AN EVALUATION OF THE TENNESSEE RAIL PLAN'S TREATMENT OF A TRANS-TENNESSEE RAIL ROUTING

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Executive Summary

E-1. Introduction

Within its state-wide Rail Plan, the Tennessee Department of Transportation (TDOT) considers the re-establishment of an all-Tennessee, east-west (Trans-Tennessee) rail routing.[1] As a part of this consideration, the Rail Plan evaluates the potential benefits that might be attributable to this project. The current analysis, initiated in December of 2003, is a follow-up to the Rail Plan evaluation of the potential Trans-Tennessee rail routing. A general goal of the analysis is to place the Rail Plan in a rigorous cost-benefit framework that considers regions outside the boundaries of Tennessee. There are five specific elements of the study, including:

- » The validation of earlier benefit estimates,
- » Development of total benefit values for participants in a multi-state intermodal rail project,
- » Allocation of benefits on an industry basis,
- » Allocation of benefits on a geographic basis, and
- » Consideration of funding issues.

E-2. Existing Research

The TDOT Rail Plan contains analyses of a potential Trans-Tennessee routing. As currently envisioned, the routing would include CSX Transportation trackage between Memphis and Nashville. From Nashville east, the route would proceed over the Nashville & Eastern line to Algood. Between Algood and Oliver Springs, the routing would require either the reconstruction of trackage once operated by the Tennessee Central Railway or the development of an altogether new alignment. Finally, the route would occupy Norfolk Southern (NS) trackage from Oliver Springs through Knoxville, on to Bristol and to points east.

The TDOT-financed evaluations previously conducted provide details regarding engineering requirements, environmental impacts, and various categories of project benefits and costs. The focus is primarily on freight operations. However, Task 8 also provides parameter estimates related to passenger operation. Both Tasks 8 and 10 evaluate alternative southern and northern alignments between Algood and Oliver Springs. The existing studies also consider the potential of the routing as a stand-alone intrastate project and as a part of a larger multi-state intermodal freight initiative.

Necessary freight-only capital expenditures range between $123 million for a stand-alone route using the southern alignment to $1.5 billion for the Tennessee portion of a multi-state project utilizing the northern alignment. Unfortunately, because of service quality considerations the stand-alone southern alignment routing yields a benefit stream with a present value of only $147 million. However, the Rail Plan estimates that the more ambitious multi-state project could yield benefits with a present value of as much as $7.5 billion.

[1] See Tennessee Department of Transportation, *Rail Plan* Tasks 5, 8, and 10.

In addition to TDOT, the Commonwealth of Virginia's Department of Rail and Public Transit performed an evaluation of an intermodal project that would significantly improve services between Virginia and a variety of locations in the southeast.[2] The Virginia study does not quantify benefits, but instead estimates the number of trucks that could be potentially diverted from I-81 and I-95. Both the Virginia and the Tennessee multi-state scenarios assume service improvements sufficient to lead motor carrier customers to opt for a truck/rail intermodal alternative.

E-3. The CBER Analysis and Findings

The CBER analysis begins with an overview of the importance of high quality national transportation infrastructure. Next is a summary of existing standards and methods for estimating transportation project benefits and costs. The discussion includes, but is not limited to, such topics as cost and benefit measurement, establishing an appropriate time horizon, and guidelines for discounting. The purpose of this review is to establish a common framework for evaluating past research and for guiding the current analysis. Examples show the relevance to the Rail Plan.

Chapter 3 contains a summary and evaluation of relevant past research. It includes an overall discussion of the Tennessee Rail Plan, along with specific discussions of the research produced under Tasks 5, 8, and 10. It is important to realize that the freight networks, network improvements, underlying assumptions, and analytical methods employed within the current analysis are considerably different than those used within the Rail Plan analysis. However, these differences do not signal any deficiency in the Rail Plan research. Instead, they simply reflect a shift in analytical orientation and the availability of an improved suite of analytical tools.

Chapter 4 is perhaps the most important chapter of the report. It provides a very careful discussion of the methodologies used by the study team to estimate and allocate potential project benefits. Some of the more important features are indicated below.

- The CBER analysis considers network improvements across Tennessee, in Virginia and Pennsylvania along a route that roughly parallels I-81, and in Virginia between Lynchburg and Norfolk.

- With one exception, the analysis only allows traffic to enter or leave the rail network at locations where there are currently mechanized intermodal facilities. At TDOT's request, the study team simulated the availability of intermodal services at a facility located at or near Knoxville.

[2] Virginia Department of Rail and Public Transit, *The Northeast - Southeast - Midwest Corridor Marketing Study* (Richmond, Virginia: December 2003).

» Consistent with earlier studies, the CBER analysis assumes that the significant investments in track and signals would make it possible to provide truck-competitive levels of service.

» The study considered cost savings attributable to moving highway traffic to rail and savings to current intermodal shipments that could be moved at lower costs if the multi-state project is successfully implemented.

» In the case of truck diversions, only traffic that moves to and from counties where intermodal service is available (or contiguous counties) is treated as divertible.

Additionally, the CBER analysis considers a number of potential implementation scenarios under which the network improvements are brought on line at various points in time. This latter attribute leads to the estimate of benefit ranges rather a single point estimate. The savings summarized in Table E.1 are based on a time horizon that spans between 2015 and 2039, with construction commencing in 2010. Alternative construction timetables and implementation alternatives are considered later in Chapter 4. Finally, benefits are discounted using two alternative real (i.e. inflation-adjusted) discount rates of 3 and 7 percent.[3]

There are two important outcomes inherent in the benefit figures that are not immediately obvious. First, the inclusion of a Knoxville facility heavily influences the truck-to-rail values in Table E.1. Second, both the Knoxville-based benefits and the Memphis-based benefits are attainable via an infrastructure alternative, involving the improvement of the existing NS routing between Knoxville and Memphis. In the event that the Trans-Tennessee routing is ever considered for funding, the NS alternative should be carefully evaluated.

In addition to the efficiency gains represented by the shipper savings, the current study also re-estimates the "external" benefits that would likely accrue to the more general population. These include improvements in air quality, less highway congestion, fewer accidents, etc. A summary of these additional benefits is provided in Table E.2, while a full explanation of each benefit category is provided in Chapter 4.

The final analytical chapter of the current document discusses issues of project finance as they relate to the Trans-Tennessee proposal. This chapter contains a discussion of private-public partnerships, including the economic rationale for such arrangements and examples of the issues that are likely to arise in actual applications. The chapter also outlines potential sources of federal project funding and discusses alternative methods for raising any necessary state funds.

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[3] The 3 percent rate reflects a setting in which the project would be funded through forgone consumption and in which there is very little risk of realizing project benefits. The 7 percent discount rate is more appropriate if the project is to be, at least partially, funded through foregone firm investment and where there are risks that threaten the realization of the projected benefit stream. In the current setting these risks might include unforeseeable investments in other portions of the freight network, a reduction in the growth of international container traffic, or unanticipated changes in fuel prices.

Table E.1: Estimated Savings from Diversions

	Average Unit Savings	Average Annual Units	Present Value of Savings: 3% Discount Rate	Present Value of Savings: 7% Discount Rate
Tennessee Intermodal Traffic	$120	139,904	$239,808,394	$99,737,808
Truck to Rail Diversions	759	96,391	620,692,754	258,149,992
Non-Tennessee Intermodal	12	2,002,127	313,848,928	130,531,729
TOTAL			$1,174,350,075	$488,419,529

Table E.2: Estimated External Benefits

	Present Value of Benefits: 3% Discount Rate	Present Value of Benefits: 7% Discount Rate
Reduced Noise Pollution	$2,649,764	$1,102,037
Improved Air Quality	16,901,164	7,029,194
Reduced Congestion Cost	21,291,840	8,855,276
Reduced Pavement Maintenance	72,558,843	30,177,223
Reduced Crash Costs	3,942,222	1,639,570
TOTAL	$117,343,833	$48,803,300

E-4. Study Conclusions

Noting the five goals of the current study effort, the CBER analysis offers the following conclusions. First, while the methodologies and networks vary considerably, the CBER findings do not differ substantially from those developed within TDOT's Rail Plan. This would seem to indicate that the underlying nature of manufacturing and commercial activities within the region is sufficiently dominant to drive transportation estimates, even in the face of methodological differences. This notion is underscored by the commodity-specific benefit estimates provided in Table 4.3, wherein savings from the movement of chemicals, wood and lumber products, and food and kindred products together account for nearly one-third of the total benefits.

However, the current study estimates of benefit streams are more modest in overall magnitude than those contained within the Rail Plan. The assumptions of the current analysis are in some instances conservative, but are nonetheless largely realistic and based on the best-available information.

In terms of geography, the inclusion of a hypothetical intermodal facility at Knoxville heavily skews the results toward east Tennessee and together east Tennessee and the Memphis region account for approximately 80 percent of the projected Tennessee-based savings. However, some considerable caution is in order. While the estimated benefits have their geographic roots in east Tennessee and west Tennessee, competitive downstream markets, combined with the verities of public ownership suggest that the final disposition of the estimated transportation savings would be much more geographically dispersed.

As indicated, the Chapter 4 analysis considers a variety of implementation scenarios. One striking outcome of this process is that the present value of the estimated benefit stream increases as the project completion date is pushed further and further into the future. This result owes directly to the important role that the growth in international container traffic plays within the empirical estimation. Readers are encouraged to develop their own opinions regarding whether the currently observable growth in international container traffic will increase, decline or be sustained at current levels.

Finally, while it is not called upon to do so, the current analysis concludes with some guidance regarding the overall desirability of recreating a Trans-Tennessee rail routing. Ultimately, given foreseeable freight flows, the necessity of this routing is not eminent. At the same time, the project's future utility may turn out to be quite high. Given fiscal realities, policymakers may choose to pursue alternative infrastructure projects that meet more immediate needs. However, to the extent possible, they would be well-advised to preserve the opportunity to pursue the Trans-Tennessee rail routing at some future date.

1. Introduction and Motivation

1.1. Study Description

The Tennessee Department of Transportation (TDOT), as part of its continuous planning process, has developed a Rail Plan that includes an evaluation of re-establishing a direct rail link between Nashville and Knoxville in order to create a Trans-Tennessee rail routing.[1] The new link would allow for coast-to-coast rail traffic through Tennessee facilitating trade and potentially alleviating congestion on the interstate highway system, benefiting both the state and national economies.

Just as Tennessee is considering the economic potential of a Trans-Tennessee routing, the Commonwealth of Virginia has been evaluating the development of additional rail capacity in order to relieve current and future congestion within the I-81 corridor. Planners in both Tennessee and Virginia recognize that the potential benefits of these projects may change considerably when the efforts are merged to create an improved rail linkage between west Tennessee and the mid-Atlantic coastal region. Certainly the benefits of dual investments will offer greater returns than investments focused on a single state.

In the evaluation of the Trans-Tennessee routing, TDOT and its contractors developed a set of potential cost savings and other related project benefits that might accrue. This initial analysis showed that a freight rail link passed the critical benefit-cost threshold and was a potentially viable investment. As thorough as the analysis was, however, not all possible benefits were quantified. Moreover, the benefit estimates developed were at a high level of aggregation and did not lend themselves to allocation across geographic and political boundaries. It is important to know who might benefit from an improved rail link across the state, in part to help gauge which parties should help finance the capital facilities that will be required.

TDOT has contracted with the University of Tennessee's Center for Business and Economic Research (CBER) to refine earlier benefit estimates. The refinements explicitly account for rail network investments in both Tennessee and Virginia and include a revision of the truck diversion analysis. Additionally CBER has been tasked with developing a geographic allocation of project benefits and with exploring potential funding issues and mechanisms for the proposed rail plan. Finally, CBER has analyzed and quantified a broader range of possible benefits—including reduced air emissions—that might follow from an improved rail linkage and less truck traffic on in-state highways.

Together the analysis is intended to support the state's long-range transportation planning initiative. Specifically it is intended to facilitate state, regional, and national decision-making on critical rail network infrastructure investments that offer a wide array of benefits. The focus of the Rail Plan is certainly novel, particularly for the region, as a major state transportation department looks beyond concrete and pavement towards alternative and potentially more efficient modes of moving freight.

[1] The series of reports are available at http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_Planning/publictrans/RailPlan/documents.htm.

1.2. Challenges of a New Century

As the United States (US) passes through the first decade of the Twenty-First Century, transportation planners and providers face formidable challenges. The ability to add capacity through new construction is limited by space, environmental concerns, and budgetary limitations. There is an additional challenge as subnational governments may not have sufficient self interest to pursue projects that are clearly to the nation's interest as a whole. The benefits of regulatory reform are largely exhausted and the advent of globalization is adding significant new demands to existing transportation networks.

The Twentieth Century saw the development and maturation of the modal networks that, today, represent the US system of surface freight transportation. The rail network was extended, then rationalized. Various jurisdictions built thousands of miles of multi-lane controlled access highways. Locks and dams were constructed to support commercial navigation and deep-draft ports were established to connect the US with international commerce. During the construction and expansion of these networks, capacity was rarely an issue. When new capacity was desired, additional route-miles or terminals were simply added to the appropriate network(s).

Late in the Twentieth Century, as the ability to add new capacity through construction waned, both rail and motor carriage underwent substantial governmental deregulation. These institutional reforms, combined with the forces of effective competition, allowed transportation providers to extract new capacity from existing networks through the implementation of efficiency-enhancing reforms. Amazingly, real (i.e., inflation-adjusted) freight transportation costs fell by 40 percent over the last two decades of the century even as the number of ton-miles increased by 39 percent.[2] By the late 1990s, however, it was clear that the capacity-enhancing effects of deregulation had, for the most part, been realized.

The growth in transportation outputs observable during the last half of the Twentieth Century is largely tied to a significant increase in international trade. In 1950, barely 10 percent of the US Gross Domestic Product (GDP) was tied to international commerce. In 2002, more than 28 percent of GDP was directly related to import and export activities.[3] Moreover, the percentage of trade-related economic activity grew from 25 percent to 28 percent in just three years. A "global" economy is emerging as a reality, and it is critical that the state of Tennessee be integrated through an efficient transportation network. Globalization is, however, placing new and significant demands on US transportation infrastructure. In 2003 nearly 20 million international container twenty-foot equivalent units (TEUs) passed through US ports bound to or from domestic producers or vendors.[4] Unconstrained, this volume is predicted to nearly triple by 2020.[5] Map 1, which appears at the end of this chapter, shows the magnitude of rail flows for Tennessee and other states for 1999. The lack of rail flow from middle to east Tennessee is clear in this figure and reflects the absence of a continuous rail link across the state.

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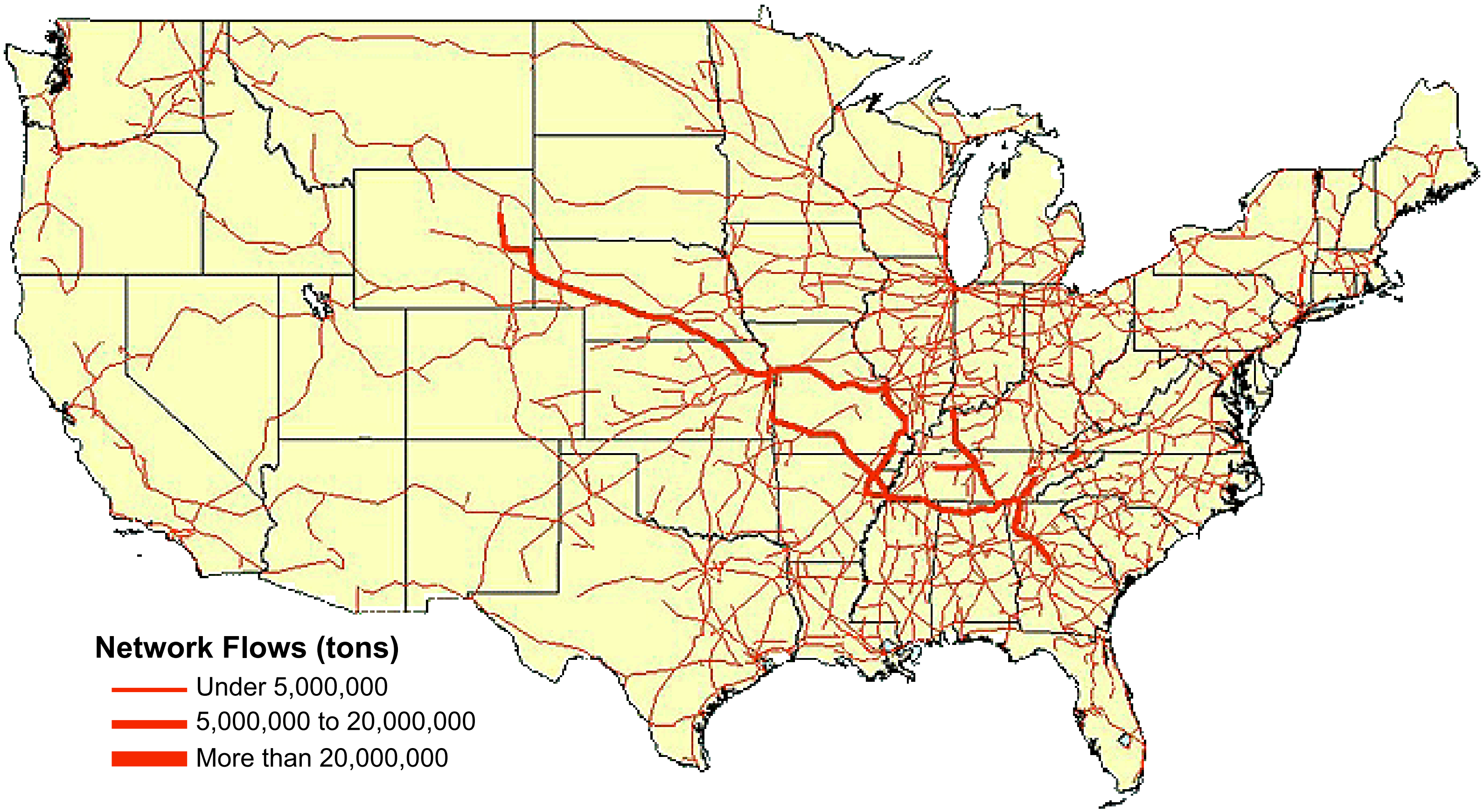
[2] Association of American Railroads, *Railroad Facts 2004* (Washington DC: 2005).
[3] US Bureau of Economic Analysis, *National Income Account Tables, Table 4.2.5, "Exports and Imports of Goods and Services by Product* (2005).
[4] Intermodal containers often vary in length. Therefore, in order to facilitate traffic comparisons, all container quantities are converted to "Twenty-foot Equivalent Units" or TEUs.
[5] US Department of Transportation, *Freight Analysis Framework* (Federal Highway Administration, Office of Freight Management and Operations).

Map 1: Tennessee Total Rail Flows, 1999



Source: U.S. Department of Transportation, Federal Railroad Administration, Office of Policy.

Globalization is increasing shipment volumes and shipment distances so that the aggregate number of ton-miles of freight transportation demanded in any single time period is being impacted by two separate forces. Moreover, emerging international trade flows are often developing in lanes that historically saw only modest amounts of freight traffic. These shifts in commodity flows are also contributing to capacity concerns.

Growth in freight traffic, coupled with growth in passenger car usage, has translated into increased congestion on the nation's highway system. The current situation is acute in some parts of the country and will increase in magnitude in the years to come. As shown in Map 2, congestion will approach or exceed highway capacity in portions of Tennessee by 2020. Map 3 puts the flow of current and projected freight traffic for Tennessee in context. Clearly increased truck traffic is an important contributing factor to rising congestion costs. The diversion of freight-to-rail offers one means of offsetting some of the growing congestion problems.

1.3. The Promise of Intermodal Transportation

If state, regional, and national transportation policymakers and practitioners are to meet the challenges outlined above, they must identify ways to extract greater capacity from largely mature networks. There are two apparent courses for doing so. First, ever-improving communication and information technologies can significantly reduce line-haul vehicle separations and enhance the efficiency of terminal operations. Specifically, both Global Positioning Systems (GPS) and Advanced Vehicle Identification (AVI) technologies are emerging as critical transportation tools. The second route to improved efficiency and additional transportation capacity is through productive combination of transportation modes in what has come to be termed *intermodal transport*.

In concept, intermodal transport is not new. For centuries, cargoes have been transloaded from maritime vessels to land-based vehicles for further movement and, even now, most cities bear the remnants of "freight houses" where railroad shipments were transloaded to trucks for final delivery.

The recent focus on intermodal transport is made novel by its design and purpose. Historically, two or more modes were seldom used when a single mode could provide the required service. It was deemed inefficient to incur transloading costs when they might otherwise be avoided. However, in recent decades, transportation practitioners have succeeded in significantly reducing the costs of moving cargoes from one mode to another, so that it is now possible to efficiently combine transport modes. This ability has become important to planners as mode-specific capacities are exhausted in some locations.

Initially, the current generation of intermodal transportation was anchored in the movement of (truck) trailers on (railroad) flat cars (TOFC). TOFC movements continue to be an important component of the North American transport network. Nonetheless, the intermodal movement of trailers has been eclipsed in volume by the movement of containers on flat cars (COFC).[6] Containerized shipping is particularly prevalent in international

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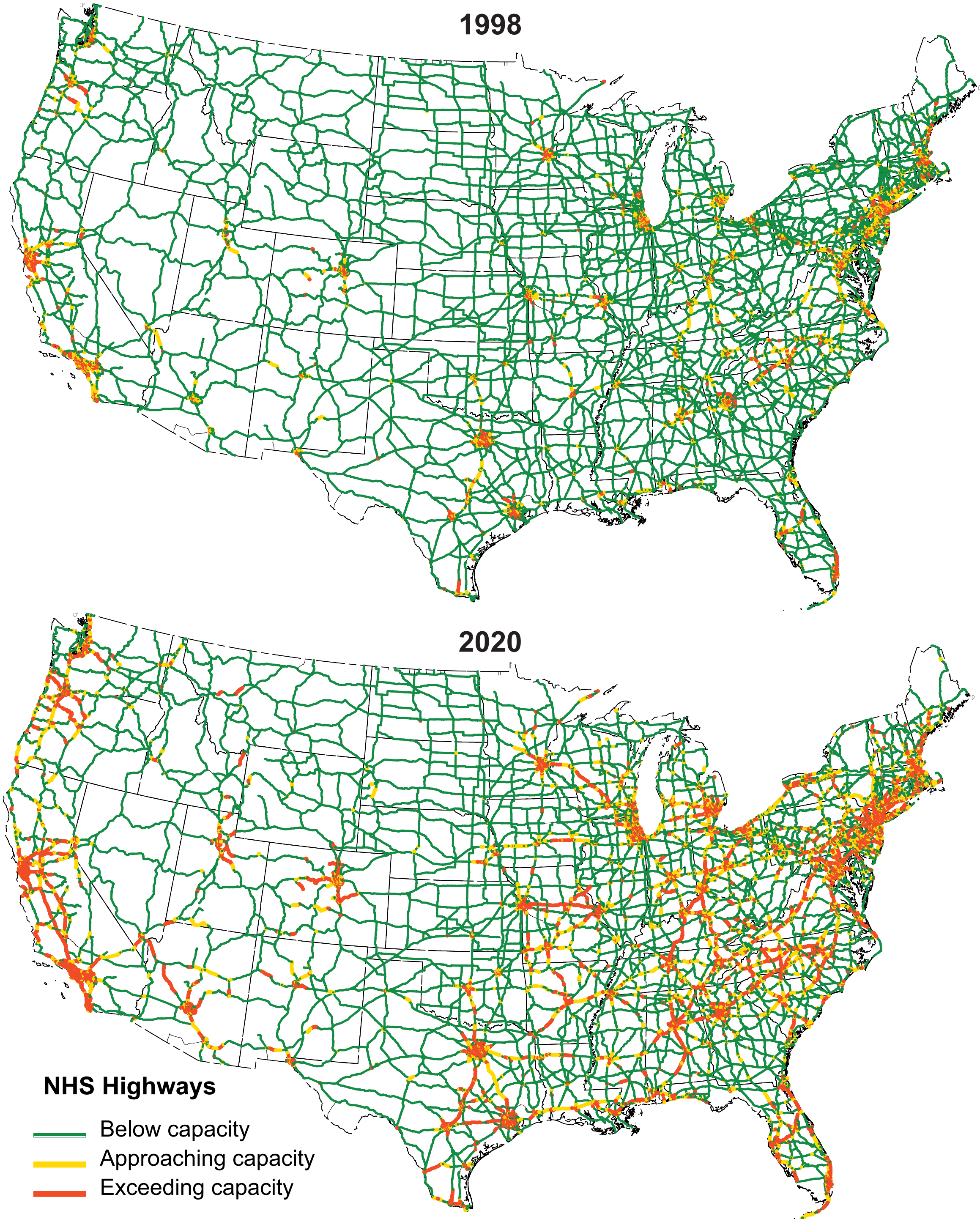
[6] The phrases "TOCF" and "COFC" are both antiquated. Trailers and containers are rarely moved by flat car. In fact, a highly specialized fleet of railroad equipment exists for intermodal traffic.

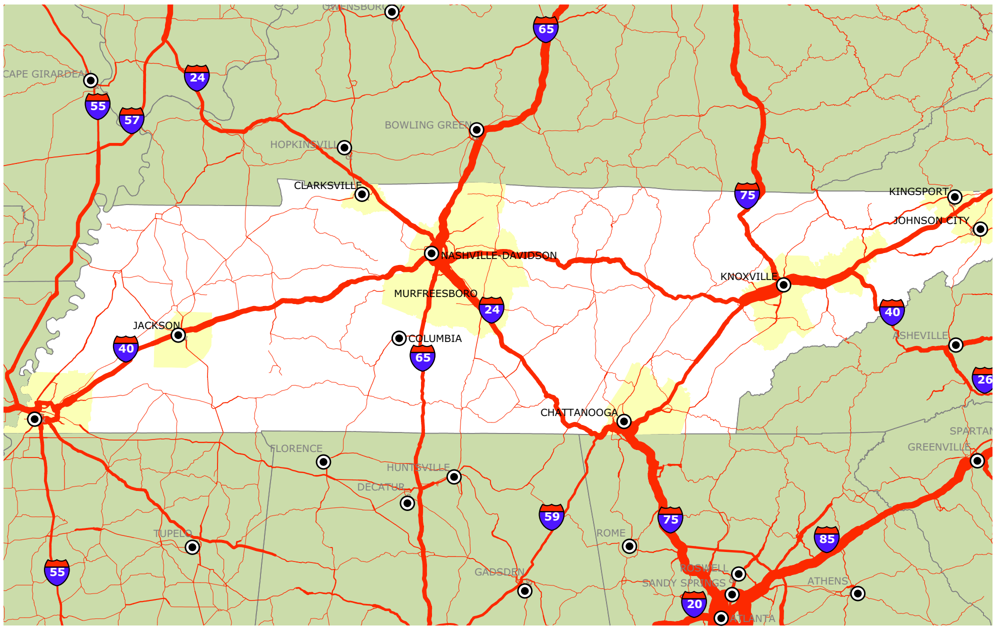
Map 2: National Highway System Estimated Peak Period Congestions, 1998 and 2020



Source: U.S. Department of Transportation, Federal Highway Administration, Of ce of Federal Management and Operations, Freight Analysis Frameworfi.

Map 3: Estimated Average Annual Daily Truck Traffic in Tennessee, 1998 and 2020

1998

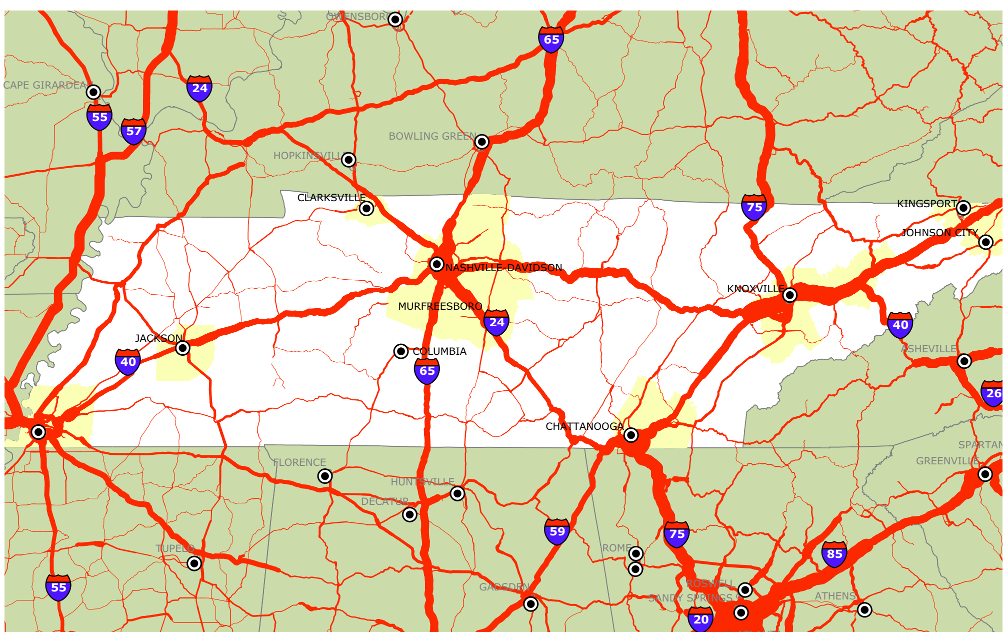


Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations Freight Analysis Frameworfi.

Truck Volume

50,000 25,000

2020



Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Frameworfi.

Truck Volume

50,000 25,000

shipping, where ocean-going container movements are combined with truck and/or rail for the land-side leg(s) of the routing.[7]

The past decade has seen dozens of infrastructure projects designed to improve intermodal capacity. These projects have largely focused on eliminating bottlenecks at coastal ports through port expansion and/or the development of inland ports.[8] Increasingly, however, policymakers are being asked to consider the expansion of line-haul intermodal capacity.[9] For many policymakers this represents a marked departure from their traditional focus.

1.4. Public Policy and the Emergence of Partnerships

For more than a decade federal transportation policy has been governed by the *Intermodal Surface Transportation Efficiency Act* (ISTEA) and its successor, the *Transportation Equity Act for the Twenty-First Century* (TEA-21). Both statutes place considerable emphasis on finding intermodal solutions to capacity shortfalls. Likewise most states and many communities have modified their traditional highway-only focus to include the consideration of intermodal infrastructures in the allocation of transportation resources. Even the most traditional supporters of highway projects concede that combining motor carriage with other modes of transport is essential on a forward-looking basis.

In many instances, new intermodal facilities are the result of cooperative efforts between various government entities and private firms. These relationships, which can vary greatly in nature, are often referred to collectively as *public-private partnerships*. The economic rationale behind these partnerships lays in what economists refer to as *economies of scope*. Government entities produce suites of goods and services as do private firms. In some cases, the combined set of outputs of both may be produced more efficiently when produced jointly. In other words, it is in the best interest of the public *and* the private sector to work cooperatively to make investments that provide returns to both parties. One of the challenges of pursuing such partnerships is that they often represent a departure from past practice for both parties.

While public-private partnerships can potentially yield otherwise unobtainable efficiencies, they also add complexity to most projects. First, private entities and public entities operate under vastly different motivations and generally have markedly different goals. Second, the formal governing mechanisms necessary to a public-private undertaking generally do not exist, so that effective organizations must be created. Finally, because public-private partnerships are typically used to create long-lived infrastructures, they require far-sighted agreements regarding the ownership, maintenance, and operations over the resulting facilities.

[7] Over the past few years, other intermodal combinations have emerged. For example, inland navigation is now occasionally used to position both empty and loaded international containers.
[8] The Port of Virginia operates an inland port at Front Royal, while the Port of New York–New Jersey operates an inland port at Albany. In both cases, containers are moved directly to and from vessels from the inland facility with only minimal processing/handling at the actual sea port.
[9] Line-haul capacity is an issue in the I-95 Corridor proposal proffered jointly by CSXT and NS, and it is a central concern in both the Heartland and I-81 Corridor projects supported by NS.

1.5. The Links between Freight Transport Policies and Economic Development

Given the patterns of commerce that have emerged over the past decade, reliable access to affordable intermodal transportation is *absolutely necessary* to future state, regional, and national economic prosperity. Unfortunately, this realization poses a considerable challenge for policymakers and planners. The current model of private investment in intermodal facilities has led to a declining number of facilities toward larger and more mechanized facilities that depend on high traffic density to produce lower unit loading and unloading (lift) costs. Thus, many mid-sized communities (places like Knoxville and Chattanooga) have no immediate intermodal access. This places these regional centers at a significant competitive disadvantage. Moreover, it means more traffic on congested highway infrastructure and the attendant costs this imposes.

There are two possible remedies to this challenge. First, the railroad industry as a whole is exploring alternative models of intermodal service that rely on more advanced vehicles that may be directly used in both road and rail service.[10] This equipment, if in widespread use, would relieve the need for mechanized lifts, thereby eliminating an important part of the overall movement cost. Perhaps more importantly, the roll-on roll-off equipment could be transported by rail to almost any location. However, even if this hybrid equipment is perfected, there are questions regarding whether the Class I railroads could provide a more widespread offering of the high-speed (and often scheduled) services required by intermodal shippers.

The second possible remedy to the disparate availability of intermodal service involves some degree of public investment in the infrastructures necessary to support such service. The advisability of such investments depends on the magnitude of the resulting incremental economic benefits as weighed against the potential impacts of competing investments.

Finally, while access to intermodal transport may be *necessary* to economic development, it is not *sufficient* to guarantee increased prosperity. Continued economic development requires the affordable access to a broad range of human and physical capital resources. These resources include a relatively educated and healthy workforce, other public investments in items like utilities and other transportation resources, and private investments that can only emerge in an economic setting characterized by an appropriate business climate.

[10] RoadRailer trailers have been available for a generation. However, the economics of RoadRailer service have limited its use to a handful of specific geographic areas. More recently, competing firms have patented similar equipment that may provide more affordable service and that is also is capable of accommodating ocean-going containers.

1.6. Overall Implications for the Current Analysis

The above discussion has a number of implications for the current study. First, the effort is focused entirely on the movement of intermodal freight traffic. Historically, there was very little on-line carload traffic between Knoxville and Nashville, and there is no reason to believe this pattern of traffic flows will differ in the future. The only possible reasons to consider the proposed project involve improving the efficiency of intermodal service to locations where it currently exists and, perhaps, extending these services to communities where they are currently unavailable. Such efficiency gains would benefit Tennessee, as well as shippers, producers, and consumers across the nation.[11]

The initial TDOT analysis considered two routings—one which largely mirrors the original route of the Tennessee Central and an alternative northern alignment. The original Tennessee Central alignment cannot accommodate the high-speed operations necessary for efficient intermodal transport. Therefore the current analysis is based on the service characteristics attainable on the alternative northern alignment.

The re-establishment of a Trans-Tennessee rail routing is one of many potential investments that will be considered by both public and private entities. The current analysis cannot account for the impacts of these alternative investments. Readers should, however, be mindful that any improvements to competing routings could significantly impact the benefits attributable to a Trans-Tennessee alternative.

[11] Chapter 5 discusses funding issues at length. However, it is important to note, even at this early juncture, that savings on shipments to and from Tennessee will not necessarily accrue to entities within the state. These savings, either in the form of lower product prices or increased economic profits, may just as easily be passed on to individuals and firms located elsewhere.

2. A Benefit-Cost Primer

2.1. The Nature of Project Benefits and Costs

Benefit-cost analysis is a technique used to determine society's return on investment from an expenditure of public funds. At the broadest level of application, it represents an approach to balancing positive outcomes of an expenditure against negative outcomes. Employing benefit-cost analysis should therefore result in a wise use of society's scarce resources. In his textbook on this subject, Edward Gramlich cites no less a distinguished personage than Benjamin Franklin as being an early practitioner of this technique.[1]

From a conceptual point of view, benefit-cost analysis represents an application of economic principles to a government spending decision.[2] The parallel to the private sector is quite obvious; if a large corporation, for example, wants to judge the efficacy of investing a significant sum of money on the development of a new product, the company would perform something akin to a benefit-cost analysis. If the analysis indicated that the investment generated a sufficient rate of return, then the project would be undertaken. The computational aspects of determining the return on investment in the public and private sectors are the same. However, executing the analysis in the public sector is considerably more difficult due to two factors: (1) the outputs produced by the government sector have what are called "public good characteristics" and (2) the government is likely to have objectives considerably broader than a simple monetarily-measured return.

The problems raised by public good characteristics are those of measurement and valuation. When purchasing a private good, these problems are not generally encountered in any significant way. For example, consider the simple consumer decision to buy a loaf of bread at the market. The quantity is easily defined as a single loaf for which the market lists a specific price, say, $2.00. If the consumer pays the $2.00, it can be said with some certainty that he or she values the loaf bread, i.e. is willing to pay, at least that amount for the benefits that may be expected from consuming the bread. Alternatively, consider the purchase of a public sector product such as national defense. It is more than doubtful that a consumer can determine the quantity he or she consumes, nor for that matter is the price he or she may be willing to pay revealed in a way that would facilitate individual valuation. Yet, there can be no doubt that people purchase and value national defense!

In a standard benefit-cost analysis, costs represent benefits forgone; that is, the opportunity costs of diverting scarce resources from other public or private sector uses to the project at hand. In order for a project to have a positive rate of return, newly-generated benefits must at least exceed opportunity costs. The result would be a ratio of benefits to costs greater than 1.0. Since this implies that scarce resources are being moved from a lower value use to a higher value use, a benefit-cost ratio greater than 1.0 is referred to as an increase in economic efficiency. Suppose, however, that not all benefits and cost are quantifiable. In such a case, the benefit-cost ratio would measure only a part of the change in economic efficiency, and perhaps not the most important part. The rational for a particular project may be focused on just those benefits and cost that cannot be measured easily. In addition, the policy objective of a government spending proposal may not be economic efficiency at all but may rather be an issue of redistribution directed at achiev-

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[1] Edward M. Gramlich, *Benefit-Cost Analysis of Government Programs* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1997) 1.

[2] The Chapter 2 Appendix provides a discussion of an alternative decision-making tool, economic impact analysis. Economic impact analysis generally focuses on benefits and costs for sub-regions of the national economy.

ing greater economic equity. Distributional issues that commonly arise may involve individuals, demographic groups, economic sectors or geographic regions.[3] Certainly the Rail Plan will produce significant economic gains for specific people, communities and sectors of the economy.

A complete evaluation of government expenditure proposals can become extremely complicated quite quickly. Fortunately, today there are excellent resources available, in the form of textbooks, manuals, articles and treatises, to guide an analyst wishing to perform a benefit-cost analysis.[4] These tools are applied to analysis of the Rail Plan in this report. As the preceding discussion implies, a correct benefit-cost analysis must include an evaluation of both quantifiable and non-quantifiable benefits and costs that increase or decrease economic efficiency, and consider the distributional issues pertinent to the project being considered. The steps that must be followed to complete a benefit-cost study are as follows: (1) Defining the Problem, (2) Defining and Measuring Benefits, (3) Defining and Measuring Costs, (4) Choosing the Decision Criteria and Dealing with Issues of Time, (5) Calculation of Benefits and Costs Over Life of the Project; Evaluation of Qualitative and Distributional Issues, and (6) Summary of Analysis, Policy Recommendation and Suggestions for Further Analysis.

2.2. Defining the Problem

Every benefit-cost analysis focuses on a specific market segment. For example, the project being investigated here is a Trans-Tennessee-Virginia rail link for freight traffic. Hence, in general, our market segment is the transportation sector of the economy; and more specifically, our concern is with investment in transportation infrastructure and long distance freight traffic. When defining the problem to be studied, it is important to specify the perceived need for the proposed expenditure; that is, how the consumers and producers would be better served if the project was to be completed. Chapter 1 of the present study represents an attempt to "define the problem" in the case of the proposed investment in rail infrastructure.

An important component of this introductory section of a benefit-cost analysis is to define the geographic boundaries of the project. For any given project, for example, the geographic scope may be national (or international) at the one extreme, or quite local (a community) at the other. The geographic region impacted by the project is important because in the ensuing analysis only benefits and costs occurring "inside" the region will be added up. In turn, the spatial reach of a project will ultimately impact the method of financing the endeavor.

Consider, for example, a project that is national in scope funded by the national government. In this case, benefits that favor only one region of the country may be of little consequence. More importantly, an increase in activity in one section of the country that is

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[3] Some of these issues can be addressed through economic impact analysis, discussed in the Chapter 2 Appendix.

[4] A good recent summary is found in Anthony E. Boardman, et al., *Cost-Benefit Analysis: Concepts and Practice, 2nd ed.* (Upper Saddle River, New Jersey: Prentice Hall Inc., 2001). See also US Water Resources Council, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (February, 1983).

offset by a reduction elsewhere is clearly seen as a redistribution or transfer rather than as an economic gain. When analyzing a local project, however, the issues may not be this clear or obvious. A community constructing an industrial park with a federal grant may wish to count the relocation of a large manufacturing plant as a project benefit, but if the funding is national then the benefits must be national. The relocation is a transfer from the national perspective. On the other hand, if the funding of the industrial park is strictly local, then it would be proper to count the relocation as a positive gain to the local economy as a result of the investment.

Another important component of defining the problem is to provide a preview of the likely benefits and cost the proposed investment will generate, and the decision criteria that will be used to determine the viability of the project. In the case of benefits and costs, it is important to warn the reader, in particular, if non-quantifiable benefits or distributional issues are likely to be important elements of a policy decision and if the ensuing analysis will consider them. If these factors loom large, the traditional benefit-cost ratio may be only one of the elements in a complex decision-making calculus.

A final issue that should be defined early in a benefit-cost study is the timeframe of the proposed project. Most public investment projects entail a considerable construction period. Once the project is operational, it is important to specify the number of years over which benefits and recurring costs will accrue, i.e. what is the life of the project? Issues of timing prove to be critical to the benefit-cost analysis of the Trans-Tennessee routing.

2.3. Measuring Benefits

Most analysts typically feel that the real work in a benefit-cost analysis lies in defining, classifying and measuring benefits. In fact, much of the research associated with benefit-cost analysis involves the development of techniques that render formerly non-quantifiable benefits as quantifiable. The grist for this mill lies in the economic efficiency gains that will be generated by the project.

Measurement Technique

For the most part, efficiency benefits can be thought of as a project's positive cash flow: "What is the contribution of the project to Gross Domestic Product?" is one useful way of thinking about efficiency gains when the geographic scope is national.[5] Typically, these benefits are measured indirectly as follows: (1) in output or product markets, the efficiency gain is seen as a cost saving; (2) in input or factor (e.g. labor) markets, the efficiency gain is seen as an increase in productivity.[6] Using the long history of investment in water resources as an example, a cost-saving benefit would ensue from the generation of hydro-electric power at a cost less than that prevailing prior to the investment while an increased productivity benefit would accrue due to the provision of irrigation water to farmers.

[5] Note that the perspective of the analysis is that of the community at large; that is, society's consumers and producers. In this context, increased taxes generated by the increase in economic activity are clearly not a separate benefit of the investment as they are included in the increase in income. On the other hand, if the perspective is to compute the rate of return to the government, then increased taxes rather than increased income would be a proper way to characterize benefits.

[6] The technical terms are increases in consumers' surplus and economic rents (producers' surplus) which are themselves only approximations of the exact efficiency effect. See Boardman.

Classification

Classification of efficiency benefits is one of the most important steps taken in the measuring benefits section of a benefit-cost analysis. A common practice is to divide benefits into a group called primary or direct and a group called secondary or indirect. The primary or direct benefits are those derived from the project that meet the principal objectives or need for which it was proposed (for example, shippers and consumers). Cost savings and productivity gains are invariably considered primary or direct benefits. In the case of transportation infrastructure investments, for example, the primary benefit of a new bridge would be the value of time savings generated per trip via the new route. If the project has multiple purposes, i.e. it is built to meet several objectives, then there may be several primary benefits. In water resource development, this is often the case with objectives ranging from flood control to improved navigation.

Secondary or indirect benefits are best thought of as spillover consequences resulting from the achievement of the project's primary mission. An economist might call them the positive external effects of the project. Continuing with the transportation example, they may include such things as improved air quality or highway safety as a result of investment in highway improvements. (It is interesting to note that in another context, say a public investment to improve environmental quality, benefits that are secondary for a transportation project would become the primary benefits.)

Secondary benefits are often difficult to measure. In some cases the cost saving and productivity techniques are viable methods. However, in other situations, it may be necessary to attempt direct measurement of the gains in economic well-being to producers and consumers.

Competition

Benefit-cost analyses are normally carried out under the assumption that markets are reasonably competitive. This competition assumption would seem to aptly characterize transportation markets in Tennessee and the southeast. On the benefits side, this assumption greatly simplifies the analysis because all benefits will accrue to final consumers or to factors of production. Prices do not change unless there is a change in marginal cost, hence impacts in related markets can often be ignored.

The Pitfalls of Double Counting and Counting Transfers

The most common error in benefit evaluation is due to the related problems of double counting and failure to net out transfers. If at the start of a project, one made a list of all the possible positive outcomes resulting from the investment, this list would invariably contain examples of both of these problems. The job of the analyst is to make sure the same benefit is not represented in more than one form, in total or in part, and to count only net gains to society.[7]

[7] The following discussion closely follows that found in E. J. Mishan, *Cost-Benefit Analysis, 4th ed.* (London: Unwin Hyman, 1988).

Double counting most frequently occurs when the positive cash flows of a project are entered as a benefit in addition to increased capital values that result from these cash flows. More difficult to see is a situation where, as in the current analysis, the investment switches freight traffic from highway to rail. The efficiency gain from this diversion is the cost saving per ton mile shipped. If the analyst then proceeds to consider reduced investment in highway capacity as a benefit, the sin of double counting has been committed.[8] (Note that reduced maintenance expenditures on existing highway infrastructure are a proper benefit and should be counted.) A transfer issue that often arises when a new investment partially replaces existing capacity has to do with reduced use of the old facility. Returning to the bridge investment discussed earlier, if traffic shifts from the old bridge to the new bridge, should the reduced traffic on the old bridge be counted as an efficiency loss? The answer is, of course, no! To do so would be double counting the same bridge users that bettered themselves by choosing the new bridge. As far as the old bridge is concerned, an economist would say "sunk costs are sunk costs" and cannot be recovered. More explicitly, if there is no change in marginal cost on the old bridge, there is no change in economic efficiency associated with its continued use. (The careful reader will notice that with both of the previous examples, if there is a change in marginal cost on the competing (old) facility, then an additional change in economic efficiency will occur. An easy example would be in the case of congestion. Note, however, that a reduction in congestion on, for example, the old bridge results in a positive benefit accruing to continued users that should be added to the efficiency cost savings generated by the new bridge.)

If the analyst remains consistently aware of the caveat that only net new benefits are to be counted, then the problem of incorrectly counting transfers as increases in value should be held in check. Increases in land values should be net increases in land values. Recreation benefits should represent an increase over what existed before. Taxes represent a transfer from people to the public sector, not a net gain for the economy as a whole.

Non-Quantifiable, Political and Distributional "Benefits"

Non-quantifiable benefits are true gains in economic efficiency that either time or technique prevents the analyst from reporting as a monetary cash flow. They must be valued, albeit in a qualitative manner, if the benefit-cost analysis is to be considered complete. What must be resolved is the relative weight to be placed on quantitative versus qualitative benefits in the final policy determination. In this regard, non-quantifiable benefits share a common property with political and distributional "benefits." Regional economic development benefits, discussed in the Chapter 2 Appendix, offer a case in point. This study does not evaluate these potential benefits, even though they may be of considerable value to policymakers.

Political "benefits" are not benefits at all in an economic efficiency sense. Most often they are project outcomes that are viewed as socially desirable at a particular historical point in time. Often distributional in nature, they frequently result in reductions in economic efficiency. Easy examples of political "benefits" are "reductions in barrels of imported oil" and "saving downtown."

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[8] In other words, the cost saving benefits (plus the investment in rail capacity) already accounts for the efficiency effect of reduced investment in highway capacity. See Mishan.

Likewise, distributional "benefits" are not true benefits either. However, their achievement may be politically or socially important. Affirmative Action Programs and the Appalachian Redevelopment Program are two examples. Whenever there are objectives that cannot be rendered as simple monetary cash flows, the weights placed on the elements become quite important. Clearly there are tradeoffs involved, e.g., perhaps a little less efficiency and a little more equity. Economists often point out that any particular gain in economic efficiency can be directed at any one of an infinite number of distributional outcomes.

The proper weights are clearly society's preferences for the alternative efficiency and non-efficiency outcomes. They must be determined via a "political" process. Fortunately, in many cases, they may be ascertained from existing policy. The key thing to remember is that non-quantifiable benefits—and in particular political and distributional "benefits"—more often than not must be counted and may be key elements in reaching a policy conclusion.

2.4. Measuring Costs

As previously noted, costs are treated as opportunity costs; that is, benefits forgone. As when measuring benefits, it is convenient to divide costs into two groups: direct and indirect. Direct costs are the capital plus operating and maintenance costs of the project. Here we are dealing with the physical inputs into the production process. Indirect costs are any spillovers or external effects that may be generated as a result of bringing the project into being. For example, during the construction phase there may be some form of environmental impacts.

Methodologically, as with benefits estimation, it is typical to assume that markets are reasonably competitive. As a result, market prices become good approximations of opportunity costs. In addition, if indirect costs are treated conceptually as negative benefits, the techniques used to measure benefits become applicable to them. The combination of (1) assuming competition and (2) treating indirect costs as negative benefits results in the measurement of the direct costs of a project becoming a straightforward engineering cost problem. The denominator of the benefit-cost ratio contains only estimates of required material inputs which are valued by the project engineer using vendor (i.e. competitive market) prices. Note that this procedure can be carried out multiple times if it is important to explore project scale and scope.

2.5. The Decision Criteria and Issues of Time

The principal idea behind benefit-cost analysis is to view government expenditures as an investment of society's resources upon which a satisfactory rate of return should be expected. Development of the Trans-Tennessee rail routing is only one of many potential investment options for the state. Analysis of private sector investments provides the public sector analyst with several alternative criteria with which to judge the efficacy of a particular expenditure. For example, perhaps the most straightforward technique is simple *payback*. In this case, the total cost of the project is divided by the annual positive cash flow generated by the expenditure. The resulting number is measured in years and reveals the time period necessary to recover the cost of the project. Many private sector firms have rules of thumb regarding an acceptable payback period. In fact, the most distinctive differentiating feature of a public versus private investment is that most public sector projects have unacceptably long paybacks from a private sector point of view.

Simple payback is but a rough gauge of rate of return. In both the private and public sectors, the preferred investment evaluation criteria are present value techniques; that is, methods that account for the time value of money. The formula for calculating the present value (PV) of a typical project benefit, $B_{i,}$ is as follows:

$$PV(B_{it}) = \frac{\sum_t B_{it}}{(l+r)^t}$$

In this equation, the benefit being evaluated is B_i which accrues and is summed (Σ) over t = 1…..T years. In year one, for example, the estimated value of B_i is multiplied by 1 / (1 + r) while in year two it is multiplied by $1 / (1 + r)^2$, and so forth up to year T. The variable r is called the discount rate and represents the opportunity cost of capital; that is, it is the rate of return on alternative uses of the resources to be used in the project under investigation. Suppose this opportunity cost of capital is 5.0 percent. As a result r = .05 is used to compute the discounted present value, PV. This process would be repeated for each project benefit (i = 1…..j) and for all costs as well.

The sum of the discounted future benefits (costs) is always less than the undiscounted sum as long as the discount rate is greater than zero. How much less depends on the values of r and T. Since the discounted sum represents the amount that must be invested at a rate r to replace a future stream of benefits (costs), B_i in our case, the higher the rate of discount, the smaller the present value. Likewise, for any value of r, the farther in the future a benefit (cost) occurs, the smaller the present value. For the Rail Plan, most costs are frontloaded while the benefits will not be realized for many years to come.

Decision Criteria

In public sector analysis, the preferred decision criteria is the ratio of the discounted present value of benefits to the discounted present value of costs. A benefit-cost ratio of 1.0 represents a breakeven point. Such a ratio comes about when the project yields a return just equal to the discount rate. Whenever the benefit-cost ratio exceeds 1.0, the project returns more than the opportunity cost of capital and is considered efficient, at least with regard to its quantifiable benefits and costs.

In most cases, calculation of the benefit-cost ratio is the end of the story. A project is relegated to one of two groups: (1) the B/C > 1 group in which case the project is worthy of further consideration and (2) the B/C < 1 group in which case the project should be viewed with caution or rejected outright. If there is more than one version of a particular project under consideration, a more sophisticated approach would be to ask which version results in the greatest gain in economic efficiency. This problem is often encountered when the scale (small versus large) of the project is a variable in the analysis. In this case, for all versions with a B/C > 1, the objective would be to maximize net benefits; that is, the discounted present value of B minus the discounted present value of C. Irrespective of the criteria employed, the analysis remains subject to all the cautions and caveats with respect to non-quantifiable, political and distributional benefits and costs that were discussed above.

The Issue of Time

All measured and unmeasured benefits and costs associated with a project must be placed within the continuum of time. Within the physical dimension, there are two viable options for establishing the beginning of the project (t =0), namely, the point at which the first costs are incurred or the point at which the project opens for business. Choosing to start the analysis at the point when expenditures begin will place the entire construction period within the scope of the benefit-cost analysis. Within this period, cash flow will, of course, be negative. Perhaps due the uncertainty surrounding when a project will actually be undertaken, it is a more common convention in public sector benefit-cost analysis to set t = 0 at the point where the project is built and open for business. In this case the project engineer provides a present value estimate of all capital costs as of the projected date of completion plus estimated annual cost escalators to be used if work is delayed.

Note that this approach makes the date of completion, when the first positive benefits may be realized, a variable in the analysis. It means that the equivalent of capital cost escalators must be estimated for all measured benefits and operating plus maintenance costs. In the case operating plus maintenance costs, the project engineer must place these costs within the overall life of the project relative to the assumed start of operations as well as provide the escalators. In the case of benefits, the project economist must similarly place the annual estimated value of benefits in perspective relative to the assumed date operations commence. The annual value of benefits will change for two reasons: (1) on the quantity side, market share will increase or decrease with time, and (2) on the price side, there may be real or inflationary changes in price. Commonly used annual growth factors for benefits subsume both of these factors.

Finally, an end date for the project and the analysis must be established. The project life should be related to the physically productive longevity of the project, e.g., the period of years over which it would produce marginal benefits in excess of marginal costs. The end date for the benefit-cost analysis is typically the same or shorter than the physical life of the project simply because of the impact of discounting on the present value of the cash flows. Because of the importance of these timing issues, the estimates below are presented under different scenarios on when the proposed Rail Plan project is developed and utilized.

Choosing the Right Discount Rate

What is the correct opportunity cost of capital for a public sector project? There is no easy answer to this question. Since the discount rate is meant to represent opportunity cost, it depends on what is given up and by whom. For public sector investment, the typical assumption is that private sector expenditure is reduced. However, resources withdrawn from the private sector may represent reduced consumption or reduced investment, and the ratio of consumption to investment may vary depending on the instrument used to make the transfer (taxes, bonds, fees), the level of government (federal, state, local) seeking to make the transfer, or if a public-private partnership is envisioned. Once the funds are transferred, another factor is the degree to which it may be assumed that they will be continuously reinvested or partially consumed.

While economists agree that the correct discount rate is almost never a simple borrowing rate, beyond this universal conclusion there are too many variables in play. In addition to those factors already noted, the rate undoubtedly may differ depending on the market in question. Fortunately, the time constraints and budget of most benefit-cost analyses has lead to the choice of discount rate being delegated to experts.[9] As a result of this outsourcing, the project economist can reference studies devoted solely to the discount rate. Guidelines are available from several government sources and are typically specific to a sector of the economy, e.g. transportation, water, etc. The importance of the discount rate is highlighted in Chapter 4 of this report.

Real versus Nominal

The watchword here is consistency. A benefit-cost analysis can be done in either mode, real (inflation-adjusted) or nominal. However, if a real discount rate is used then benefits and cost must be stated in real terms. Similarly, if nominal (inclusive of price inflation) discount rates are employed, then projected benefits and costs must be stated in nominal projected dollars.

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[9] In many settings government planners will also use the discount rate as a vehicle for treating the uncertainty of benefit realization, particularly late in a project's life. To do so, planners increase the discount rate (either real or nominal) above the perceived opportunity cost associated with the necessary funding.

2.6. Calculation of Benefits and Costs over the Life of the Project

Benefits and costs may be thought of as arrayed in a matrix with rows being defined as the various categories to be evaluated and columns being different years in the life of the project. Using a standard spreadsheet program such as Excel greatly facilitates the organization of the data in this manner and the calculation of present values. More importantly, within a typical spreadsheet program it is possible to make the present value calculations dependent on the critical underlying variables and assumptions in the analysis. During the preceding discussion, several such critical factors have been identified: (1) the discount rate, (2) the life of the project, (3) the project start date, and (4) growth rates and escalators. By programming in sensitivity to these and other factors, the spreadsheet becomes an extremely flexible policy analysis tool.

Evaluation of Qualitative and Distributional Issues

Once the discounted present values are calculated, it is time to compute the benefit-cost ratio. Since so-called political benefits are normally quantifiable, they may be included already. It is recommended to compute the ratio of benefits to cost both with and without them, however. The result will be a much clearer view of the project's impact on economic efficiency. Assuming there is a well-defined distributional objective associated with the project, it can be viewed as a constraint on the analysis. For example, if the stated distributional objective is to raise the median family income in a depressed region by a certain amount, only projects that can meet this constraint would be considered. Ideally, careful analysis would result in the greatest gain in economic efficiency consistent with meeting the distributional objective. It may be worth noting that it is not necessary for a project to have a specific distributional objective included in the benefit-cost analysis.

The determination of the relative weight to be placed on the quantitative benefit-cost analysis and the evaluation of non-quantifiable benefits and costs is not normally within the purview of the project engineer or the project economist. Alternatively, the adoption of some reasonably rigorous tool for qualitative consideration of benefits and costs is recommended. Certainly, other things equal, a project with a benefit-cost ratio marginally greater than 1.0 but with significant negative nonmeasurable impacts should be considered for rejection. Similarly, other things equal, a project with B/C = .95 should not be rejected out of hand if there are strong positive non-quantifiable impacts. The analysis of this report makes no attempt to evaluate distributional gains (losses) for the Trans-Tennessee rail link.

2.7. Summary of Analysis, Policy Recommendations, Further Analysis

This section of a benefit-cost study has two important functions beyond a brief recapitulation of important findings and a review of the scope of the analysis as defined in section one: (1) the study's policy recommendation and (2) recommendations for further study. The policy recommendation must be related to the scope of the analysis; that is, it should be based on the study just completed. The obvious short-comings of the study should be made clear. It is acceptable to include any insights regarding the likely impacts of factors not subjected to rigorous analysis in the policy recommendation as long as it is noted that these are both contemplative and speculative in nature. Recommendations for further study should first address the limitations of the present study and suggest possible avenues for continued analytical investigation. A second and perhaps more important set of recommendations for further study pertain to the possible next steps in the policy process for the project under investigation, assuming implementation is recommended. In this regard, attention should be focused on the allocation of the cost of the project among beneficiaries and the actual method by which the project will be financed.

Chapter 2 Appendix: Economic Impact Analysis

Economic Impact Analysis versus Benefit-Cost Analysis

Economic impact analysis (EIA) is a tool used to evaluate the consequences of changes in economic activity, such as those that result from the location or closure of a manufacturing facility. It is widely used at the state and local levels to facilitate planning in the face of economic change and transition. It is also commonly applied to gauge the economic and fiscal costs and benefits of new economic activity in order to set economic development incentives. The incentives that Tennessee granted to Nissan and Saturn, for example, were guided by economic and fiscal impact analysis. Tennessee now requires that local governments conduct economic impact analysis prior to the granting of payments-in-lieu of taxes (or PILOTs).

EIA is not the same as benefit-cost analysis. With EIA, the typical focus is on estimating the gains and losses for a regional economy. For example, if a new manufacturing facility locates in a county, how much new tax revenue will be generated, how much will schooling costs increase, and how many new jobs will be created? Benefit-cost analysis, on the other hand, seeks to measure the gains in efficiency (or economic well-being) for the economy as a whole, not just for a part of the national economy. On net, are consumers and producers better off with the new manufacturing facility?

To further draw out the differences in methodology, consider a firm that relocates its facility from another state to Tennessee. The fact that the firm moves to a better location based on market considerations suggests that a benefit-cost analysis for the nation would reveal some efficiency gains from the move. But for the state as a whole, it is now the beneficiary of new jobs, increased income and an expanded tax base, while another region loses these same benefits. This aspect of the shift in economic activity represents a zero-sum game for the nation as a whole. The economic development benefits for Tennessee in this example, as evaluated by EIA, would generally exceed the gains produced by benefit-cost analysis and do so by a wide margin. This is one reason people are opposed to the use of economic development incentives, particularly when used to induce firms to move their place of business. There may very well be no gain for the national economy in such instances. But it remains in the self interest of states and localities to try to recruit jobs through incentives.

The examination of the Trans-Tennessee Rail Plan in this report is guided by a benefit-cost analysis that looks at gains for the nation as a whole. While the narrow focus of the study is Tennessee and nearby states, the benefits from an improved transportation infrastructure are conceivably bestowed on citizens in every state in the country. It is for this reason that the federal government should be considered as one funding source if the Rail Plan is pursued.

The Methodology of EIA

The starting point for conducting EIA is some change in economic activity driven in part or in whole by purchasing power from outside the region. Again manufacturing serves as a fine example. Production activity in a local manufacturing facility benefits from the purchasing power of consumers in other regions if not countries. As these consumers spend their incomes on the manufactured product, the facility is able to hire workers, purchase supplies, make capital investments and pay taxes to state and local governments. Workers in the manufacturing plant in turn spend their incomes in the local community, supporting additional jobs, particularly in the retail trade and service sectors. This income is spent and re-spent, a sequence commonly referred to as the multiplier process. The same effects would follow from any type of firm, including firms in the service sector, that export the final good or service to other regions.

Fiscal impact analysis (FIA) is driven by EIA. In other words, fiscal effects—both the effect on tax bases *and* the effect on government service delivery costs—depend largely on properly capturing economic changes. For example, Tennessee's sales tax base depends on the expenditures of households, which in turn depends on household income, as well business expenditures that are sales taxable. (About 40 percent of state sales tax revenue is derived from spending by businesses.) Similarly, any changes in local property tax revenue hinge on how residential and commercial/industrial property change.

The fiscal *costs* of economic development are often ignored in practice, which is very inappropriate. Even if a new company comes to a community and hires workers from the local labor force, other workers will be needed to do the jobs that have been just vacated. In practice this may mean inmigration of workers and their families from other places. This puts pressure on schools, emergency services, infrastructure, and so on. Proper application of fiscal impact analysis requires consideration of both the revenue and expenditure sides of the budget.

Implications for the Trans-Tennessee Rail Routing

Some regions of Tennessee might see significant economic development benefits from the Trans-Tennessee rail routing. In the short run significant benefits may accrue from facility construction and improvement. Jobs and income will be created, and new tax revenue will accrue to state and local government. Over the long run, some communities with current rail freight capacity might see economic activity expand as transportation service quality improves through a continuous east-west routing. Other communities—those which currently do not have rail access—may be able to better market themselves to business and industry and thus add to their economic base by attracting and retaining firms and jobs.

A portion of any new economic activity in Tennessee may simply be the result of the re-location of firms from other states in the southeast. From a national perspective there may be little net gain from a reallocation of this economic activity. But certainly the gain to Tennessee and to the local host community may be pronounced. Similarly, some economic activity along the new rail routing may have been reallocated from another Tennessee location. In this case there is no net gain for the state, while there may be significant benefits for the community from firm location.

These distributional (i.e. regional) aspects of the Rail Plan can be appropriately evaluated through EIA. In some instances the distribution of project-related benefits evaluated by EIA may be of great importance to Tennessee policymakers. For example, if depressed areas of the state would benefit markedly from an improved rail transportation infrastructure, this may add value to the project that is not captured in the benefit-cost analysis presented in the body of this report. As another example, there may be specific sectors of the Tennessee economy that would benefit appreciably from the Trans-Tennessee routing. To the extent state policymakers place additional value on such industry-specific benefits, this also would add to project benefits. Distributional gains (and losses) like these are not easily included in formal benefit-cost analysis, but they can nonetheless be of significant practical importance.

3. The TDOT Rail Plan, Its Review of the Trans-Tennessee Option, and Other Relevant Research

3.1. Introduction

The Rail Plan developed by the Tennessee Department of Transportation (TDOT) provides a comprehensive evaluation of both freight and passenger railroad facilities and services within the state. It is important to carefully review this previous work to place the current analysis in context. The overarching goals of the Rail Plan are well described in the following text from the plan's Task 2 Introduction.

> This plan (was) designed to develop broad-based input from all stakeholders in a manner that will result in a well-written and well-defined Rail Plan that reflects the interests and concerns of the citizens of Tennessee. The product (is) a Rail Plan that addresses the near- and long-term needs of the state and the needs expressed by the broad-based community of stakeholders identified by the Project Team. The Rail Plan, when implemented, will contribute to the overall economic growth of the state while protecting and preserving the quality of life issues so important to everyone.

The Rail Plan reflects a comprehensive effort to address a number of foreseeable rail-related challenges and opportunities, including but not limited to, the preservation of branch-line railroad capacity as an economic development tool; the reestablishment of a state-wide passenger rail network; and the need to substitute rail freight transport for motor carriage as a means of relieving highway congestion and improving air quality. The overall set of tasks undertaken in the development of the Rail Plan is summarized in Table 3.1.

3.2. Rail Plan Research

Very nearly every task undertaken within the plan has some bearing on the proposed Trans-Tennessee rail routing. For example, work produced in response to Task 2 carefully describes the existing network that would serve as the basis for a Trans-Tennessee freight route. Task 4 discusses rail passenger traffic over the routing between Knoxville and Bristol that constitutes the east-Tennessee end of the Trans-Tennessee routing. However, the first direct treatment of freight movements over the proposed routing was produced in response to Task 5 (Freight Forecasting). The analysis produced estimates of divertible highway freight currently moving between Memphis, Nashville, Knoxville, and Bristol. It is important to note that it did not include traffic that moves over the routing to origins and/or destinations outside of Tennessee.

The Task 5 analysis also included a survey of shippers, motor carriers, short-line railroads, and Class I railroads. The survey responses suggested that very few shippers would divert truck traffic to a rail alternative. Reasons included long transit times, short shipment distances, and issues regarding railroad reliability. Class I railroad responses focused on the infrastructure requirements each would need in order to provide service over an all-Tennessee routing. Interestingly, CSXT, which operates over more track than

Table 3.1: Task-Specific Summary of the Tennessee Rail Plan

Plan Development Task	*Task Summary*
Task 1. Public Involvement Plan	Contact information, information on meetings and other procedures through which the public is notified of the project's development.
Task 2. Rail System Inventory	Summary of the operations of Class I and shortline railroads in Tennessee.
Task 3. Short Line Program Review and Recommendations, and Policy and Procedures Manual.	A discussion on what constitutes the TDOT Short Line Railroad Rehabilitation Program and recommendations for a new approach. The Policy and Procedures Manual examines how TDOT has administered the track and bridge rehabilitation programs.
Task 4. Potential Intercity Passenger Rail Corridors	Determination of the most promising candidate corridor for the implementation of new intercity passenger rail service in Tennessee.
Task 5. Freight Movement Inventory and Future Demand Analysis	Analysis of the potential for the diversion of I-40 truck freight to the proposed all-Tennessee east-west rail link.
Task 6. Rail Freight Intermodal Facility Needs and Rail System Connections	Potentially beneficial rail infrastructure improvements, policies or regulatory intervention that would enhance rail operations within the state of Tennessee.
Task 7. Strategic Project Evaluation Protocols and Procedures	A report of the protocols and procedures that were used by TDOT to analyze the benefits which would accrue to the state of Tennessee by the realization of the proposed east-west freight rail corridor.
Task 8. Evaluation of Rail Infrastructure Proposals	Cost-benefit analysis for the following three projects: Basic Freight Rail Connection, Planning Horizon Scenario Connection and the Memphis Rail Bypass.
Task 9. Rail Impacts of Possible Chickamauga Lock Closure	An analysis of the effect on the Tennessee Rail System of the potential permanent closure of the Chickamauga Lock, located on the Tennessee River near Chattanooga, TN.
Task 10. Advance Planning Report	Analysis of three alternatives to close the gap between Oliver Springs and Algood, TN. The second section focuses on the establishment of freight and passenger rail service between Memphis and Knoxville.
Task 11. Summary, Funding Options, and Rail Program Recommendations	A summary of topics analyzed more extensively in other tasks, as well as a review of the funding sources for the intermodal and freight rail projects.
Task 12. Summary of Interactions with Tennessee Metropolitan Planning Organizations in the Development of the Rail System Plan	A discussion of the interactions of TDOT with the nine Metropolitan Planning Organizations (MPOs) located in Tennessee.

any other Class I carrier within the state, declined to respond to the survey, noting no interest in the proposal. Finally, the Task 5 analysis produced link-specific transit time estimates for the Memphis–Knoxville portion of the routing, including separate estimates for the competing southern and the northern alignments between Nashville and Algood and Oliver Springs.

Task 7 reports the protocols and procedures that were used by TDOT to analyze the benefits which would accrue to the state of Tennessee by the realization of the proposed east-west freight rail corridor (as well as other proposed projects). The analysis of the outcome of the proposed project is implemented on the following levels: economic impact—the overall addition of new dollars into the economy; employment impact—a measurement of the number of jobs being created by the subject project; tax impact—the added tax revenues resulting from the implementation of the project and induced business activity, operational, socioeconomic and environmental effects; and return on state capital investment. The last category includes, among others, the diversion of truck traffic to the potential rail corridor, savings in terms of reduced highway maintenance costs, savings from increased efficiency in fuel usage, and reduced congestion costs. It should be noted that this task provides only a description of the benefit categories as well as of their measurement methodology and does not provide numerical estimates.

The heart of the Rail Plan's analysis with regard to the Trans-Tennessee freight routing is found in the materials produced as a result of Tasks 10 and 8. Task 10 yielded an advanced planning report (March 2002) that evaluated three competing Trans-Tennessee routings, including: (1) the existing (southern) alignment, (2) the existing alignment with improvements, and (3) the alternative (northern) alignment. The document contains careful and thorough descriptions of each routing and the type of train operations it would support. However, the report did not provide formal estimates of project benefits or costs.

A full evaluation of the Trans-Tennessee rail routing is provided in the report prepared in response to Task 8. This report evaluates the economic potential of a variety of proposed rail projects, including one that would produce a Trans-Tennessee routing via a southern alignment (Basic Freight Connection) and one that would produce a Trans-Tennessee routing via a northern alignment (Planning Horizon Scenario).

The cost of creating the southern alignment is relatively low, with a net present value of approximately $123 million. Unfortunately, the route produces poor transit times, so that it does not compete well with existing transportation infrastructures (both highway and rail). As a consequence, the estimated present value of the projected benefit stream is only $147 million, yielding a benefit-cost ratio of 1.19.

The Task 8 analysis of the northern alignment is considerably more complex. First, the analysis includes the costs and benefits of both passenger and freight transport via the routing. Second, transit times are sufficiently good to imagine that some portion of existing I-40 truck traffic could be diverted to the new rail routing, along with a portion of existing rail traffic. Readers will note that, for the purposes of the current analysis, passenger benefits and costs are, once again, excluded.

The analysis did not attempt to pinpoint the expected level of truck diversions from I-40. Instead it estimated benefits and costs based on diversion rates of between 5 and 40 percent. The northern alignment is considerably more expensive, with a present value of freight-only costs ranging between $1.2 and $1.5 billion, depending on traffic volumes. However, the present value of the savings attributable to the much more substantial northern alignment diversions ranged between $1.0 and $7.5 billion, so that the benefit-cost ratios ranged between 0.78 and 5.06. Estimated benefits and costs for the southern alignment (Basic Freight Connection) are reproduced here in Table 3.2, while similar estimates for the northern alignment (Planning Horizon Scenario) are provided in Table 3.3.

3.3. A Discussion of Rail Plan Benefit Calculations

Chapter 2 of this report carefully describes the challenges inherent in estimating the economic benefits of fairly radical changes to the surface freight transportation network. Given these challenges and a relatively constrained set of data from which to work, the Rail Plan study team developed a sound methodology for calculating potential project benefits.

Table 3.2: Rail Plan Benefits and Costs, Southern Alignment

Annual Benefits	
Impact on Shipping Costs	$5,779,323
Rail Operations Cost Differential	31,148
Highway Maintenance Reduction	1,741,474
Accident Savings	93,490
Highway Congestion Savings	1,123,709
State Fees/Revenues	266,422
TOTAL BENEFITS	$9,035,566
Costs	
Total Capital Costs	$118,041,839
Freight O&M Costs	541,392
TOTAL COSTS	$118,583,231
Benefit-Cost Analysis	
NPV Benefits	$147,356,883
NPV Costs	$124,335,521
Total NPV	$23,021,252
Benefit-Cost Ratio	1.19

The estimation of benefits requires two key components—an estimate of divertible traffic volumes and an assessment of the transportation cost savings that are assignable to diverted traffic. These savings may accrue to shippers in the form of transportation rates, they may accrue to carriers in the form of increased profits, and they may accrue to the more general public in the form of reduced congestion, increased safety, and improved air quality.

The Rail Plan study team apparently did not have the means to generate traffic diversion estimates that satisfied their standards. They, therefore, adopted a strategy of evaluating five varying diversion scenarios in which for-hire trucking diversions ranged between 5 percent and 40 percent and private truck diversions ranged between 2.5 percent and 20 percent.[1] This is a perfectly valid approach. The same study team estimated that a switch to intermodal transport would save shippers 20 percent versus observable motor carrier rates on a representative 750-mile truck movement. The 20 percent parameter is consistent with a diversion to a TOFC movement or a single-stack container movement. It is, however, significantly less than the savings that would be realized through a diversion to a double-stack container movement. Therefore, the unit savings hypothesized within the Rail Plan analyses may substantially understate the potential shipper savings.

Table 3.3: Rail Plan Benefits and Costs, Northern Alignment

	Diversion Levels		
Benefits	5% For Hire 2.5% Private Truck	20% For Hire 10% Private Truck	40% For Hire 20% Private Truck
Impact on Shipping Costs	$43,944,572	$175,778,288	$351,556,575
Rail Operations Cost Differential	31,148	31,148	31,148
Highway Maintenance Reduction	7,118,472	28,473,886	56,955,163
Accident Savings	380,683	1,522,734	3,045,863
Highway Congestion Savings	4,196,803	16,787,213	33,578,783
State Fees/Revenues	4,047,461	6,944,434	10,807,330
TOTAL BENEFITS	$59,719,139	$229,537,703	$455,974,862
Costs			
Capital Cost	841,989,167	841,989,167	841,989,167
Freight O&M Cost	495,957	10,558,419	18,236,254
TOTAL COSTS	842,485,124	852,547,586	860,225,421
Benefit-Cost Calculations			
NPV Benefits	979,564,535	3,765,459,585	7,480,055,080
NPV Costs	1,259,422,446	1,352,640,585	1,476,951,501
Total NPV	-279,857,911	2,412,819,000	6,003,103,579
Benefit-Cost Ratio	0.78	2.78	5.06

[1] The current analysis, described in Chapter 4, excludes private truck movements from the pool of potentially divertible traffic, based on the belief that private truck users would not idle tractor fleets in order to avail themselves of intermodal opportunities.

Much of the Rail Plan's discussion of benefits is not clear, so that the current study team was concerned that the principles enumerated here within Chapter 2 might not have been carefully adhered to in the preparation of the Rail Plan benefit estimates. However, a careful evaluation of the methodology employed within the Rail Plan suggests that these concerns were unwarranted. For example, the text refers to fuel cost savings and shipper savings separately, when the fact is that fuel cost savings often drive shipper savings. To count both within the preparation of benefit estimates would clearly be double counting. However, the methods section of the Rail Plan discussion makes it clear that fuel cost savings were subsumed under the more general category of shipper savings within the actual benefit calculations.

One unfortunate outcome of the Rail Plan benefits' methodology is that it does not provide the means to allocate potential benefits among various constituencies. This shortfall handicaps necessary discussions of alternative project funding scenarios. However, with this said, the current study team finds no other significant flaws in the previously applied methodology nor any reason to seriously question the resulting estimations.

3.4. Non-Quantified Impacts

Task 7 of the Rail Plan develops an intricate means of combining project-related quantifiable economic effects with non-quantified economic and community impacts in order to achieve an overall project "score." Evaluating this methodology is well outside the scope of the current analysis. It is, however, useful to note that the non-quantifiable impacts are not ignored within the Rail Plan and that it is possible to compare the values assigned to the southern and northern alignments. These are summarized in Table 3.4.

Table 3.4: The Scoring of Nonquantified Impacts

Criteria	*Weighted Score, Southern Alignment**	*Weighted Score, Northern Alignment**
Cost Effectiveness	2.0	2.0
Public Safety	0.4	0.4
Freight and Passenger Service Expandability	1.2	1.6
Ability to Serve Business	1.2	1.2
Consistency with Regional Plans and Existing Planned Development	1.2	1.6
Community Compatibility	0.8	1.2
Natural Environment Effects	1.6	0.4
Public and Agency Support	0.8	1.6

*Each criterion is given a raw score of between 1 and 5, where 5 represents the most desirable outcome. Raw scores are then weighted based on "the policy priorities established by the State."

Generally, the northern alignment scores as well or better than the southern alignment in every category except one: Natural Environment Effects. This outcome almost certainly owes to the fact that the southern route largely utilizes an existing alignment, whereas the northern route requires the construction of an altogether new alignment over a distance of approximately 40 miles.

3.5. The Reebie Virginia Research

Tennessee's evaluation of the more expensive, higher capacity routing utilizing the northern alignment notes that the benefits attributable to this project rest on the requirement that other states undertake similar investments in rail infrastructure so that improved services can be offered in at least one more extensive transport corridor. This same outlook motivated Virginia's Department of Rail and Public Transit to fund a freight study conducted by Reebie and Associates which was released in December of 2003.[2]

The Virginia study considers two scenarios—one in which improvements are made only within the commonwealth and one in which Virginia infrastructure improvements are accompanied by improvements elsewhere (presumably including Tennessee). The study focuses on estimating the volume of divertible I-81 traffic given specific improvements in the service characteristics of rail transport within the region.[3]

The Reebie study does not yield explicit benefit estimates under the two scenarios, but it does conclude, based on traffic volumes, that a Virginia-only set of improvements is unlikely to provide benefits sufficient to justify the construction costs which are, in fact, carefully calculated within the analysis.[4]

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[2] Virginia Department of Rail and Public Transit.
[3] The Reebie analysis assumes service improvements that are far more aggressive than those that support the CBER analysis described in Chapter 3.
[4] The Reebie cost estimates of Virginia facility construction are used here, in Chapter 4, to determine the overall construction cost of a combined Tennessee-Virginia-North Carolina project.

4. Evaluation and Allocation of Benefits and Costs

The development of a Trans-Tennessee freight rail route link would require construction expenditures well in excess of one billion dollars over a multi-year period. The resulting infrastructure improvements would, however, yield significant new transportation capacities that could, in turn, play an important role in relieving foreseeable interstate highway congestion and, at the same time, provide substantial cost savings to shippers and to the public that consumes their shipped products.

4.1. The Network and Network Improvements

Over the past decade a variety of potential freight rail projects have been proposed in recognition of growing traffic congestion in the I-81 and I-95 corridors. While these proposals often contain common network elements, there are also import geographic differences between them. Based on discussions with TDOT, the study team combined two specific proposals to form the network modification that is subsequently evaluated. The current analysis combines the Trans-Tennessee routing, evaluated in the Tennessee Rail Plan, with the track modifications evaluated within Virginia's most recent study to form the study scenario. This focus is a marked departure from the original Rail Plan.

Figure 4.1 provides a schematic of the intermodal routings that would be affected by implementation of the study scenario while Map 4 places this more broadly in the context of Tennessee's rail infrastructure. These routings are comprised largely of NS trackage but also include a completed rail route between Knoxville (Harriman) and Nashville, as well as improved CSXT trackage between Nashville and Memphis.[1] The improved route segments are represented as green-dashed or red-dashed lines within Figure 4.1 and orange-dashed lines within Map 4.

From a Tennessee standpoint, there are two important corridors. The first of these would include origins and destinations in the northeast and central seaboard with Knoxville, Nashville, and Memphis. The second corridor would link these cities with the intermodal port facilities at Norfolk. The two corridors converge/diverge at Lynchburg, Virginia.

It is also important to consider the impacts these track modifications would have on non-Tennessee traffic. A significant amount of current and forecasted NS intermodal traffic already uses the network segments between Harrisburg and Lynchburg and between Lynchburg and Norfolk.[2] To the extent that the proposed track improvements increase average train speeds and, thereby, reduce the number of necessary train hours, they would reduce the cost of providing services between the northeast and a number of locations in the southern and southwestern US.

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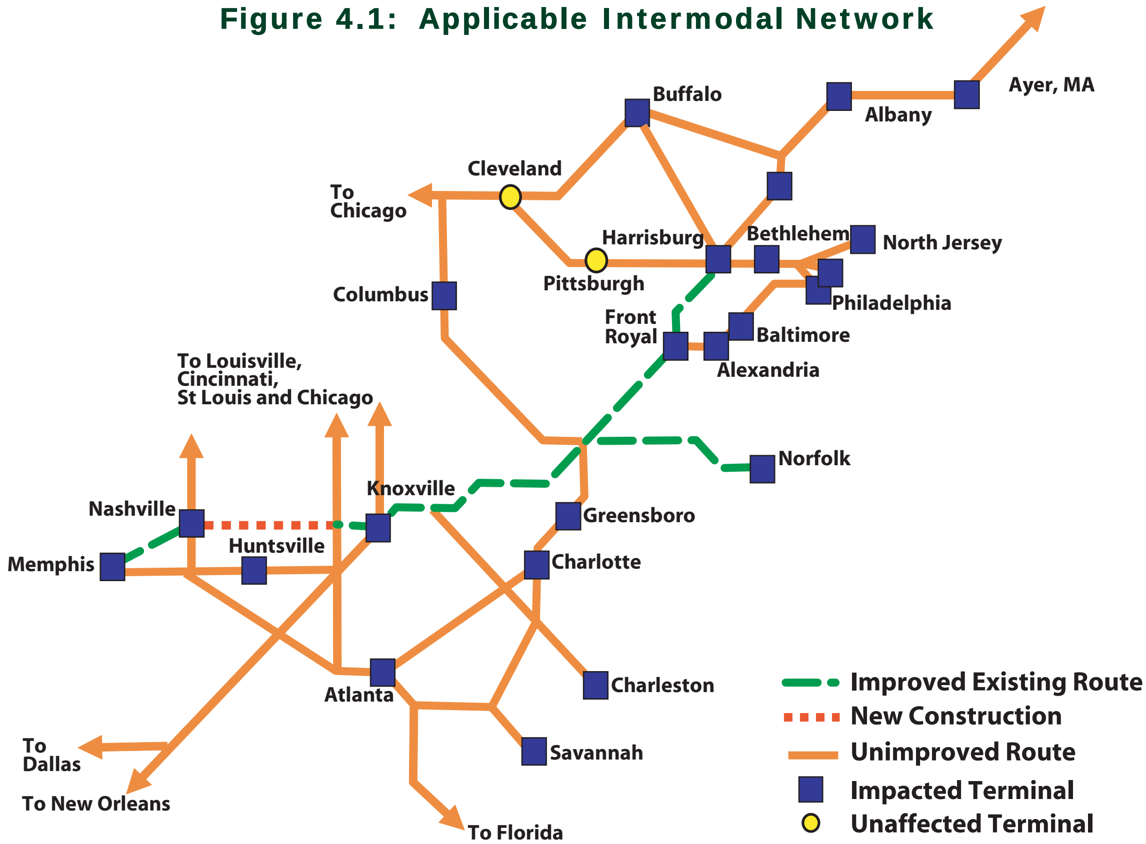
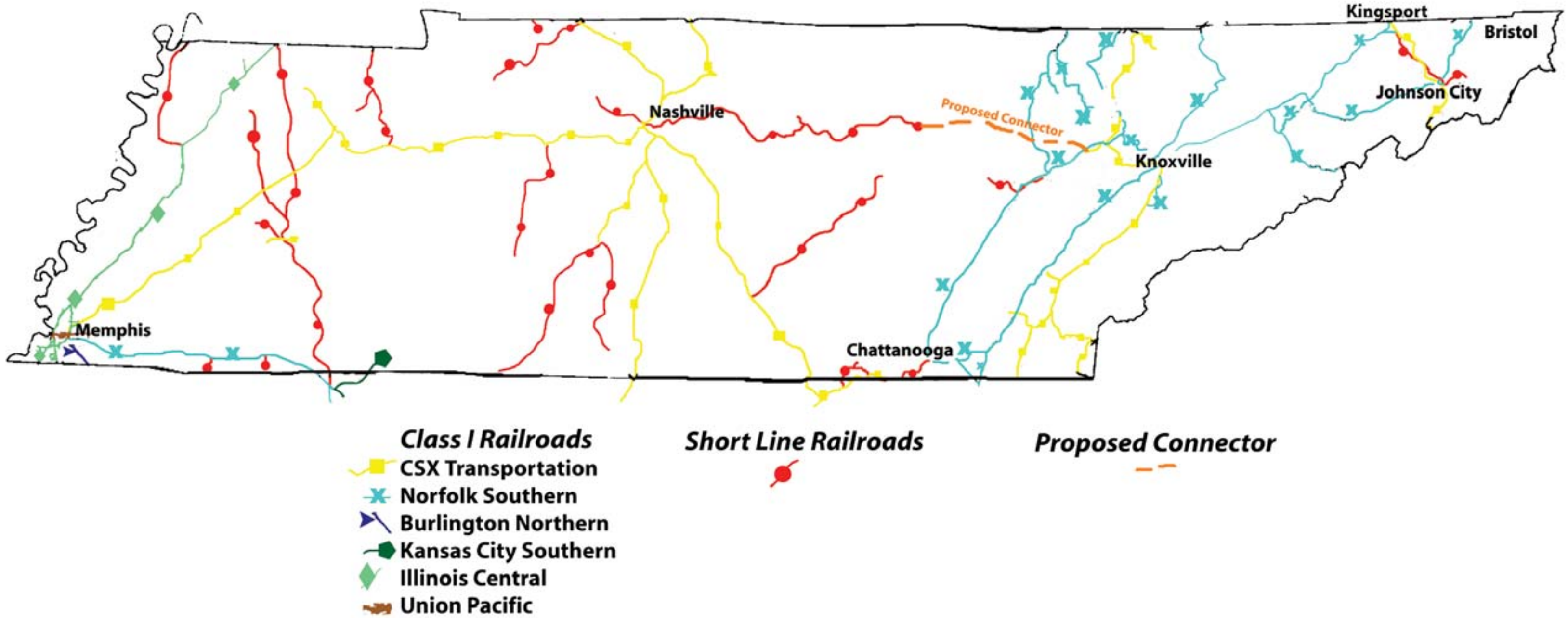
[1] As a matter of completeness, the schematic includes CSXT north-south trackage through both Knoxville and Memphis. However, traffic over these routings would be completely unaffected by the proposed project. This fact may explain CSXT's failure to respond to survey questions regarding the project as summarized in Task Five of the Tennessee Rail Plan.

[2] At least one alternative proposal includes the improvement of trackage between Lynchburg and Atlanta (via Charlotte) and the improvement of existing trackage between Knoxville and Memphis (via Chattanooga). However, because these improvements were not discussed within the Tennessee Rail Plan, they were not evaluated within the current analysis. Finally, NS and the states of Virginia, West Virginia, and Ohio are working, through their Heartland Corridor Initiative, to significantly improve the intermodal infrastructure connecting Norfolk with Columbus. The network modifications considered here would certainly complement the Heartland effort. However, once again, this alternative proposal was not considered within the current analysis. A more extensive network would yield additional benefits and involve additional costs. It is not clear, however, that it would materially affect the outcome of the current analysis.

Figure 4.1: Applicable Intermodal Network



Map 4: Tennessee Railroad Network



NOTE: Information on this map was modified from TDOT'S Tennessee Railroad Network Map, available at http://www.tdot.state.tn.us/plango/railnetwork.html.

4.2. The Cost of Network Improvements

The infrastructure improvements necessary to create the envisioned Trans-Tennessee linkage between the eastern seaboard and mid-south vary based on geography, current ownership, and current usage.

The western portion of the proposed routing, between Memphis and Nashville, is currently owned and operated by CSXT. While this route segment currently accommodates intermodal trains, it will require non-trivial improvements if it is to provide the capacity and train speeds necessary to create truck-competitive services. It will also be necessary to create a new connection track between CSXT and the trackage that is to connect Nashville with Knoxville. See Map 4.

The Nashville–Knoxville route segment is comprised of three distinct parts. From Nashville east, the routing first would utilize trackage currently operated by the Nashville & Eastern (N&E) between Nashville and Monterey.[3] Importantly, the Nashville to Lebanon segment is currently being upgraded to support commuter rail service, so that much of this route link will already be capable of sustaining higher train speeds.

From Monterey to Oliver Springs, the Trans-Tennessee will require the construction of new trackage along an alignment that roughly parallels Tennessee State Highway 62. The eastern most portion of this segment is through particularly rugged terrain and would require the construction of at least one substantial tunnel. It is, however, possible that the associated construction costs could be reduced by connecting with existing NS trackage at Lancing rather than Oliver Springs.[4]

East of Knoxville, the envisioned routings are over trackage owned and operated by NS. Much of this trackage already accommodates traffic in excess of 50 million tons per year, including several intermodal trains per day. Developing the capacity to accommodate more trains operated at higher average train speeds would require substantial infrastructure improvements, including longer and more frequent sidings and the elimination of a limited number of restrictive curves.

The construction of new trackage between Algood and Oliver Springs, along with the modifications to CSX and NS trackage necessary to complete a high-speed rail routing between Knoxville and Nashville are estimated to cost approximately $691 million. This estimate is drawn directly from the Tennessee Rail Plan.[5] The estimated costs for the remaining track and facilities are derived either directly or indirectly from the Virginia study of a possible rail remedy to congestion along the I-81 corridor.[6] The Virginia study also provides estimates of other route segments that are part of the Virginia inquiry, which

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[3] The N&E currently operates between Nashville and Algood. The Algood to Monterey segment is, however, scheduled for rehabilitation and a return to service.
[4] As currently designed, the Trans-Tennessee would cross the NS Chattanooga–Cincinnati line at Lancing. If a connection is possible, the NS line provides access to Knoxville via Harriman. However, at Lancing, the Trans-Tennessee routing would likely be at an elevation that is significantly higher than that of the NS line, so that the viability of such a connection is, by no means, certain.
[5] Tennessee Department of Transportation, *Rail Plan Task 8, Exhibit 6*. 22.
[6] Virginia Department of Rail and Public Transit.

are not described here.[7] The Virginia study provides estimates for two capacity levels. The first of these considers the track improvements needed to accommodate high-speed intermodal and passenger operations under current and immediately foreseeable traffic conditions. The second Virginia scenario accounts for the improvements that would be necessary to sustain these services in a long-run setting. Both estimates are included in Table 4.1. Also note that this table contains an estimate for improvements between Lynchburg and Norfolk. This segment is integral to the analysis presented here. However, because it is not important to the Virginia I-81 effort, it was not directly considered in the Virginia study. Accordingly, the study team used average costs within Virginia to indirectly estimate the cost of modifying the Lynchburg – Norfolk link.

4.3. Diversion Estimates and Potential Benefits

The addition of a new link in the rail network that serves the southeastern US would certainly change commodity flows. Depending on the service characteristics of this link and potential transportation cost savings, both highway traffic and existing rail traffic could be diverted to the modified infrastructure and current traffic could move at a substantial cost savings. The nature and extent of these traffic diversions and cost savings lay at the heart of nearly all benefit calculations. Efficiency gains as measured by cost savings to both freight and potentially passenger users, reductions in vehicle emissions, and any improvements in public safety all hinge on the magnitude and course of freight traffic diversions.

TDOT has evaluated these potential diversions through an analysis performed in 2002 by Don Breazeale & Associates and summarized in Chapter 3 of this report. A primary purpose of the analysis contained in the current chapter is to evaluate potential diversions in light of the intermodal network described by Figure 4.1 and to allocate benefits among the set of affected constituencies in an effort to shed additional light on potential funding options. This provides the study team with the opportunity to validate the overall magnitude of the earlier diversion estimates through the application of tools and methods that vary from those used in the initial study.

Table 4.1: Infrastructure Costs

All Cost Values x $1 Million

Segment	*Short Time Horizon*	*Long Time Horizon*
Memphis – Knoxville	$690	$690
Knoxville Terminal	18	18
Knoxville – Bristol	71	300
Norfolk – Lynchburg	155	635
Bristol - Rippon, WV	375	1,012
Rippon, WV – Hagerstown	12	80
Hagerstown – Harrisburg	185	339
TOTAL	$1,506	$3,074

[7] Virginia Department of Rail and Public Transit. These include trackage segments between Lynchburg, Charlotte, and Atlanta, segments between Knoxville, Chattanooga, and Memphis, and segments between Chattanooga, Birmingham, and the southwest.

In attempting to model the probable freight traffic affected by a newly constructed Trans-Tennessee rail routing, the study team applied a methodology that is nearly identical to that used by the US Army Corps of Engineers in the evaluation of proposed navigation infrastructure improvements.[8] This process very carefully mirrors the guidance provided in Chapter 2. Current and future transportation costs in a *without project* setting are estimated, then compared to the costs that are likely to be observed if the proposed project moves forward. The difference between the two cost magnitudes represents project benefits. The current analysis assumes that relevant markets are effectively competitive. Accordingly, cost savings would result in the lower transportation rates necessary to induce changes in the behavior of various shippers. In some settings, this assumption is problematic. However, in the case of the Trans-Tennessee rail link, this assumption is, in fact, quite tenable.[9]

The current analysis considers three potential sources of affected traffic. The first of these involves current truck movements along the I-81 / I-40 corridors. Depending on service characteristics, it is possible that a Trans-Tennessee rail routing could provide a competitive alternative to these truck routes. The second potential source of traffic is related to existing rail/truck intermodal traffic moving to or from Tennessee.[10] Currently observed traffic over some origin/destination pairs could likely be moved more efficiently over a Trans-Tennessee routing. Finally, the third potential source of affected traffic involves intermodal traffic to and from non-Tennessee origins and destinations that would, nonetheless, move more cheaply because of improvements to network components.

The assumptions and methodologies specific to diversion calculations for each potential traffic source are provided below. However, it must be emphasized that, in all cases, it is assumed that competing route alternatives will remain as they exist at the current time. Any significant investment in either competing highway or alternative rail infrastructures could substantially affect diversions, cost savings, and subsequent benefit calculations.

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[8] US Army Corps of Engineers, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (March, 1983).

[9] While a Trans-Tennessee rail linkage could be used for more traditional railroad bulk commodity movements, the study team has assumed that such movements, if evidenced at all, would represent only a very minor share of overall traffic. A survey of regional shippers conducted within the development of the state's Rail Plan and historical commodity flows both clearly support such an assumption. Instead, the current study focus is on the movement of higher-valued commodities either by truck or as part of a rail/truck intermodal movement, often in association with international commerce. These transport markets are characterized by truck-rail competition, competition between rail routings, and fierce competition among rival ports. Consequently, the assumption that cost reductions would result in lower transport rates is largely palatable. Readers will also note (Section 3.1) that this assumption is consistent with commonly practiced economic methods.

[10] Within the current analysis, the term "intermodal" generally refers to Trailer-On-Flat-Car (TOFC) or Container-On-Flat-Car (COFC) traffic.

The Basic Model

The modeling employs the following cost function in evaluating movement costs under differing modal alternatives.

(1) $TSC = R_{TM}(TM) + R_H(H) + EVD + THC + ED$

Where:

TSC = Total Shipment Cost
R_{TM} = Transportation Rate per Ton-Mile
TM = Number of Shipment Ton-Miles
R_H = Inventory Value per Hour
H = Total Transit Time in Hours
EVD = Expected Value of Delay Outside of Performance Guarantee
THC = Total Handling (Terminal) Costs
ED = Equipment Differential

Methodological Discussion of Diversions under Static Traffic Conditions

Existing Intermodal Shipments to Memphis and Nashville. The magnitude of diversions will depend on the availability of faster service over the new routing. There could be a modest reduction in shipment distance that would marginally reduce TM and H, but significant diversions would depend on faster transit times. Absent these, shipping costs will generally be the same under both *with* and *without* project conditions.

Container Traffic between Memphis / Nashville Currently Moving by Truck. Under an intermodal alternative, R_{TM} would almost certainly decline, while TM could increase marginally. Overall, their combined impact on TSC would likely be negative. R_H is invariant to route/mode selection. However H would increase.[11] EVD would have to remain largely unchanged which means the additional cost of mid-shipment diversion to truck should be included in order to assure performance.[12] THC would likely be higher, given that an intermodal routing would involve one additional lift. ED would equal zero.

[11] It is very nearly impossible for a rail/truck combination to match the transit times offered by a truck-only routing.
[12] There is ample evidence that those who ship by truck will not accept significant reductions in the quality of service.

I-81 / I-40 Truck Traffic. Again, under an intermodal routing, R_{TM} would decline. TM might increase marginally, but the combined effect should be overwhelmingly negative. R_H is invariant to shipping decisions, but H will almost certainly increase measurably. Again, in order to keep EVD constant contingency truck charges should be included. THC is positive, given that there are two lifts versus zero in an all truck movement. Finally, light-weight truck trailers can accommodate approximately 8 percent greater loading weights, so in those instances where weight and not cubic feet limit shipment sizes, ED would be positive. Given the many cost disadvantages associated with the intermodal movement, it is perhaps reasonable to only consider the cost of a domestic container movement where the rail portion is moved in a double-stack configuration that achieves the greatest reduction in R_{TM}.

Methodological Discussion of Diversions under Highway Traffic Growth

Existing Intermodal Shipments to Memphis and Nashville. Given that these movements are currently moving via a rail/truck combination, relative modal costs are completely unaffected by increased highway traffic and resulting congestion.

Container Traffic between Memphis / Nashville Currently Moving by Truck. Highway congestion diminishes the advantage of truck transport in several ways. First, under greater congestion fuel, driver and equipment costs increase so that the relative R_{TM} is greater. At the same time the inventory management advantages of trucking decrease, with relative increases in H and EDV. Other cost determining parameters are unchanged. It should be noted that most congestion is projected in and around urban areas and that congestion in or around origin/terminal locations will impact transportation costs negatively regardless of modal choice.

I-81 / I-40 Truck Traffic. The scenario is the same as the one involving truck movements of containers.

Variations in Fuel Prices or Rail Network Congestion

Line-haul rail carriage typically involves the consumption of less fuel than movement by truck, so that the effects of fuel price increases are amplified in the calculation of total transportation costs. It should be noted, however, that the fuel usage differential between truck and rail is only moderate in the case of TOFC/COFC rail traffic. This is because intermodal rail service is similar in nature to passenger train operations, with lighter and more heavily powered, and generally faster, trains.

Current railroad volumes have largely utilized all available capacity within the study region. Thus, any traffic changes that materially increase rail shipment volumes could lead to higher unit costs for all traffic. This fact is made more important by the projected growth in coal-fired electricity generation and the potential for a relative shift toward Illinois basin coal.

Current Costing Assumptions

Truck to Rail Diversion Assumptions. Consideration of the above issues resulted in the adoption of the following assumptions:

- With one exception, only locations that currently have mechanized intermodal terminals are considered. The single exception involves the development of a mechanized intermodal facility at an east-Tennessee location.[13]
- Only shipments to/from origins and destinations in the terminal county or contiguous counties are considered.
- Movements with shipment distances of less than 600 miles are excluded.
- Dry-bulk commodities (coal, ore, non-metallic minerals, etc.) are excluded.
- Private truck movements in shipper-owned equipment are excluded.
- Less-Than-Truckload movements are <u>included</u>.
- Intermodal movements are costed for 53' domestic container movements in a double-stack configuration.
- Assumes service improvements (transit times and reliability) sufficient to secure diversions.[14]
- Assumes no additional incremental service costs.

Rail-to-Rail Container/Trailer Diversions. Similarly, consideration of the above issues resulted in the adoption of the following assumptions:

- Only locations that currently have mechanized intermodal terminals are considered.
- Analysis considered traffic in the Baltimore/Norfolk – Nashville/ Memphis/Little Rock lanes.
- Assumes containers are already double-stacked.

[13] Traffic estimates for an east Tennessee facility were based on methods developed within earlier analyses. For a full description see Rahall Transportation Institute, *Central Corridor Double-Stack Initiative* (Marshall University, March 2003). What is unclear, however, is the extent to which traffic over an east Tennessee facility would represent the diversion of existing intermodal movements over Memphis, Nashville, Cincinnati, or Atlanta versus the diversion of all-truck movements. Overall savings calculations are somewhat sensitive to this issue. Finally, it should be noted that the savings attributable to the construction and operation of an intermodal facility at Knoxville (42 percent of the total savings) would be largely achievable given the current railroad infrastructure.
[14] The rail network improvements outlined in the TDOT Rail Plan and in the Virginia study (described in Chapter 2) should support freight train operating speeds of 60 m.p.h. over most route segments. Moreover, these improvements should allow trains to be dispatched in a fashion that yields reliable truck-competitive transit times. This having been said, there are currently no rail-truck intermodal routings in the eastern US that achieve this level of performance.

- » No equipment changes.
- » Eight percent annual traffic growth.
- » Increased line-haul speed from 27 to 50 m.p.h.
- » Reduced aggregate terminal dwell times by 50 percent.
- » Line-haul distance is unchanged.

Other Network Traffic

An examination of Figure 4.1 quickly reveals that the network improvements proposed in conjunction with the creation of a Trans-Tennessee routing would also benefit traffic that does not move through the state. In particular, nearly all NS traffic between the northeast and deep south would move over improved tack segments as would traffic between the Midwest and the port of Norfolk. Depending on specific origins and destinations, traffic could move as much as 525 miles (or roughly 40 percent of total distance) over trackage that would support measurably higher train speeds. In order to estimate the financial impact of the track improvements on non-Tennessee traffic, the study team made the following assumptions.

- » Only intermodal traffic would benefit from higher average train speeds.
- » Over the affected segments, average intermodal train speeds would increase from 30 m.p.h. to 50 m.p.h.
- » Fuel usage would be unaffected by the greater train speeds.
- » Crew and equipment costs average $500 per hour for NS.
- » Container traffic will continue to grow at an annual rate of 8 percent, while TOFC traffic will decline at a rate of 5 percent per year.

These assumptions were then combined with route-specific intermodal volumes for NS in order to estimate the present value of the stream of cost reductions over a 25 year planning horizon.

Discounting Future Benefits

As Chapter 3 makes clear, identifying the appropriate discount rate is an essential part of the project benefit evaluation process. The current analysis uses two different values for this purpose. Future benefits are first discounted at a real rate of 3 percent. This value reflects a setting in which funds are obtained through deferred consumption and in which there is very little uncertainty regarding the realization of project benefits.

Next, benefits are discounted at a real annual rate of 7 percent. This is the value currently prescribed by the federal Office of Management and Budget (OMB).[15] This significantly higher value reflects two potential situations. First, the appropriate real discount rate will be much higher if project funds are obtained through deferred private sector investment. Second, as noted in Chapter 3, it may be appropriate to use a higher real discount rate if there is perceived uncertainty regarding the value of benefits in later years.

The baseline benefit (and later cost) figures assume that costs are incurred over a five year construction period beginning in 2010 and that the benefit stream begins at the end of construction in 2015. However, the analysis also includes benefit and cost calculations under varying implementation scenarios later in the current chapter. Finally, deferred project costs are uniformly discounted at an annual rate of 3 percent.

Aggregated Findings

Estimated traffic diversions and the cost savings that generate them are summarized in Table 4.2.[16] In terms of the number of affected units, the diversion of existing intermodal traffic and the diversion of traffic that is currently all-truck are much the same in volume. However, it is the diversion of the all-truck traffic that drives the total magnitude of savings. This outcome is directly attributable to the large savings that occur when an all-truck routing is replaced with one that relies heavily on double-stack rail transport. Savings to existing non-Tennessee rail traffic are also an important source of savings.

The savings summarized in Table 4.2 are based on a time horizon that spans between 2015 and 2039, with construction commencing in 2010. Alternative construction timetables and implementation alternatives are considered later in Section 4.4.[17] However,

Table 4.2: Estimated Diversions and Cost Savings

			Present Value of Savings	
	Average Unit Savings	Average Annual Units	3% Discount Rate	7% Discount Rate
Tennessee Intermodal Traffic	$120	139,904	$239,808,394	$99,737,808
Truck to Rail Diversions	759	96,391	620,692,754	258,149,992
Non-Tennessee Intermodal	12	2,002,127	313,848,928	130,531,729
TOTAL			$1,174,350,075	$488,419,529

[15] OMB Circular A-94, Section 8-a. Readers will observe that this circular also advises planners to conduct sensitivity analyses to establish the impact of discount rate selection on overall project viability.
[16] The diversion analysis and calculations of potential cost savings utilized a variety of data sources. Truck volumes were developed through an allocation of the Freight Analysis Framework (FAF) motor carrier data. Motor carrier rates were updated from an earlier TVA study. Rail shipment volumes were identified through the Surface Transportation Board's Carload Waybill Sample and rail rates were developed through the application of proprietary data originally obtained for a Marshall University study in 2001.
[17] Readers will recall from Section 3.1 that identifying the appropriate temporal path is often difficult. The current analysis meets this challenge by providing multiple implementation scenarios.

it is useful to note that the results do not vary radically as construction/implementation periods are varied, at least within reason.

The magnitude of the estimated benefits depicted in Table 4.2 is greater than the benefit level under the Rail Plan's Diversion Level A and less than the value for Diversion Level B when benefits are discounted at a 3 percent annual rate. However, readers will note that the Table 4.2 values reflect transportation savings only and are not impacted by highway maintenance expenditure reductions, reduced highway congestion, or other external benefits. When benefits are discounted at the rate of seven percent, they are measurably lower than the estimates provided within the Rail Plan.

The restrictions the current study places on the origins and destinations of divertible truck traffic leads to a lower diverted volume. At the same time, the average unit cost reduction of $759 for truck diversions to rail is considerably larger than the $202 value evident in the Rail Plan. This outcome reflects two differences in methodology. First, the 20 percent cost-reduction parameter used in the Rail Plan is appropriate for truck diversions to TOFC or single-stack COFC service. However, it grossly understates the unit savings achievable when truck traffic is diverted to double-stack COFC service. Second, the use of actual origin-destination pairs lead to average shipment distances that are measurably greater than the 750 mile representative movement used in the Rail Plan calculations.

Commodity-Specific Findings

Table 4.3 depicts the all-truck to intermodal results on a commodity-specific basis. Data limitations make it impossible to extend this analysis to include the current intermodal movements that would be diverted to the new Trans-Tennessee routing or the non-Tennessee intermodal traffic. Not surprisingly, food & kindred products, chemicals, paper & paper products, and lumber & wood products dominate both the diverted volumes and the potential savings. At the lower end, we generally find higher-valued commodities which are more difficult to divert from traditional all-truck routings, which are generally shipped in smaller volumes and which are not as prominent in the study region's economy.

4.4. Taxonomy of External Benefits, Estimation Methodology, and Results[18]

Traditional benefit-cost analysis focuses on transportation cost savings. However, as noted in Chapter 2, other benefit categories have become increasingly recognized as important factors in determining the value of a project. Attempts to monetize these benefits often involve estimation of non-market values, such as the value of a statistical life and the value of time savings.

A thorough study of benefits that affect highway transportation costs was completed as a part of a 1997 Highway Cost Allocation Study published by the US Department of Transportation Federal Highway Administration. The study calculated marginal cost

[18] Readers will observe that the methods used in the current section are precisely those that appear within the Tennessee Rail plan except that air quality benefits have been added to the analysis.

Table 4.3: Commodity-Specific Diversions and Cost Savings

COMMODITY	Average Unit Savings	Average Annual Units	3% Discount Rate	7% Discount Rate
Apparel	$590	1,066	$5,902,277	$2,454,757
Chemicals	617	25,082	130,059,540	54,091,763
Concrete Clay Glass & Stone	780	672	4,765,640	1,982,030
Electrical Equipment	992	947	9,219,388	3,834,343
Fabricated Metal Prod	577	8,976	45,239,292	18,815,022
Farm Products	762	2,499	19,085,605	7,937,703
Food & Kindred Prod	615	9,499	56,386,876	23,451,302
Furniture & Fixtures	744	1,876	12,640,185	5,257,053
Lumber & Wood Prod	804	9,836	75,369,001	31,345,968
Machinery	576	1,494	7,631,354	3,173,880
Paper & Paper Prod	670	6,330	43,364,081	18,035,121
Petroleum Prod	572	3,061	15,569,642	6,475,414
Primary Metal Prod	600	8,258	49,829,527	20,724,100
Printed Material	657	5,504	33,952,728	14,120,940
Rubber & Plastic Prod	928	3,498	29,415,956	12,234,096
Textile Mill Prod	1,354	2,515	30,348,761	12,622,050
Transportation Equip	1,068	5,278	51,912,902	21,590,576
TOTAL		96,391	$620,692,754	$258,146,117

factors related to highway and pavement maintenance, congestion, crash avoidance, and noise costs. The study was amended in 2000 to include marginal cost factors of air pollution. Crash cost savings include medical costs, lost productivity, property damage, pain and suffering, and other costs associated with highway incidents. Pavement costs represent the contribution of a mile of travel by different vehicles to pavement deterioration and the costs of repairing the damage. Congestion costs are defined in terms of the value of added travel time due to additional small increments of traffic. Air pollution costs are measured in terms of the cost of premature death, illness, and other effects of various highway-related emissions. Noise costs reflect changes in the value of adjacent properties caused by motor vehicle-related noise.[19]

All marginal cost factors were reported in cents per unit per mile. This benefit estimation used the marginal cost factors associated with an 80,000 pound 5-axle combination truck. Presumably, cargo which will be diverted to rail was previously carried by only the largest class of trucks. For each benefit category, a marginal cost parameter was calculated based on a weighted average of the urban and rural estimates. The weighted average was achieved by calculating the total miles and percent of those miles which represent urban travel for each origin-destination pair. This parameter was then multiplied by the total number of miles between the origin and destination, and the number of units

[19] US Department of Transportation, *1997 Federal Highway Cost Allocation Study Summary Report* (Federal Highway Administration, August 1997).

diverted from truck to rail. As in the case of transportation cost savings the results are presented in terms of a base scenario wherein a five year construction period begins in 2010, and diversions begin at construction's end in 2015. Benefits accrue through the end of 2039. See Table 4.4.

4.5. Review and Reconciliation of Estimated Costs and Benefits

The benefits described above rest on the assumption that a Trans-Tennessee rail routing will provide intermodal services with characteristics that largely mirror those offered by motor carriage. This outcome, would, in turn, require both the addition of new trackage between Algood and Oliver Springs and significant modifications to existing trackage throughout Tennessee, North Carolina, Virginia, Maryland, and Pennsylvania.

The cost and benefit figures begin with a baseline scenario in which it is assumed that costs are incurred over a five year construction period beginning in 2010 and that the benefit stream begins at the end of construction in 2015. In order to establish the sensitivity of the results to the assumed construction and implementation schedule, the study team developed three alternative scenarios. All four scenarios and resulting benefit and cost estimates are summarized in Table 4.5. Again, however, these estimates assume that other jurisdictions make the additional investments necessary for the Trans-Tennessee routing to provide potential efficiency gains based on their unique benefits and costs. All reported values are in real 2002 dollars.

The results, once again, underscore the critical importance of discount rate choice. The cost and benefit values associated with the four scenarios also signal the importance of intermodal traffic growth to the value of a Trans-Tennessee rail routing. Specifically, because container traffic is growing at a rate that is nearly triple the real discount rate used to calculate the present values, the values actually increase as the implementation is moved further out in time.

4.6. Allocation of Potential Benefits

As Chapter 2 notes, most economists are only modestly concerned about the division of efficiency gains. However, in a policy setting, this division can be important, particularly when buyers and sellers are located in various jurisdictions. Accordingly, one of the primary tasks under the current scope of work is the allocation of potential benefits to the geographic units where those benefits are likely to accrue.

Within the current setting, we observe three types of shipments—shipments that originate in Tennessee, those that terminate within the state, and shipments that are likely to "pass through" the state on a Trans-Tennessee routing, neither originating nor terminating here. Within the state, we have three distinct origin and destination regions: Knoxville, Memphis, and Nashville.

Table 4.4: Ancillary Benefit Estimates

	Present Value of Benefits	
	3% Discount Rate	7% Discount Rate
Reduced Noise Pollution	$2,649,764	$1,102,037
Improved Air Quality	16,901,164	7,029,194
Reduced Congestion Cost	21,291,840	8,855,276
Reduced Pavement Maintenance	72,558,843	30,177,223
Reduced Crash Costs	3,942,222	1,639,570
TOTAL	$117,343,833	$48,803,300

Table 4.5: Benefit-Cost Analysis: Alternative Scenarios

Scenario Description	*Present Value of Necessary Investments*	*Present Value of Estimated Benefit Stream (3% Discount Rate)*	*Present Value of Estimated Benefit Stream (7% Discount Rate)*	*Benefit / Cost Ratio (3% Discount Rate)*	*Benefit / Cost Ratio (7% Discount Rate)*
	($ Millions)	*($ Millions)*	*($ Millions)*		
1. BASE CASE: Five year decision process, five year construction period, 25 year project life, no benefits until the project is fully in place.	$1,189.9	$1,174.4	$488,419,529	0.987	0.410
2. ALT 1: Ten year construction period, 25 year project life, no benefits until the project is fully in place.	$1,284.6	$1,174.4	$488,419,529	0.914	0.380
3. ALT 2: Five year construction period, 25 year project life, no benefits until project is fully in place.	$1,379.4	$1,069.7	$541,754,295	0.775	0.393
4. ALT 3: Five year construction period, 25 year project life, partial benefit flows begin in year three of the construction period.	$1,379.4	$1,121.8	$585,901,758	0.813	0.425

Given available data, there is no reliable way to predict whether either the originating or the terminating firm has any ability to disproportionately capture the available cost savings. However, our assumptions regarding competition suggest that carriers will pass these savings through to one or both entities in the form of lower transportation rates. Given this lack of information, the current analysis simply assumes that any gains are split evenly among the transacting parties.

Table 4.6 provides an initial geographic allocation of benefits. These results are consistent with *a priori* expectations. Within Tennessee, benefit estimates are greatest for the Memphis area, followed by Knoxville. In the case of Knoxville, this outcome is predictable, given that this locale currently has no local intermodal rail/truck service. Memphis fares better than Nashville, largely because shipment distances to and from east coast origins and destinations are longer, so that per-ton-mile savings accrue over a greater number of units. Finally, while the data labels refer to specific geographic locations, readers should realize that the economic activities that generate these savings will likely occur within areas that go well beyond the jurisdictional bounds of these metropolitan areas.

Table 4.6: Geographic Allocation of Project Benefits

REGION	Present Value of Shipper Savings (3% Discount Rate)	Present Value of Shipper Savings (7% Discount Rate)	Present Value of External Benefits (3% Discount Rate)	Present Value of External Benefits (7% Discount Rate)
Memphis	$464,710,061	$193,272,914	$46,435,164	$19,312,385
Nashville	106,072,633	44,115,608	10,599,082	4,408,158
Knoxville	268,830,264	111,806,507	26,862,292	11,172,027
Other	334,737,117	139,217,167	33,447,894	13,910,979
TOTAL	$1,174,350,075	$488,412,196	$117,344,432	$48,803,549

4.7. Summary

The CBER study team has developed estimates of project benefits that are largely consistent with both earlier analyses and with the geographic scope of the current project. The primary source of benefits consists of the estimated shipper savings from three traffic sources–truck traffic currently moving over the I-40 / I-81 corridor; intermodal railroad traffic that is currently using an alternative rail routing; and intermodal rail traffic that, at least partially, is utilizing the target network links. These savings, along with traffic volumes were used to estimate the benefit stream over a 25 year time horizon. The benefit estimation process rests on the assumption that improved railroad infrastructure could support the higher quality rail services necessary to attract this traffic.

Next, the study team collected estimated infrastructure costs from a variety of available sources in order to assess the incremental cost of completing a Trans-Tennessee routing. As noted, these expenditures would yield the projected benefits only if other jurisdictions participate in a multi-state program of rail improvements. If such a multi-state program is undertaken, the current analysis suggests that the incremental costs and benefits of a Trans-Tennessee routing would yield a benefit-to-cost ratio of between roughly 0.4 and 1.0, depending on the construction time path, implementation schedule and discount rate selection.

In addition to the shipper savings, there are also other quantifiable sources of project benefits which are generally tied to the mitigation of currently observable external costs. The set of "external" benefits considered above includes reductions in vehicle emissions and resulting improvements in air quality, reductions in ambient noise levels, a reduction in the costs associated with highway crashes, a reduction in the costs associated with highway congestion, and a substantial reduction in the cost of maintaining the current highway infrastructure. All told, these benefits have a present value of approximately $117 million and $48 million over the 25 year project life when 3 percent and 7 percent discount rates are applied.

5. Financing the Trans-Tennessee Project: Public-Private Partnerships

Table 4.1 summarizes the costs of modifying existing trackage and building the new route miles necessary to create a Trans-Tennessee rail connection to east coast locations. These costs reflect capital costs only. The current analysis assumes there will be no direct public involvement in the operation of the infrastructure once it is in place.

As envisioned, the rail routing has the potential to benefit a variety of constituencies. The Class I rail carriers will almost certainly benefit through incremental increases to profits. Shippers throughout the nation will benefit from lower transportation costs. And the states through which the route passes will benefit from enhanced opportunities for economic development. Accordingly, a variety of both public and private entities may have interests in the proposed project.

The diverse set of project beneficiaries also implies that project funding should be derived from a variety of sources. Certainly, no entity will be willing to contribute more than the present value of the future project benefits it anticipates for its shareholders or constituents. However, all groups who will receive even modest returns from the proposed project must, at least, be considered as a funding source. Moreover, the fact that both public and private entities stand to gain from the proposed project implies that this project, if undertaken at all, will be undertaken as a public-private partnership.

The balance of this chapter is focused on four specific tasks. First, we provide a discussion of public-private partnerships from both a theoretical and a pragmatic vantage. Next, we describe the various mechanisms for recovering funding from private entities. This is followed by a discussion of both extant and potential federal funding programs. Finally, the chapter concludes with text outlining the institutional funding management tools available to the states should they elect to pursue the proposed project.

5.1. A Review of Public Private Partnerships

The single motivation for the pursuit of public-private partnerships (PPPs) is rooted in what Adam Smith called "self love."[1] Under some circumstances, private sector firms and public sector entities can each offer improved outcomes to their constituencies by jointly undertaking specific activities. In the case of private sector firms, this implies increased profits. For the public sector, a PPP will be judged as successful only if it results in the more affordable provision of high quality public services.

Generally, there are two settings in which both government and business can be made better through extensive interaction. The first of these occurs when the private sector, through its efficiencies, can help the public sector reduce the cost of providing the goods and services for which government entities are responsible. The second setting in which PPPs represent a viable policy option occurs when economies of scope allow public sector outputs and private sector outputs to be produced at lower costs when they are produced jointly rather than separately. Each case is discussed at length.

[1] "(in seeking services from vendors) we address ourselves, not to their humanity, but to their self-love." Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776).

Private Sector Participation in Producing Public Sector Outputs

Governments are called upon to intervene in markets where unfettered market interactions lead to less than desirable economic outcomes. Such situations are commonly referred to as market failures. Fortunately, the public sector has many avenues available for addressing market failures when they occur. Some remedies involve replacing private sector activity with the public provision of a specific set of goods or services. In other cases, private sector interests may play pivotal roles in the public sector's remedy to the market failure. The state of Tennessee's current short-line rail program is a clear example of this form of public-private partnership wherein the public sector and private entities team to provide transportation services that would be absent without government intervention.

Economies of Scope and PPPs

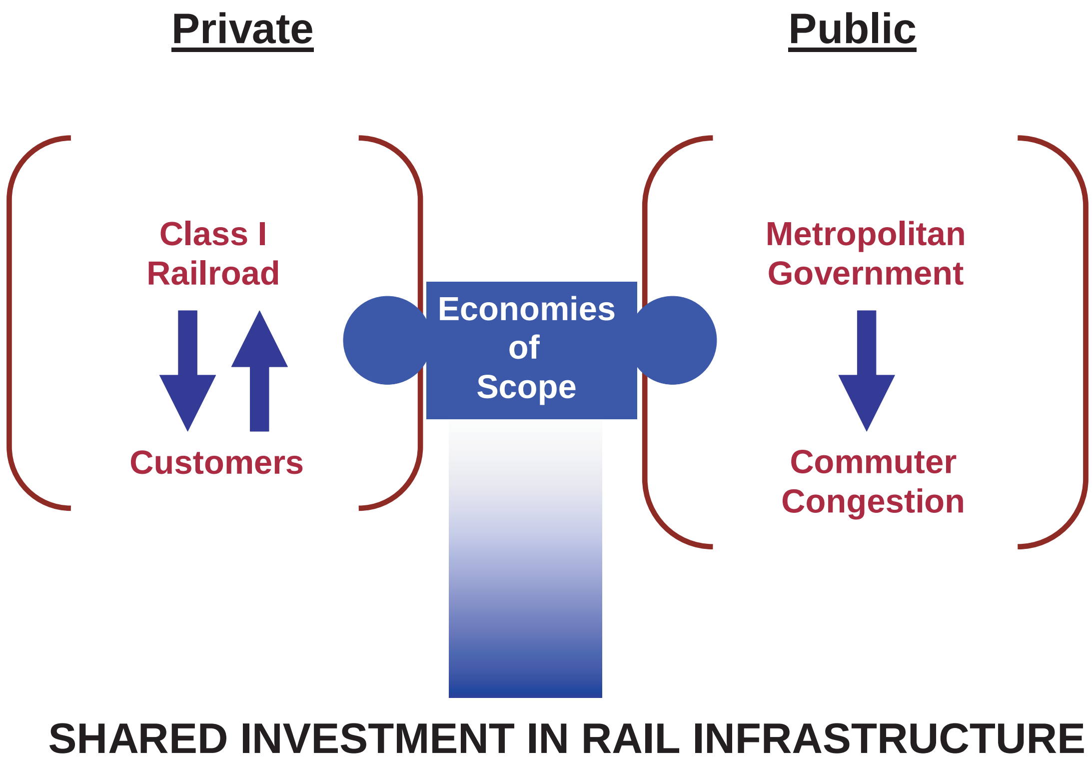
Figure 5.1 graphically depicts a situation in which economies of scope might well motivate the creation of a PPP. In this example, a government jurisdiction produces passenger rail transportation for regional commuters and a private firm produces freight transportation services for shippers through private market transactions. However, because of the characteristics of the two very different production processes, each set of services can be produced more cheaply if both are produced together. In this setting, both could be made better off by investing jointly through a PPP. It should be noted, however, that the combined infrastructure supporting the dual uses may look radically different than the individual infrastructures that would be developed for each separate use.

Public-private partnerships are not without their own set of peculiarities and problems. Common issues include the following:

- Government entities and private firms typically have vastly different objective functions so that what is an optimal outcome for one may be suboptimal for the other. For example firms typically focus on the stream of net profits and, therefore, may favor cost-cutting measures that reduce service quality. Government entities, however, typically have no profit objectives and may, therefore, be more oriented toward actions that preserve service quality.

- Government entities and private firms typically have very different cultures, so that behaviors, work rules and other employment practices that are routine and acceptable for one partner may be unacceptable to the other. For example, public sector employee compensation is rarely tied to business objectives, so that contributing uncompensated overtime is

Figure 5.1: Public-Private Partnerships



not worthwhile. Conversely, outcomes-based annual bonuses often represent a significant share of private sector employee compensation packages, so that extra efforts are rewarded, albeit indirectly.

» PPPs that involve shared investments may lead to difficult ownership issues, particularly if one entity elects to abandon the partnership. For decades, this issue limited the extent of public private partnerships between government entities and privately controlled railroads that own the rights-of-way over which they operate.

» PPPs that involve multiple government entities may require the development of new, complex institutional arrangements. In fact US code allows the formation of multi-state compacts only with explicit Congressional approval, so that historically, the number of such compacts has been rather limited. Even in the case of local governments, where there may be no statutory prohibition, ceding decision-making powers to some combined authority is often difficult for policymakers.

» The very scope economies that often motivate a PPP may lead to reduced employment, particularly within the public sector entities. To the extent that organized labor is involved, the length of time necessary to realize the potential cost savings may be increased. Even when this is not the case, PPPs that lead to observable job losses face a considerable public relations challenge.

All told, however, the scarcity of governmental resources and the desire for enhanced efficiency has increased the usage of PPPs, and they are particularly evident in the development of new transportation infrastructure, including railroad corridors.[2] Moreover, looking toward the future, the growth in public sector budget shares dedicated to retirement payments, employee and retiree health care, and other relatively fixed budget items, virtually guarantees the need for more rather than fewer PPPs.

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[2] See, for example, the Alameda rail corridor project in southern California, the CREATE rail plan for the metropolitan Chicago area, and the new highway toll bridge project in Charleston, SC.

5.2. Sources of Federal Funds

The current analysis assumes that the vast majority of project-related transportation cost savings will be passed through to transportation users and their customers. While these savings may have their geographic roots within the project region, they are likely to be widely dispersed to economic entities located throughout the US. Imagine, for example, a 20 percent reduction in intermodal shipping costs between Memphis and the eastern US. Competition from other area railroads (serving alternative east coast ports) and from motor carriers virtually guarantees that such a reduction would soon lead to lower transport rates for Memphis-area shippers. To the extent that there is competition in the markets served by area firms, the savings would again "pass through" to downstream customers in the form of relatively lower prices. Alternatively, the savings could be retained as additional profits for firms that do not face substantive competition. In either case, the cost savings generated by the proposed project would be widely distributed among consumers and/or shareholders. Accordingly, it is appropriate to envision the extensive use of federal funds.

There are currently a variety of federal funding programs through which the proposed project might be funded.[3] However, in nearly every instance funding the proposed project would diminish the pool of federal funds available for traditional highway projects within the applying states. In a time of relative austerity, this outcome is likely to be politically unacceptable.

There is, however, potential for funding through an altogether new federal program. The most recent transportation legislation passed by the US House of Representatives contains a new program area referred to as "Projects of National and Regional Significance."[4] This program area is specifically intended to fund large capital projects that would typically go unfunded under existing federal programs. Both the minimum funding threshold of $500 million and other program requirements seem compatible with characteristics of the proposed Trans-Tennessee project. At the current time, there is no Senate analogue to the new House program so it remains to be seen whether or not this provision will survive the conference process.

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[3] For example, the proposed project could likely be funded under the federal governments Congestion Mitigation and Air Quality (CMAQ) Program.
[4] See H.R. 3, *Transportation Equity Act: A Legacy for Users*, Section 1304, 162 for a full description of this program.

5.3. Matching Private Funds

While it is generally assumed that most savings will passed to downstream customers through effective competition, there is, in practice, a general recognition that most such projects are profitable to private sector participants. Moreover, PPPs often provide capital that is a substitute for equipment and facilities that the private firm would have otherwise had to self-provide. Accordingly, there are very few PPPs that do not require at least some financial contribution from participating private firms.

Each PPP is different, and financial arrangements are often affected by project size, borrowing ability, available revenue streams, etc. There are, however, a variety of vehicles available for securing the financial share from private sector partners. In the case of relatively small projects, private entities may wish to simply make an up-front cash contribution to the project.[5] Alternatively, depending on the nature of the partnership, firms may wish to pay a fixed annual franchise fee of access to infrastructure. There are also several cases in which private facility users participate financially by make usage-based payments. While specific financial arrangements may have substantial impacts on the cash flows of various project participants, there is no optimal format from an economic perspective.

5.4. The State's Role in Funding and Funding Management

Even though many of the anticipated project benefits have their origin in Tennessee, one can readily demonstrate that the majority of these benefits will ultimately be enjoyed by economic entities that are geographically far removed from the state. Accordingly, the state's share of any equitable funding program is likely to be modest. Still, this share is not likely to be zero. Moreover, it is certainly possible that the state will choose to undertake supplemental investments in additional infrastructure intended to maximize the economic development potential of the overall project.[6] Also, while federal funds may be made available, federal funders typically rely on individual states to administer such funds, so that Tennessee, in cooperation with other participating states, must be prepared to manage both the funding and construction processes.

With regard to the state's contribution to the overall project cost, there are a number of available options. All of these, however, require the state to provide up-front construction monies along with some mechanism to recover these funds over time. Should the owners of the publicly created portion of the project choose to sell their portion of the completed project to either a public or private entity, the state could recover any outlay through the transaction price. This outcome is, however, fairly unlikely because of the complexity inherent in any such transaction.

It is more likely that the contributors to the publicly owned project segments will choose to retain ownership, while leasing operating rights to one or more tenants. Under such a scenario, the state could potentially build its share of the capital costs into the lease payments it receives from the service provider(s). However, the fact is that lease payments that fully reflect capital costs, when combined with operating costs, may make it

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[5] For example, this will likely be NS's desired course if the *Heartland Corridor* project moves forward.
[6] For example, the state may wish to invest in local roadways that will facilitate the location of privately-owned distribution operations near in-state intermodal terminals.

impossible for the service providers(s) to operate the property profitably. For this reason, the state should probably not look toward private lease payments as the sole source for repaying construction outlays.

One alternative to recovering initial outlays through private repayment is the reliance on incremental tax revenues directly attributable to the construction of the proposed project. The creation of a new transportation alternative will almost certainly redirect economic activity to in-state venues. These activities, in turn, will generate tax revenues that are incremental to the project. Some portion of these otherwise unattainable revenues could be used to repay the state's portion of the initial capital costs. Within the arena of public finance, the formal nature of this process is referred to as *tax increment financing*.

In practice, linking a specific revenue source to tax increment financing can be problematic. At the local level this problem can often be mitigated. For example, a new downtown shopping facility will produce readily observable increases in the sales and property tax bases, and new revenues are commonly used to support development costs. At the state level this is not as easily accomplished under a scenario like the Trans-Tennessee rail routing. The state could rely on general road user fee revenues (i.e., the gasoline tax), but this would place a drain on the ability to fund traditional highway investments and maintaining funding from year to year may prove politically difficult. State general revenue from the sales tax and other revenue sources similarly could be tapped to provide financing support. The challenge here is the competition for funds by different state agencies and again the difficulty of ensuring long-term funding in a challenging political environment.

For a multi-year investment project like the Trans-Tennessee routing it would be important for the state to rely on a consistent and dedicated revenue stream. This is important in its own right to ensure project completion, but equally important to ensure other parties (like private investors) that the project will in fact be completed. General obligation bonds are a practical option, but retiring the debt on these bonds would necessitate a funding source from general appropriations or the state's sinking fund. Nonetheless the commitment to bond finance is a pretty firm commitment to proceed with the project. Unique earmarked revenues offer yet another possibility. One example would be a surcharge under the diesel tax. A practical justification would be that shippers (and ultimately final consumers) are the beneficiaries of an improved transportation infrastructure.

The matter of funding management also raises a set of complex issues. Typical transportation infrastructure projects involve the federal government and a single local or state jurisdiction. In these cases, the state or local entity typically manages the project, operating under federal guidelines and oversight. In the current setting, the project, as envisioned, would involve the federal government, three state governments and, at least, two private rail carriers. In smaller settings (for example the Alameda Corridor effort), participants in public-private infrastructure projects have created independent entities to manage both financing and construction. Unfortunately, there are no immediate examples of similar arrangements on the scale of the proposed project.

6. Summary and Conclusions

Recently, in an unrelated survey of wood products manufacturers, study team members encountered vociferous complaints about rising transportation costs. These complaints and the increased costs that motivated them are partially the result of increased fuel prices that may or may not be transitory. Unfortunately, the increased transport costs also reflect the growing congestion that is the first sign of the greater freight-management problems that are predicted for the coming decades.

The same wood products manufacturers also indicated that they have chosen to forego otherwise attractive new international opportunities because of the inability to secure affordable transportation to these markets. This is a very small example of how congestion and resulting transportation cost increases can choke off commerce and threaten economic development efforts. If this relatively minor anecdote is to remain an isolated example, policymakers must be prepared to add transportation capacity, both through new capital investments and through the more effective management of existing networks.

For policymakers, the challenge is two-fold. While the need for additional freight capacity is clear, the pool of funds available for discretionary expenditures continues to shrink in relationship to government budget totals. Accordingly, policymakers must ensure that any freight transport project in which public funds are invested represents the best choice among the set of available alternatives. An otherwise good idea may not be good enough in an environment of fiscal austerity. In such a setting, the caution TDOT has exercised in reviewing the proposal to re-establish an all-Tennessee east-west rail routing is consistent with responsible infrastructure planning practices.

Chapter 4 carefully outlines the assumptions and methodologies used within the current analysis to estimate the economic viability of a trans-Tennessee routing. If future outcomes are substantially different from those assumed within the analysis, then the predicted results may be invalid. For this reason, the underlying assumptions are summarized here. They include:

- The assumption that an improved rail infrastructure could support truck-competitive levels of service;
- The assumption that container traffic will continue to grow at eight percent per year, a rate that is nearly three times higher than the overall rate of economic growth within the US;
- The assumption that the trend toward fewer intermodal terminals and to higher density intermodal terminals will not be substantially reversed;
- The assumption that the trend toward the replacement of TOCF shipments with domestic container movements will continue; and

- The assumption that there will be no significant change in the ownership of the relevant railroad route segments.

The benefit estimates developed within the current analysis are quite close to those believed to be most realistic and presented in the original Rail Plan, which is interesting given that the two analyses employed very different techniques, data sources, and freight networks. Based on these estimates and other study findings, the study team offers the following recommendations and conclusions.

- As a stand-alone project, a Trans-Tennessee freight rail routing is unlikely to generate a benefit stream sufficient to justify necessary expenditures.

- Alternatively, if the states of Virginia and North Carolina, along with NS and CSX Transportation, are willing to participate in a multi-state, public-private effort to improve rail service between the eastern seaboard and the mid-south, then a Trans-Tennessee routing could play a role in the resulting network improvements.

- The vast majority of the benefits attributable to the multi-state program described above are also attainable under scenarios that rely nearly exclusively on existing railroad rights of way. A comparison of the costs and benefits of these alternatives should be undertaken before any decision is made with regard to the Trans-Tennessee option.

- The viability of a multi-state rail alternative to increased highway traffic depends on the quality of service that is achievable over such a network. Shippers have made it clear both through public forums and through their actual transportation decisions that service quality is not negotiable. Intermodal transit times, the variability of transit times, the probability of freight loss or damage, and many other service quality measures must mirror the service parameters achievable through motor carriage. Given this point and the findings of earlier engineering studies, any further consideration of a Trans-Tennessee routing should focus exclusively on the "northern" alignment.

» As the Chapter 4 analysis indicates, the benefits attributable to a modified rail network that includes a Trans-Tennessee component are very dependent on the continued strong growth in international container traffic. Accordingly, the present value of the benefits stream increases as the onset of service is pushed to later dates. In that light, it is difficult to see a sense of urgency attached to the proposed project. To the contrary, the data suggest a “wait and see” approach.

» While the current analysis does not consider the possible economic implications, the infrastructure improvements necessary to improve freight intermodal services would also support relatively high speed passenger operations. Moreover, intermodal freight operations are generally compatible with passenger movements. Particularly given passenger programs in both Virginia and North Carolina and the relative fragility of the freight benefit stream, further exploration of the topic is likely warranted.

» There are tremendous institutional and operation issues involving current freight service providers that would require effective treatment in order for a Trans-Tennessee rail routing to yield the benefits estimated in Chapter 4. If the findings developed under Task 5 of the Rail Plan are still accurate, the Class I freight railroads (1) are not particularly interested in the proposed project and (2) would very certainly require substantial incentives in order to participate.

The preservation of existing railroad capacity, where possible, can greatly reduce the difficulty and expense of meeting future transportation needs. This point is underscored by the current program that will soon establish commuter rail service between Lebanon and Nashville and the plans to re-establish freight service between Algood and Monterey. It is likely that, at some point in the past, neither project was viewed as eminent. However, had surviving railroad capacity suffered further degradation, it is possible that both projects would have become prohibitively expensive.

The lesson these experiences offer to the consideration of a Trans-Tennessee rail routing is clear. At the current time, given the conclusions enumerated above, it is difficult to view an all-Tennessee, east-west rail corridor as eminent. At the same time, prudent public policy would suggest that the capacity to establish such a corridor be preserved if at all possible and that viability of a Trans-Tennessee rail alternative be re-evaluated on a periodic basis.

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