct Effects}}$$

$$\text{Type II Multiplier} = \frac{\text{Direct} + \text{Indirect} + \text{Induced Effects}}{\text{Direct Effects}}$$

Type II multipliers capture the direct, indirect, and induced effects of an expansion in final sales, earnings, or employment in a given industry. The induced effects capture the impacts of the spending of workers in the affected industry. When an industry expands its outputs, it will create a stream of wages and salaries for its workforce and a stream of profits/interest/rents for its owners, who will spend a portion of their incomes on goods and services and new housing produced by other state industries, thereby expanding output, earnings, and employment in these other state industries.

The higher the wages and salaries of workers in the industry, the higher their degree of residency in the state, the higher their propensity to consume locally produced goods and services, and the higher the geographic concentration of owners in the state, the higher will be the size of these induced effects. All of these developments will raise the induced effects from an

\* In input-output models, the size of the direct and indirect requirements from each industry to produce a dollar of gross output from industry *i* are estimated by inverting the  $[I - A]$  matrix of coefficients where *A* is the technical coefficients matrix and *I* is the identity matrix.

expansion of final demand sales and employment, thereby increasing the value of Type II multipliers. The value of the Type II multiplier for a given industry is calculated by dividing the sum of the direct, indirect, and induced effects by the direct effect. (See table.) The higher the indirect and induced effects, the higher the value of the Type II multiplier.

A variety of economic multipliers can be produced through the application of input-output analysis, particularly when the I-O analysis is supplemented by earnings and employment data by industry. Among the types of multipliers used in economic impact studies at the national, state, and local level are output, earnings, income, and employment multipliers.

The BEA has provided values of state multipliers for three bus manufacturing and bus component manufacturing industries:

- NAICS 336120: Heavy Duty Truck Manufacturing
- NAICS 336211: Motor Vehicle Body Manufacturing
- NAICS 3363: Motor Vehicle Parts Manufacturing

### Estimating the Overall Employment Impacts of Changes in Employment in U.S. Motor Vehicles Manufacturing Industries Using the U.S. Bureau of Labor Statistics' National Employment Matrix

In estimating its 10-year employment projections, the U.S. Bureau of Labor Statistics (BLS) makes many assumptions regarding the economic performance of the national economy and key demographic trends, including population and labor force growth. These assumptions include projected trends in current and real gross domestic product, personal income and its disposition, federal/state/local government receipts and expenditures, foreign trade, employment, hours of work, labor force and labor force participation rate, productivity, costs, and prices.

To generate employment projections, BLS relies on inter-industry relationships data, also known as input-output data (the I-O matrix), to estimate final demand and value-added data and the employment multipliers. According to the BLS, “the input-output data show the flow of commodities from production through intermediate use by industries and purchases by final users.”<sup>3</sup> Using the I-O matrix, the BLS generates an employment multipliers matrix for 202 X 202 industries at the national level. These multipliers

are estimated in two different ways: including and excluding imports.

The BEA multipliers in the previous section excluded imports. Another key difference is that the BLS industries are more aggregated than the ones used by the BEA. The BEA produces various multipliers for 406 NAICS industries versus the 202 industries avail-

able from the BLS. As a result, our analysis is conducted for the motor vehicle manufacturing industry, which includes heavy truck and auto and light truck manufacturing. A third distinction is that unlike the BEA multipliers, which include induced effect multipliers, the BLS does not produce employment multipliers that incorporate induced spending effects.

## Endnotes

### Linking U.S. Manufacturing and Transportation

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#### Scenarios for U.S. Rail and Transit Employment

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#### Key Assumptions About the Investment Scenarios and Realizing Their Employment Impact

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#### Appendix: Methodology for Employment Projections

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*Streetcar in Portland, Oregon.*

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**Northeastern University**  
*Kitty and Michael Dukakis Center  
for Urban and Regional Policy*