Infrastructure investment: The supply chain connection

Government decision makers rarely consider the impact of infrastructure investments on supply chains. But they should: Failing to do so will stifle a nation’s economic competitiveness.

Because of its importance in maintaining and improving economic competitiveness, transportation infrastructure has become a frequent subject of discussion around the world. In the United States, for instance, those discussions reflect concerns about whether the country has the necessary infrastructure to compete with expanding economies like China and India. Another concern is whether the transportation infrastructure can handle international trade growth—a major issue considering that the value of exports and imports as a percentage of gross domestic product (GDP) has nearly doubled since 1990. Rising logistics costs are yet another worry. After years of decline, transportation and logistics costs as a percentage of GDP increased from 8.6 percent in 2003 to 9.9 percent in 2006. Many researchers believe that inadequate infrastructure and the resulting congestion are partly to blame for that cost increase.

The economic implications of these trends are such a concern that in 2005 the United States Congress created the National Surface Transportation Policy and Revenue Study Commission to evaluate transportation conditions and the funding of infrastructure maintenance and improvements. The commission finished its work on July 7, 2008. One of its findings was that recent investment levels are not sufficient to meet the rising demand for trade and goods movement within the U.S. freight system.

We contend that this underinvestment in transportation infrastructure is due in part to a failure to consider the supply chain benefits of infrastructure investments. Recent research and analysis have shown that governments and policy makers typically do not account for the economic stimulus provided by supply chain benefits when they evaluate large-scale infrastructure investments. This is unfortunate because they are overlooking an opportunity to provide a significant boost to the economy. Our research has shown that an investment in freight transportation infrastructure that reduces direct transportation costs by 10 percent will result in supply chain improvements that will help companies reduce their operating costs by 1 percent. By failing to take into account such potential supply chain benefits, governments are basing their investment decisions on inaccurate cost-benefit calculations. As a result, many projects that should be funded do not receive the support that they deserve.

This paper, however, will not show how to measure the supply chain benefits of a generic transportation investment (for example, the benefit per US $100 million of investment), nor does it prescribe which transportation mode or project to invest in. Rather, this article will first explain how businesses reconfigure their supply chains in response to transportation infrastructure improvements that increase efficiency and reduce shipping costs, and then will use the experience of the United States to argue that governments should target, measure, and consider supply chain benefits when deciding whether or not to fund an infrastructure project.

Good infrastructure benefits shippers When new transportation infrastructure is built, companies take advantage of the new capacity by adjusting their logistics processes and supply chains to improve service and reduce costs. In the short term, they change purchasing and operations behavior. In the longer term, they make input substitutions and reconfigure production processes to take advantage of transportation system improvements. For example, new transportation connectors, gateways, and intermodal links allow shippers to source from more distant suppliers at a lower cost; to reduce transportation costs by forming “hub and spoke” networks that connect multiple distribution points through central operating hubs; and to reduce inventory by switching from bulk shipments to smaller, more frequent orders.

Here are some other ways shippers benefit from adjusting their supply chains in response to more efficient transportation systems:

Lower sourcing costs. Companies want to source from a more diverse base of lower-cost suppliers because it increases their margins. Often this involves offshore sourcing, a strategy that requires managing logistics and transportation over long distances. The lower transportation and logistics costs achieved through efficient freight flows can make it economically rewarding for companies to source from overseas suppliers.

Lower transport costs and an efficient transportation network also help shippers source from fewer locations. Because it is more affordable to ship longer distances from each facility, they are able to reduce the number of plants they operate and thereby increase their return on assets.

Reduced fleet, warehousing, and inventory costs. Infrastructure improvements increase a transportation system’s capacity and reduce or eliminate congestion, thus improving the system’s reliability. This, in turn, reduces variability in transit times, making it possible to predict on-time performance with greater accuracy. As a result, shippers need fewer vehicles to maintain service levels on congested roadways and can downsize their fleets.

Improved reliability also allows shippers to consolidate warehouses that had been holding inventory to buffer against the congestion-related unreliability of inbound shipments. Moreover, when line-haul transportation flows freely (and therefore predictably), shippers can replace traditional warehouses with effi-
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Here are some other ways shippers benefit from adjusting their supply chains in response to more efficient transportation systems: Lower sourcing costs. Companies want to source from a more diverse base of lower-cost suppliers because it increases their margins. Often this involves offshore sourcing, a strategy that requires managing logistics and transportation over long distances. The lower transportation and logistics costs accrued through efficient freight flows can make it economically rewarding for companies to source from overseas suppliers. High transportation and logistics costs, caused in part by inadequate infrastructure (and the resulting congestion), can make it uneconomical for shippers to do so.

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Infrastructure benefits of freight transportation investments

<table>
<thead>
<tr>
<th>Infrastructure Benefit</th>
<th>Supply Chain Impact</th>
<th>Express as % of Operating Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% transport cost reduction</td>
<td>Lower material cost by substituting farther, cheaper sources</td>
<td>0.11%</td>
</tr>
<tr>
<td></td>
<td>Consolidate plants due to extended reach</td>
<td>0.24%</td>
</tr>
<tr>
<td></td>
<td>Switch modes and reduce shipment size, decreasing inventory</td>
<td>0.17%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.44%</td>
</tr>
<tr>
<td>10% capacity increase</td>
<td>Reduce safety stock</td>
<td>0.08%</td>
</tr>
<tr>
<td></td>
<td>Rationalize fleet and warehouse assets</td>
<td>0.06%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.14%</td>
</tr>
<tr>
<td>10% better in-transit visibility</td>
<td>Gain postponement benefits (cost side only)</td>
<td>0.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.4%</td>
</tr>
<tr>
<td>Secondary effects</td>
<td>Increase service levels</td>
<td>Not quantified</td>
</tr>
<tr>
<td>Revenue benefits</td>
<td>Convert cost savings to price reductions</td>
<td>Not quantified</td>
</tr>
<tr>
<td></td>
<td>Implement on-demand supply chains</td>
<td>Not quantified</td>
</tr>
</tbody>
</table>

Source: Boston Strategies International

**Why are supply chain benefits ignored?**

Despite these demonstrated benefits, government transportation officials and their consultants rarely account for short-term and long-term supply chain effects in their financial evaluations of freight transportation investments. There are a number of reasons for this.

First, whereas the infrastructure priority following World War II was to construct highways, today’s freight movements are substantially different. Typically, freight travel involves longer distances than passenger travel, and thus it involves more governmental jurisdictions in infrastructure decisions.

Furthermore, private sector stakeholders own many key rail and maritime assets, and these do not have standard procedures for participating in the public funding and authorization process. In addition, many freight movements today are multimodal, and infrastructure decisions for this type of traffic require deeper transportation experience and more complex analytics than had ever been needed for passenger traffic infrastructure.

Second, decision makers don’t always have the time to consider every aspect of every potential infrastructure project, especially the smaller ones. Evaluations are complicated because there are many types of costs, benefits, and impacts involved. For example, there are at least eight major types of potential consequences of infrastructure projects:

1. Environmental impacts
2. Safety and security benefits
3. Public operating and capital expense benefits
4. Direct user or carrier benefits
5. Direct shippers benefits (which include access to terminals and possibly more efficient modes of transportation that could save time and cost)
6. Economic impact (jobs, industry and market growth)
7. Supply chain benefits
8. International economic benefits (through sup-

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**Infractions and benefits of freight transportation investments**

- **10% transport cost reduction**
  - Lower material cost by substituting farther, cheaper sources
  - Consolidate plants due to extended reach
  - Switch modes and reduce shipment size, decreasing inventory
- **10% capacity increase**
  - Reduce safety stock
  - Rationalize fleet and warehouse assets
- **10% better in-transit visibility**
  - Gain postponement benefits (cost side only)
- **Secondary effects**
  - Increase service levels
- **Revenue benefits**
  - Convert cost savings to price reductions
  - Implement on-demand supply chains
Perhaps the biggest—albeit indirect—supply chain benefit of a transportation infrastructure project is the potential enhancement of revenues through the adoption of new business models. Shippers can take the savings they realize as a result of reduced transportation costs and reinvest in more competitive pricing. Infrastructure improvements can also help companies reach a broader market, facilitate increased sales. Alternatively, they may decide to offer higher service levels (shorter order-to-delivery lead times) instead of, or in addition to, pocketing the savings.

It is not easy to quantify the relationship between infrastructure investment and increased revenues for shippers. There is no question, however, that such investments improve supply chain efficiency. When one considers that some of the most successful companies are those that use their supply chains as competitive weapons—Zara, Wal-Mart, Dell Computer, and Amazon.com are just some that come to mind—it seems likely that investing in transportation infrastructure will provide economic benefits, including sales growth, for the companies using that infrastructure.

**Quantifying the benefits**

Now that we have a sense of the types of supply chain improvements that can result from infrastructure improvements, we can quantify the impact of some of those benefits.

When the consulting and research firms Boston Strategies International (then Boston Logistics Group), Cambridge Systematics, and the Economic Development Research Group collaborated on a comprehensive economic study, Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects, for the United States Department of Transportation in 2006, they concluded that the supply chain benefits of an infrastructure investment that reduces direct transport costs by 10 percent has the potential to reduce a company’s operating cost by an additional 0.5 percent. This estimate was based on a sample of a wide variety of industries.

Since that report was published, however, a number of significant changes have pushed up transportation and logistics costs even higher. We estimate that increases in the price of fuel have raised U.S. companies’ transportation costs from roughly 5 percent to about 6 percent of their total expenditures. Meanwhile, some companies’ safety stocks increased from 20 percent to 25 percent of inventory as a result of more offshoring, which made it necessary for companies to carry more buffer stock. However, labor-cost inflation in China has cut into the savings that drew companies to source there. In our estimation, the cumulative effects of these and other supply chain changes have increased the potential supply chain benefit of the scenario described above to 1.0 percent of operating costs. Note that this savings does not account for the additional revenue that can be derived from improved transportation infrastructure by allowing shippers and carriers to increase service levels, convert cost savings into price reductions, and build on-demand supply chains.

Figure 1 breaks down this revised estimate of the supply chain effects of the hypothetical infrastructure project that increased in-transit visibility by 10 percent, the hypothetical infrastructure investment that reduced transportation costs by 10 percent. If a company responded to this improvement by optimizing its supply chain (through such steps as switching to more distant but lower-cost suppliers, consolidating plants, using cheaper transportation modes, and reducing shipment size), it would see an additional 0.5 percent reduction in operating costs. This is estimated based on Boston Strategies International’s strategic sourcing survey of 182 companies in 13 service and product industries, its analyses of low-cost country sourcing economics, and a major consumer goods company’s experience with plant consolidation. A transportation infrastructure investment that reduced transportation costs by a higher or lower percentage would yield higher or lower benefits. Furthermore, if that infrastructure improvement increased capacity by 10 percent, we believe that the resulting fleet and warehouse rationalization and reduction in safety stocks would amount to a 0.4 percent reduction in operating cost. This estimate is based on Boston Strategies’ analysis of the inventory of 29 companies in six different types of supply chains and inventory and fleet benchmarks from its analyses of four companies’ logistics networks; data from published sources such as CSCMP’s annual State of Logistics study; and fleet data collected by the American Trucking Associations.

Finally, if that infrastructure improvement increased in-transit visibility by 10 percent, and the company takes advantage of this to implement postponement, it will be able to reduce operating costs by at least 0.2 percent. This reduction in operating costs is based on reductions in stockouts experienced by retailers such as Wal-Mart and consumer packaged-goods suppliers such as Procter & Gamble.

While the aforementioned examples are from the United States, the same principles apply to major economies worldwide, especially large countries and economic areas where shippers can take advantage of distinctive and large-scale infrastructure to design more economically efficient supply chains.

### Why are supply chain benefits ignored?

Despite these demonstrated benefits, government transportation officials and their consultants rarely account for short-term and long-term supply chain effects in their financial evaluations of freight transportation investments. There are many reasons.

First, whereas the infrastructure priority following World War II was to construct highways, today’s freight movements are substantially different. Typically, freight travel involves longer distances than passenger travel, and thus it involves more governmental jurisdictions in infrastructure decisions.

Furthermore, private sector stakeholders own many key rail and maritime assets, and they do not have standard procedures for participating in the public funding and authorization process. In addition, many freight movements today are multimodal, and infrastructure decisions for this type of traffic require deeper transportation experience and more complex analytics than had even been needed for passenger traffic infrastructure.

Second, decision makers don’t always have the time to consider every aspect of every potential infrastructure project, especially the smaller ones. Evaluations are complicated because there are many types of costs, benefits, and impacts involved. For example, there are at least eight major types of potential consequences of infrastructure projects:

1. Environmental impacts
2. Safety and security benefits
3. Public operations and capital expense benefits
4. Direct user or carrier benefits
5. Direct shippers benefits (which include access to terminals and possibly more efficient modes of transportation that could save time and cost)
6. Economic impact (jobs, industry and market growth)
7. Supply chain benefits
8. International economic benefits (through sup-
Increased revenue from adopting new business

RAIL FREIGHT CASE STUDY RESULTS (IN US$ MILLIONS)

CONSIDERATION OF BENEFITS IN FOUR PROPOSED FREIGHT PROJECTS

Lower fleet, warehousing, and safety stock costs

CSCMP's Supply Chain Quarterly

www.SupplyChainQuarterly.com

[FIGURE 2] CONSIDERATION OF BENEFITS IN FOUR PROPOSED FREIGHT PROJECTS


Impact on public operating and capital expense

Reduction in pavement wear

Highway investment avoided

Not quantified

Economic impact of operating and capital expense

Reduction in pavement wear

Fuel tax revenue

Direct impact on carriers

Savings for rail operators

Savings for rail operators

Improvement in ability of the system to maintain capacity to meet projected demand (trains, carloads, and value of goods) using the rail system

Reduction in costs for existing freight rail carriers and reduction in congestion for remaining trucks

Direct economic impact on shippers and passengers

Not quantified

Mitigation of congestion in future growth of highway passenger traffic

Time savings for rail commuters and for motorists at crossings

Reduction in road system delay associated with excess vehicle miles and hours traveled for commercial vehicle operations, commuting, and overall highway network efficiency in the region

Travel time and reliability benefits of diversion from truck to rail

Direct economic impact on shippers and passengers

Not quantified

Inventory reduction savings (national assessment only)

Not quantified

Not quantified

Impact on supply chains

Impact on international trade

Not quantified

Not quantified

Not quantified

Not quantified

Impact on the environment

Reduction in air and noise pollution

Value of emission reductions due to reduced train and motor vehicle idling

Not quantified

Value of emission reductions from diversion from truck to rail

Impact on safety

Reduction in accidents

Savings tied to accident reduction at crossings and less congested highways

Reduction in accidents

Fewer highway accidents

Total economic benefit

$23 million

Almost $500 million in public benefits; 1,000 jobs and $50 million payroll

$1.5 billion in high-impact scenario, benefit/cost ratio of 1.6

$0.6 billion personal income nationally and 29,000 jobs in New York metro area by 2025 in double-tunnel system

SOURCE: NON-DECISION ECONOMICS SUMMARY OF CASE STUDIES PRESENTED IN GUIDE TO QUANTIFYING THE ECONOMIC IMPACTS OF FEDERAL INVESTMENTS IN LARGE-SCALE FREIGHT TRANSPORTATION PROJECTS.

Impact on international trade

Not quantified

Not quantified

Not quantified

Not quantified

Impact on the environment

Reduction in air and noise pollution

Value of emission reductions due to reduced train and motor vehicle idling

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port of international trade

While public officials commonly address some of the benefits and impacts on this list in their cost-benefit analyses, they usually do not consider all of them. In our experience, they most often consider a project’s impact on the environment, safety, public operating and capital expense budgets, and direct benefits for users, carriers, and shippers. The economic impact, in terms of job creation or loss, is sometimes considered, especially in large-scale investments where multiple constituencies or stakeholders are affected.

However, our research has found that supply chain benefits and international trade benefits are most often omitted from any type of analysis, resulting in an incomplete assessment of a project’s benefits. This is illustrated in Figure 2, which summarizes which factors were considered and which were not in a sample of recent freight project evaluations in North America. Chicago’s CREATE project, a consortium of public and private parties working to develop streamlined intermodal connections and traffic patterns in Chicago, was the only one of the four that examined extended supply chain benefits.

Case example: Baltimore rail project

The Baltimore Freight Rail Bypass investment project illustrates how the inclusion of supply chain benefits in an infrastructure cost/benefit analysis can yield a result that would be more likely to lead to funding. This project involved the commitment of about US $1 billion for new tunnels beneath the city of Baltimore, Maryland, USA; alternate alignments that would bypass the city to resolve congestion that led to repeated train delays; and upgrades to the condition of tracks and tunnels. There are multiple stakeholders: track is shared by freight and passenger rail and is owned by several companies.

Figure 3 calculates the anticipated benefits and costs of the project when including different benefit categories and perspectives. The first column only considers benefits to the state of Maryland, while the other columns include national benefits that take into account all trip origins and destinations, whether inside or outside of the state. The US $270 million benefit for freight rail operators represents the direct operational cost savings (in labor, fuel, and so forth) that would result from less travel time through the current bottleneck. The shipper benefits represent the savings to shippers and receivers who would ship via rail (with lower per-ton-mile shipping rates) rather than by truck due to the increased capacity.

The Amtrak (U.S. national rail service) benefits relate to faster travel times for passengers because of a drastic reduction in shared-track conflicts with freight trains. The highway benefits result from reduced truck traffic on state and interstate highways because rail would carry a larger share of future freight. The economic impact, in terms of job creation or loss, is sometimes considered, especially in large-scale investments where multiple constituencies or stakeholders are affected. These benefits would come from a reduction in accidents, vehicle emissions, and pavement damage, and slightly improved traffic conditions for the remaining highway users.

Finally, the supply chain benefits were estimated using the parameters in Figure 1 regarding the relationship between reduced transportation costs and supply chain benefits for private industry. The supply chain benefits were based on the direct freight-related cost savings and were customized based on the industry and commodity mix of the multistate region where most freight trips start or end. These include:

• Lower sourcing costs;
• Lower freight, warehousing, and safety stock costs because of increased reliability;
• Lower inventory due to smaller shipments and the postponement of final configuration; and
• Increased revenue from adopting new business models.

[FIGURE 3] RAIL FREIGHT CASE STUDY RESULTS (IN US$ MILLIONS)

Benefit

Maryland Benefits Only

(No Supply Chain Benefits Included)

National Benefit (Excluding Full Highway User Benefits and Supply Chain Benefits)

Total National Benefits

Freight rail operators

$270

$270

$270

Shipper costs

1,052

1,654

1,654

Amtrak (U.S. national rail service)

426

426

426

Highway

874

Supply chain

1,303

Total benefits

2,563

4,252

4,252

Total costs

3,046

3,046

3,046

Benefit/cost ratio

0.7

0.8

1.6

[SOURCE: EXCEPT FROM FIGURE 6 IN GUIDE TO QUANTIFYING THE ECONOMIC IMPACTS OF FEDERAL INVESTMENTS IN LARGE-SCALE FREIGHT TRANSPORTATION PROJECTS]
Lower inventory due to smaller shipments and the

RAIL FREIGHT CASE STUDY RESULTS (IN US$ MILLIONS)

Total economic benefit
Impact on safety
Impact on the environment
Impact on supply chains
Direct economic impact on shippers and passengers
Direct impact on carriers
Improvement in ability of the system to maintain capacity to meet projected demand (trains, carloads, and value of goods) using the rail system
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Travel time and reliability benefits of diversion from truck to rail
Not quantified
Not quantified
Not quantified
Not quantified
Not quantified
Mitigation of congestion in future growth of highway passenger traffic
Time savings for rail commuters and for motorists at crossings
Not quantified
Not quantified
Not quantified
Not quantified
Inventory reduction savings (national assessment only)
Regional construction stimulus
National growth and productivity
Ability of the Vancouver region, British Columbia province, and Western Canada to maintain its economic vitality and importance
Business attraction/retention due to greatly enhanced freight rail service and a new intermodal yard
Economic impacts to the region and nation
Reduction in accidents
Value of emission reductions due to reduced train and motor vehicle idling
Value of emission reductions from diversion from truck to rail
Not quantified
Not quantified
Not quantified
Impact on international trade
Impact on the environment
Reduction in air and noise pollution
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| FIGURE 2 | CONSIDERATION OF BENEFITS IN FOUR PROPOSED FREIGHT PROJECTS |
|-------------|-----------|-----------|
| Impact on public operating and capital expense | Reduction in pavement wear | Highway investment avverted | Not quantified |
| Fuel tax revenue | Economic impact of operating and capital expense | Reduction in pavement wear | |
| Direct impact on carriers | Savings for rail operators | Savings for rail operators | Not quantified |
| Direct economic impact on shippers and passengers | Not quantified | Mitigation of congestion in future growth of highway passenger traffic | |
| Economic impact | Not quantified | Regional construction stimulus | National growth and productivity |
| Impact on supply chains | Not quantified | Inventory reduction savings (national assessment only) | |
| Impact on international trade | Not quantified | Not quantified | Not quantified |
| Impact on the environment | Reduction in air and noise pollution | Value of emission reductions due to reduced train and motor vehicle idling | Not quantified |
| Impact on safety | Reduction in accidents | Savings tied to accident reduction at crossings and less congested highways | Reduction in accidents |
| Total economic benefit | $23 million | Almost $500 million in public benefits: 1,000 jobs and $50 million payroll | $1.5 billion in high-impact scenario, benefit/cost ratio of 1.6 |
| Source: How Decision Economics Summary of Case Studies Presented in Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects |

| FIGURE 3 | RAIL FREIGHT CASE STUDY RESULTS (IN US$ MILLIONS) |
| Benefit | Maryland Benefits Only (No Supply Chain Benefits Included) | National Benefit (Excluding Full Highway User Benefits and Supply Chain Benefits) |
| Freight rail operators | $270 | $270 |
| Shipment costs | 1,052 | 1,654 |
| Amtrak (U.S. national rail service) | 176 | 426 |
| Highway | 565 | 874 |
| Supply chain | 1,303 | |
| Total benefits | 2,563 | 4,279 |
| Total costs | 3,046 | 3,046 |
| Benefit/cost ratio | 0.7 | 0.8 |

| Source: Except from Figure 4 in Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects |

While public officials commonly address some of the benefits and impacts on this list in their cost-benefit analyses, they usually do not consider all of them. In our experience, they most often consider a project’s impact on the environment, safety, public operating and capital expense budgets, and direct benefits for users, carriers, and shippers. The economic impact, in terms of job creation or loss, is sometimes considered, especially in large-scale investments where multiple constituencies or stakeholders are affected.

However, our research has found that supply chain benefits and international trade benefits are most often omitted from any type of analysis, resulting in an incomplete assessment of a project’s benefits. This is evident in Figure 2, which summarizes which factors were considered and which were not in a sample of recent freight project evaluations in North America. Chicago’s CREATE project, a consortium of public and private parties working to develop streamlined intermodal connections and through-traffic patterns in Chicago, was the only one of the four that examined extended supply chain benefits.

Case example: Baltimore rail project

The Baltimore Freight Rail Bypass investment project illustrates how the inclusion of supply chain benefits in an infrastructure cost/benefit analysis can yield a result that would be more likely to lead to funding. This project involved the commitment of about US $3 billion for new tunnels beneath the city of Baltimore, Maryland, USA; alternate alignments that would bypass the city to resolve congestion that led to repeated train delays; and upgrades to the condition of the system to greatly enhanced traffic conditions for the remaining train operators. The highway benefits result from reduced truck traffic on state and interstate highways because rail would carry a larger share of future freight traffic. These benefits would come from a reduction in accidents, vehicle emissions, and pavement damage, and slightly improved traffic conditions for the remaining highway users.

Finally, the supply chain benefits were estimated using the parameters in Figure 1 regarding the relationship between reduced transportation costs and supply chain benefits for private industry. The supply chain benefits were based on the direct freight-related cost savings and were customized based on the industry and commodity mix of the multi-state region where most freight trips start or end. These include:

- Lower sourcing costs;
- Lower fleet, warehousing, and safety stock costs because of increased reliability;
- Lower inventory due to smaller shipments and the postponement of final configuration; and
- Increased revenue from adopting new business models.
If one counts only the benefits to the state of Maryland, the benefit/cost ratio was shown to be 0.7, meaning that costs exceed benefits when limiting the analysis to dollars with origins and destinations in Maryland. By including national benefits that accrued to shippers outside of Maryland (including Antrak but excluding highway user and supply chain benefits), the benefit/cost ratio rose to 0.8. The inclusion of both supply chain and national highway user benefits increased the benefit/cost ratio to 1.6—in other words, the projected benefits exceed the cost of the project. Assuming the forecasts of benefits are reasonably accurate, these projections present a strong case for investment in and support of this project.

Nationwide implications

Based on case studies analyzed for the Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects, we can estimate that omitting supply chain benefits in an infrastructure project analysis may cause government planners to underestimate the potential benefits of freight transportation investments by up to 37 percent. This is demonstrated in Figure 4, which is drawn from a analysis of supply chain benefits in relation to the freight rail project in Baltimore. In this example, there were $62 million of supply chain benefits in the 2006 study and $278 million of total benefits. After updating the coefficients to reflect changes in costs since 2006, the projected supply chain benefits could be $126 million and $342 million, respectively. Assuming for the moment that approximately half of potential investment projects are similar to the case examined for this research, and that 10 percent to 15 percent of the projects that currently are rejected would be accepted if planners accounted for those additional supply chain benefits, we estimate that on average, 13 percent more projects would be approved if planners did consider those benefits.

The implication is that the United States may have been underinvesting by 1.9 percent annually (see Figure 5) since roughly 1985, when supply chain management gained currency as a management movement and companies began actively managing their supply chains to best leverage transportation investments and efficiencies. Based on actual federal and state capital expenditures for all transportation modes in 2004, an additional $4 billion would be spent annually. Retrospectively, the cumulative value of a 1.9 percent underinvestment for 23 years would have resulted in 156 percent more capital expenditure than actually occurred during that period.

What should happen now?

In our opinion, there are suitably disproportionate benefits that are responsible for transportation investment decisions should change the way they evaluate major freight projects to incorporate the supply chain benefits for private industry. This will help to ensure that essential freight transportation infrastructure projects are funded and that businesses and the national economy receive these critical supply chain benefits. We believe that government agencies involved in infrastructure investment should:

- Identify and review high-profile projects that are especially likely to generate supply chain benefits. Taking a step in that direction, the National Surface Transportation Policy and Revenue Study Commission recommended the creation of a program of investment in a report called “Freight Transportation: A Program to Enhance U.S. Global Competitiveness.” In that report, the committee recommended a substantial national commitment to transportation investment of “at least $225 billion annually from all sources for the next 50 years.”

- Identify and review high-profile projects for the potential to add the method-3 proposed in Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects. As that report indicated, the magnitude of the supply chain benefits of freight projects will vary depending on the mix of industries for the shippers and receivers that are affected by the improvement.

- Develop methodologies for sharing the costs and benefits among jurisdictions (local, state, federal) and the public and private sectors. This includes funding the research needed to establish a framework for splitting the costs and benefits among affected parties, as well as identifying the multipliers for different regions and types of investments. This last step will require a subordinate but critical piece of research: an acceptable method for quantifying the international trade benefits of large-scale infrastructure projects will be essential to equitably allocating supply chain benefits.

These are not concerns for government alone; other stakeholders must get involved if infrastructure funding is to be accelerated. Governments, carriers, and shippers all need to play an active role in ensuring that the right projects get approved and the costs and benefits for private industry. Transportation infrastructure investments that are especially likely to generate supply chain benefits. Taking a step in that direction, the National Surface Transportation Policy and Revenue Study Commission recommended the creation of a program of investment in a report called “Freight Transportation: A Program to Enhance U.S. Global Competitiveness.” In that report, the committee recommended a substantial national commitment to transportation investment of “at least $225 billion annually from all sources for the next 50 years.”

Endnotes:

1. The total value of transportation investments (and the revenue sources used to fund them) in the United States is determined within a complex set of factors that includes political and public priorities, gas taxes, the federal Highway Trust Fund, and other effects (safety, congestion, environmental) of transportation.


3. The 2006 study estimated supply chain benefits of $61.9 million and total benefits of $278 million. The estimated supply chain benefits increased by 118 percent since 2006 due to increases in fuel costs, Chinese labor costs, and other relevant costs.

4. Assumes that the average project budget is expanded over a three-year time horizon, and that the transportation budget consists of 47 percent capital expenditure and 53 percent operating and maintenance expenditure, which was the case with the U.S. federal highway budget in 2006.

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TABLE 5

HYPOTHETICAL IMPACT ON THE U.S. TRANSPORTATION BUDGET

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation capital expenditures, 2004</td>
<td>$113</td>
</tr>
<tr>
<td>Percent additional projects that would be funded</td>
<td>10</td>
</tr>
<tr>
<td>Percent of budget for capital projects (vs. operating expenses)</td>
<td>47</td>
</tr>
<tr>
<td>Average years duration of capital projects</td>
<td>3</td>
</tr>
<tr>
<td>Cumulative underinvestment</td>
<td>3%</td>
</tr>
<tr>
<td>Cumulative underinvestment percent</td>
<td>1.9%</td>
</tr>
</tbody>
</table>

If one counts only the benefits to the state of Maryland, the benefit/cost ratio was shown to be 0.7, meaning that costs exceed benefits when limiting the analysis to freight transportation improvements with origins and destinations within the state. By including national benefits that accrued to shippers outside of Maryland (including Antrak but excluding highway user and supply chain benefits), the benefit/cost ratio rose to 0.8. The inclusion of both supply chain and national highway user benefits increased the benefit/cost ratio to 1.6—in other words, the projected benefits exceed the cost of the project. Assuming the forecasts of benefits are reasonably accurate, these projections present a strong case for investment in and support of this project.

### Nationwide Implications

Based on case study analyses conducted for the Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects, we can estimate that omitting supply chain benefits in an infrastructure project analysis may cause government planners to undervalue the potential benefits of freight transportation investments by up to 37 percent. This is demonstrated in Figure 4, which is drawn from an analysis of supply chain benefits in relation to the freight rail project in Baltimore. In this example, there were $62 million of supply chain benefits in the 2006 study and $278 million of total benefits. After updating the coefficients to reflect changes in costs since 2006, the projected incremental supply chain benefits could be $126 million and $342 million, respectively.\(^3\) Assuming for the moment that approximately half of potential investment projects are similar to the case examined for this research, and that 10 percent to 15 percent of the projects that currently are rejected would be accepted if planners accounted for those benefits, we estimate that on average, 13 percent more projects would be approved if planners did consider those benefits.

### Figure 5: Incremental Projects that Would be Funded if Supply Chain Benefits Were Considered

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (Percent or US$ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply chain benefits</td>
<td>$126</td>
</tr>
<tr>
<td>Total benefits</td>
<td>$342</td>
</tr>
<tr>
<td>Supply chain benefit as percent of total benefits</td>
<td>37%</td>
</tr>
<tr>
<td>Total benefits</td>
<td>$404</td>
</tr>
<tr>
<td>Total second-order benefits as percent of total benefits</td>
<td>74%</td>
</tr>
<tr>
<td>Percent of cases like Baltimore</td>
<td>50%</td>
</tr>
<tr>
<td>Percent of cases that are within 31 percent of having a net positive net present value</td>
<td>20%</td>
</tr>
<tr>
<td>Percent of cases that are within 72 percent of having a net positive net present value</td>
<td>30%</td>
</tr>
<tr>
<td>Percent additional projects that would be approved—low estimate</td>
<td>10%</td>
</tr>
<tr>
<td>Percent additional projects that would be approved—high estimate</td>
<td>15%</td>
</tr>
<tr>
<td>Percent additional projects that would be approved—average</td>
<td>13%</td>
</tr>
</tbody>
</table>

(\(\text{Source: Cambridge Systematics and Boston Strategies International}\\n\text{www.dot.gov/freight/guide061018/guide.pdf}\).

The estimated supply chain benefits increased by 118 percent since 2006 due to increases in fuel costs, Chinese labor costs, and other relevant costs.

4. Assumes that the average project budget is expanded over a three-year time horizon, and that the transportation budget consists of 47 percent capital expenditure and 53 percent operating and maintenance expenditure, which was the case with the U.S. federal highway budget in 2006.

### Endnotes

1. The total value of transportation investments (and the revenue sources used to fund them) in the United States is determined within a complex set of factors that includes political and public priorities, gas taxes, the federal Highway Trust Fund, and other effects (safety, congestion, environmental) of transportation.


3. The 2006 study estimated supply chain benefits of $61.9 million and total benefits of $278 million. The estimated supply chain benefits increased by 118 percent since 2006 due to increases in fuel costs, Chinese labor costs, and other relevant costs.

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