United States Government Accountability Office

GAO

Report to Congressional Committees

February 2011

# INTERCITY PASSENGER AND FREIGHT RAIL

# Better Data and Communication of Uncertainties Can Help Decision Makers Understand Benefits and Trade-offs of Programs and Policies

GAO
Accountability * Integrity * Reliability

GAO-11-290

Highlights

Highlights of GAO-11-290, a report to congressional committees

## Why GAO Did This Study

Concerns about the weak economy, congestion in the transportation system, and the potentially harmful effects of air emissions generated by the transportation sector have raised awareness of the potential benefits and costs of intercity passenger and freight rail relative to other transportation modes such as highways. GAO was asked to review (1) the extent to which transportation policy tools that provide incentives to shift passenger and freight traffic to rail may generate emissions, congestion, and economic development benefits and (2) how project benefits and costs are assessed for investment in intercity passenger and freight rail and how the strengths and limitations of these assessments impact federal decision making. GAO reviewed studies; interviewed federal, state, local, and other stakeholders regarding methods to assess benefit and cost information; assessed information on project benefits and costs included in rail grant applications; and conducted case studies of selected policies and programs in the United Kingdom and Germany to learn more about their policies designed to provide incentives to shift traffic to rail.

## What GAO Recommends

GAO recommends DOT conduct a data needs assessment to improve the effectiveness of modeling and analysis for rail and provide consistent requirements for assessing rail project benefits and costs. DOT, Amtrak and EPA provided technical comments, and DOT agreed to consider the recommendations.

View GAO-11-290 or key components.
For more information, contact Susan Fleming at (202) 512-4431 or flemings@gao.gov.

February 2011

# INTERCITY PASSENGER AND FREIGHT RAIL

## Better Data and Communication of Uncertainties Can Help Decision Makers Understand Benefits and Trade-offs of Programs and Policies

## What GAO Found

Although implementing policies designed to shift traffic to rail from other modes may generate benefits, and selected European countries' experiences suggest that some benefits can be achieved through these types of policies; many factors will affect whether traffic shifts. The extent to which rail can generate sufficient demand to draw traffic from other modes to achieve the desired level of net benefits will depend on numerous factors. Some passenger or freight traffic may not be substitutable or practical to move by a different mode. For example, certain freight shipments may be time-sensitive and thus cannot go by rail. Another key factor will be the extent to which sufficient capacity exists or is being planned to accommodate shifts in traffic from other modes. How transport markets respond to a given policy—such as one that changes the relative price of road transport—will also affect the level of benefits generated by that policy. Experiences in selected countries suggest that varying amounts of mode shift and some benefits were attained where decision makers implemented policies to move traffic from other modes to rail. For example, a road freight pricing policy in Germany resulted in environmental and efficiency improvements, and freight rail grants in the United Kingdom led to congestion relief at the country's largest port. Pursuing policies to encourage traffic to shift to rail is one potential way to generate benefits, and other policies may be implemented to generate specific benefits at a potentially lower cost.

Information on the benefits and costs of intercity passenger and freight rail is assessed to varying degrees by those seeking federal funding for investment in rail projects; however, data limitations and other factors reduce the usefulness of such assessments for federal decision makers. Applicants to two discretionary federal grant programs—the Transportation Investment Generating Economic Recovery program and the High-Speed Intercity Passenger Rail program—provided assessments of potential project benefits and costs that were generally not comprehensive. For instance, applications varied widely in the extent to which they quantified and monetized some categories of benefits. In addition, GAO's assessment of selected applications found that most applicants did not provide key information recommended in federal guidance for such assessments, including information related to uncertainty in projections, data limitations, or the assumptions underlying their models. Applicants, industry experts, and Department of Transportation (DOT) officials GAO spoke with reported that many challenges impacted their ability to produce useful assessments of project benefits and costs, including: short time frames in which to prepare the assessments, limited resources and expertise for performing assessments, poor data quality, lack of access to data, and lack of standard values for monetizing some benefits. As a result, while information on project benefits and costs was considered as one of many factors in the decision-making process, according to DOT officials, the varying quality and focus of assessments resulted in additional work, and the information provided was of limited usefulness to DOT decision makers.

# Contents

## Figures

## Abbreviations

| | |
|---|---|
| AAR | Association of American Railroads |
| BTS | Bureau of Transportation Statistics |
| DOT | Department of Transportation |
| EPA | Environmental Protection Agency |
| FAA | Federal Aviation Administration |
| FAF | Freight Analysis Framework |
| FHWA | Federal Highway Administration |
| FRA | Federal Railroad Administration |
| HGV | Heavy Goods Vehicle |
| HSIPR | High-Speed Intercity Passenger Rail Program |
| ITIC | Intermodal Transportation and Inventory Cost Model |
| NHTSA | National Highway Traffic Safety Administration |
| OMB | Office of Management and Budget |
| PRIIA | Passenger Rail Investment and Improvement Act of 2008 |
| Recovery Act | American Recovery and Reinvestment Act of 2009 |
| RRIF | Railroad Rehabilitation and Improvement Financing |
| SAFETEA-LU | Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users |
| TIFIA | Transportation Infrastructure Finance and Innovation Act |
| TIGER | Transportation Investment Generating Economic Recovery |
| VMT | vehicle miles traveled |

United States Government Accountability Office
Washington, DC 20548

February 24, 2011

The Honorable John D. Rockefeller IV
Chairman
The Honorable Kay Bailey Hutchison
Ranking Member
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Frank R. Lautenberg
Chairman
The Honorable John Thune
Ranking Member
Subcommittee on Surface Transportation
and Merchant Marine Infrastructure,
Safety and Security
Committee on Commerce, Science, and Transportation
United States Senate

Concerns about the weak economy, congestion in the transportation system, and the potentially harmful effects of greenhouse gases and airborne pollutants from transportation have raised awareness of the potential benefits and costs of intercity passenger and freight rail relative to other transportation modes. The U.S. economy and its competitive position in the global economy depend in part on the nation's transportation networks working efficiently. In addition, factors such as cost and time can impact passengers' and shippers' demand for a particular transportation mode. Congestion delays that significantly constrain both passenger and freight mobility can result in increased economic costs to passengers, shippers and also to the nation. According to the Texas Transportation Institute, in 2009 the yearly peak-period delay per auto commuter was 34 hours, with a total cost of $115 billion.[1] Continued development and efficient management of the nation's transportation system is essential to accommodate the anticipated future

[1]Data are based on a review of 439 urban areas in the United States and includes both highways and principal arterials. Yearly delay per auto commuter is the extra time spent traveling at congested speeds rather than free-flow speeds by private vehicle drivers and passengers who typically travel in peak periods. The value of travel time delay is estimated at $16 per hour of person travel and $106 per hour of truck time. Texas Transportation Institute Urban Mobility Report 2010.

growth of the nation's passenger and freight mobility demands. For example, the Department of Transportation (DOT) forecasts that between 2010 and 2035 the freight transportation system will experience a 22 percent increase in total freight tonnage moved in the United States, from 12.5 billion to 15.3 billion tons.[2] In addition, the transportation industry continues to be one of the biggest energy users and contributors to greenhouse gas emissions. According to the Environmental Protection Agency (EPA), for 2008 the transportation sector accounts for 27 percent of the nation's greenhouse gas emissions.[3] Because shifting intercity passenger and freight traffic to rail from other more energy-intensive modes is seen as a potential option to address some of these concerns, there is a growing interest in investing in and enhancing rail capacity and implementing policies that will encourage more traffic by rail.[4]

The Passenger Rail Investment and Improvement Act (PRIIA), enacted in October 2008,[5] authorized over $3.7 billion for three different federal programs for high-speed rail,[6] intercity passenger rail congestion,[7] and intercity passenger rail service corridor capital grants.[8] The American Recovery and Reinvestment Act of 2009 (Recovery Act), enacted in February 2009, appropriated $8 billion for the three PRIIA-established intercity passenger rail programs. In addition, the Recovery Act authorized new discretionary grants under the Transportation Investment Generating Economic Recovery (TIGER) program.[9]

[2]Forecast is based on an analysis of the Commodity Flow Survey (CFS) which is developed in partnership by the Census Bureau and the Bureau of Transportation Statistics (BTS).

[3]The primary greenhouse gasses produced by the transportation sector are carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_20$), and hydrofluorocarbon (HFC).

[4]While outside the scope of this study—the potential benefits of rail are not solely limited to emissions, congestion, and economic development benefits that result from modal shift. Improved or expanded rail service may simply increase the desire and ability of people to travel or engage in trade, and to enjoy the subsequent benefits that flow from that enhancement in mobility and access.

[5]Pub. L. No. 110-432, Div. B, 122 Stat. 4907 (October 2008).

[6]49 U.S.C. § 26106.

[7]49 U.S.C. § 24105.

[8]49 U.S.C. § 24402.

[9]Pub. L. No. 111-5, Title XII, 123 Stat. 115 (2009).

PRIIA and the Recovery Act created new responsibilities for Federal Railroad Administration (FRA) to plan, award, and oversee the use of new federal funds for intercity passenger rail. In response, FRA launched the High-Speed Intercity Passenger Rail (HSIPR) program in June 2009 by issuing a funding announcement and interim guidance, that outlined the requirements and procedures for obtaining federal funds.[10] Moreover, in 2010 DOT awarded over $2 billion in TIGER and $10 billion in HSIPR grants. Both programs required applications to include information on the costs and benefits of proposed projects, including information on such benefits as reducing environmental impacts and congestion and encouraging economic development.

One of the many considerations that can help inform transportation decision making is determining which investment or set of policies will yield the greatest net benefit (that is, benefits minus costs). While there is some debate around the extent to which investment in rail or policies that encourage shifting traffic to rail from other modes can help address problems, such as congestion and greenhouse gas emissions, there are a variety of analytical approaches, such as benefit-cost analysis and others, that may be employed to help evaluate proposed transportation investments. Tools such as these can provide decision makers with information on the benefits and costs of alternative investments and policy choices needed to make informed decisions. Given your interest in the potential net benefits of intercity passenger and freight rail policies and programs, we examined (1) the extent to which transportation policy tools that provide incentives to shift passenger and freight traffic to rail may generate emissions, congestion, and economic development benefits and (2) how project benefits and costs are assessed for investment in intercity passenger and freight rail and how the strengths and limitations of these assessments impact federal decision making.

To address our objectives, we reviewed our prior work on rail and transportation investment decision making and documentation from an array of sources, as well as interviewing officials and various stakeholders regarding methods to assess the benefits and costs of transportation investments. Our interviews included discussions with officials from DOT, EPA, and the National Railroad Passenger Corporation (Amtrak); representatives from transportation coalitions and associations, metropolitan planning organizations, and state DOTs; and other

[10] 74 Fed. Reg. 29900 (June 23, 2009).

transportation stakeholders. We also reviewed and assessed information on potential project benefits and costs included in 40 rail-related applications submitted to the HSIPR and TIGER grant programs—20 from each program. We selected a random sample of applications that was weighted to ensure approximately proportional representation of the range of applications submitted to each program. Two GAO analysts independently reviewed each selected application based on Office of Management and Budget (OMB) guidelines on benefit-cost analysis,[11] with input from GAO economists and methodologists. We conducted an extensive literature search to identify studies analyzing potential mode shift and the impact of mode shift on selected benefits for intercity passenger or freight rail projects and policies. We used the studies and information we reviewed to inform our work and relied on multiple sources of additional information, including testimonial evidence, interviews, and case studies. We conducted case studies of selected policies and programs designed to provide incentives to shift passenger and freight traffic from other modes to rail in the United Kingdom and Germany to learn more about their experiences with efforts to shift traffic to rail in order to generate benefits. These two countries were chosen based on a number of criteria, including their experience in implementing such policies. While European intercity passenger and freight rail systems are very different in size, structure, and scope than the U.S. rail system, the experiences of countries such as the United Kingdom and Germany provide illustrative examples of other countries' experiences with policy tools that provide incentives to shift traffic to rail.[12] Finally, we conducted our own computer simulation of transportation scenarios on mode choice for freight shipments. See appendix IV for a discussion of the simulation and appendix I for a detailed discussion of our scope and methodology.

We conducted this performance audit from December 2009 to February 2011, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe the

[11]OMB, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, Circular No. A-94 (Oct. 29, 1992), as revised through Dec. 8, 2009. OMB, *Principles for Federal Infrastructure Investments*, Exec. Order No. 12893 (Jan. 26, 1994). *Regulatory Analysis*, Circular No. A-4 (Sept. 17, 2003).

[12]For example, the European rail system is focused primarily on passenger operations, while the U.S. rail network is predominantly a freight transport system.

evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

## Background

Passenger and freight rail are part of a complex national transportation system for transporting people and goods. Currently, there are seven Class I railroads and over 500 short line and regional railroads operating in the United States.[13] These railroads operate the nation's freight rail system and own the majority of rail infrastructure in the United States. Railroads are the primary mode of transportation for many products, especially for such bulk commodities as coal and grain. In addition, railroads are carrying increasing levels of intermodal freight (e.g., containers and trailers), which travel on multiple modes and typically require faster delivery than bulk commodities. According to the Association of American Railroads (AAR), based on ton-miles, freight railroads carried about 43 percent of domestic intercity freight volume in 2009. In addition, according to DOT, the amount of freight rail is expected to continue to grow with a projected increase of nearly 22 percent by 2035. Intercity passenger rail service is primarily provided by Amtrak. Amtrak operates a 21,000-mile network, which provides service to 46 states and Washington, D.C., primarily over tracks owned by freight railroads. Federal law requires that freight railroads give Amtrak trains preference over freight transportation and, in general, charge Amtrak the incremental cost—rather than an apportioned cost—associated with the use of their tracks.[14] Amtrak also owns about 650 route miles of track, primarily on the Northeast Corridor, which runs between Boston, Massachusetts, and Washington, D.C.

Transportation may impose a variety of "external" costs that can result in impacts such as health and environmental damage caused by pollution.[15]

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[13]As defined by revenue, for 2009, Class I railroads are freight rail carriers having annual operating revenues of $379 million or more. [49 C.F.R. 1201-1]. The railroads include CSX Transportation (CSX), BNSF Railway Company (BNSF), Union Pacific Railroad Company (Union Pacific), Norfolk Southern, Kansas City Southern Railway Company, Canadian National Railway, and Canadian Pacific Railway. Regional and short line railroads are medium-sized and small railroads, respectively, and are categorized based on operating revenues and mileage. Generally, for 2009, regional railroads are Class II railroads (carrier having annual operating revenues greater than $30 million but less than 379 million) and short line railroads are Class III railroads (carriers having annual operating revenues of $30 million or less).

[14]49 U.S.C. § 24308.

[15]An externality is an unintended side effect (negative or positive) of an activity of one individual or firm on the well-being of others.

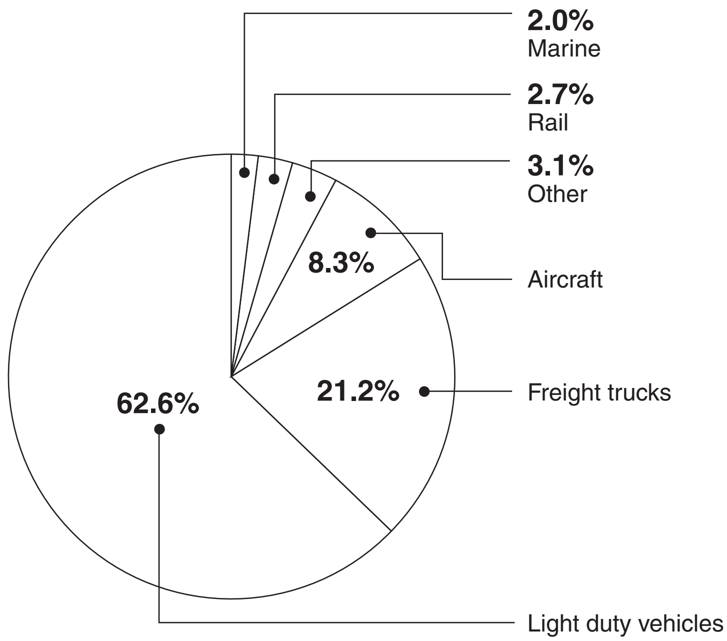
For example, in choosing to drive to work, a commuter may not take into account the car emissions' contribution to local pollution, which may damage property or the health of others. Following are some negative effects of transportation:

- *Greenhouse gas emissions, nitrogen oxide ($NO_x$) and fine particulate matter, and other pollutants:* Based on estimated data from the EPA, from 1990 through 2008, transportation greenhouse gas emissions increased 22 percent. Carbon dioxide ($CO_2$) is the primary greenhouse gas associated with the combustion of diesel (and other fossil fuels) and accounted for over 95.5 percent of the transportation sector's greenhouse gas emissions.[16] Based on 2008 data from the EPA, cars, light trucks, and freight trucks together contributed over 80 percent of the transportation sector greenhouse gas emissions (see fig. 1).[17]

[16]For 2008, HFCs accounted for 3 percent, and $CH_4$ and $N_20$ together accounted for about 1.5 percent of the transportation total greenhouse gas emissions. $N_20$ and $CH_4$ gasses are released during fuel consumption, although in much smaller quantities than $CO_2$, and are also affected by vehicle emissions control technologies. U.S. DOT, *Transportation's Role in Reducing U.S. Greenhouse Gas Emissions*, volume 1, Synthesis Report, P. 2-5, April 2010.

[17]Data are based on "tailpipe" emissions and do not include other processes that also produce additional greenhouse gas emissions. These include the production and distribution of fuel, the manufacture of vehicles, and the construction and maintenance of transportation infrastructure. These supporting processes—known as the fuel, vehicle manufacture, and infrastructure cycles—generally are not included in U.S. transportation sector greenhouse gas estimates.

Figure 1: 2008 Estimates of U.S. Greenhouse Gas Emissions by Transportation Mode




Source: GAO analysis of EPA data.

Note: “Light duty vehicles” includes passenger cars and light duty trucks. “Freight trucks” includes heavy and medium trucks. “Marine” includes ships and boats. For Marine, the source indicates that emission estimates reflect data collection problems. “Other” includes motorcycles, lubricants, buses, and pipelines.

In addition, $NO_x$ and fine particulate matter with a diameter of 2.5 microns or less (PM2.5) contribute to air pollution. Both of these pollutants are emitted through high temperature combustion and activities such as burning fossil fuels. For 2002, based on our analysis of EPA data, it was estimated that trucks emitted 3.02 tons of $NO_x$ and .12 tons of PM2.5 per million ton-miles.[18]

[18]GAO, *Surface Freight Transportation: A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers*, GAO-11-134 (Washington D.C.: Jan. 26, 2011). Estimates are based on the most current data available. Estimated emissions were obtained directly from EPA and are based on the current MOVES2010 model for estimating on-road vehicle emissions. Estimates assume that nearly all on-road diesel emissions are freight-related, and 15 percent of gasoline powered vehicle emissions are freight-related.

- *Congestion:* While congestion is geographically concentrated in metropolitan areas, international trade gateways, and on some intercity trade routes, congestion is a serious problem, contributing to longer and more unpredictable transit times and resulting in increased transportation costs. The Texas Transportation Institute estimates that for 439 domestic urban areas, congestion costs in 2009 alone were $115 billion and accounted for a total of 3.9 billion gallons of gasoline consumption. For freight, congestion delays that significantly constrain freight mobility could result in increased economic costs for the nation. The Federal Highway Administration (FHWA) has calculated that delays caused by highway bottlenecks cost the trucking industry alone more than $8 billion a year. Similarly, we have previously reported on the significant level of congestion that exists, and is expected to grow, at airports in large urban areas throughout the country. The Federal Aviation Administration (FAA) predicts that, by 2025, the number of airline passengers will increase 57 percent—from about 700 million to about 1.1 billion per year—and the number of daily flights will increase from about 80,000 to more than 95,000. Today's air transportation system will be strained to meet this growth in air traffic.[19]

- *Accidents:* Each year, there are tens of thousands of truck and vehicle accidents that result in injury or fatality. Based on National Highway Traffic Safety Administration (NHTSA) data, there were 33,808 fatal motor vehicle crashes in the United States in 2009. This resulted in a national motor vehicle death rate of 1.13 deaths per 100 million vehicle miles traveled (VMT). For freight, preliminary data from DOT for 2009 shows the rate of fatalities involving large trucks and buses was 0.121 per 100 million VMT. A portion of motor vehicle crash costs are not covered by private insurance. According to a 2000 NHTSA report, approximately $21 billion, or 9 percent of all costs are borne by public sources. Similarly, we estimated truck external accident costs of $8,000 per million ton-miles that are not passed on to consumers.[20]

[19]GAO, *Nextgen Air Transportation System: FAA's Metrics Can Be Used to Report on Status of Individual Programs, but Not of Overall NextGen Implementation or Outcomes*, GAO-10-629 (Washington, D.C.: July 27, 2010).

[20] Estimates are in 2010 dollars. To obtain an estimate in accident costs we included the number of fatalities multiplied by the latest value for human life used by DOT in guidance for its own analysts, and then assumed that carriers are already compensated for 50 percent of those costs. The economic costs of transportation accidents reflect the value assigned to the loss of a human life and the reduced productive life and pain and suffering related to serious injuries. (GAO-11-134).

## Investment and Policy Tools to Attain Benefits through Rail

While there are multiple approaches to address externalities in transportation, policies that provide incentives to shift traffic to rail can be appealing because they offer an option to address multiple externalities simultaneously by changing behavior to favor rail over other modes. For example, market-based policies that change the relative prices of the modes are likely going to be the most cost-effective. Policies such as increasing fuel taxes, imposing new fees such as a vehicle mile travel fee or a congestion charge, investing in increased capacity in one mode, or subsidizing travel in one mode can provide incentives to users to switch travel from one mode to another, and can achieve both a reduction in greenhouse gas emissions and alleviate congestion.[21] Some stakeholders also believe that investing in rail may help to stimulate economic development. In order to obtain similar benefits without the goal of shifting traffic to rail, it might be necessary to introduce a suite of policies, each more directly targeted at a specific externality.[22] For example, a congestion pricing policy may reduce traffic during peak travel times, but if it shifts traffic to nonpeak times, it may have a limited impact on overall emissions. Conversely, providing incentives to purchase more fuel efficient truck engines may do nothing to improve congestion or economic development.

With respect to direct investment, the federal government typically has not provided extensive funding for freight rail or for intercity passenger rail outside of the Northeast Corridor between Boston, Massachusetts and Washington, D.C. In addition, according to Amtrak officials, funding has not been predictable, consistent, or sustained. However, recent legislation has increased the federal role and funding available for investment in intercity passenger and freight rail infrastructure. In 2008, PRIIA authorized the HSIPR program.[23] The program is administered through DOT's FRA, which has responsibility for planning, awarding, and overseeing the use of federal funds for the development of high-speed and

[21]A recent legislative proposal has put forth potential policy goals for transportation that include such things as reducing delays, improving safety, reducing greenhouse gas emissions, and shifting 10 percent of freight traffic in the United States off of highways and onto other modes. See S.1036, 11th Cong. (2009).

[22]It is difficult to assess whether the benefits associated with a policy that seeks to shift traffic to rail outweigh the various costs associated with these policies. In addition, there are also costs associated with alternative approaches that may affect which one or combination of policies would be most desirable for a given situation.

[23]Pub. L. No. 110-432, Div. B, 122 Stat. 4907 (Oct. 16, 2008).

intercity passenger rail.[24] As of 2010, over $10 billion had been awarded through the HSIPR program to fund high-speed rail projects.[25] Moreover, through the Recovery Act, Congress authorized the TIGER Discretionary Grant Program for investment in a variety of transportation areas, including freight and passenger rail.[26] In 2010, DOT awarded over $2 billion in TIGER funding. The TIGER program was designed to preserve and create jobs and to promote economic recovery and investment in transportation infrastructure that will provide long-term economic benefits and assist those most affected by the current economic downturn. The TIGER grants are multimodal, and criteria were developed for a framework to assess projects across various modes. For more information on the HSIPR and TIGER programs, see appendix III.[27]

## Assessment of Benefits and Costs in Decision Making

Decision makers may consider a number of factors in deciding between various alternative investments or policies. These factors may include the objective or goal of the proposed actions—for example, preserving and creating jobs or promoting economic recovery or reducing an environmental externality. Other factors, such as the benefits and costs of alternatives, are also important to consider in decision making. Some benefits are associated with reducing an externality and are part of the assessment of whether policy alternatives for addressing the externality

[24]In addition to these responsibilities, FRA is also responsible for developing a national rail plan. The agency also has responsibility for railroad safety oversight, providing operational and capital grants to Amtrak, and approval for Railroad Rehabilitation and Improvement Financing loans and Rail Line Relocation and Improvement Capital Grants under the Transportation Infrastructure Finance and Innovation Act (TIFIA) (see 23 U.S.C. chapter 6) and Railroad Rehabilitation and Improvement Financing (RRIF) (at 45 U.S.C. chapter 17) programs.

[25]Additional funding was provided through other FY 2009 and FY 2010 appropriations to DOT.

[26]Pub. L. No. 111-5, Title XII, 123 Stat. 115 (2009). A later, second round, known as TIGER II, was authorized and funds appropriated by the Consolidated Appropriations Act, 2010, Pub. L. No.111-117, Div. A, Title I, 123 Stat 3034, 3036 (Dec. 16, 2009).

[27]In addition to the TIGER and HSIPR programs, other DOT programs that provide investment in rail projects also consider information on project benefits and costs as part of their application processes. The TIFIA and RRIF programs allow applicants to include information on economic, environmental, and safety benefits in their applications. However, neither program provides applicants with specific requirements for assessment of potential benefits and costs.

can be justified on economic principles.[28] Costs should also be accounted for when considering various investment or policy alternatives. For example, there are direct costs, such as construction, maintenance, and operations, and less obvious types of costs, such as delays and pollution generated during construction.

There are tools that can be employed in evaluating proposed transportation alternatives, including benefit-cost analysis[29] and economic impact analysis. Benefit-cost analysis is designed to identify the alternative with the greatest net benefit by comparing the monetary value of benefits and costs of each alternative with a baseline. Benefit-cost analysis provides for a comparison of alternatives based on economic efficiency, that is, which investment or policy would provide the greatest net benefit (i.e., greater benefits than costs). As we have previously reported, while benefit-cost analysis may not be the most important decision-making factor—but rather, one of many tools that decision makers may use to organize, evaluate, and determine trade-offs of various alternatives—the increased use of systematic analytical tools such as benefit-cost analysis can provide important additional information that can lead to better informed transportation decision making.[30] Economic impact analysis is a tool for assessing how the benefits and costs of transportation alternatives would be distributed throughout the economy and for identifying groups in society (for example, by region, income, or race) that are likely to gain from, or bear the costs of, a policy.

The use of benefit-cost analysis information is not consistent across modes or types of programs that provide funding to transportation projects. Competitive programs such as TIGER and HSIPR and loan guarantee programs such as TIFIA and RRIF require information on

[28]The benefits associated with policies to address external costs of transportation activities may include reductions in pollution, congestion, and improvements in safety (reducing accidents). The policies may also affect economic activity such as by increasing construction-related jobs.

[29]For the purposes of this report, we use the term "assessment of benefits and costs" to mean a general evaluation of benefits and costs that may encompass a variety of types of analyses and "benefit-cost analysis" refers to a formalized analysis as it is strictly defined.

[30]GAO, *Highway And Transit Investments: Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results*, GAO-05-172 (Washington, D.C.: Jan. 24, 2005) and GAO, *Surface Transportation: Many Factors Affect Investment Decisions*, GAO-04-744 (Washington, D.C.: June 30, 2004).

benefits and costs.[31] Formula programs (such as the Federal-Aid Highway Program)[32] do not necessarily require benefit-cost information. Federal guidance exists for conducting benefit-cost analyses, including OMB Circular No. A-94, OMB Circular No. A-4, and Executive Order No. 12893. The directive and related OMB guidance outline a number of key elements that should be included in the assessment of benefits and costs in decision making, as described in table 1.

**Table 1: Key Elements for Benefit-Cost Analysis from Presidential Exec. Order No. 12893 and OMB Circulars Nos. A-94 and A-4**

| | |
|---|---|
| Comparison to base case and alternatives | Establish a base case for comparison. |
| | Identify alternative projects—benefits and costs should be defined in comparison with a clearly stated alternative. |
| Analysis of benefits and costs | Define a time frame for analysis. |
| | Quantify and monetize impacts as benefits and costs to the maximum extent possible, but consider qualitative measures reflecting values that are not readily quantified. |
| | Measure and discount benefits and costs over the full life cycle of the project and identify the year in which dollars are presented. |
| Transparency of information and treatment of uncertainty | Clearly state all assumptions underlying the analysis of benefits and costs. |
| | Assess the sensitivity of the analysis to changes in assumptions and forecasted inputs and recognize uncertainty through appropriate quantitative and qualitative assessments. |

Sources: GAO analysis of Presidential Exec. Order No. 12893 and OMB Circulars Nos. A-94 and A-4.

Specifically Executive Order No. 12893 and OMB Circulars Nos. A-94 and A-4 indicate that benefit and cost information shall be used in decision making, and the level of uncertainty in estimates of benefits and costs shall be disclosed.[33] Other aspects of the benefit-cost analysis should be completed to the extent possible. For example, while the guidance suggests that impacts should be quantified and monetized, to the extent

[31]See previous footnotes 24 and 27 for additional information on TIFIA and RRIF.

[32]The Federal-Aid Highway Program provides federal financial resources and technical assistance to state and local governments for constructing, preserving, and improving the National Highway System. Funding is distributed to states through annual apportionments established by statutory formulas.

[33]OMB Circular No. A-94 recognizes that "[e]stimates of benefits and costs are typically uncertain because of imprecision in both underlying data and modeling assumptions." The type of information that would help decision makers understand the level of uncertainty associated with a benefit-cost analysis would include the key sources of uncertainty, the expected value estimates of outcomes, the sensitivity of results to important sources of uncertainty; and where possible, the probability distributions of benefits, costs, and net benefits.

that this is not possible, qualitative assessments should be provided for those impacts that are not readily quantifiable. As we have previously reported in our work on transit investments, qualitative information can help ensure that project impacts that cannot be easily quantified are considered in decision making.[34]

Both the HSIPR and TIGER grant programs required applicants to provide information on proposed project benefits and costs. The type of information required, however, differed between the two programs and, for the TIGER program, depended on the level of federal funding sought, as described in table 2. In addition, while requirements for assessment of project benefits and costs were more specific for TIGER than for the HSIPR program, officials for both programs considered whether project benefits were likely to exceed project costs as part of their respective application assessment processes.

**Table 2: Federal Discretionary Transportation Grant Program Requirements for Assessments of Project Benefits and Costs**

| Grant program | Size of grant sought | Program requirements for assessment of benefits and costs | Benefit-cost guidance referred to in the Federal Register |
|---|---|---|---|
| TIGER | Less than $20 million | Information on project benefits and costs not required. | Exec. Order No.12893 and OMB Circular Nos. A-94 and A-4 |
| | Between $20 million and $100 million | Required to include estimates of the projects' expected benefits in five long-term outcome categories: (1) state of good repair, (2) economic competitiveness, (3) livability, (4) sustainability, and (5) safety.[a] | |
| | More than $100 million | Required to provide a "well developed" analysis of expected benefits and costs, including calculation of net benefits and a description of input data and methodological standards used for the analysis. | |

[34]GAO, *Public Transportation: Improvements Are Needed to More Fully Assess Predicted Impacts of New Starts Projects*, GAO-08-844 (Washington, D.C.: July 25, 2008).

| Grant program | Size of grant sought | Program requirements for assessment of benefits and costs | Benefit-cost guidance referred to in the Federal Register |
|---|---|---|---|
| HSIPR | Any amount | Required to provide information on public return on investment in three categories: (1) transportation benefits, (2) economic recovery benefits, and (3) public benefits, which include energy independence and efficiency, environmental quality, and livable communities.<br>Applications to HSIPR were divided into four groups, each of which required assessments of public return on investment in these categories. However, importance of benefit categories varied across these groups (see app. III). | Exec. Order No.12893 |

Source: GAO analysis of TIGER and HSIPR *Federal Register* notices.

Note: For TIGER II—the second round of TIGER funding that DOT awarded in October 2010—DOT required benefit-cost analyses from all applicants, regardless of the amount of funding requested.

[a]According to DOT, projects that contribute to a state of good repair by improving the condition of existing facilities and transportation systems; projects that meet economic competitiveness criteria contribute to the economic competitiveness of the United States over the medium-term and long-term; projects that meet livability criteria improve the quality of living and working environments and experience for people in communities across the United States; projects that meet sustainability criteria improve energy efficiency, reduce dependence on oil, reduce greenhouse gas emissions, and benefit the environment; and projects that meet safety criteria improve the safety of U.S. transportation facilities and systems.

## Shifting Traffic to Rail from Other Modes May Generate Benefits, but Many Factors Will Affect Whether Traffic Shifts, and Policies Abroad Have Produced Mixed Results

### Determining the Extent of Benefits That Can Be Achieved through Rail Is Complicated by Numerous Factors

In order to generate benefits—such as a decrease in the harmful effects of transportation-related pollution—through mode shift, a policy first has to attract sufficient rail ridership or rail freight demand from other modes that have higher harmful emissions. In practice, the extent to which rail can generate sufficient demand to draw traffic from other modes and generate net benefits will depend on numerous factors.[35] In addition to mode shift, policies that produce price changes can prompt other economic responses in the short run, such as the use of lighter-weight materials or a shift toward more fuel-efficient vehicles; over the longer term, there is greater potential for responses that will shape the overall distribution and use of freight and passenger transportation services.[36]

For intercity passenger rail, factors such as high levels of population density, expected population growth along a corridor, and strong business and cultural ties between cities can lead to a higher demand for intercity passenger travel. In order for rail to be competitive with other transportation modes, it needs to be time- and price-competitive and have favorable service characteristics related to frequency, reliability, and safety. Further, high-speed rail has more potential to attract riders in corridors experiencing heavy intercity travel on existing modes of transportation—particularly where air transportation has high traffic

[35]More generally, infrastructure policies should be assessed with respect to benefits and costs, as per Exec. Order No. 12893 and federal guidance.

[36]GAO-11-134.

levels and a large share of the market over relatively short distances—and where there is, or is projected to be, growth in congestion and constraints on the capacity of existing systems. For example, rail traffic in the densely populated Northeast Corridor is highly competitive with other modes, and Amtrak now has a 65 percent share of the air-rail market between Washington, D.C. and New York and a 52 percent share between New York and Boston.[37] The potential for network effects are also an important factor in the level of traffic that may shift to rail, as more riders are attracted when the line is located where it can carry traffic to a wide number of destinations or connect to other modes. For example, local transit systems can serve as feeders to the success of intercity passenger rail operations.[38] Passenger modes can also work as complements, if, for example, passenger rail service delivers passengers to airports. DOT has indicated where passenger rail generally competes with other modes. For example, for intercity distances of 100-600 miles, in corridors with moderate population densities, high-speed rail competes with auto and bus and at high population densities competes with air, as shown in figure 2.[39]

[37]According to Amtrak officials, the Northeast Corridor has experienced a 37 percent increase in ridership between Washington, D.C. and New York and 20 percent between New York and Boston over the past 10 years.

[38]A recently released report explored the relative ability of regional corridors to attract passengers based on factors that have contributed to rail ridership in other systems around the world. Petra Todorovich and Yoav Hagler, America 2050, *High Speed Rail in America*, January 2011.

[39]DOT, *National Rail Plan: Moving Forward*, Progress Report, September 2010.

**Figure 2: Competition among Passenger Transportation Modes**

| Intercity distance | Population density | | |
|---|---|---|---|
| | Light | Moderate | High |
| 0-100 miles[a] | Auto<br>Bus | Auto<br>Bus<br>Commuter rail | Auto<br>Bus<br>Commuter rail |
| 100-600 miles[a] | Auto<br>Bus<br>Conventional rail | Auto<br>Bus<br>High-speed rail | High-speed rail<br>Air |
| 600-3,000 miles | Auto<br>Bus<br>Air | Auto<br>Bus<br>Air | Air |

Source: GAO analysis of DOT information.

[a]In certain corridors in high-density areas, conventional rail also competes with other modes (e.g., New York to Philadelphia).

In freight markets, one mode may have a distinct comparative advantage over another for certain types of shipments, thereby limiting the potential for traffic to shift to rail. For example, carriage of bulk commodities (e.g., coal) relies almost entirely on rail and waterways, while carriage of high-value and very time-sensitive commodities is dominated by truck and aviation. Conversely, modes often work as complements to complete a shipment. Intermodal freight is designed to move on multiple modes, using a container that can be moved from a truck to a train to a ship without handling any of the freight itself when changing modes. In other cases, the modes may be substitutable for certain types of trips and will compete directly for shipments or for segments of shipments based on price and performance. For example, some long-haul trucking and rail shipments may be substitutable. DOT has produced some basic parameters that influence competition across the modes for freight, as shown in figure 3.

**Figure 3: Competition among Freight Transportation Modes**

| Freight intercity distance | Transportation modes that compete for different types of freight | | |
|---|---|---|---|
| | Retail goods | Consumer durables and other manufactured goods | Bulk goods |
| 0-250 miles | Truck | Truck<br>Rail | Truck<br>Rail<br>Water |
| 250-500 miles | Truck | Truck<br>Rail intermodal<br>Rail | Truck<br>Rail<br>Water |
| 500-1,000 miles | Truck<br>Rail intermodal | Truck<br>Rail intermodal<br>Rail | Rail<br>Water |
| More than 1,000 miles | Truck<br>Rail intermodal | Truck<br>Rail intermodal<br>Rail | Rail<br>Water |

Source: GAO analysis of DOT information.

The extent to which mode-shifting is possible in the United States is difficult to estimate and will largely be determined by the types of parameters discussed above, such as whether shipping is feasible by another mode (e.g., rail lines may not be available for some routes), or practical (e.g., sending heavy coal shipments long distance by truck or time-sensitive shipments by rail may not be practical), and by the relative prices and other service characteristics of shipping by different modes.

To further explore the potential for mode shift, we used a computer model developed by DOT[40] to simulate the short-term change in VMT resulting from a 50-cent increase in per-mile truck rates. We simulated two scenarios: one using the model's default assumptions and one in which the assumptions pertaining to truck speed, reliability, and loss and damage were adjusted to make truck relatively more costly than rail.[41] Under both scenarios, the 50-cent increase in truck rates (an increase of roughly 30 percent) resulted in less than a 1 percent decrease in truck VMT. Although both the default scenario and the alternative scenario produced similar estimates, these simulations are only suggestive, rather than definitive, of the impact that an increase in per-mile truck rates might have on VMT reduction. While the results of our simulation suggest that a 50-cent increase in per-mile truck rates would have a limited impact on diversion of freight from truck to rail, data limitations prevent us from making precise predictions with a high level of confidence. See appendix IV for a more detailed description of our modeling efforts, data quality issues, and a full list of assumptions in the model.

In both the United States and in other countries we visited—where freight and passenger traffic generally share the same rail infrastructure— the potential benefits of a policy designed to shift freight traffic to rail are also affected by the amount of capacity available or planned on the rail network to accommodate a shift in traffic, as well as the capacity available or planned on competing transportation modes. For example, freight rail officials we met with in the United States indicated that in heavily congested corridors, such as in the Northeast, there is limited capacity available to accommodate both planned freight rail projects and proposed intercity passenger rail traffic, because the rail line is already congested. Plans for new dedicated high-speed rail lines would eliminate some of

[40]The Intermodal Transportation and Inventory Cost Model (ITIC) is a computer model for calculating the costs associated with shipping freight via alternative modes, namely truck and rail. The model can be used to perform policy analysis of issues concerning long-haul freight movement, such as diversion of freight shipments from truck to rail. DOT provides the ITIC model framework as a useful tool for ongoing policy studies, and shares the model, along with some internally developed data, for this purpose. We chose to use the ITIC model to simulate mode shift from truck to rail because of its federal origins and its direct applicability to freight shipments.

[41]The model has 17 default assumptions. Because of resource constraints, our analysis only varied 3 of these assumptions and considered only one change in these values, instead of varying a larger number of assumptions for a wider range of scenarios. Therefore, we cannot conclude that the model results are robust to all plausible variations in all of the model assumptions.

these capacity sharing issues and could potentially create the capacity needed to accommodate both freight and improved or expanded passenger service but must be weighed against the costs associated with constructing and maintaining new equipment and infrastructure, as well as acquiring rights of way for the track.[42] Furthermore, significant investment and improvements to operations for highway infrastructure or airport infrastructure could offset the impact of policies designed to shift passenger or freight traffic to rail. For example, the FAA is currently pursuing modernization of the air transportation system to create additional capacity and efficiencies. If, as a result, flights become more efficient and travel times decrease, then travelers originally expected to shift to rail as a result of the implemented policy may not do so. In contrast, the existence of other policies in place concurrently may also be a contributing factor to improvements in environmental or congestion benefits, as separate policies may work together and lead to greater cumulative benefits. In either case, it can be difficult to distinguish the impact of a given policy due to these other factors.

Following are descriptions of how shifting traffic to rail can address externalities and produce benefits, as well as some of the factors that affect the extent to which those benefits may materialize:

*Reduced greenhouse gas emissions and increased fuel efficiency:* Rail emits fewer air emissions and is generally more fuel efficient than trucks. For example, a report by the American Association of State Highway and Transportation Officials (AASHTO) cites that the American Society of Mechanical Engineers estimates 2.5 million fewer tons of carbon dioxide would be emitted into the air annually if 10 percent of intercity freight now moving by highway were shifted to rail, if such traffic has the potential to shift.[43] A recent study conducted by FRA comparing the fuel efficiency of rail to freight trucks calculated that rail had fuel efficiencies ranging from 156 to 512 ton-miles per gallon, while trucks had fuel efficiencies ranging

[42]Amtrak officials noted that dedicated high-speed rail lines make up a very small portion of worldwide rail mileage.

[43]Cited from the American Society of Mechanical Engineers in “Transportation Invest in America: Freight–Rail Bottom Line Report,” American Association of State Highway and Transportation Officials (2003).

from 68 to 133 ton-miles per gallon.[44] According to Amtrak officials, their intercity passenger rail service has also been shown to be more energy efficient than air or passenger vehicle traffic.[45] In addition, passenger and freight rail can be electrified to eliminate even current emissions generated by rail transport, as alternative power (e.g., hydro or nuclear) may be used to generate electric propulsion. For example, many of the routes in the United Kingdom are electrified, and efforts are under way to continue to electrify additional segments of the rail network in order to reduce emissions. While rail generally provides favorable emissions attributes and fuel efficiency in comparison with highway and air travel, there are many factors that could affect the extent to which environmental benefits are achieved. These factors may include the type of train equipment, the mix of commodities being transported, the length of the rail route versus the truck route for a given shipment, traffic volume, and capacity. In addition, if the current transportation system is not designed to facilitate rail transport, it may be necessary to invest in additional capital infrastructure or build new rail yards closer to urban areas, which could have additional environmental costs and may diminish the extent of potential net benefits. Furthermore, how transport system users respond to a given policy will also impact the extent to which the policy generates any benefits. For example, a policy that changes the price of road transport by tolling could result in a freight hauler responding by changing the load factor of existing road shipments by consolidating shipments or increasing return loads to decrease the number of empty return trips. A similar policy could also lead to reduced transport volumes due to reduced demand for the product being shipped. According to DOT officials, correctly pricing usage of the transportation system is an ongoing challenge, as incorrect pricing can lead to inefficiencies and misallocation of resources beyond what market conditions would otherwise allow. Other policies aside from mode shift can more directly target environmental externalities. More targeted policies—such as increasing fuel taxes or implementing a carbon pricing scheme—may encourage drivers to purchase more fuel-efficient vehicles or make fewer vehicle trips, without shifting significant traffic to rail.

[44] Rail fuel efficiency was calculated in ton-miles per gallon to move commodity; truck fuel efficiency is calculated in lading ton-miles per gallon. Federal Railroad Administration, "Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors" (Nov. 19, 2009).

[45] Amtrak's relative fuel efficiency advantage is based on the available data in the Department of Energy's Transportation Energy Data Book http://cta.ornl.gov/data/Index.shtml, table 2.12.

*Congestion:* Where passenger or freight rail service provides a less costly alternative to other modes—through more timely or reliable transport—individuals and shippers can shift out of more congested modes and onto rail, thus alleviating congestion. For certain goods, a train can generally carry the freight of 280 or more trucks, relieving congestion by removing freight trucks from the highways.[46] Similarly, an intercity passenger train can carry many times more people than the typical passenger vehicle.[47] Consequently, if fewer vehicle miles are traveled, then there is less wear and tear on the highways and less cost to the public for related repairs and maintenance. However, congestion relief will vary based on specific locations, times of day, types of trips being diverted to another mode, and the conditions of the corridors and areas where trips are being diverted. For freight, long-haul shipments might have the most potential to shift to rail, but diversion of these trips to rail, while removing trucks from certain stretches of highway, may do little to address problems at the most congested bottlenecks in urban areas. Similarly, Amtrak officials noted that aviation can provide travelers' alternative options for travel in high-density corridors which may help relieve congestion at capacity-constrained airports. If high-speed rail can divert travelers from making an intercity trip through congested highway bottlenecks or airports at peak travel times, then there may be a noticeable effect on traffic. However, any trips on a congested highway corridor that are diverted to another mode of travel, such as rail, may at least partially be replaced by other trips through induced demand. For example, since congestion has been reduced on a highway, making it easier to travel, more people may respond by choosing to drive on that highway where faster travel times are available, limiting the relief in the long-run. Other policies can be implemented that are designed to more directly address congestion where it is most acute, such as congestion pricing (e.g., converting high-occupancy vehicle lanes to high-occupancy toll lanes) or other demand management strategies.

*Safety:* While safety has improved across all transportation modes over time, both passenger and freight rail may have a comparative advantage over other modes. Shippers and passengers who use rail in lieu of other modes may accrue measurable safety benefits because rail traffic is, for the most part, separated from other traffic. Because most rail accidents—

[46]For example, a major rail corridor for high-value, time-sensitive container freight exists between Los Angeles and Chicago.

[47]According to Amtrak officials, intercity passenger trains also carry more passengers than the typical aircraft.

both injuries and fatalities—involve traffic at limited locations such as grade crossings or on railroad property, safety benefits can be expected when more traffic is moved via rail. On a per-mile basis, passenger and freight rail are substantially safer than cars or trucks. For example, according to Amtrak, there were 8 passenger fatalities between 2003 and 2007. In addition, in 2007 most freight accidents occurred on highways—over 6 million—as compared with rail, which accounted for approximately 5,400 accidents. Between 2003 and 2007, freight rail averaged 0.39 fatalities per billion ton-miles, compared with 2.54 fatalities per billion ton-miles for truck.[48] There are a variety of policies and regulations that directly address safety concerns for each mode (e.g., safety standards and inspections for rail, vehicle safety features, etc.).

*Economic development:* The recent economic downturn has spurred interest in developing opportunities to preserve and create jobs in order to help promote economic recovery. According to DOT, investment in intercity passenger and freight rail may aid in the short-term creation of jobs and potentially in the long-term development of higher density economic activity through concentrating retail and commercial business activity near rail lines or stations. Investment in intercity passenger and freight rail may be viewed as a potential avenue to generate economic development and produce wider economic impacts.[49] Wider economic impacts associated with the investment in rail may include such things as added regional and national economic output and higher productivity and lower infrastructure costs. For example, investment in intercity high-speed passenger rail service could significantly influence the nature of regional economies beyond employment and income growth related to the investment in a rail system by spurring increases in business activity through travel efficiency gains. Moreover, the existence of new transport hubs and corridors creates the potential for economic development, as businesses may start to operate in the newly developed area in and around the rail corridor over the medium-term and the long-term. However, in

[48]Freight moved by water between 2003 and 2007 averaged only .01 fatalities per billion ton-miles. GAO has utilized ton-miles data from FHWA's Freight Analysis Framework (FAF)[3] for these calculations, while the Bureau of Transportation Statistics uses a different estimate of ton-miles.

[49]Certain effects, sometimes referred to as wider economic impacts, of investments in transportation infrastructure may not be captured in standard benefit-cost analysis. These impacts may include effects related to returns to scale and agglomeration. Because markets are often not perfect, such wider economic impacts—both positive and negative—may result from transportation investments.

some cases, these types of impacts may reflect transfers of economic activity from one region to another and thus may not be viewed as benefits from a national perspective, or these impacts may already be accounted for through users' direct benefits. As such, there is much debate about achieving these wider economic impacts and a number of challenges associated with assessing these types of impacts. While high-speed rail may have wider economic impacts, the impact varies greatly from case to case and is difficult to predict. Estimates of benefits vary, as one study has suggested that wider economic benefits would not generally exceed 10 to 20 percent of measured benefits, while an evaluation of another proposed high-speed rail line estimated these benefits to add 40 percent to direct benefits.[50] There are a variety of other policies that could be implemented to help stimulate economic development without mode shift.

## In Selected European Countries, Experiences Suggest That Policies Intended to Produce Mode Shift May Lead to Varying Amounts of Mode Shift and Some Benefits

Based on experience in the United Kingdom and Germany where decision makers made a concerted effort to move traffic from other modes to rail through pricing policies, targeted grants, and infrastructure investments, these policies resulted in varying amounts of mode shift.[51] The full extent of benefits generated from these policies is ultimately uncertain, though benefits realized included environmental and efficiency improvements or localized congestion relief. Foreign rail officials told us it was difficult to determine the full extent of the benefits due to complicating factors (as described throughout the previous section). While some benefits were attained through implementation of policies designed to shift traffic to rail, these benefits were not necessarily achieved in the manner originally anticipated or at the level originally estimated. Furthermore, it is uncertain whether the benefits attained were achieved in the most efficient manner, or whether similar benefits could have been attained through other policies at a lower cost.

[50]Other studies have shown varying potential economic impacts. For example, a study of the Trans-European Transport Network suggested that it would not change regional GDP by more than 2 percent.

[51]The European intercity passenger and freight rail systems are very different in size, structure, and scope than the U.S. rail system. For example, the European rail system is focused primarily on passenger operations, while the U.S. rail network is predominately a freight transport system. While the systems differ, the experiences of countries we visited, such as the United Kingdom and Germany provide illustrative examples of other countries experiences with policy tools that provide incentives to shift traffic to rail.

*Road freight pricing policies:* In 2005, the German government implemented a Heavy Goods Vehicle (HGV) tolling policy on motorways to generate revenue to further upgrade and maintain the transportation system and to introduce infrastructure charging based on the "user pays" principle by changing the relative price of road transport relative to rail. The HGV tolling policy was also designed to provide an incentive to shift approximately 10 percent of road freight traffic to rail and waterways in the interests of the environment and to deploy HGVs more efficiently. According to German Ministry of Transport officials, while the HGV toll policy did not result in the amount of mode shift originally anticipated, some level of environmental benefits and road freight industry efficiency improvements were realized. These benefits are attributed to a more fuel-efficient HGV fleet making fewer empty trips. For example, officials told us that, in response to the tolling policy, trucking companies purchased more lower emission vehicles, which were charged a lower per-mile rate in order to decrease their toll.[52] For the most part, German freight shipments continued to be made primarily on trucks, and trucks' mode share has not changed appreciably since instituting the policy. Findings in a study conducted for the Ministry of Transport also indicated that transport on lower emission trucks has increased significantly, totaling 49 percent of all freight operations subject to tolls in 2009. According to German transport officials, the share of freight moved by rail has only slightly increased during the last decade. However, this increase cannot be clearly attributed to a particular policy tool, such as the HGV toll.

Other countries have had similar experiences implementing pricing policies to provide incentives to shift traffic to rail. For example, the Swiss government implemented a HGV fee in 2001 on all roads to encourage freight traffic to shift from road to rail. This policy similarly resulted in improved efficiency because the trucking industry adapted its fleet and replaced some high emission vehicles with new lower emission vehicles. According to Swiss Federal Office of Transport documentation, HGV traffic through the Swiss Alps also decreased compared with what it would have been without introduction of the fee. However, to fully assess the magnitude of benefits of these types of tolling policies, these improvements would need to be weighed against the costs of implementing the policy, and this type of analysis has not been conducted.

[52] We did not analyze the costs associated with trucking companies' response to the HGV policy. Therefore, we cannot determine whether the costs associated with purchasing and transitioning to a more fuel-efficient fleet outweigh the policy's environmental and other benefits, including those from the increased fuel efficiency of the trucking fleet.

*Freight rail operations and capital support:* The United Kingdom's Department for Transport uses two grant programs providing financial support for specific rail freight projects to encourage mode shift and provide congestion relief, based on the view that road freight generally does not pay its share of the significant external costs that it creates. The department's Mode Shift Revenue Support scheme provides funding for operational expenses and the Freight Facilities Grant program supplements capital projects for freight infrastructure. The British government's experience with these policies—which draw from a relatively small pool of annual funding and are intentionally designed to serve a targeted market—led to localized benefits for particular segments of the freight transport market in specific geographic locations such as congested bottlenecks near major ports. An evaluation of the Freight Facilities Grants program found that the program funding played an important role in developing or retaining rail freight flows, traditionally focused on bulk commodities.[53] According to officials we met with, the grants from the Mode Shift Revenue Support scheme encourage mode shift principally for the economically important and growing intermodal container market and have been successful in reducing congestion on specific road freight routes because the program focuses on container flows from major ports (in which rail now has a 25 percent market share). These officials noted that, out of approximately 800,000 truck journeys removed from the road as a result of the grants from the Mode Shift Revenue Support scheme, between 2009 and 2010, 450,000 trucks were removed from England's largest port—the Port of Felixstowe. Therefore, officials said the grants appear to have led to a decrease in truck traffic concentrated in specific locations for a particular segment of the freight transport industry.

*Intercity passenger rail infrastructure investments:* Few postimplementation studies have been conducted to empirically assess the benefits resulting from investment in high-speed intercity passenger rail. Based on our previous work, some countries that have invested in new high-speed intercity passenger rail services have experienced discernable mode shift from air to rail where rail is trip-time competitive. For example, the introduction of high-speed intercity rail lines in France and Spain led to a decrease in air travel with an increase in rail ridership, and Air France

[53]Allan Woodburn, "Evaluation of Rail Freight Facilities Grant Funding in Britain," School of Architecture and the Built Environment, *Transport Reviews*, 27 (3), pp. 311-326, May 2007.

officials estimated that high-speed rail is likely to capture about 80 percent of the air-rail market when rail journey times are between 2 and 3 hours.[54] For example, with the introduction of the Madrid-Barcelona high-speed rail line in February 2008, air travel dropped an estimated 30 percent. In France, high-speed rail has captured 90 percent of the Paris-Lyon air-rail market. While discernible mode shift has been observed, the extent to which net benefits were achieved is unclear. Factors such as the proportion of traffic diverted from air or conventional rail versus newly generated traffic affect the extent of benefits. Furthermore, quantifying any resulting environmental benefits, such as reduced greenhouse gas emissions, or assessing the extent to which these benefits exceed the costs associated with developing these new high-speed rail routes is difficult. Some evaluations have been conducted in Spain and France and have indicated that net benefits were less than expected due to higher costs and lower than expected ridership, although, in France, the evaluations still found acceptable financial and social rates of return.[55]

Policies that provide incentives to shift passenger and freight traffic to rail offer the opportunity to attain a range of benefits simultaneously, but a variety of complicating factors can have a significant impact on the extent to which these benefits may be attained. In addition, if these policies are unable to generate the ridership or demand necessary to shift traffic from other modes to rail, the potential benefits may be further limited. While officials from some European countries we visited indicated that they have attained benefits from policies intended to shift traffic to rail, gains have been mixed, and the extent of benefits attained has depended on the specific context of policy implementation in each location, as the benefits realized are directly related to the particulars of each project. Furthermore, it is not always clear that the policy goals were feasible to begin with or that mode shift would have been the most cost-effective way to achieve the benefits sought. Some officials and stakeholders we met with told us that it is very difficult to attribute causation and draw conclusions regarding the effectiveness of transportation policy tools because so many factors are at play and may change simultaneously. In some cases, officials cannot determine the full extent of benefits or link

[54]GAO, *High Speed Passenger Rail: Future Development Will Depend on Addressing Financial and Other Challenges and Establishing a Clear Federal Role*, GAO-09-317 (Washington, D.C.: Mar. 19, 2009).

[55]Chris Nash, "Enhancing the Cost Benefit Analysis of High Speed Rail" (paper presented at the California High Speed Rail Symposium, Berkeley, Calif., Dec. 3, 2010).

impacts to a given policy with certainty, making it difficult for decision makers to know what to expect from future policies being considered or developed.

In the next section, we look at two recent U.S. investment programs that awarded grant funding to freight and intercity passenger rail projects. Although neither of these programs were adopted for the specific purpose of shifting passenger or freight traffic to rail, both programs do seek to attain benefits, such an economic development and environmental benefits, by investing in rail. As previously noted, the degree to which benefits can be generated depends on a variety of factors, including the ability to attract riders or freight shipments either through mode shift or new demand. We discuss how applicants assessed the potential benefits and costs of their specific projects, based on the particular circumstances of each project, and the usefulness of those assessments for federal decision makers in making their investment decisions.

## Grant Applicants' Assessments of Project Benefits and Costs Are of Varying Quality and Usefulness to Decision Makers

### Grant Applicants' Assessments of Project Benefits and Costs Were Not Comprehensive in Many Respects

According to DOT officials from both programs, as well as our assessment of 40 randomly selected rail-related TIGER and HSIPR applications,[56] information on project benefits and costs submitted by applicants to the TIGER and HSIPR[57] programs varied in both quality and comprehensiveness. While a small number of analyses of project benefits and costs were analytically strong—with sophisticated numerical projections of both benefits and costs and detailed information on their data and methodology—many others (1) did not quantify or monetize benefits to the extent possible, (2) did not appropriately account for benefits and costs, (3) omitted certain costs, and (4) did not include information on data limitations, methodologies for estimating benefits and costs, and uncertainties and assumptions underlying their analyses.

First, the majority of applications we assessed contained primarily qualitative discussion of project benefits, such as potential reductions in emissions, fuel consumption, or roadway congestion, which could have

[56]We selected a nongeneralizable random sample of 20 applications from each program that included components of intercity passenger or freight rail and assessed the benefit and cost information contained in the applications based on OMB guidelines for benefit-cost analysis, with input from GAO economists and methodologists. For more information on the methodology of our study assessment, see appendix I.

[57]FRA allowed applicants to the HSIPR program to submit applications under four different funding "Tracks." The pool of HSIPR applications from which we randomly selected projects for review were from Track 2, which included applicants evaluated under PRIIA §§301 and 501, i.e., 49 U.S.C. §§ 24402 and 26106, which authorize grants to support intercity passenger rail service and development of high-speed intercity rail systems, respectively, excluding intercity passenger rail congestion projects and including only projects using Recovery Act funding. 74 Fed. Reg. 29909. Except as otherwise stated, our references to HSIPR in this portion of this report are to HSIPR Track 2 as defined by FRA. See appendix III for more detail.

been quantified and monetized. For instance, while 36 of the 40 applications we assessed included qualitative information regarding potential reductions in congestion, 20 provided quantitative assessments of these benefits, and 13 provided monetary estimates.[58] This pattern was consistent across categories of benefits we assessed; however, some categories of impacts, such as safety and economic development, were even less frequently quantified. While federal guidelines, including Executive Order No. 12893, allow for discussion of benefits in a qualitative manner, they note the importance of quantifying and monetizing benefits to the maximum extent practicable. However, in some cases, certain categories of impacts may be more difficult to quantify than others and qualitative information on potential benefits and costs can be useful to decision makers.

Second, common issues identified by DOT economists in the applications they assessed[59] included failure to discount future benefits and costs to present values or failure to use appropriate discount rates,[60] double counting of benefits, and presenting costs only for the portion of the project accounted for in the application while presenting benefits for the full project. Similarly, 33 of the 40 applications we assessed did not use discount rates as recommended in OMB Circular No. A-94 and OMB Circular No. A-4. Further, DOT economists who reviewed assessments of project benefits and costs contained in selected TIGER applications stated that many applicants submitted economic impact analyses—which are

[58]Our study assessment was limited to applications to TIGER and HSIPR that were required to include information on project benefits and costs.

[59]Of the approximately 1,450 applications DOT received for the TIGER program, DOT officials selected 166 to be forwarded to review teams for additional consideration. These applications were selected based on criteria such as project readiness and potential for job creation. The benefit and cost information contained in these 166 applications was reviewed by a team of DOT economists, who rated each evaluation for adequacy and value. For more information on these ratings, see below.

[60]Benefits and costs expected to occur in future years are discounted to account for the time value of money. In general, discounting gives relatively less weight to benefits and costs expected to occur in the future. Not discounting or using an inappropriate discount rate can affect the results of a benefit-cost analysis. OMB provides guidance on choosing appropriate discount rates for different types of investments and recommends both 3 percent and 7 percent discount rates for benefit-cost analyses of proposed investments. DOT asked applicants to the TIGER program to discount future benefits and costs using a discount rate of 7 percent and permitted them to provide an alternative analysis using a discount rate of 3 percent. However, HSIPR applicants were not required to perform benefit-cost analysis and were not provided information on discounting in the *Federal Register* notice for the program.

generally used to assess how economic impacts would be distributed throughout an economy but not for conducting benefit-cost analysis of policy alternatives. Economic impact analyses may contain information that does not factor into calculations of net benefits, such as tax revenue and induced jobs, and do not generally include information on other key benefits that would be accounted for in a benefit-cost analysis, such as emissions reduction or congestion relief. Applicants' focus on economic impacts in their assessments of project benefits may have stemmed from additional funding criteria that DOT identified for both programs related to job creation and economic stimulus, as well as decision makers' focus on these issues at the state and local levels.

Third, important costs were often omitted from applications. In many cases, applicants would estimate a benefit, but not account for associated costs, such as increased noise, emissions, or potential additional accidents from new rail service. For instance, applicants often counted emission reduction benefits from mode shift to rail as a benefit but did not include corresponding increases in emissions from increased rail capacity and operation in their calculations of net benefits. Our assessments of TIGER and HSIPR applications found that of the applicants who projected potential safety or environmental benefits for their projects, only three applicants addressed potential safety costs, and only four applicants addressed potential environmental costs.

Finally, we also found that analyses of benefits and costs in many applications consistently lacked other key data and methodological information that federal guidelines such as OMB Circular No. A-94 and OMB Circular No. A-4 recommend should be accounted for in analyses of project benefits and costs.[61] Notably, the majority of the applications to the TIGER and HSIPR programs that we reviewed did not provide information related to uncertainty in projections, data limitations, and the assumptions underlying their models. While a small number of applications we assessed provided information in all of these areas, 31 out of 40 did not provide information on the uncertainty associated with their estimates of benefits and costs, 28 out of 40 did not provide information on

[61]It is important to note that DOT did not specifically refer HSIPR applicants to this guidance. However, TIGER applicants were directed to this guidance through the federal "Notice of Funding Availability for Supplemental Discretionary Grants for Capital Investments in Surface Transportation Infrastructure" under the American Recovery and Reinvestment Act, 74 Fed. Reg. 28755 (June 17, 2009), which also directed applicants toward specific values to apply in assessing some categories of benefits.

the models or other calculations used to arrive at estimates of benefits and costs, and 36 out of 40 did not provide information on the strengths and limitations of data used in their projections. Furthermore, of those that did provide information in these areas, the information was generally not comprehensive in nature. For example, multiple applications provided information on the models or calculations used to quantify or monetize benefits, but did not do so for all the benefit and cost calculations included in their analysis.

## Short Time Frames, a Lack of Clear Standard Values, and Data Limitations Contributed to the Inconsistent Quality and Limited Usefulness of Assessments of Project Benefits and Costs

Applicants, industry experts, and DOT officials we spoke with reported that numerous challenges related to performing assessments of the benefits and costs of intercity passenger or freight rail projects can contribute to variation in the quality of assessments of project benefits and costs in applications to federal programs such as the TIGER and HSIPR programs. These challenges include (1) limited time, resources, and expertise for performing assessments of project benefits and costs; (2) a lack of clear guidance on standard values to use in the estimation of project benefits; and (3) limitations in data quality and access. These challenges impacted the usefulness of the information provided for decision makers, and, as a result, changes have been made or are being considered for future rounds of funding.

### Time, Resources, and Expertise

Performing a comprehensive assessment of a proposed project's potential benefits and costs is time and resource intensive and requires significant expertise. According to experts, a detailed and comprehensive benefit-cost analysis requires careful analysis and may call for specialized data collection in order to develop projections of benefits and costs. The short time frames for assembling applications for the TIGER and HSIPR programs—which were designed to award funds quickly in order to provide economic stimulus—may have contributed to the poor quality of many assessments. In addition, according to DOT officials, many applicants to the TIGER and HSIPR programs may not have understood what information to include in their analyses. The recent nature of federal requirements for state rail planning means that states are still building their capacity to perform complex analyses to assess rail projects and, in many cases, rail divisions within state departments of transportation are very small. State rail divisions often face funding and manpower issues since there is typically no dedicated state funding for rail services, and state transportation planning has historically focused more on highway projects.[62] As a result, some applicants to competitive federal grant programs may have more capacity to perform assessments of project benefits and costs than others. For example, according to DOT officials, freight railroads have more resources to devote to developing models and estimating potential project benefits and costs.

### Valuing Benefits

Standard values to monetize some benefits are not yet fully established, which can create inconsistency in the values used by applicants in their projections. While DOT has published guidance on standard estimates for the value of travel time and the value of a statistical life—which can be used to estimate the value of congestion mitigation efforts and safety improvements, respectively—values for other benefits are less clear. For instance, according to DOT officials, uncertainties associated with analyzing the value of time for freight shipment prevents DOT from issuing specific guidance in this area. In addition, there are substantial uncertainties associated with analyzing the value of many benefits, such as reduction in greenhouse gas emissions. While mode shift to rail may reduce pollution and greenhouse gas emissions, experts do not agree on the value to place on that benefit.[63] DOT has issued guidance on values for use in calculating the social benefits of pollutant emissions, however according to modeling experts we interviewed, disagreement regarding how to value different benefits can lead some analysts to limit their assessments of benefits and costs to only that which can be monetized, while others may include all categories of benefits and costs in their assessment. As a result, some TIGER and HSIPR applicants may have used differing values to monetize projected benefits and costs, while others did not monetize benefits at all. Without clear guidance to applicants on preferred values for use in assessments of project benefits and costs, DOT decision makers may be hindered in their ability to compare the results of assessments of benefits and costs across projects or across modes. A standard set of values for key benefit categories may enable transportation officials to more readily compare projects and potentially place more weight on the results of assessments of project benefits and costs in their decision-making processes.

[62]GAO-09-317.

[63]Economic research indicates that the value associated with reduction in greenhouse gas emissions can vary substantially depending on factors such as assumptions about future economic growth and discount rates.

## Data Quality and Access

According to DOT officials, historically lower levels of state and federal funding for rail compared with other modes of transportation have contributed to data gaps that impact the ability of applicants to project benefits and costs for both intercity passenger rail and freight rail projects. For instance, lack of data on intercity passenger travel demand made it difficult for some applicants to the HSIPR program to quantify potential benefits for some new high-speed rail lines. The lack of data may be related to cuts to federal funding for the Bureau of Transportation Statistics resulting in a decreased emphasis on the collection of rail-related data. Multiple state and association officials stated that previous state and national surveys of travel behavior did not capture traveler purposes for intercity travel and did not have a sufficient number of intercity traveler responses for use in travel modeling. In addition, lack of access to proprietary data on goods movement made it challenging for some applicants to the TIGER program to quantify benefits that might be associated with freight rail. According to officials from the California Department of Transportation (Caltrans), when performing analyses to estimate project benefits and costs, Caltrans employees had to manually count freight trains for a 24-hour period in order to gather data for use in their analyses. Furthermore, state transportation officials we spoke with indicated that the quality of data available for use in projecting benefits and costs of a project is often inconsistent. Officials we interviewed stated that data included in assessments of project benefits and costs are often from different years, contain sampling error, and may be insufficient for their intended use. These limitations lessen the reliability of estimates produced to inform transportation decision-making, as available data provide critical inputs for travel models.

Modeling and forecasting limitations also make it harder to project shifts in transportation demand and related benefits and costs accurately. Benefit-cost analyses of transportation projects depend on forecasts of projected levels of usage, such as passenger rail ridership or potential freight shipments, in order to inform calculation of benefits and costs. Limitations of current models and data make it difficult to predict changes in traveler behavior, changes in warehousing and shipper behaviors for businesses, land use, or usage of nearby roads or alternative travel options that may result from a rail project. Since transportation demand modeling depends on information on traveler or shipper preferences in order to inform predictions, the lack of good intercity traveler and shipper demand data greatly impacts the quality of projections, particularly for new intercity passenger or freight rail service where no prior data exists to inform demand projections.

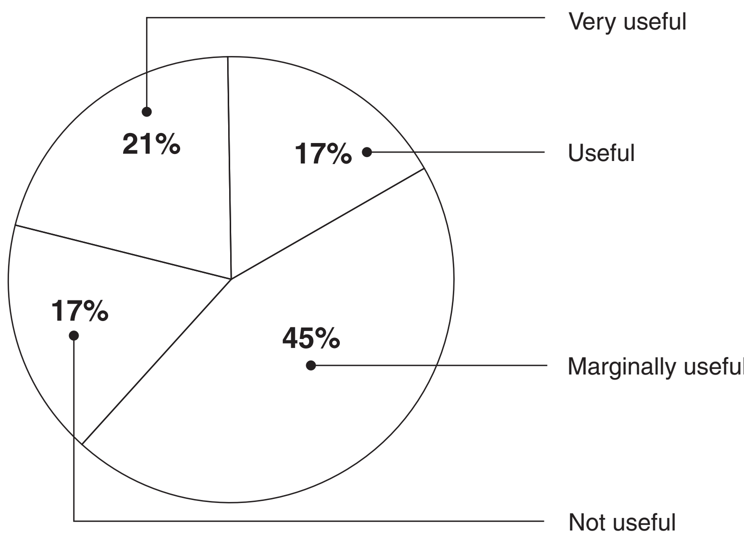
## Usefulness of Assessments of Benefits and Costs

As a result of the limitations described above, DOT officials stated that the assessments of benefits and costs provided by TIGER and HSIPR applicants were less useful to decision makers than anticipated. In general, the majority of rail-related applications we reviewed that were forwarded for additional consideration for the TIGER program[64] contained assessments of project benefits and costs that were either marginally useful or not useful to DOT officials in their efforts to determine whether project benefits were likely to exceed project costs.[65] Overall, 62 percent of forwarded rail-related applications had assessments of benefits and costs that were rated by DOT economists as "marginally useful" or "not useful," and 38 percent had assessments that were rated as "very useful" or "useful" (see fig. 4). However, DOT officials noted that railroads generally did a better job with their benefit-cost analyses in their applications than other modes.

[64]We identified TIGER applications for projects that contained rail elements. Applications included those for projects that were rail-only, as well as those that were multimodal in nature and included rail infrastructure improvements. Of these rail-related applications, DOT economists assessed the "usefulness" of benefit-cost information only for those applications that were forwarded by initial review teams for additional consideration.

[65]DOT economists grouped benefit-cost analyses submitted by TIGER applicants into four categories of usefulness: (1) very useful assessments quantified and monetized the full range of costs and benefits for which such measures are reasonably available and provided a high degree of confidence that the benefits of the project will exceed the project's costs, (2) useful assessments quantified and monetized expected benefits and costs with some gaps and provided a sufficient degree of confidence that benefits of the project will exceed the project's costs, (3) marginally useful assessments had significant gaps in their analysis of project benefits and costs and were those for which DOT was uncertain whether the benefits of the project will exceed the project's costs, and (4) nonuseful assessments did not adequately quantify and monetize benefits and costs, did not provide sufficient confidence that the benefits of the project will exceed the project's costs, and demonstrated an unreasonable absence of data and analysis.

**Figure 4: DOT Assessment of Usefulness of Benefit-Cost Analyses from Forwarded Rail-Related TIGER Applications**




Source: GAO analysis of DOT data.

Note: DOT economists assessed usefulness of benefit-cost information only for those applications that were forwarded by initial DOT review teams for additional consideration.

While applicants to the HSIPR program were not required to conduct a benefit-cost analysis, the *Federal Register* notice for the program stated that information on benefits and costs provided by applicants would be used by DOT to conduct a comprehensive benefit-cost analysis for projects. However, according to FRA officials, the quality of the information provided prevented DOT from being able to use the information in this manner.

While it is possible to offset the impact of the limitations described above and improve the usefulness of assessments of benefits and costs to decision makers by providing clear information on assumptions and uncertainty within analyses, as we stated above, very few TIGER and HSIPR applicants did so. Without information on projection methodologies and assumptions, DOT officials were not able to consistently determine how demand and benefit-cost projections were developed and whether the projections were reasonable. As a result, officials for both programs focused on simply determining whether project benefits were likely to exceed project costs, rather than a more detailed assessment of the magnitude of projects' benefits and costs in relation to one another. See app. IV for a discussion of the challenges related to assumptions and uncertainty we encountered during our attempt to use a model to predict freight mode shift from truck to rail.

The varying quality and focus of assessments of project benefits and costs included in both TIGER and HSIPR applications resulted in additional work for DOT officials in order for DOT to be able to determine whether project benefits were likely to exceed project costs. For example, DOT officials stated that DOT economists for the TIGER program spent 3 to 4 hours per application examining whether it contained any improper analysis techniques or other weaknesses, seeking missing information, and resolving issues in the analyses. For the HSIPR program, a DOT economist with subject matter expertise reviewed the demand forecasts provided by selected Track 2 applicants,[66] devoting significant time to assess the level of risk the uncertainty in these projections was likely to pose to the ultimate success of the project.

## Recent Changes and Improvements to Program Guidance

In order to improve the quality of applicant assessments of project benefits and costs, DOT economists identified limitations of the benefit-cost analyses submitted during TIGER I and used that information to develop guidance for TIGER II.[67] In the *Federal Register* notice for TIGER II, DOT provided additional information to applicants regarding what should be included in assessments of project benefits and costs.[68] This guidance included information on the differences between benefit-cost analysis and economic impact analysis, assessment of alternatives in relation to a baseline, discounting, forecasting, transparency and reproducibility of calculations, and methods of calculating various benefits

[66]As mentioned earlier and discussed in more detail in appendix III, Track 2 applicants were selected under PRIIA §§301 and 501, i.e., 49 U.S.C. §§ 24402 and 26106, which in turn authorized grants to support intercity passenger rail capital assistance and development of high-speed intercity rail systems, respectively, using Recovery Act funding, but excluding Track 1 projects. Track 1 included Recovery Act projects authorized under PRIIA §§301 (intercity passenger rail capital assistance projects) or 302 (projects to address intercity passenger rail congestion), imposed tighter time frames, but allowed applications from a broader range of applicants, including groups of states, public rail service providers, and entities established under Interstate Compacts. 49 U.S.C. §§ 24402, 24105. 74 Fed. Reg. 29900, 29908-29917.

[67]DOT announced the availability of $600 million in federal discretionary grant funding for transportation projects through the TIGER II program in June 2010 and announced TIGER II recipients in October 2010.

[68]Notice of Funding Availability for the Department of Transportation's National Infrastructure Investments Under the Transportation, Housing and Urban Development, and Related Agencies Appropriations Act for 2010, 75 Fed. Reg. 30460 (June 1, 2010).

and costs. As part of its guidance on assessing costs, DOT noted that applicants should use life-cycle cost analysis in estimating the costs of projects.[69] For example, DOT guidance states that external costs, such as noise, increased congestion, and environmental pollutants resulting from construction or other project activities, should be included as costs in applicants' analyses. Furthermore, applicants should include, to the extent possible, other costs caused during construction, such as delays and increased vehicle operating costs.

FRA also plans to alter HSIPR requirements in order to increase the quality of information on project benefits and costs provided by future applicants. According to FRA officials, while applicants to the second round of HSIPR funding were presented with similar guidelines for assessing project benefits and costs as those provided in the first round, future HSIPR applicants will be required to provide more rigorous projections of ridership, benefits, and costs and to revise their assessments of project benefits and costs based on their improved ridership projections. Officials noted, however, that the process will be iterative and anticipated that models for the high-speed rail program will improve as domestic historical data on ridership becomes available over time. In addition, officials stated that FRA plans to take steps to encourage consistency in the methodologies grant applicants use to project demand, benefits, and costs. For instance, FRA is currently in the preliminary stages of developing a benefit-cost framework for states and localities, which represent the majority of applicants to programs such as TIGER and HSIPR, to use in assessing rail projects. Officials stated that FRA plans to issue guidance on performing assessments of benefits and costs for passenger rail projects when the framework is fully developed but did not provide a timeline for its development.

While DOT officials for both programs have taken steps to improve the quality of benefit-cost information and associated analyses in the short term, other steps are necessary to improve quality over time. Some of these additional steps, such as developing historical data for intercity passenger rail demand, making improvements to forecasting and modeling, and increasing accessibility and quality of key data, may take

[69]Life-cycle cost analysis can be used for the consideration of certain transportation investment decisions. In life-cycle cost analysis, all the relevant costs that occur throughout the life of a proposed project, not just the originating expenditures, are included. Costs accounted for in life-cycle cost analysis include the effects of construction and maintenance activities on users.

more time. Nonetheless, improving the quality of benefit and cost information considered for programs such as TIGER and HSIPR could simplify the decision-making process and lend more credence to the merit of the projects ultimately selected for funding.

## Conclusions

Difficult and persistent problems face the U.S. transportation system today. Our system is largely powered by vehicles that use fossil fuels that produce harmful air emissions and contribute to climate change. Our existing infrastructure is aging and, in many places, is in a poor state of repair. Demand for freight and passenger travel will continue to grow, and the growing congestion in urban areas and at key bottlenecks in the system costs Americans billions of dollars in wasted time, fuel, and productivity each year. Adding to these problems, expanding or improving the efficiency of our existing road and air transportation networks has proven difficult, costly, and time-consuming. Both the HSIPR and TIGER programs provided a new opportunity to invest in rail—a mode that has historically been underrepresented in the U.S. transportation funding framework. Some see investment in rail infrastructure, along with other policies designed to shift traffic to rail, as important to addressing these problems, pointing to rail's advantages over cars and freight trucks in terms of energy efficiency, safety, and lower emissions. While investments in rail or policies designed to shift traffic to rail may generate some benefits—as occurred to some degree in the United Kingdom and Germany—benefits must be weighed against direct project costs and other costs (e.g., noise) to determine whether an investment or policy produces overall net benefits. Further, close attention must be paid to the extent to which freight and passenger travel can actually shift to rail from other modes, given the choices available to, and the preferences of, travelers and shippers.

While an assessment of benefits and costs is only one factor among many in decision making regarding these investments and policies, a decision maker's ability to weigh information depends on the quality of benefit and cost information provided by project sponsors—regardless of whether this information is provided in a benefit-cost analysis or a more general discussion or enumeration of benefits and costs. We found that many TIGER and HSIPR applicants struggled to provide the benefit-cost information requested or to use appropriate values designated for their respective program. The lack of consistency and completeness in the benefit-cost information provided makes it more difficult for decision makers to conduct direct project comparisons or to fully understand the extent to which benefits are achievable and the trade-offs involved. While the shortened time frames of the programs and resource limitations among project sponsors were key causes of the varying quality of analyses, data limitations (including a lack of historical data—particularly with respect to high-speed rail), data inconsistencies, and data unavailability also accounted for some limitations in applicants' benefit-cost information and will continue to impact these analyses in future funding rounds. Until data quality, data gaps, and access issues are addressed for the data inputs needed for rail modeling and analysis, projections of rail benefits will continue to be of limited use. In addition, almost no applicants discussed limitations in their analysis, including the assumptions made and levels of uncertainty in their projections. Only when assumptions and uncertainty are conveyed in assessments of benefits and costs can decision makers determine the appropriate weight to give to certain projections.

To its credit, DOT has provided more explicit guidance to TIGER applicants in its second round of grant applications on how to meet federal benefit-cost analysis guidelines. While such guidance should result in improved quality of benefit-cost information provided for this program, this guidance neither ensures consistency across analyses in terms of common data sources, values, and models, nor will it have any impact on how benefits and costs are evaluated across programs that invest in other modes (such as the Federal-Aid Highway Program) which do not have a benefit-cost analysis requirement. Providing more standardized values for calculating project benefits and costs and developing a more consistent approach to assessing project benefits and costs so that proposed projects across modes may be more easily compared with one another can have numerous benefits. For instance, standardized values and a consistent approach allow for more confidence that projects and policies chosen will produce the greatest benefits relative to other alternatives, give more credence to investment decisions across programs and modes, and limit DOT officials' need to invest time and resources in order to use the information as part of the decision making process. If benefit-cost considerations are ever to play a greater role, DOT will need to look at ways it can improve the quality and consistency of the data available to project sponsors.

## Recommendations for Executive Action

To improve the data available to the Department of Transportation and rail project sponsors, we recommend that the Secretary of Transportation, in consultation with Congress and other stakeholders, take the following two actions:

- Conduct a data needs assessment and identify which data are needed to conduct cost-effective modeling and analysis for intercity rail, determine limitations to the data used for inputs, and develop a strategy to address these limitations. In doing so, DOT should identify barriers to accessing existing data, consider whether authorization for additional data collection for intercity rail travel is warranted, and determine which entities shall be responsible for generating or collecting needed data.

- Encourage effective decision making and enhance the usefulness of assessments of benefits and costs, for both intercity passenger and freight rail projects by providing ongoing guidance and training on developing benefit and cost information for rail projects and by providing more direct and consistent requirements for assessing benefits and costs across transportation funding programs. In doing so, DOT should:

    - Direct applicants to follow federal guidance outlined in both the Presidential Executive Order 12893 and OMB Circulars Nos. A-94 and A-4 in developing benefit and cost information.

    - Require applicants to clearly communicate their methodology for calculating project benefits and costs including information on assumptions underlying calculations, strengths and limitations of data used, and the level of uncertainty in estimates of project benefits and costs.

    - Ensure that applicants receive clear and consistent guidance on values to apply for key assumptions used to estimate potential project benefits and costs.

## Agency Comments and Our Evaluation

We provided copies of our draft report to DOT, Amtrak and EPA for their review and comment. DOT provided technical comments and agreed to consider the recommendations. Amtrak and EPA provided technical comments, which we incorporated as appropriate.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees, the Secretary of Transportation, the Administrator of the Federal Railroad Administration, Amtrak, EPA, the Director of the Office of Management and Budget, and other interested parties. The report also will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff members have any questions about this report, please contact me at (202) 512-2834 or flemings@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix V.

Susan A. Fleming
Director, Physical Infrastructure Issues

# Appendix I: Objectives, Scope, and Methodology

To better understand the potential net benefits of intercity passenger and freight rail, we examined (1) the extent to which transportation policy tools that provide incentives to shift passenger and freight traffic to rail may generate emissions, congestion, and economic development benefits and (2) how project benefits and costs are assessed for investment in intercity passenger and freight rail and how the strengths and limitations of these assessments impact federal decision making.

## Interviews

We conducted interviews with the Department of Transportation (DOT), the Environmental Protection Agency (EPA), and Amtrak. We also interviewed representatives from transportation coalitions and associations, metropolitan planning organizations, state DOTs, and transportation consultants. Interviews with officials were in regards to methods to assess the benefits and costs of transportation investments and the limitations and challenges to assessing benefits. We also conducted interviews with officials from the High-Speed Intercity Passenger Rail (HSIPR), the Transportation Investment Generating Economic Recovery (TIGER), and Transportation Infrastructure Finance and Innovation Act (TIFIA) programs to gather insights into the usefulness of the cost-benefit study information in decision making. In addition to interviews with agency officials, interviews were conducted in three rail corridors (California, Midwest, and the Northeast) to ascertain additional information on challenges associated with conducting and communicating findings from benefit and cost assessments to decision makers. These interviews involved applicants and other corridor stakeholders who had applied to either or both the HSIPR and TIGER grant programs. Similarly, some of our interviews with organizations in the rail corridors included consultants such as Cambridge Systematics and Parsons Brinckerhoff which were involved in the development of studies for corridors. Following is table 3 with a list of selected organizations whose officials and representatives we interviewed.

**Table 3: Interviews**

| Federal Agencies and Entities | Industry associations |
|---|---|
| **Amtrak**<br>**DOT**<br>Bureau of Transportation Statistics<br>Federal Highway Administration<br>Federal Railroad Administration<br>Inspector General<br>Office of the Secretary<br>**EPA** | American Association of State Highway and Transportation Officials<br>American Public Transportation Association<br>Association of American Railroads |
| **United States** | **United Kingdom** |
| California Department of Transportation<br>California High Speed Rail Authority<br>CSX<br>I-95 Corridor Coalition<br>Illinois Department Of Transportation<br>Metropolitan Transportation Commission<br>Northern New England Passenger Rail Authority<br>Ohio Department of Transportation<br>Ohio Rail Development Commission<br>Pennsylvania Department of Transportation<br>San Diego Association of Governments | Department for Transport<br>Greengauge 21<br>National Audit Office<br>Network Rail<br>Rail Freight Group<br>**Germany**<br>Deustche Bahn<br>Federal Ministry of Environment, Nature Conservation and Nuclear Safety<br>Federal Ministry of Finance<br>Federal Ministry of Transport, Building and Urban Development |
| **Other** | |
| Louis Thompson, Thompson, Galenson and Associates<br>Organization for Economic Cooperation and Development (OECD), International Transport Forum<br>University of Leeds, Institute for Transport Studies | |

Source: GAO.

## Study Review

We reviewed our prior reports and documentation from an array of sources, including the DOT Inspector General, Congressional Research Service, and Congressional Budget Office. In addition, we identified studies through our interviews with stakeholders and conducted an extensive systematic search of literature published in the last 15 years. We reviewed this information to identify studies that analyzed the benefits and costs of intercity passenger and freight rail, mode shift to intercity passenger or freight rail, or the potential net benefits that could be attained through mode shift. In general, we did not find a sufficient number of available studies that adequately addressed our researchable questions, had an appropriate scope, or utilized empirically reliable methodologies. As a result, we used the studies and information we reviewed to inform the engagement as a whole and provided examples and illustrations of the potential costs and benefits that may be attained from policies that provide incentives to shift traffic to rail. In addition, we conducted case studies in the United Kingdom and Germany and asked officials to synthesize their experiences based on their professional judgment and data. Officials we met with also confirmed that it is difficult to causally link policy interventions to specific outcomes.

## Assessment of HSIPR and TIGER Applications' Cost and Benefit Information

We reviewed and assessed information on potential project benefits and costs included in selected applications to the HSIPR grant program and the Grants for TIGER grant program—20 applications from each grant program. We selected a nongeneralizable random sample of 40 applications from a larger pool of HSIPR and TIGER applications that we identified as including components related to intercity passenger rail or freight rail. For HSIPR, we included all applications submitted under Track 2 of the program, which focused on intercity passenger rail projects, in our selection pool, while for TIGER, we included all applications requesting more than $20 million that included components related to intercity passenger rail or freight rail in project descriptions provided by DOT. Twenty applications from each grant program were randomly selected for our review. The random sample of applications was weighted to ensure approximately proportional representation of applications from both programs that were awarded funding by DOT to those that were not awarded funding by DOT and, for the TIGER program, weighted to ensure approximately proportional representation of applications that were selected by DOT for additional review during DOT's application review process to those that were not selected by DOT for additional review.

Information pertaining to project benefits and costs in each of the 40 randomly selected applications was independently reviewed by two of our analysts based on Office of Management and Budget (OMB) guidelines for benefit-cost analysis and input from our economists and methodologists. Application information assessed by our analysts included whether benefits and costs related to congestion mitigation, emissions reduction, and economic development were assessed qualitatively, quantitatively, or were monetized. In addition, analysts identified whether applications included information on a number of key methodological elements identified by OMB and in our prior work. Any discrepancies in findings by the two analysts were reconciled for the final assessment.

## International Case Studies: The United Kingdom and Germany

We conducted case studies of selected policies and programs in the United Kingdom and Germany to learn more about policies to address concerns about emissions, congestion and economic development. These two countries were chosen based on a number of criteria, including experience in implementing capacity enhancing and demand management policy tools in order to encourage mode shift to rail and attain potential benefits. We reviewed studies and reports on policy tools used in these countries and in the European Union. We interviewed officials from the United Kingdom's Department for Transport and Germany's Ministry of Transport, Building and Urban Development. In addition, we interviewed officials in the German Federal Ministry of Finance and Ministry for the Environment, Nature Conservation and Nuclear Safety, as well as the United Kingdom's National Audit Office. We also met with representatives from rail industry organizations and rail companies and stakeholder groups from these countries. For more information, see appendix II.

## Computer Simulations of Freight Diversion from Truck to Rail

We conducted our own simulation of transportation policy scenarios on mode choice for freight shipments. Disaggregated data from the Freight Analysis Framework (FAF)[1] was analyzed to obtain the distance traveled for shipments across commodity and truck types. Then this data from FAF, along with aggregated data on underlying assumptions, were used as inputs into the Intermodal Transportation and Inventory Cost Model (ITIC).[2] This model estimates mode choices for each shipment under baseline conditions and various policy scenarios. See appendix IV for additional discussion of the simulations.

We reviewed technical documentation associated with both of these models. We also conducted interviews with officials at DOT to better understand any data limitations or reliability issues with the model and data inputs. For more information see appendix IV.

[1]This is a data set maintained by the Federal Highway Administration (FHWA) that estimates commodity flows and related freight transportation activity among states, sub-state regions, and major international gateways. See http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm. FAF uses data from the Commodity Flow Survey, a nationally representative survey of freight shipments administered by the Bureau of Transportation Statistics (BTS). See http://www.bts.gov/publications/commodity_flow_survey/index.html.

[2]U.S. Department of Transportation, Federal Railroad Administration, *ITIC-IM Version 1.0: Intermodal Transportation and Inventory Cost Model Highway-to-Rail Intermodal User's Manual*, March 2005.

# Appendix II: International Case Study Summaries: The United Kingdom and Germany

## The United Kingdom

### Background

The United Kingdom's Department for Transport sets the strategic direction for the railways and Network Rail owns and operates Britain's rail infrastructure. Network Rail is a private corporation run by a board of directors and composed of approximately 100 members—some rail industry stakeholders and some members of the general public. Freight and passenger operators pay access charges to Network Rail for access to the rail tracks. In the United Kingdom, freight and passenger rail share many of the same tracks. The system is open to competition through passenger rail franchises and through "open access" provisions for freight and other new passenger services.

### Transportation Project Planning Process

The Department for Transport's current approach to transportation policy planning emphasizes the assessment of a range of options driven by the desire to push transportation as a means to improve general economic performance, as well as environmental and societal goals. The Department for Transport plans and develops freight and intercity passenger rail projects based on a 5-year planning cycle, referred to as a Control Period. The last Control Period covering 2009-2014 resulted in plans to invest £6.6 billion (at 2010/2011 prices) in capacity enhancements for the passenger and freight rail system and strategic rail freight network. The 5-year cycle is intended to identify, develop, and prioritize policy interventions and investment decisions, reflecting the long-term nature of the transportation sector. The Department for Transport publishes High Level Output Specifications and Statements of Funds Available, reflecting what types of rail projects the government wants to buy based on the government's transport goals and objectives and how much money it has to spend on those projects. Network Rail selects and implements projects to meet the High Level Output Specifications and outlines planned projects in a detailed delivery plan. All potential United Kingdom transportation projects are required to undergo standardized assessment processes to evaluate benefits and costs through the Web-based Transport Appraisal Guidance, which includes guidance on benefit-cost analysis for major transportation projects, including information on comparisons of proposed projects to alternatives, data sources for use in analyses, and methods for quantifying benefits and costs and performing sensitivity analysis.

## Selected Policy Tools

The Department for Transport has developed and implemented a range of policies to encourage a shift to rail transport. We explored some of these policies—in figure 5 below—during our site visits in the United Kingdom.

**Figure 5: Selected Polices to Benefit Intercity Passenger and Freight Rail in the United Kingdom**

| Country | Selected policies | Type of rail | |
|---|---|---|---|
| | | Intercity passenger | Freight |
| United Kingdom  | Recent and planned high-speed rail projects | ✓ | |
| | Mode shift revenue support scheme | | ✓ |
| | Freight facilities grants | | ✓ |

Sources: GAO and Map Resources (map).

*Recent and planned high-speed rail projects (HS1 and HS2)*—The Channel Tunnel Rail Link—referred to as HS1—is the United Kingdom portion of the route used by the Eurostar services from London to Paris and Brussels and was completed in 2007. The 109-kilometer Channel Tunnel Rail Link was the first major new railway to be constructed in the United Kingdom for over a century and the first high-speed railway. In 2009, the government began to develop plans for a new dedicated high-speed passenger rail line—HS2. The current government plans to begin a formal consultation process in 2011 and hopes to begin construction on the new high-speed line by 2015.

*Mode shift revenue support scheme*—This program provides funding to companies for operating costs associated with shipping via rail or inland water freight instead of road. It is intended to facilitate and support modal shift, as well as generating environmental and wider social benefits from having fewer freight shipments on Britain's roads.

*Freight facilities grants*—These grants provide support for freight infrastructure capital projects such as rail sidings or loading and unloading equipment. Funding is granted on the principle that if the facilities were not provided, the freight in question would go by road. Applicants must predict the type and quantity of goods that will use the proposed facility and demonstrate that the freight facility will secure the removal of freight trucks from specific routes. The program has been available since the 1970s, and it has a long history of providing funding for capital infrastructure.

# Germany

## Background

In Germany, the Federal Ministry of Transport, Building and Urban Development (Ministry of Transport) is responsible for financing the development and maintenance of the country's intercity passenger and freight rail network. Germany has the largest rail network in Europe, and both the intercity passenger and freight rail systems are open to competition. The majority of the rail system in Germany is managed by a single infrastructure provider—Deutsche Bahn.[1] The German government provides Deutsche Bahn with approximately €3.9 billion a year in investment grants for infrastructure renewal, upgrades, and new projects; freight and passenger operators pay access charges to Deutsche Bahn for access to the rail tracks. In addition to serving as the railway infrastructure provider, Deutsche Bahn also provides much of the intercity passenger and freight logistics service in Germany. Passenger and freight rail usually share the same track in Germany which, according to German transport officials, can enhance the efficiency of the network. However, sharing the same network also impacts the overall capacity available to accommodate new passenger or freight traffic.

## Transportation Project Planning Process

The Ministry of Transport develops a Federal Transport Infrastructure Master Plan approximately every 10 years to set the long-term strategic policy direction for both passenger and freight transportation. These infrastructure plans describe projects required to cope with the forecast traffic development. The goals and objectives of these long-term plans are then translated into 5-year plans—Federal Transport Infrastructure Action Plans—which are then used to develop new projects. After determining short-term transportation priorities and developing action plans intended to align with long-term goals, all potential rail projects undergo standardized assessment processes to evaluate benefits and costs. As the primary infrastructure manager for the rail network in Germany, Deutsche Bahn maintains rail data sets that allow officials to generate consistent estimates of project benefits and costs with confidence, facilitated by centralized data collection. The rail infrastructure planning process is currently under way, and officials at the Ministry of Transport have just

[1]Approximately 34,000 kilometers of Germany's rail infrastructure are managed by Deutsche Bahn's DB Netz, while an additional 4,000 kilometers are run by other infrastructure managers.

reviewed requirement plans for rail infrastructures projects—a process that occurs every 5 years—in order to complete and release an updated Action Plan.

## Selected Policy Tools

Germany's Ministry of Transport has developed and implemented a range of policies that may encourage a shift to rail transport. We explored some of these policies—in figure 6 below—during our site visits in Germany.

**Figure 6: Selected Polices to Benefit Intercity Passenger and Freight Rail in Germany**

| Country | Selected policies | Type of rail | |
|---|---|---|---|
| | | Intercity passenger | Freight |
| Germany  | Upgrade and maintain high-speed rail network | ✓ | |
| | Vehicle mineral oil (fuel) tax | ✓ | ✓ |
| | Heavy Goods Vehicle tolls | | ✓ |

Sources: GAO and Map Resources (map).

*Upgrade and maintain the rail network*—The German government has committed to investing annually in projects to upgrade and renew the existing high-speed and passenger rail network. Each year, the German government invests approximately €3.9 billion to renew the existing rail infrastructure and to construct, upgrade, or extend rail infrastructure.

*Vehicle mineral oil (fuel) tax*—Between 1999 and 2003, the German government began to implement routine, annual increases in the vehicle fuel tax for the explicit purpose of curbing car use and promoting the purchase of more fuel-efficient vehicles. Diesel is now taxed at approximately 47 euro cents a liter, and gas is taxed at 65 euro cents a liter, generating approximately €39 billion in revenue in 2009 for the general tax fund.

*Heavy Goods Vehicle (HGV) tolls*—Germany implemented a distance-based HGV toll in 2005, in part to support an explicit goal of shifting a portion of freight traffic to rail. The policy generated approximately €4.4 billion revenue in 2009, which was primarily used to maintain and upgrade the road network.[2] This policy was viewed as imposing additional costs on the business community, and the new government has said it will not raise the toll rates or expand the tax to passenger vehicles in this legislative period.

[2]HGV toll revenue may also be used to maintain and upgrade the rail and waterway networks.

# Appendix III: HSIPR and TIGER Discretionary Grant Program Information

## HSIPR

The American Reinvestment and Recovery Act of 2009 (Recovery Act)[1] provided $8 billion to develop high-speed and intercity passenger rail service, funding the Passenger Rail Investments and Improvement Act (PRIIA), which was enacted in October 2008.[2] The funding made available is significantly more money than Congress provided to fund rail in recent years. The Federal Railroad Administration (FRA) launched the high-speed and intercity passenger rail (HSIPR) program in June 2009 with the issuance of a notice of funding availability and interim program guidance, which outlined the requirements and procedures for obtaining federal funds.[3] Congress appropriated an additional $2.5 billion for high-speed rail for fiscal year 2010,[4] and in January 2010 FRA announced the selection of 62 projects in 23 states and the District of Columbia.

FRA allowed applicants to the HSIPR program to submit applications to be evaluated under four funding tracks.[5] See table 4 below.

**Table 4: High-Speed Intercity Passenger Rail Program Funding Tracks**

| | |
|---|---|
| Track 1 | Applications aimed at addressing the economic recovery goals of the Recovery Act through construction of ready-to-go intercity passenger rail projects, including projects to relieve congestion. |
| Track 2 | Applications that included projects either to develop new high-speed rail corridors and intercity passenger rail services or substantially upgrade existing corridor services, excluding intercity passenger rail congestion projects. |
| Track 3 | Applications that focused on service planning activities. These projects are aimed at establishing a pipeline of future high-speed rail and intercity passenger rail projects and service development programs by advancing planning activities for applicants at earlier stages of the development process. |
| Track 4 | Provides an alternative for projects that would otherwise fit under Track 1, but applicants must offer at least a 50% nonfederal share of financing. Applicants have up to 5 years (as opposed to 2 years) to complete projects. |

Source: HSIPR *Federal Register* notice.

[1]American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, Title XII, 123 Stat. 115 (2009) (Recovery Act).

[2]Pub. L. No. 110-432, Div.B, 122 Stat. 4907 (October 2008).

[3]74 Fed. Reg. 29900 (June 23, 2009).

[4]Consolidated Appropriations Act, 2010, Pub. L. 111-117, Div. A, Title I, 123 Stat 3034, 3056 (Dec.16, 2009).

[5]Tracks 1 and 2 of the HSIPR program were funded from an $8 billion appropriation of Recovery Act funds, while tracks 3 and 4 of the HSIPR program were funded from an appropriation of approximately $90 million from FY 2008 and FY 2009 Capital Grants to States-Intercity Passenger Service DOT appropriations. Each track prioritized evaluation criteria differently.

Applications were evaluated by technical evaluation panels against three categories of criteria: (1) public return on investment across categories of benefits including transportation benefits, economic recovery benefits, and other public benefits; (2) project success factors, such as project management approach and sustainability of benefits, as assessed by adequacy of engineering, proposed project schedule, National Environmental Policy Act compliance, and thoroughness of management plan; and (3) other attributes, such as timeliness of project completion. Projects were rated on a scale of 1 point to 5 points, with 1 point being the lowest, and 5 points being the highest, based on the fulfillment of objectives for each separate criterion.

Using the best available tools, applicants were required to include benefit and cost information for the following three general categories of benefits:

- Transportation benefits, which include improved intercity passenger service, improved transportation network integration, and safety benefits;
- Economic recovery, which includes preserving and creating jobs (particularly in economically distressed areas); and
- Other public benefits, such as environmental quality, energy efficiency, and livable communities.

Final project selections were made by the FRA Administrator building upon the work of the technical evaluation panels and applying four selection criteria specified in the *Federal Register* notice: (1) region/location, including regional balance across the country and balance among large and small population centers; (2) innovation, including pursuit of new technology and promotion of domestic manufacturing; (3) partnerships, including multistate agreements; and (4) tracks and round timing, including project schedules and costs.

## TIGER

The Recovery Act also appropriated $1.5 billion for discretionary grants to be administered by DOT for capital investments in the nation's surface transportation infrastructure.[6] These grants were available on a competitive basis to fund transportation projects that would preserve and create jobs and provide long-term benefits, as well as incorporate innovation and promote public-private or other partnership approaches. In

[6]Pub. L. No. 111-5, Title XII, 123 Stat. 115 (2009).

making awards, the legislation required DOT to address several statutory priorities, including achieving an equitable geographic distribution of the funds, balancing the needs of urban and rural communities, prioritizing projects for which a TIGER grant would complete a package of funding, and others.[7] In December 2009 Congress appropriated $600 million to DOT for a "TIGER II" discretionary grant program, which was similar to the TIGER program's structure and objectives.[8]

Eligible projects included highway or bridge projects, public transportation, passenger and freight rail projects, and port infrastructure projects. The TIGER program established three categories of project applications based on the amount of federal funding sought[9] and three sets of criteria to determine grant awards in each project application category:

- *Primary selection criteria:* Long-term outcomes, such as state of good repair, evidence of long-term benefits, livability, sustainability, safety, and job creation and economic stimulus.
- *Secondary selection criteria:* Priority to projects that use innovative strategies to pursue long-term outcomes and those that demonstrate strong collaboration among a broad range of participants. Secondary selection criteria were weighted less than primary selection criteria in the application review process.
- *Program-specific criteria:* Program-specific information was used as a tie breaker to differentiate between similar projects. This information was only applied to projects in the following categories: bridge replacement, transit projects, TIGER-TIFIA payment projects, and port infrastructure projects.

[7] 74 Fed. Reg. 28755 (June 17, 2009).

[8] Consolidated Appropriations Act, 2010, Pub. L. No. 111-117, Div. A. Title I, 123 Stat 3034 (Dec. 16, 2009).

[9] Applicants requesting less than $20 million in federal funding were not required to submit a benefit-cost analysis for proposed projects, while those requesting between $20 million and $100 million in federal funding were required to include a basic benefit-cost analysis, and those requesting greater than $100 million were required to submit a more comprehensive benefit-cost analysis.

# Appendix IV: Computer Simulations of Freight Diversion from Truck to Rail

In general, quantifying benefits that may be attained through rail can be challenging, in part, because of data limitations. In order to both estimate the extent to which freight shipments might be diverted from truck to rail under various scenarios and identify challenges related to making such estimates, we conducted simulations using a computer model developed by DOT. We sought to estimate the number of diverted truck freight shipments under scenarios that increased the price or decreased the speed of freight shipments by truck as compared with rail.

## ITIC Model

The Intermodal Transportation Inventory Cost (ITIC) model is a computer model for calculating the costs associated with shipping freight via alternative modes, namely truck and rail. The model can be used to perform policy analysis of issues concerning long-haul freight movement, such as diversion of freight shipments from truck to rail.[1] DOT provides the ITIC model framework as a useful tool for ongoing policy studies, and shares the model, along with some internally developed data, for this purpose. We chose to use the ITIC model to simulate mode shift from truck to rail because of its federal origins and its direct applicability to freight shipments.[2]

The ITIC model—of which we used the highway freight to rail intermodal version—predicts diversion from truck to rail by assuming that shippers will select the mode of transportation with lower total shipment cost. The model replicates the decision-making trade-offs made by shippers in selecting which transportation mode to use for freight shipments. The model estimates the total cost—including both transportation and logistics costs—required to ship freight by both truck and rail for a given type of commodity and a given county-to-county route. Transportation costs include the costs associated with the actual movement of commodities, such as loading and unloading freight, and logistics costs represent a range of other costs, such as loss and damage of the freight, safety stock

[1]The ITIC model was first developed in 1995 under a joint effort by the U.S. Department of Transportation Office of the Secretary (OST), the Federal Railroad Administration (FRA), the Federal Highway Administration (FHWA) and the Bureau of Transportation Statistics (BTS). Since 1995, DOT has modified and updated the model, and used it in DOT's *Comprehensive Truck Size and Weight Study*, which was submitted to Congress in 2000.

[2]The ITIC model is one tool of many that are available to aid in analysis, and its results should not be considered as the sole answer when making decisions or advancing a policy position. It should be used in concert with other models to build a framework for decision making.

carrying cost, and capital cost on claims (see fig. 8 for the components of these costs).

In order to estimate diversions of freight shipments from truck to rail, the ITIC model runs in two steps. First, the model establishes a baseline that can be used for comparison against each of the simulated scenarios. To do this, the ITIC model requires input data on actual truck freight shipments that it uses to calculate total cost to ship each type of commodity for each county-to-county pair for both truck and rail. After generating a base case, diversion of freight from truck to rail can be estimated for various scenarios by changing the input assumptions to the model. As these assumptions are changed, the model reestimates the transportation and logistics costs for both truck and rail and determines whether these estimated changes have made rail a lower cost option for any of the shipments that were originally sent by truck. The model assumes that shipments will switch from truck to rail if the total cost for making a shipment by rail is lower than the total costs for making a shipment by truck.

## Reliability of Model Inputs

A lack of reliable data for a number of major ITIC model inputs at the national level prevented us from fully assessing the uncertainty associated with estimates of freight diversion from truck to rail. As a result, we are unable to report on the confidence levels of the results of our simulations. The ITIC model is based on 26 inputs (see table 6 for a complete list of ITIC model inputs). For our national analysis, empirical data were available for 9 of the inputs; accordingly, we had to rely on the preprogrammed model assumptions for the remaining 17 inputs.[3] Using these 26 inputs, the model made 24 calculations (see table 7 for full list of ITIC model calculations), 22 of which relied on at least one of the model's 17 default assumptions (see table 5 below).

[3]Our choices of data sources were similar to data used in previous applications of the ITIC model by FRA and FHWA, but we selected more recent data when possible. We did not assess whether sufficiently reliable data were available at more disaggregate scales, such as single traffic corridors, individual states, or within regions.

**Table 5: Extent of Data and Assumptions Underlying Intermodal Transportation Inventory Cost Model Inputs and Calculations**

| | ITIC components | Number |
|---|---|---|
| ITIC model inputs | Assumptions | 17 |
| | Data | 9 |
| **Total** | | **26** |
| ITIC model calculations | Calculated from assumptions | 22 |
| | Calculated only from data | 2 |
| **Total** | | **24** |

Source: GAO analysis of ITIC model.

To determine whether the available data and model assumptions were reliable for our purposes, we considered some important factors for assessing data reliability, including their relevance, completeness, accuracy, validity, and consistency.[4] We found that the data and the basis for assumptions used in the ITIC model vary in terms of the following factors.

- Relevance: The 26 ITIC model inputs are relevant for the purposes of determining total transportation and logistics costs. These inputs have been shown to be conceptually important because they reflect economic theory underlying shipper choices, include a range of factors specified in the literature on freight shipments, and provide default assumptions based on theory and professional expertise.

- Completeness: Completeness refers to the extent that relevant records are present and the fields in each record are populated appropriately. We were unable to obtain complete national data for 20 ITIC model inputs. Of these 20 inputs, partial data were available for 3.[5] For the remaining 17 inputs, we were unable to obtain any empirical data and consequently relied on the default assumptions that are provided in the model itself. However, without a reliable source of available data against which to judge the accuracy and validity of these assumed values, we could not determine how much uncertainty the assumptions added to any estimates produced by the model.

[4] GAO, *Applied Research and Methods: Assessing the Reliability of Computer-Processed Data*, GAO-09-680G (Washington D.C.: July 2009).

[5] Specifically, partial data was available for truck rates, the weight per cubic foot, and the value per pound of particular commodities.

- Accuracy: Accuracy refers to the extent that recorded data reflect the actual underlying information. Of the 26 ITIC model inputs, we were unable to verify the accuracy for 20, including all 17 assumptions, as well as available truck rate data and 2 inputs (weight per cubic foot and value per pound of each commodity group) provided by FRA. FRA officials stated that they originally generated these input values using empirical data, but were unable to provide documentation of their analysis. We were therefore unable to judge the accuracy of the resulting data, or the level of uncertainty associated with estimates produced from FRA's data.

- Validity: Validity refers to an input correctly representing what it is supposed to measure. Of the 26 ITIC model inputs, we were unable to verify the validity for 18, including all 17 default assumptions and available truck rate data. For the latter, we used the source of data previously used by the Federal Highway Administration, a proprietary collection of truck rates from 2006 for 120 city pairs. Documentation of the collection methods was unavailable, and we were not able to validate or assess the data for reliability, and thus could not estimate the uncertainty associated with per-mile truck rates. Because this value is a primary driver of total transportation and logistics costs, the uncertain reliability of truck rate data was a major limitation to using the model's estimates.

- Consistency: Consistency is a subcategory of accuracy and refers to the need to obtain and use data that are clear and well defined enough to yield similar results in similar analyses. Of the 26 ITIC model inputs, we identified consistency issues for 7 data inputs. For example, truck rate data were collected in 2006, and data on truck shipments were from 2002, making it problematic to compare these figures. For the other 6 inputs, we encountered different levels of data aggregation for data that we had otherwise deemed reliable. For example, the FAF collects regional data, while the FRA lookup tables for certain truck and rail origin and destination miles are collected at a county level. In order to use both sources of data, the FAF data had to be disaggregated for use at the county level, and our disaggregation method adds additional uncertainty to our estimates.

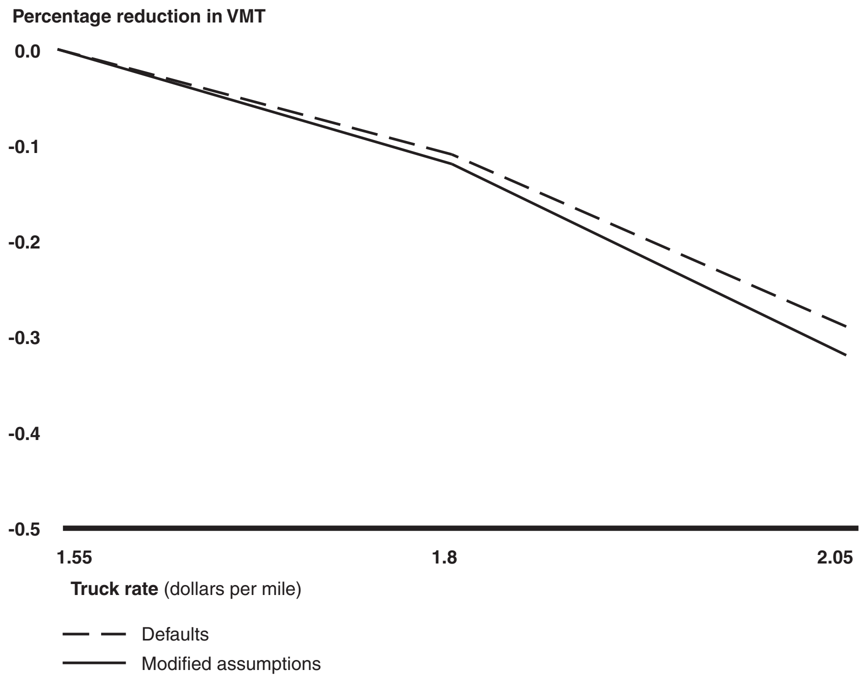
## Reliability of Model Estimates

In order to better understand the impact of uncertainty in the ITIC model's estimates caused by use of assumptions and data of questionable reliability, we examined how the model's estimates change when key underlying assumptions were varied. In particular, we used the model to simulate the impact that a 50-cent increase in per-mile truck rates would have on vehicle miles traveled (VMT) under two scenarios: the first scenario uses the model's default values for all assumptions, including truck speeds of 50 miles per hour, freight loss and damage as a percentage of gross revenue equal to 0.07 percent, and a reliability factor equal to 0.4;[6] the second scenario changes these three assumptions to respective values of 40 miles per hour, 0.10 percent freight loss and damage, and reliability factor equal to 0.5. Each of these changes creates a higher total cost for trucks, potentially leading the model to predict some additional diversion to rail. However, for these sensitivity analyses, we are more concerned with the impact of changing truck rates under the alternative scenarios than we are with the individual impacts of changing assumptions.

For a 50-cent increase (approximately 30 percent of per mile truck rates) in the first scenario, the model estimates a reduction in VMT of about 1.02 percent. For the same reduction in rates in the second scenario, the model estimates a reduction in VMT of about 1.04 percent. Figure 7 shows the estimated percentage reduction in VMT associated with increased per-mile truck rates for the two scenarios. Under either scenario, the impact of increasing per-mile truck rates by approximately 30 percent results in decreases of roughly 1 percent of VMT. This result suggests that we can have some degree of confidence that the model will consistently predict that changing per-mile truck rates will have a minor impact on total VMT traveled.

[6]Reliability factor describes the shape of the reliability distribution, rather than a direct measure of truck reliability.

**Figure 7: Impact of Increased Per-Mile Truck Rates on Vehicle Miles Traveled (VMT) by Trucks under Two Scenarios**



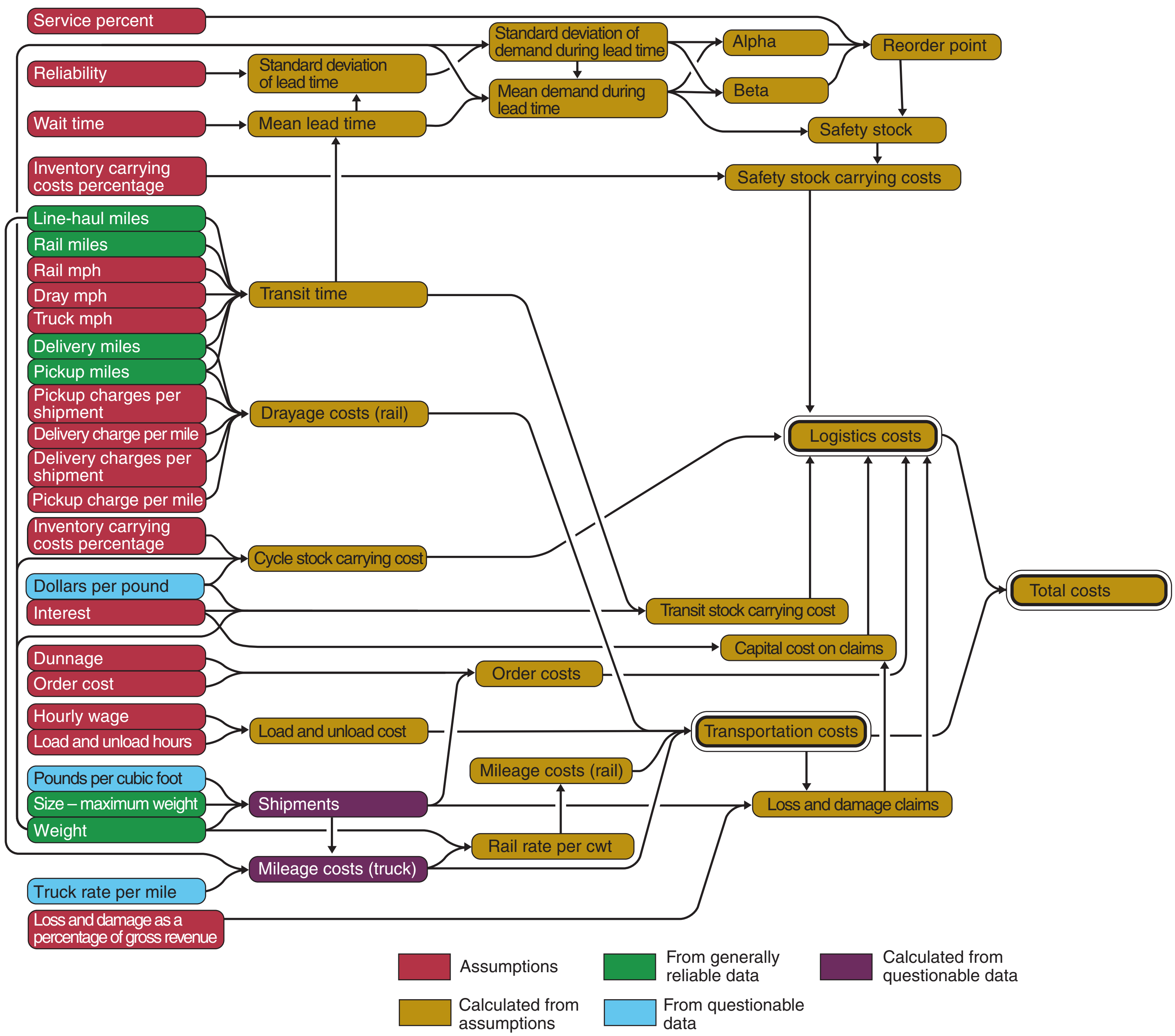

Source: GAO.

In spite of the results of our two scenarios, the estimates of VMT diversion based on the ITIC model are still subject to limitations. As a result, these estimates are only suggestive, rather than conclusive, of the impact that an increase in per-mile truck rates might have on VMT reduction in actual policy scenarios. First, the issues of completeness, accuracy, validity, and consistency of our data negatively impact their reliability and increase the uncertainty of our estimates. Second, because of resource constraints, our analysis only varies 3 of the 17 default ITIC model assumptions and considers only one change in these values, instead of varying a larger number of assumptions for a wider range of scenarios (see table 6 for a full list of assumptions). Therefore, we cannot conclude that the model results are robust to all plausible variations in all of the model assumptions. Therefore, while the results of our simulation suggest that a 50-cent increase in per-mile truck rates would have a limited impact on diversion of freight from truck to rail in the short-term, we do not have enough confidence in the quality of data inputs to make precise predictions that would be reliable enough to inform policymaking decisions. Reliable data for model inputs would be necessary in order to produce estimates of changes in VMT with confidence.

## Implications for Future Simulations

Sufficiently reliable data were not readily available for producing national estimates of mode shift under specific policy scenarios. As a result, it was necessary to rely on assumptions and data of undetermined reliability when conducting national simulations, which may result in unreliable estimates of freight diversion and an inability to fully quantify the uncertainty of the estimates produced. Our simulations suggest that a large increase (approximately 30 percent) in per-mile truck rates results could result in a relatively small (approximately 1 percent) decrease in VMT, even when multiple assumptions related to truck freight cost are changed. Despite this, limitations in the reliability of our data and ability to conduct further sensitivity analyses reduce our confidence in these estimates. While reliable data may be available at state and local levels for use in simulations of mode shift, the importance of communicating the uncertainty underlying projections to decision makers remains. Assessments of data reliability and assumptions, along with quantification of uncertainty, are necessary to enable the comparison of the risk of inaccurate results against the potential value of the estimates produced and would improve decision makers ability to reliably interpret these estimates and compare estimates across projects. In order to accomplish this and produce reliable estimates of freight diversion and uncertainty at the national level, it would be necessary to obtain complete, accurate, and valid data that are collected consistently for the model's relevant inputs.

**Figure 8: Intermodal Transportation and Inventory Cost (ITIC) Model Process**




Source: GAO.

**Table 6: Inputs to the ITIC Model**

| Input | Source | Reliability | Definition |
|---|---|---|---|
| Truck rate per mile | Proprietary data | Undetermined | Per-mile cost of using a truck for shipping (2006) |
| Line haul miles | FRA lookup table | Reliable for our purposes | Distance traveled by truck |
| Pickup miles | FRA lookup table | Reliable for our purposes | Length of rail drayage at origin |
| Delivery miles | FRA lookup table | Reliable for our purposes | Length of rail drayage at destination |
| Rail miles | FRA lookup table | Reliable for our purposes | Distance traveled on rail |
| Dollars per pound | FRA commodity attribute table | Undetermined | Average value of a given commodity class |
| Pounds per cubic foot | FRA commodity attribute table | Undetermined | Weight per cubic foot of a given commodity class |
| Commodity type | Freight Analysis Framework (FAF) | Reliable for our purposes | Two-digit STGC code for commodity being carried in the shipment |
| Trailer size/max weight factor | FRA | Reliable for our purposes | Factor for ensuring that weight per shipment is not over legal limits or cubic footage of truck trailer or COFC |
| Weight | FAF | Reliable for our purposes | Total annual weight of a given commodity transported between regions (2002) |
| Interest | Assumption | Undetermined | Cost of capital during transit and during loss and damage claims |
| Inventory carrying cost % | Assumption | Undetermined | Costs associated with possession of a commodity, including capital cost, insurance, taxes, obsolescence, pilferage, transfer, handling, and storage. |
| Load and unload hours | Assumption | Undetermined | Amount of time needed to load or unload a truck trailer or COFC |
| Hourly wage | Assumption | Undetermined | Amount paid to workers loading and unloading a truck trailer or container on a flat car (COFC) |
| Pickup charges per shipment | Assumption | Undetermined | Flat fee charged to pick up shipments by rail |
| Delivery charges per shipment | Assumption | Undetermined | Flat fee charged to deliver shipments by rail |
| Pickup charge per mile | Assumption | Undetermined | Per-mile charge for rail drayage over 30 miles at origin |
| Delivery charge per mile | Assumption | Undetermined | Per-mile charge for rail drayage over 30 miles at destination |
| Reliability | Assumption | Undetermined | A factor used to represent the skewness of the transit time distribution for truck and rail to represent likelihood that transit time will be the predicted value |
| Loss and damage as a percentage of gross revenue | Assumption | Undetermined | Ratio of loss and damage costs to commodities over the gross revenue from shipping |
| Order cost | Assumption | Undetermined | Cost of placing an order to be shipped |

| Input | Source | Reliability | Definition |
|---|---|---|---|
| Dunnage | Assumption | Undetermined | extra charge (assumed $50) to rail orders |
| Truck mph | Assumption | Undetermined | Average truck speed |
| Rail mph | Assumption | Undetermined | Average rail speed |
| Dray mph | Assumption | Undetermined | Average speed of drayage to/from rail |
| Wait time | Assumption | Undetermined | Number of days before a shipment can be transported |
| Service percent | Assumption | Undetermined | Probability of no stock out (inventory) during the replenishment cycle |
| **Disaggregation** | **Source** | **Reliability** | **Definition** |
| Origin region | FAF | Reliable for our purposes | FAF-defined regions |
| Destination region | FAF | Reliable for our purposes | FAF-defined regions |
| County establishments | QCEW | Reliable for our purposes | Proxy for the share of economic activity an individual county within a FAF region is responsible for (2006) |

Source: GAO analysis of ITIC model.

**Table 7: ITIC Calculations**

| Calculated values | Definitions |
|---|---|
| Shipments | Number of shipments per year needed to transport total annual weight |
| Transit time | Average amount of time (in days) from origin to destination |
| Mean lead time | Average amount of time in advance a shipper needs to order to receive a commodity on time |
| Standard deviation of lead time | Error associated with average lead time |
| Mean demand during lead time | Average demand (in tons) of a commodity during lead time |
| Standard deviation of demand during lead time | Error associated with average demand during lead time |
| Alpha | Measure of the variance of demand during lead time |
| Beta | Measure of the skewness of the distribution of demand during lead time |
| Reorder point | Amount of commodity (in tons) remaining in a shippers stock when they should reorder |
| Safety stock | Amount of commodity (in pounds) a shippers needs to maintain in stock to insure they won’t stock out |
| Rail cost per one hundred pounds | Cost of transporting 100 pounds of a commodity by rail |
| Cycle stock carrying cost | Cost of holding inventory of a commodity |
| Safety stock carrying cost | Cost associated with carrying additional inventory of a commodity to prevent stock out |
| Capital cost on claims | Cost incurred through interest paid while filling loss and damage claims |
| Loss and damage claims | Cost incurred through loss and damage to commodities during transit |
| Order costs | Total cost (order cost plus dunnage) to place an order |
| In-transit stock carrying cost | Cost incurred through interest accrued while stock is in transit |

| Calculated values | Definitions |
| --- | --- |
| Mileage costs: truck | Cost for a shipment to move from origin to destination by truck |
| Mileage costs: rail | Cost for a shipment to move from origin rail junction to destination rail junction |
| Drayage costs: rail | Cost for a shipment to move between origin/destination and rail junctions |
| Load and unload cost | Cost to load and unload a truck or container on a flat car |
| Logistics costs | Costs associated with possession of the commodity |
| Transportation costs | Costs associated with movement of the commodity |
| Total costs | Sum of transportation and logistics costs |

Source: GAO analysis of ITIC model.

# Appendix V: GAO Contact and Staff Acknowledgments

## GAO Contact

Susan Fleming, (202) 512-4431, flemings@gao.gov

## Staff Acknowledgments

In addition to the individual named above, Andrew Von Ah, Assistant Director; Mark Braza; Caroline Epley; Tim Guinane; Bert Japikse; Delwen Jones; Brooke Leary; Steven Putansu; Max Sawicky; Sharon Silas; and Maria Wallace made key contributions to this report.

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