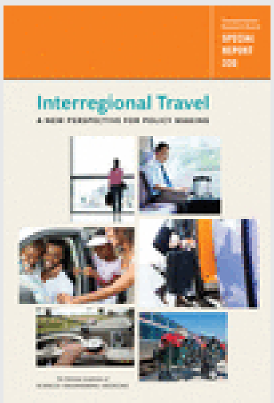

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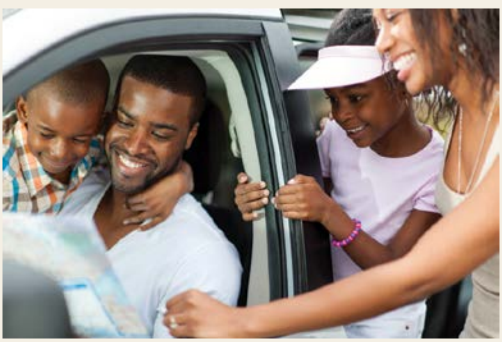


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**SPECIAL
REPORT
320**

Interregional Travel

A NEW PERSPECTIVE FOR POLICY MAKING

Committee for a Study of Intercity Passenger
Travel Issues and Opportunities in Short-Haul Markets

Transportation Research Board

The National Academies of
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This report has been reviewed by a group other than the authors according to the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Medicine.

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Committee for a Study of Intercity Passenger Travel Issues and Opportunities in Short-Haul Markets

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Preface

Transportation is the subject of public policy for many reasons. It underpins the economy and affects the daily rhythm of life. It is a key determinant of the location of commerce and social activity, the quality of the environment, and the size and shape of communities. It is a major user of energy, producer of emissions, and source of public safety concern. Advances in transportation technology and the expanding reach of transport networks have had transformative effects on society. While these impacts alone ensure government attention, a substantial portion of the supply of transportation itself is a direct responsibility of the public sector. The nation's vast infrastructure of highways, railways, airports, and airways is planned, financed, managed, and operated by federal, state, and local governments to differing degrees, and often exclusively by government. As a result, public-sector investments in transportation can be profoundly important. Within a few years of the building of the Interstate highway system, its influence had become evident, especially in shaping the country's cities and their metropolitan regions. A growing awareness of these effects stimulated the creation of new policy goals and responsibilities for state- and metropolitan wide transportation planning agencies.

Government investments in transportation have impacts that extend well beyond city and state borders. However, understanding and accounting for these impacts can be difficult when they transcend the jurisdictional boundaries of those planning and making the investments. The United States contains hundreds of metropolitan regions, and their social and economic interconnections with neighboring metropolitan regions are growing. These metropolitan regions are often linked by heavily used travel corridors that span multiple states. Viewing public investments in transportation from the perspective of a single metropolitan region, an individual state, or the nation as a whole is therefore not sufficient. As the frequency and range of personal travel grow, so must government efforts to understand the trips that are made through travel corridors that connect and cross neighboring states and to ensure that appropriate investments are being made in the transportation systems that accommodate them.

Trips between 100 and 500 miles are referred to as "interregional" in this report. Travel in this distance range accounts for about three-quarters of all long-distance trips. Interregional trips can involve more than one transportation mode and are often made through multistate corridors. A reason for singling out 100- to 500-mile trips is that they are especially prone to neglect because of deficiencies in transportation planning and programming from a multistate and multimodal perspective. Two of the major modes of intercity transportation whose ridership is heavily oriented to 100- to 500-mile trips are buses and trains. They are almost exclusively interregional forms of transportation. Both modes, however, are frequently missing from or inconsistently addressed in the planning and programming of the transportation investments made by government.

As explained in more detail in Chapter 1, this study was sponsored by the Transportation Research Board's (TRB's) Executive Committee out of concern that interregional trips are not given attention proportional to their prevalence, despite periodic proposals to invest in new interregional transportation systems such as high-speed trains. Even when such proposals hold promise, they encounter the fundamental problem of decision makers having relatively little information on interregional travel demand and often not being in a position to coordinate the planning and programming of transportation investments from an interregional perspective. Two years before the Executive Committee conceived the study, the Obama administration had announced a plan to provide states with more than $8 billion in grants to add and upgrade intercity rail service, and the voters of California had approved a plan to develop a new intrastate high-speed rail system. The Executive Committee was thus aware that the attention of policy makers was turning to interregional travel and concluded that a study aimed at understanding this component of the transportation sector would be timely.

The statement of task for the study is provided in Chapter 1. It calls for a broad-based review of what is known about the demand for and supply of interregional transportation and, if merited, recommendations on how this segment of transportation might be better served. To conduct the study, TRB convened a 16-member committee of experts in travel demand, transportation supply, economics, and public policy led by Martin Wachs, Distinguished Professor Emeritus of Civil and Environmental Engineering and Professor of City and Regional Planning at the University of California. The contents and findings of the report represent the consensus of the committee members, who served uncompensated in the public interest.

The committee convened in person eight times between July 2012 and June 2015 and held several conference calls during preparation of the report. Data-gathering sessions during these meetings included briefings by many individuals with varied backgrounds from government, the transportation industry, consulting, and academia. The committee heard from current and former top officials of the U.S. Department of Transportation (USDOT), who described federal efforts to address transportation needs from an interregional perspective and provided background on the Obama administration's plan to provide federal grants for intercity rail. They also explained how existing federal transportation financing and grant programs may be used for multistate and multimodal projects. Sessions with officials from the agencies that administer the federal highway, rail, and aviation programs gave the committee information on how those programs view interregional trip making. Along with representatives from state and regional associations, they described the challenges that public agencies face in providing transportation capacity that aligns with the country's interregional corridors.

In other sessions the committee heard from representatives of the intercity rail and bus industries and from experts in the evaluation and planning of high-speed rail. Subsequent briefings were devoted to understanding the challenges associated with forecasting travel demand, assessing and conveying forecasting uncertainty, and predicting how travel behavior will evolve in response to changing telecommunications and information technologies. Along with briefings from USDOT's Bureau of Transportation Statistics (BTS), these sessions helped the committee understand the importance of detailed and up-to-date information on long-distance travel behavior and better analytical tools to inform transportation investment decisions in interregional markets, where demand uncertainty can be substantial.

ACKNOWLEDGMENTS

The committee benefited from the briefings, information, and ideas offered by many individuals and organizations during the course of the study. Thanks go to the following USDOT officials who briefed and assisted the committee: Patricia Hu and Thomas Bolle of BTS; Jeffrey Lindley, Mary Lynn Tischer, and Tianjia Tang of the Federal Highway Administration (FHWA); Joseph Post, Nan Shellabarger, and Ralph Thompson of the Federal Aviation Administration; and Chad Edison, Scott Greene, and Neil Moyer of the Federal Railroad Administration. They provided program overviews, and FHWA's Tang supplied the committee with trip-making data vital to the committee's work.

Former USDOT officials Susan Binder of Cambridge Systematics and Mortimer Downey and Roy Kienetz of Parsons Brinckerhoff discussed national policies and federal funding programs that pertain to interregional transportation, and Janet Oakley of the American Association of State Highway and Transportation Officials and Rich Brancato of the Coalition of Northeastern Governors provided state-level perspectives. Andrew Galloway of Amtrak and Louis Thompson of Thompson, Galenson, and Associates discussed issues facing intercity rail systems and the challenges that arise in the planning of high-speed railways. David Hall of BoltBus provided a firsthand account of the changes that have been taking place in the intercity bus industry and of its revitalization. Andrew Mack of Xpress West provided insight into the challenges that face proponents of new, infrastructure-intensive interregional transportation systems. Thanks go to all for deepening the committee's understanding of the institutional, planning, and decision-making environment that applies to interregional transportation.

Thomas Adler of RSG, Inc., Marisa Di Natale of Moody's Analytics, and Richard Kuzmyak of Renaissance Planning Group discussed the challenges associated with forecasting travel demand and conveying the uncertainty of forecasts. Patricia Mokhtarian of the Georgia Institute of Technology discussed the ways in which changes in information and telecommunications technology may be affecting travel behavior. The committee thanks all four. Their discussions were especially helpful in

informing and shaping the committee's views on the importance of better analytical tools and more detailed and up-to-date data on long-distance travel behavior.

Thomas R. Menzies, Jr., and Katherine Kortum were the principal project staff. Menzies managed the study and drafted the report with assistance from Kortum under the guidance of the committee and the supervision of Stephen R. Godwin, Director, Studies and Special Programs, TRB. Colin Smith of RSG, Inc., supported the committee in its analyses of FHWA trip table data. Timothy Devlin and Claudia Sauls provided extensive support to the committee in arranging its many meetings and in managing documents. In addition, the committee acknowledges Norman Solomon, who edited the report; Juanita Green, who managed the production; Jennifer J. Weeks, who prepared the manuscript for prepublication web posting; and Javy Awan, Director of Publications, TRB, under whose supervision the report was prepared for publication.

The report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the institution's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. Thanks go to the following individuals for their review of this report: Jennifer Dill, Portland State University, Oregon; Emil Frankel, Eno Center for Transportation, Washington, D.C.; Michael Goodchild, University of California, Santa Barbara (emeritus); Matthys Levy, Weidlinger Associates, Inc. (retired), Burlington, Vermont; D. Bruce Montgomery, Magplane Technology (retired), Hampton, New Hampshire; Stacey Mortensen, San Joaquin Regional Rail Commission, Stockton, California; Mark Muriello, Port Authority of New York and New Jersey, New York City; Joseph Schofer, Northwestern University, Evanston, Illinois; Louis Thompson, Thompson, Galenson, and Associates, LLC; and Roger Vickerman, University of Kent, England. The review was overseen by Lawrence Brown, University of Pennsylvania,

Philadelphia, and Susan Hanson, Clark University (emerita), Worcester, Massachusetts. They were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of the report rests solely with the authoring committee and the institution. Karen Febey, Senior Report Review Officer, managed the report review process.

Contents

Summary

Most long-distance trips begin in one metropolitan region and end in another less than 500 miles away. These "interregional" trips account for about three-quarters of all long-distance trips. Several recent developments have emphasized the importance of this segment of travel. Among them are California's plan to invest more than $60 billion in a new high-speed rail line connecting the state's southern and northern cities and the emergence of express curbside bus lines in the interregional corridors of the Northeast and in other parts of the country. In these and other cases where new transportation systems—some requiring large public investments in long-lived infrastructure—are being considered, interregional travel demand, transportation service options, and corridor traffic and trip-making patterns need to be well understood.

This study reviews the demand for interregional travel in the United States and the uncertainties that arise in supplying transportation services and infrastructure to accommodate it. Consideration is given to relevant experience in other countries, especially in providing intercity passenger rail. A central finding is that appropriate analytical tools and up-to-date data on long-distance travel in the United States are lacking, which complicates decisions about how to invest in the country's interregional corridors in ways that will serve future travelers most effectively and further other policy goals such as protecting the environment, enhancing safety, and curbing energy use. In addition, the study finds significant gaps in the decision-making capacity itself, largely because transportation funding sources and institutions do not align well with the country's interregional corridors, which can span multiple states.

Experience at the metropolitan level suggests that filling this institutional gap will provoke demand for better travel data and the analytical

tools needed to inform public investments in transportation systems serving interregional markets. After the key study findings are summarized, several recommendations are offered with the intent of improving long-distance travel data, supporting the development and application of state-of-the-art analytical tools, and providing incentives for the creation of interregional planning entities to inform regional and corridor-level transportation decisions.

KEY FINDINGS

Because of outdated travel behavior survey data, long-distance travel is not nearly as well understood as local travel.

Understanding of long-distance travel in the United States is informed mainly by the American Travel Survey (ATS), a national survey of long-distance trips conducted in 1995. If a long-distance travel survey were conducted today, it would likely reveal many travel patterns not observed by the ATS, as would be expected after two decades of demographic, economic, and technological change. Interregional travelers who do not travel by automobile must typically make at least one mode transfer near the origin and destination, and they may use different modes for the access and line-haul portions of the trip. Such trip complexity can create challenges for data collection and modeling. This complexity, coupled with a reliance on travel information and behaviors observed a generation ago, is a source of considerable uncertainty for today's decision makers as they plan and invest in interregional transportation systems that will be used for decades to come.

The automobile is used for most interregional trips, especially by families and other people traveling together for nonbusiness purposes. Understanding the strong appeal of driving for nonbusiness travel is critical in planning transportation investments to accommodate interregional travelers.

The private automobile has many service attributes that differentiate it from other modes. Among them are its ability to provide door-to-door service and carry multiple people at little extra cost. These attributes and widespread automobile ownership make the automobile the mode of choice for most interregional trips, especially by families. However, driving is not an option for people who lack access to a car. In addition, it can have limited utility for those who are traveling alone, for business purposes, for longer distances, or to locations such as downtowns where a car is not needed and is costly to park. The car's dominance in interregional travel means that transportation planners have a critical need for information concerning whether and how uses of the automobile may be changing over time and in specific markets—for example, because of changes in vehicle availability, technology, operating costs, and utility.

The recent proliferation of intercity express bus services illustrates the uncertainties associated with forecasting the demand for interregional travel and with anticipating how the demand will be met.

During the 1990s, the nation's intercity bus industry was in the midst of a long-term decline in ridership. Today, the industry has been rejuvenated by bus companies providing nonstop service between the downtowns of major cities. The express bus appears to have filled a void in the low-fare and shorter-haul interregional market. It accommodates mostly solo travelers who lack access to automobiles, find driving too expensive or a car unnecessary at the destination, or want to make enjoyable or productive use of travel time through onboard amenities and the uninterrupted use of portable electronic devices. On the one hand, public officials noticing this renaissance might question whether capital-intensive transportation investments are needed or will be competitive with the low-cost private bus. On the other hand, they might view this development as indicative of more people seeking transportation alternatives to the automobile and thus perhaps as a signal for investing in other options, such as intercity train service and priority access lanes and terminals for intercity buses.

Sparse interregional train service throughout much of the country can be attributed to a number of factors. One is the preponderance of trains operating over the lines of private freight railroads, which limits opportunities for competitive schedule times and frequencies.

Intercity trains in most of the country's interregional corridors operate on freight lines. Corridor investments to increase passenger train speeds and frequencies are generally not attractive to the private freight railroads that own these lines, and they may be undesirable if they hinder the efficient movement of freight. With their skeletal passenger train service and their limited prospects for introducing competitive service levels on heavily trafficked freight lines, few corridors other than the passenger-oriented Northeast Corridor (NEC) have developed a large ridership base. The absence of such a base increases the uncertainty associated with introducing competitive passenger service, particularly when a large commitment of public funds is needed for infrastructure development.

The NEC is the only interregional corridor having train frequencies and schedule times that can compete successfully for market share with airlines, buses, and automobiles, and it accounts for most interregional train ridership in the United States. The 400-mile corridor, which links Boston, New York, and Washington, D.C., contains many large metropolitan areas that are closely spaced and positioned linearly so that multiple city-pair markets can be served with frequent trains on a single line. Another factor fundamental to the success of train service in the NEC is Amtrak's control of the electrified right-of-way, which carries little freight and is used mainly by local commuter and intercity passenger trains.

The provision of interregional transportation in Europe and Japan can inform U.S. transportation infrastructure decisions, particularly with regard to when and where to invest in intercity passenger rail.

The scarcity of passenger train service in the United States contrasts sharply with its widespread availability in Europe and Japan. Because Japan and most European countries are geographically compact, passenger rail networks can connect each country's major cities in ways that are not practical in the United States. Over the past 50 years, the national governments of Europe and Japan have made sustained investments to create modern and increasingly integrated rail networks to accommodate fast, frequent, and reliable passenger trains. Consequently, most European and

Japanese investments in new or substantially upgraded passenger rail services are made in markets already demonstrating high rail ridership. In this regard, the European and Japanese experience bears directly on the NEC, which has a well-established intercity train service and known ridership demand. Where train service is sparse and ridership is low or nonexistent, as is characteristic of most U.S. corridors, the European and Japanese experience in providing passenger rail is less informative of the large demand and decision-making uncertainties that can arise.

Despite substantial demand uncertainty in a mostly untested rail market, the state of California is proceeding with a plan to build a new high-speed intercity passenger railway informed mainly by airline traffic and stated preference surveys as opposed to evaluations of the demand revealed by existing train ridership. Transportation planners there recognize that use of the main lines of freight railroads is not a practical option for establishing a schedule-competitive rail service and gradually building a strong ridership base. Thus, they are planning to build a new high-speed trunk line and to use some existing passenger rights-of-way for the approaches to major urban areas. Reliance on existing freight lines is likewise impractical in most of the country's other interregional corridors, many of which have the added challenge of obtaining large funding commitments from multiple states. In Europe and Japan, a 100- to 500-mile interregional corridor can cross a large portion of the country, which creates an incentive for transportation system planning at the national level. California's plan is for a 400-mile high-speed rail line contained fully within its borders, but most other interregional corridors in the United States cross multiple states. Interregional corridors that are not national in scope but that cross multiple states can be problematic for transportation system planning, programming, and funding.

In the United States, the NEC is unique in having many of the geographic, demographic, and demand conditions that European and Japanese experience suggests are favorable to public investments in intercity rail. However, its multijurisdictional setting complicates the provision of intercity rail and coordination with the corridor's other transportation modes.

The NEC is characterized by the following:

- Numerous large metropolitan areas in the region are
  - Well connected economically and socially, which creates densely trafficked interregional rail, air, and highway routes;
  - Located within 100 to 300 miles of each other and positioned in a linear fashion that suits service by a single rail line;
  - Served by extensive public transit systems capable of providing fast, convenient access to downtown train and bus stations; and
  - Centered on cities whose downtowns are major origins and destinations for interregional travelers.
- It has an electrified rail right-of-way that is devoted to passenger rail and is thus able to accommodate frequent, fast trains without being unduly encumbered by freight trains.
- Its rail and bus ridership levels are comparable with those of corridors in other countries where sustained investments have been made to develop competitive rail service, in some cases by investing in high-speed trains.
- Several major airports in the area have regulatory limits on daily flights, and there is general difficulty in expanding airport and airway capacity.
- Its transportation infrastructure spans numerous states—too many to have generated a highly coordinated program contributing to the infrastructure's development but too few to have strong national-level support.

The geographic, demographic, and travel demand circumstances of the NEC set it apart from other U.S. interregional corridors. The NEC presents far less uncertainty with regard to the potential for passenger rail investments, including investments in high-speed rail, to confer benefits. The NEC's distinct circumstances, coupled with its location in one of the country's most populous and heavily trafficked regions, suggest that it be treated differently from other corridors, at least in terms of the scale and timing of the resources made available for assessing and meeting its transportation investment needs. However, the many difficulties inherent in coordinating the planning and priority-setting of multistate corridors in general have long hindered development of the NEC.

Because interregional travel corridors often span multiple states, many lack the coordinated planning and funding structures needed to ensure that investments in transportation capacity are made from a corridor-level perspective.

Although most evident in the case of the NEC, the planning and development of all interregional corridors are complicated by the many public and private entities having responsibility for the supply of transportation services and infrastructure. Even when a corridor resides within a single state, much of the transportation infrastructure is funded and planned by mode-specific programs and agencies. In the case of highways and aviation, private individuals and companies supply the vehicles and operate the transportation services. Federal, state, and local governments have varying responsibility for funding, planning, and operating most of the fixed infrastructure of roadways, airways, and airports. In the absence of institutions and funding programs that transcend individual modes and jurisdictions, it is difficult to see how the planning and programming of transportation infrastructure can be expected to embody a corridorwide perspective.

To encourage the development of urban transportation systems that are integrated and function well across a metropolitan region, the federal government has long required state and local authorities to coordinate their urban highway and transit investments. The goal of this coordination, which is often challenging to implement, is to guide transportation investments from a multimodal and multijurisdictional perspective that is informed by sound data and objective analysis.

History indicates that an institutional framework is essential for ensuring multimodal and multijurisdictional transportation planning. While decades of planning and priority-setting activities by metropolitan planning organizations (MPOs) have had mixed success, they have generally fostered the development of urban transportation systems designed to accommodate access and mobility needs from a metropolitanwide perspective. This continuing attention, in turn, has prompted the development and refinement of standard methods for travel demand forecasting, for assessing policy and investment options, and for collecting requisite data.

The federal government, which mandates the MPO process, has provided leadership and resources to aid these efforts. There are no institutional parallels for interregional corridors.

RECOMMENDATIONS

In contrast to the MPO process, the provision of interregional transportation appears to lack the most basic information on travel activity and the well-honed analytical tools needed for transportation planning and priority-setting. This deficiency can be explained in part by the absence of interregional planning and decision-making bodies seeking these data and tools on a continuing basis. Nevertheless, interregional corridors are often the subject of proposals for transportation investments, and some involve large, long-term commitments, as exemplified by California's plan to develop a high-speed rail line. These proposals require careful analysis and planning. In addition, most large transportation investments require institutional coordination, which is absent in many interregional corridors.

The findings from this study indicate how the transportation infrastructure in the United States is seldom planned, constructed, or operated with an eye to its effectiveness in serving people making interregional trips. This situation can be addressed, in the committee's view, by more federal attention and leadership. Accordingly, the committee recommends that the U.S. Department of Transportation (USDOT) seek to bring about a more rational and coordinated process for developing the nation's interregional transportation systems by taking the following actions:

1. **Supporting the establishment of a national data program focused on observing and understanding the behavior of long-distance travelers and the transportation services available to them.**
2. **Supporting the development and application of state-of-the-art analytical tools for planning and prioritizing interregional transportation investments, including methods for representing the uncertainties that can accompany decisions to invest in long-lived transportation systems that require forecasting of public benefits and traveler demand.**
3. **Creating, by seeking authority from Congress as necessary, the incentives for states to collaborate in developing multimodal,**

interregional transportation planning and decision-making organizations. The incentives should be designed to allow states to choose whether to form such organizations and to provide the flexibility to structure them and define their responsibilities in ways best suited to meeting corridor-specific interests and needs.

Fifty years ago, the desirability of planning and prioritizing urban transportation systems from a metropolitanwide perspective was recognized. That was the genesis of what eventually became the multimodal and multijurisdictional MPO process. At times, the federal government has also helped in creating and supporting interregional bodies such as the NEC Commission and I-95 Corridor Coalition. These efforts not only offer conceptual models for coordinated transportation planning and programming but also indicate the importance of leadership by the federal government and USDOT in motivating and supporting implementation. The actions recommended in this report are intended to provide similar support and motivation.

1

Introduction

Americans travel to engage in work, school, and leisure activities, among other reasons. Most trips are short and begin and end at or near the traveler's home. In large urbanized areas, one-way trips covering distances of 25, 50, and even 100 miles may be considered local if they are confined to a single metropolitan region.[1] Local travel has been the subject of considerable study and is relatively well understood by planners and public officials concerned with urban and intrametropolitan transportation. Another important component of personal travel is the long-distance trip, which is generally defined as a one-way trip that exceeds about 100 miles.[2] Most long-distance trips are shorter than 500 miles, but some cross-country and international journeys extend for thousands of miles.[3] To save time, the latter trips are usually made in airplanes. This report is concerned with the shorter-haul component of long-distance travel, specifically trips of 100 to 500 miles, which is a distance range suited to transportation by several alternative modes, including automobiles, airplanes, trains, and buses. Trips of such length are referred to as "interregional" in this report because most involve travel that begins in one metropolitan region and ends in

[1] Among transportation planners, a "region" is generally associated with a greater metropolitan area. The Census Bureau uses core-based statistical areas (CBSAs) to represent greater metropolitan areas. Therefore, all references in the report to core "cities" (e.g., Los Angeles, New York) are shorthand for the entire CBSA. The land area of a CBSA can be large; for example, the driving distance between Palmdale, California, on the northern edge of the Los Angeles CBSA, and Irvine, California, on the southern edge, is about 100 miles. When the straight-line distance between two CBSAs is measured, the centers of the two core cities are used as the endpoints.

[2] The 100-mile threshold was used to define a long-distance trip by the 1995 American Travel Survey; accordingly, this threshold is used in this report.

[3] As discussed in Chapter 2, trips of less than 500 miles account for about three-quarters of all long-distance trips.

another. They are of particular interest because of their modal substitutability and because they are the largest component of long-distance travel in terms of trips made.

Interregional trips are seldom studied. One reason may be that transportation planners and public officials prioritizing infrastructure investments seek to accommodate the much larger number of trips made locally for commuting, shopping, entertainment, and other routine purposes. Because many people make only a handful of trips longer than 100 miles each year, the destinations and other details of these trips may go unrecorded in the household travel surveys conducted by metropolitan and state planners concerned mainly with local and in-state trips. Another reason may be that some of the line-haul modes used, such as buses and airplanes, are supplied by commercial entities that are viewed as outside the scope of metropolitan and state transportation investment plans. Regardless of their specific causes, these data deficiencies hinder the understanding of the people making interregional trips, where and why they travel, and the transportation modes they use and prefer.

Although the data on interregional trip making are scarce, people making such trips—or those who will make them in the future—are often the target of proposals for public investments in new or substantially improved transportation systems. Passenger rail service, which is missing or skeletal in most interregional corridors, is frequently the subject of these proposals. The proposals sometimes involve the inauguration of a new conventional or high-speed rail service or the enhancement of an existing service with faster and more frequent trains.[4] Passenger trains have been the recipient of billions of dollars in federal aid over more than 40 years since the creation of Amtrak in 1971.[5] During the past two decades, many state governments have increased funding for passenger rail, which has been supported in recent years by the availability of

[4] Trains that have top speeds of 125 miles per hour represent an upgrade over conventional intercity rail and are usually characterized as "higher speed." California's planned trains would have top speeds of more than 200 miles per hour and a goal of being capable of traveling between metropolitan Los Angeles and metropolitan San Francisco in less than 3 hours (http://www.hsr.ca.gov/).

[5] According to a recent National Cooperative Rail Research Program report (CPCS et al. 2015, 16), Amtrak operating losses have totaled more than $68 billion (in 2013 dollars) since its creation.

federal stimulus grants for improving rail infrastructure.[6] The creation of a high-speed passenger railway connecting California's northern and southern cities, approved by state voters in 2008, represents one of the largest public commitments to interregional transportation that has ever been made in the United States.

The 100- to 500-mile market is also the subject of periodic proposals for using public funds to prompt the development and introduction of transformational transportation technologies. Among such technologies are trains operating on magnetic levitation (maglev) guideways,[7] Interstate highways capable of accommodating platoons of self-driving cars and buses,[8] commercial tilt-rotor aircraft flying outside of congested airports and airspace (OTA 1991), increasingly automated small airplanes offering on-demand passenger service from general aviation airports,[9] and even "hyperloop" systems that would transport passengers long distances in reduced-pressure tubes (Bilton 2013).[10]

Public officials face uncertainty with regard to how to invest public resources in transportation systems intended to serve travelers decades into the future. The unanticipated growth in the availability and popu-

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[6] On February 17, 2009, President Obama signed the American Recovery and Reinvestment Act, which included more than $8 billion in grants for intercity and high-speed rail projects.

[7] Maglev trains have demonstrated speeds exceeding 250 miles per hour. Although no maglev systems serve interregional markets, three intracity (<35 miles) systems are in commercial operation in Shanghai, China; Aichi, Japan; and Seoul, South Korea. Section 1218 of the Transportation Equity Act for the 21st Century, passed in 1998, created a National Magnetic Levitation Transportation Technology Deployment Program. The special infrastructure required for maglev trains necessitates high construction costs and precludes compatibility with the railway network. Maglev trains have since been proposed for the Los Angeles–Las Vegas and Baltimore–Washington, D.C., markets.

[8] See, for example, the current Google Self-Driving Car Project (http://www.google.com/selfdrivingcar/) and the U.S. Department of Transportation's National Automated Highway System Research Program from the 1990s and early 2000s (TRB 1998).

[9] For example, the National Aeronautics and Space Administration's (NASA's) Aeronautics Research and Mission Directorate has spent more than 15 years supporting research to further the development of systems that would improve the ability of small (one- to nine-seat) general aviation aircraft to serve interregional markets of 50 to 500 miles (http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140002448.pdf). NASA envisions air-taxi service and traveler-operated applications of small aircraft with advanced technologies as well as the eventual development and use of autonomous, self-operated aircraft for on-demand transportation. A Transportation Research Board committee reviewed the program in 2002 (http://www.trb.org/Main/Blurbs/153338.aspx).

[10] http://www.spacex.com/hyperloop.

larity of express intercity bus services over the past decade illustrates this uncertainty. During the 1990s, the nation's intercity bus industry was in the midst of a long-term decline in ridership. Today, the industry is rejuvenated by bus companies providing fast, nonstop service between the downtowns of major cities. On the one hand, public officials considering whether to invest in passenger rail cannot help but notice the renaissance in bus service, and they might wonder whether capital-intensive rail investments are needed or will be competitive with the private bus. On the other hand, they might view the growing popularity of intercity buses as an indication that more people are seeking transportation alternatives to the automobile and thus as a positive sign for the future of intercity trains.

In 1991, the Transportation Research Board (TRB) issued *Special Report 233: In Pursuit of Speed: New Options for Intercity Passenger Transport.*[11] That report also concentrated on the 100- to 500-mile market and examined the experience with public investments in high-speed interregional systems such as passenger rail. Since publication of the report, surprisingly little attention has been given to understanding this market, even as interest in investments in high-speed rail and other transportation alternatives has waxed and waned. Without an understanding of the interregional market, potentially beneficial investments in transportation capacity to serve it may be neglected, while some large investments may be made on the basis of envisioned benefits that do not materialize.

In sponsoring this study, the TRB Executive Committee recognized the dilemma that public officials face in deciding whether to make potentially large commitments to transportation systems under conditions of uncertainty. Therefore, the study examines the demand for and supply of interregional transportation in the United States in detail, in part to identify gaps in understanding that need to be filled. After additional background on interregional travel and its relevance to transportation institutions and policy issues is provided, the chapter concludes with a more detailed review of the study charge and organization of the report.

[11] http://www.trb.org/Publications/Blurbs/153319.aspx.

ADDITIONAL BACKGROUND

The metropolitan population of the United States grew by more than one-third from 1990 to 2010, compared with the nation's overall population growth rate of 24 percent.[12] Today more than 250 million people live in the country's metropolitan areas, and the largest 75 of them—all having more than 500,000 people—now account for about half the population.[13] Although the United States is geographically vast, its population is concentrated in a relatively small number of large metropolitan areas, and many of them are located in a few geographic regions. Hence, when residents of these metropolitan areas leave their homes for personal, leisure, and business trips, they often travel to neighboring metropolitan areas that are within a few hundred miles: three of every four long-distance trips are to destinations less than 500 miles away.[14]

Unlike cross-country and international trips, which are made predominantly by airplane to save time, shorter-haul interregional trips are made by automobile, bus, train, and airplane. These modes have different prices and service attributes, and their substitutability can depend on many factors, including the availability of the service, traveler valuations of time, sensitivities to ticket prices, requirements for hauling luggage and gear, and the need for local transportation at the destination. Because of its advantages with respect to many of the factors, private automobiles account for most trips under 500 miles. Use of the automobile is especially prevalent among families and others traveling for leisure and other nonbusiness purposes. As travel distances approach 200 miles, business travelers, who tend to place a high value on time, are more likely to fly or use trains when that service is both available and fast. When trip lengths approach about 300 miles, airline use increases more generally, and use of buses and trains drops off.

While the automobile and airplane dominate interregional travel, there is notable variability in the use and availability of the other transporta-

[12] http://www.census.gov/newsroom/releases/archives/2010_census/cb12-50.html; http://www.census.gov/population/censusdata/urpop0090.txt.

[13] According to the Census Bureau, the New York–Newark metropolitan region is the most populated urbanized area, while Cleveland, Ohio; Raleigh, North Carolina; and Columbia, South Carolina rank 25th, 50th, and 75th, respectively.

[14] Chapter 2 contains statistics on trip making by distance.

tion modes by region and among individual city pairs. In general, travelers beginning and ending their trips in large cities are likely to have more transportation options than are travelers between smaller cities where traffic volumes are light. In addition, the service options available in a given city-pair market can depend on the traffic characteristics of the corridor in which it resides. This is particularly true for service by passenger rail. Unlike buses, which can offer schedule frequency with as few as 40 passengers per trip, interregional trains that operate with frequency in the United States average about 200 passenger miles per train mile. They require 250 to 300 seats in sets of five, six, or seven passenger cars.[15] Thus, trains can be scheduled with high frequency even in relatively small markets (e.g., Newark, New Jersey–Wilmington, Delaware) when they fall within longer travel corridors anchored by major cities (e.g., New York–Washington, D.C.). In particular, the likelihood of an interregional trip being made by rail or bus increases significantly if the trip occurs within the densely traveled Northeast Corridor (NEC), where travelers have many mode and schedule options.

For the most part, the transportation infrastructure used for interregional travel serves local and longer-distance travelers as well as freight. For example, most of the vehicle traffic on the country's urban Interstate highways is local, airlines use hub-and-spoke networks to carry both long- and short-haul passengers on the same flights, and intercity passenger trains often share track with commuter and long-distance freight trains. Accordingly, these transportation systems are seldom planned, designed, or operated with interregional travelers exclusively in mind. The transportation options available to interregional travelers are the outcome of many choices made for many reasons and by many entities. Private individuals and companies own and operate the automobiles, buses, and airplanes, but the highways, airports, and airways they use are largely owned and operated by federal, state, and local authorities. Most of the rail infrastructure used by intercity passenger trains is owned and operated by private railroads

[15] For example, the Amtrak trains operating on the Northeast Corridor routes average about 220 passenger miles per train mile, with some portions of the corridor exceeding this average. See Federal Railroad Administration Rail Service Metrics and Performance: Quarter Ended June 2015, Table 5 (https://www.fra.dot.gov/eLib/Details/L17088).

whose primary interest is the movement of freight, which adds to the complexity.

Although they lack the formal institutions that coordinate transportation investments within metropolitan areas and states, a few of the country's interregional corridors are the subject of public- and private-sector coalitions. In the conurbation of the Northeast, heavy volumes of local, regional, and longer-distance passenger and freight traffic compete for highway capacity. This situation has prompted state and local governments on the corridor to join with industry users in creating the I-95 Corridor Coalition,[16] which advocates more government coordination in the prioritization of highway investments and has conducted analyses of corridor capacity and bottlenecks as they pertain to the rail, bus, air, and waterborne modes. More generally, the coalition has served as a forum for members of the transportation community in exchanging best practices, promoting professional capacity building, and identifying issues where a broader interregional perspective is needed. Similar public–private coalitions have been created by governments and industry in other parts of the country, such as the West Coast Corridor Coalition, the I-81 Corridor Coalition, and the I-80 Coalition.[17]

Several multistate partnerships help to sustain passenger train service on a number of interregional routes. For example, the states of Illinois and Missouri are collaborating in financing upgrades to the freight rail infrastructure between Chicago and Saint Louis to allow for faster and more frequent passenger trains. Virginia and North Carolina are coordinating similar upgrades between Charlotte, Raleigh, and Richmond, with the intent of strengthening rail connections to Washington, D.C., and the other cities of the NEC. Oregon and Washington State contribute to the funding of passenger rail service between Eugene, Portland, and Seattle, and Oklahoma and Texas have partnered to support service between Oklahoma City and Dallas. The most notable example of a multistate body coordinating passenger rail is the Northeast Corridor Commission,[18] which was created by Congress to advise on the financing

[16] http://www.i95coalition.org/.

[17] The Federal Highway Administration maintains a list of these regional coalitions at http://www.ops.fhwa.dot.gov/freight/corridor_coal.htm.

[18] http://www.nec-commission.com/resources/mission/.

and planning of infrastructure serving the many commuter, freight, and intercity trains using the NEC lines.

Funding transportation infrastructure, particularly projects that require long-term funding commitments from multiple states, is challenging under most circumstances. As motor vehicle fuel economy improves and the revenues generated from traditional fuel taxes wane, states confronted with tighter transportation budgets may be inclined to focus their resources on local and state needs rather than on interregional projects. However, even in the face of growing funding constraints, public officials are being asked to respond to new policy concerns in the planning of transportation investments. Long-standing interests such as improving transportation safety, curbing congestion, and reducing energy consumption are now accompanied by an interest in controlling greenhouse gas emissions and making transportation services more accessible and convenient, especially for those lacking access to an automobile.

STUDY CHARGE AND APPROACH

The TRB Executive Committee noted the Obama administration's proposal to spend more than $8 billion of stimulus funds on state rail projects and California's initiative to pursue high-speed rail. Members of the committee discussed whether and how circumstances had changed since the publication of *Special Report 233* (TRB 1991) to justify these investments. That study had urged the U.S. Department of Transportation to develop the databases and analytical capacity required for assessing interregional travel demand before committing to high-speed rail or other technology options. For the most part, these recommendations have not been pursued. In the meantime, the market for interregional transportation has clearly changed, as evidenced by the growing popularity of express intercity bus services, which the Executive Committee observed.

The last comprehensive survey of long-distance travel in the United States was conducted in 1995. The Executive Committee questioned whether the nearly 20-year-old survey and current analytical capacity, which has been little improved, would be sufficient to inform the policy makers who have demonstrated a renewed interest in interregional corridors. The members concluded that the transportation community would benefit from a study focused on this travel segment and elected to sponsor this review of

- *Interregional travel behavior and patterns*, including traveler and trip characteristics and factors that influence travel choices, such as service price, accessibility, convenience, comfort, frequency, reliability, safety, and travel time;
- *The supply of interregional transportation infrastructure and services by automobile, airplane, bus, and train;*
- *The characteristics of interregional travel markets and corridors* that affect their suitability for service by particular modes of transportation, including spatial and demographic conditions as revealed by conditions and experience in the United States and in other industrialized countries;
- *Planning, programming, and funding challenges* that arise in the provision of interregional transportation, including those associated with forecasting travel demand and evaluating public benefits and costs associated with long-term government commitments to interregional transportation systems such as passenger rail; and
- *The data and analytical capabilities* needed to plan and program transportation investments to serve interregional travelers.

These five bullet items are a synthesis of the study's full charge, which is given in Box 1-1. To carry out this charge, TRB convened a committee of experts in transportation system planning and operations, economics, policy analysis, travel data, behavior, and modeling. In reviewing the transportation literature, the committee found a large number of studies pertaining to long-distance and intercity travel generally but relatively little information specific to the shorter-haul, interregional segment and to its transportation planning and decision-making processes. Consequently, the committee spent much time at the outset of the study meeting with individuals knowledgeable about interregional travel markets, including service providers, transportation analysts and planners, modal experts, and representatives of government agencies. These individuals are acknowledged in the Preface.

BOX 1-1

Statement of Task

This study will examine U.S. regional intercity passenger transportation, with a focus on markets for which there are potentially multiple modal options with distances in the range of 100 to 500 miles. Consideration will be given to travel by personal automobile, airplane, motor coach, and train, including attention to opportunities and challenges for service by high-speed and conventional passenger rail, curbside bus, and future modes of travel made available by emerging system technologies.

The study will describe U.S. intercity travel markets, including mode share for tripmaking, geographic patterns (e.g., coast, regional corridors), traveler characteristics (e.g., party size and household income), and trip characteristics (e.g., duration, distance). In examining market demand, the committee will compile available information on factors that influence travel choices, such as service price, accessibility, convenience, comfort, frequency, reliability, safety, and travel time. To the extent possible, this information will be interpreted with respect to traveler demographics and how they are expected to change over time.

In examining transportation supply, the study will draw upon experience in the United States and other industrialized nations with respect to factors such as modal competition and cooperation, service cost and revenues, funding requirements, and alternative institutional and financing mechanisms, including public–private partnerships. The study will also consider the physical condition, structure, and capacity of transportation networks. The study will assess future travel markets and potential mixes of services to meet the demand for short-haul intercity passenger transportation.

The committee will examine policy and planning issues that arise in public debates concerning the provision of transportation services. The report will offer guidance to policy makers where warranted to inform these debates, acknowledging areas of uncertainty and identifying those that may be addressed through further research.

The literature reviews, expert consultations, and examinations of interregional transportation systems in other countries yielded many insights. They helped shape the committee's views about the importance of decision makers having better data, analytical tools, and institutional means for planning and investing in interregional transportation. The committee did not try, as requested in the statement of task, to characterize each transportation mode's current physical condition and capacity. Such sweeping characterizations are bound to be misleading given the variability in circumstances among individual facilities, corridors, and regions. The immense highway, air, and rail transportation systems, which cross many regions and serve many purposes (i.e., local and long-haul trips and freight and passenger traffic) are not homogeneous across markets and regions. Attempts to characterize their physical condition and capacity at the national level would be misleading or require too many caveats to be informative. The same logic holds for assessing future travel markets. The committee was not in a position to project interregional travel trends given the many uncertainties about future demand and supply and their variability from one corridor to the next. The committee reasoned that decision makers considering investments in interregional transportation do not need speculative forecasts of demand; they need access to travel behavior data and forecasting tools that can be applied to their individual circumstances. Instead of trying to provide the mode- and site-specific details needed by public officials to inform investments in individual corridors, the committee reasoned that its time and resources were best spent in examining the general state of interregional transportation planning and decision making to advise on ways to strengthen their processes.

REPORT OVERVIEW

The remainder of the report consists of six chapters. Chapter 2 gives general information about interregional travel in the United States. The information comes mainly from the only database offering sufficient detail, the 1995 American Travel Survey. The chapter thus provides a snapshot of interregional travel behavior from 20 years ago. The snapshot sheds light on some of the basic factors affecting the demand for interregional travel and mode choice, but its ability to offer detailed information needed by transportation planners is questionable in light of two decades of changes in demographics, economics, and technology.

Chapter 3 describes the four main modes of transportation used for interregional travel—automobiles, buses, airplanes, and trains. Consideration is given to how the modes compare in attributes such as price, travel speed, and schedule frequency.

Chapter 4 examines the location and shape of the country's major interregional transportation corridors. Particular attention is given to how the size, spacing, and relative position of cities in a corridor can affect traffic flows and the functioning of different interregional transportation systems.

Chapter 5 describes the public sector's role in supplying interregional transportation infrastructure and services. The few funding programs and institutions that align with interregional corridors are identified and discussed. For comparative purposes, the public sector's role in providing interregional passenger rail in Europe is summarized.

Chapter 6 describes the kinds of data and analytical tools needed to inform investments in interregional transportation. Among the topics discussed are more up-to-date travel surveys, models for forecasting traveler demand, and methods for assessing and conveying uncertainty.

Chapter 7 summarizes the key findings from the study. It concludes with recommendations on how the federal government can help improve long-distance travel data, support the development and application of state-of-the-art analytical tools, and provide incentives for the creation of interregional transportation planning entities to support sound decision making.

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Abbreviations

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TRB Transportation Research Board

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2

Interregional Travel Behavior and Patterns

This chapter provides a snapshot of interregional travel in the United States as revealed by the 1995 American Travel Survey (ATS), which is the most recent data source of sufficient detail to describe long-distance travel by people living in the United States.[1] Developed from interviews of individuals from more than 80,000 households, the ATS concentrates on trips with one-way distances of 100 miles or more from the respondent's home.[2] The chapter's focus is on ATS trips having distances up to 500 miles, which are defined as "interregional" in this report. Interregional trips dominate long-distance travel. More than three-quarters of all long-distance trips in the ATS were for distances of 500 miles or less.[3]

An examination of the ATS indicates a number of relationships among interregional trip making, mode choice, trip length, trip purpose, and household characteristics. Many of these relationships are similar to those of long-distance trips generally. For example, people from higher-income households tend to make more long-distance trips for all purposes (e.g., leisure, personal, and business) and across all trip lengths than do people from lower-income households.[4] Because of their shorter lengths, interregional trips are better suited to the surface modes than

[1] The survey was conducted for the U.S. Department of Transportation's Bureau of Transportation Statistics by the U.S. Bureau of the Census as a component of the Census of Transportation.

[2] The survey consisted of four detailed telephone interviews conducted approximately every 3 months from April 1995 to March 1996. In most cases, one adult member of the household provided information for all members. Respondents were asked to report each round-trip taken during a quarter in 1995 in which one direction was at least 100 miles (i.e., each time a person in the household visited a place at least 100 miles away from home and returned). Because of the household-based structure of the survey, trips by visitors to the United States were not recorded.

[3] ATS (see subsequent discussion and figures in this chapter).

[4] ATS (see subsequent discussion and figures in this chapter).

are longer-distance trips, which are more often made by airline when the one-way distance exceeds 500 or 600 miles.[5] While travel distance is a key determinant of mode use, the ATS shows the effect of other factors, including the purpose of the trip and whether the trip involves people traveling together. An understanding of these factors is important in planning transportation systems for long-distance travel, particularly for interregional travelers, who may be served in a comparable fashion by more than one type of interregional mode.

For 20 years, the ATS has been the only detailed source of information on long-distance travel in the United States. The relationships derived from it continue to be used by government transportation planners, transportation companies, and the tourism industry. However, many circumstances have changed since it was completed in 1995, and the survey's relevance has likely diminished. Since 1995, the U.S. population has increased by more than 20 percent, grown older (the median age was 34.3 years in 1995 and 37.6 years in 2013), become more concentrated in metropolitan areas, and continued to shift further to the South and West.[6] Average household size has declined as the number of households with children has grown at a slower rate than households consisting of couples and individuals living alone.[7]

Transportation technologies have also changed, in some cases dramatically. Advances in in-vehicle electronics have made travel by automobile more reliable and comfortable for longer-distance trips, not only by assisting with driving functions (e.g., adaptive cruise control, lane-keeping systems) but also by providing onboard entertainment and navigation assistance.[8] The commercialization of the Internet and the introduction of the smartphone and other electronic and tele-

5 ATS (see subsequent discussion and figures in this chapter).

6 For 1995 population and median age, see https://www.census.gov/popest/data/national/totals/1990s/tables/nat-agesex.txt; for 2013 population and median age, see http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk; for other demographic trends, see USDOT 2015, 12–31.

7 https://www.census.gov/hhes/families/files/graphics/HH-4.pdf.

8 The individual modes and their supply characteristics are examined in Chapter 3, which discusses a number of these developments.

communications devices have created new means of marketing and shopping for airline, train, and bus fares (e.g., travel agency websites and online ticketing). Mobile computer and communications technologies have also allowed more productive use of time spent traveling. These technologies may be influencing travelers' choice of modes (e.g., travelers may prefer modes that allow their portable devices to be used) and even their overall demand for travel because of the growing number of options for working remotely and staying connected to friends and family.[9] Accordingly, an ATS-like snapshot of long-distance travel taken today would likely reveal distinct differences in where, why, and how people travel compared with circumstances a generation ago.

The 1995 ATS remains the most recent comprehensive source of information on long-distance travel in the United States. Some of the basic relationships it reveals, such as the ways in which trip purpose, party size, and household income affect mode use and trip-making propensity, have been observed in other travel surveys, such as the Census of Transportation from 1977 and the 2001 National Household Travel Survey (NHTS), which focused on local travel.[10] Because there is no obvious reason to believe that these most basic relationships have changed markedly since 1995, they are summarized below for background purposes on the basis of the ATS. Nevertheless, the applicability of the ATS data is increasingly questionable for more detailed analyses of long-distance travel behaviors and activity. From the standpoint of public officials who are considering investments in long-lived transportation systems, which require forecasts of travel decades into the future, the lack of more recent data can be especially problematic.

[9] For example, Connolly et al. (2009) present the results of a survey conducted on Irish Rail to observe how the value of travel time may change if individuals are able to engage in another activity during travel.

[10] The NHTS combined the surveys for long-distance and daily travel into one sample. Although the NHTS is more recent than the ATS, the NHTS sample was too small for detailed analyses of long-distance trips.

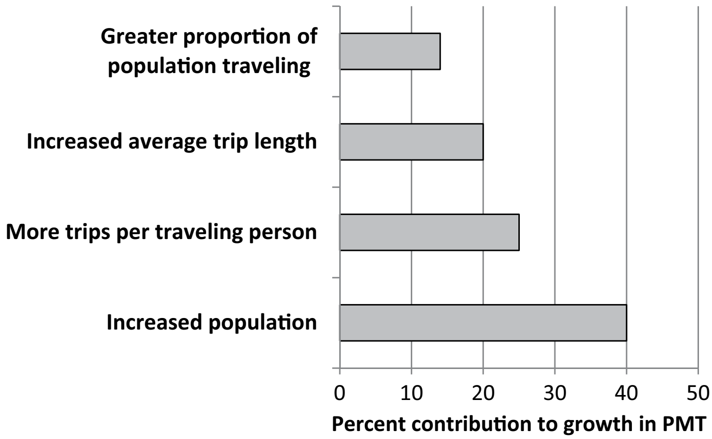

FIGURE 2-1 Factors contributing to increases in long-distance person miles of travel (PMT), 1977–1995. (Derived from Pisarski 2013.)

INSIGHTS INTO LONG-DISTANCE TRAVEL FROM THE 1995 ATS

Historical Growth in Long-Distance Travel

Historically, between 15 and 20 percent of all person miles of travel, including local travel, are from trips of 100 miles or longer.[11] During 1995, Americans averaged about four long-distance trips per person by all modes (BTS 1997, 1, 11, Table 1). The average one-way distance for a trip was 413 miles (BTS 1997, 11, Table 1), and total annual miles traveled averaged 3,075 per person (McGuckin 2013). People living in about one-third of U.S. households did not make any long-distance trips that year (BTS 1997).

In the years between the 1977 Census of Transportation and the 1995 ATS, the average number of long-distance trips per capita increased by more than two-thirds, while total person miles of long-distance travel more than doubled. The increase in person miles had several sources, as shown in Figure 2-1. First, more people took long-distance trips in 1995. This growth was caused both by a 20 percent increase in U.S. population and by a higher percentage of the population making at least one trip. Second, the share of the population that did travel took more

[11] As indicated by the 1995 ATS and 1977 Census of Transportation and by ATS analyses undertaken for this study by McGuckin (2013).

trips in 1995 than in 1977. Finally, the average trip length increased. About 40 percent of the increase in person miles was due to population growth; most of the increase was caused by the combination of long-distance trips becoming longer on average, a larger share of the population taking trips, and travelers taking more trips on average.

Mode Use and Trip Length

Figure 2-2 shows the share of person trips of varying lengths made by automobile, airplane, train, and bus according to the 1995 ATS. A relationship between trip length and mode use is apparent: automobiles dominated the shortest trips, and airlines dominated the longest ones. Because trips of 100 to 500 miles account for nearly 80 percent of all long-distance trips (Figure 2-3), the automobile is the most heavily used mode of transportation for long-distance travel.

Examination of Interregional Trips in the ATS

As indicated in Figure 2-3, nearly 80 percent of long-distance trips are for interregional distances of 100 to 500 miles. The following sections

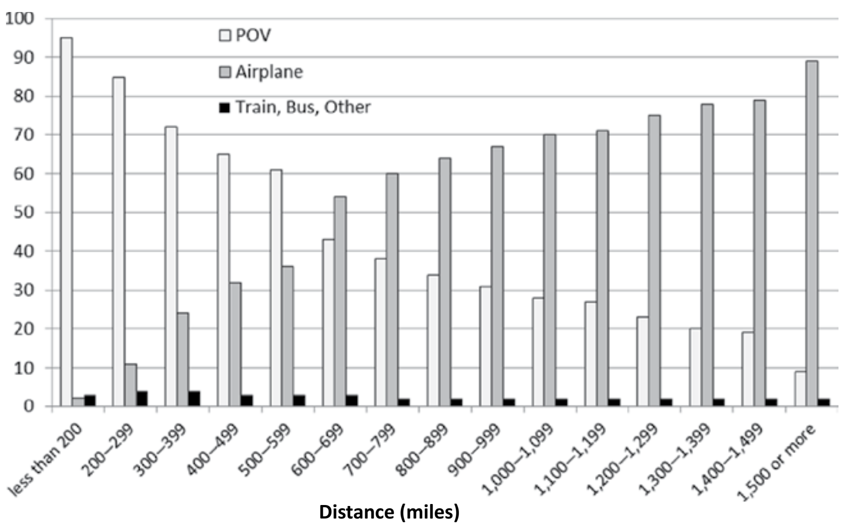

FIGURE 2-2 Percentage of person trips by mode and one-way trip distance, 1995 ATS. (POV = privately owned vehicle.) (SOURCE: McGuckin 2013.)

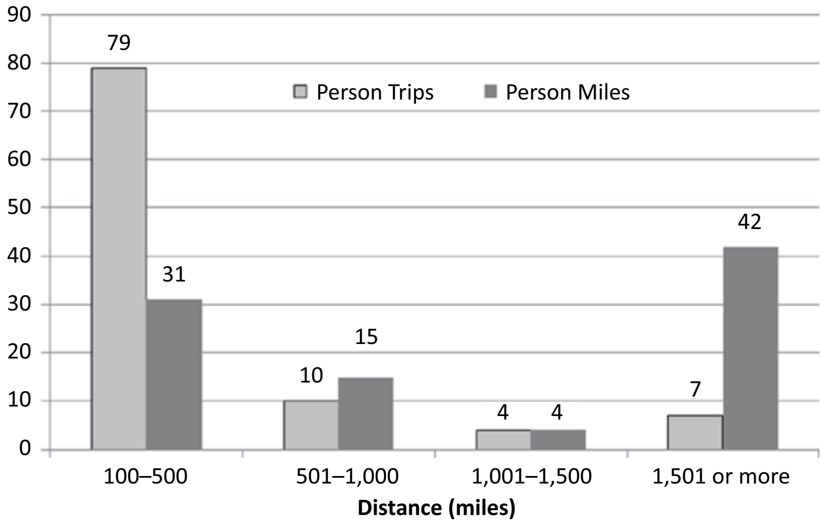

FIGURE 2-3 Percentage share of long-distance person trips and person miles by one-way trip length, 1995 ATS. (SOURCE: McGuckin 2013.)

examine these trips by trip purpose, travel party type and size, and household income and composition.

Trip Purpose and Travel Party Type and Size

For some activities such as participation in an out-of-town sales conference, client meeting, or family wedding, there may be no good substitutes for long-distance travel. For other activities such as vacationing, acceptable substitutes for a long-distance trip may exist. For example, a vacationer may drive to a nearby beach rather than fly to a distant resort. The person traveling for leisure tends to have more discretion about whether and where to travel. For a person traveling on business, decisions about the time, place, and even mode of travel are likely to be made or heavily influenced by the business itself, because it incurs most of the costs and benefits of the trip. People traveling for leisure and other nonbusiness purposes tend to pay their own way and are generally more concerned about the price of the trip, which they may try to minimize by adjusting the trip's timing and transportation mode. As a result of these fundamental differences in the decision-making process, the elasticity of demand can be different for

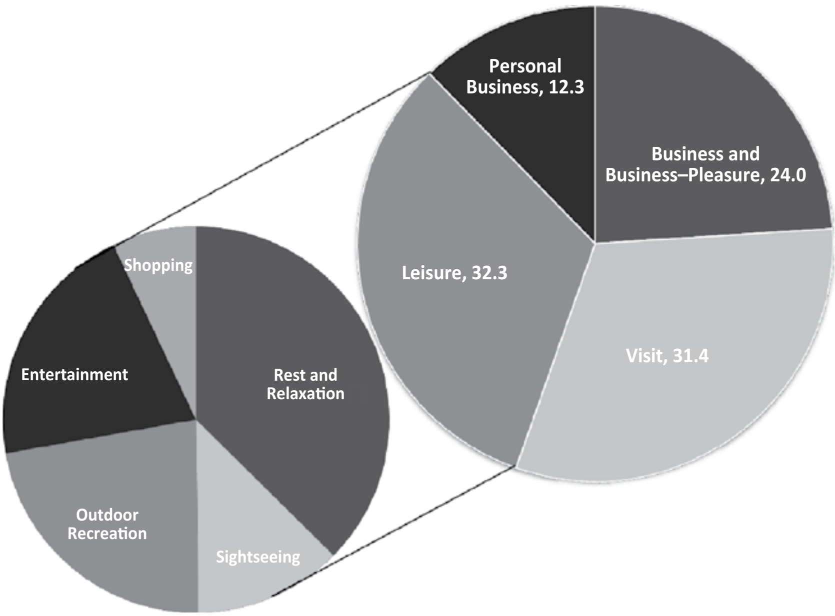

FIGURE 2-4 **Percentage of interregional trips by trip purpose, 1995 ATS.** (SOURCE: McGuckin 2013.)

trips made for business and nonbusiness purposes, and they are usually treated separately in analyses of travel data.[12]

According to the ATS, nearly one-quarter of interregional trips in 1995 were made for business reasons (including business combined with pleasure); about three-quarters were made for nonbusiness reasons, such as to visit family and friends, participate in leisure activities (e.g., sightseeing, shopping, entertainment, outdoor recreation), and conduct personal business (e.g., attend school, seek medical treatment) (Figure 2-4).

[12] In surveying price elasticity of demand estimates in the literature from the 1970s and 1980s, Oum et al. (1990, 170, Table 2) found that the range of price elasticities for vacation and leisure travel by intercity rail and airline was 1.1 to 2.7. The range for business travel was more price-inelastic: 0.4 to 1.2. Gillen et al. (2002) surveyed price elasticity estimates in the literature for air travel only. They separated the values by travel distance and purpose. The estimates are directionally consistent with those of Oum et al. They indicate that short-haul leisure travelers had a price elasticity range of 1.3 to 1.7, while short-haul business travelers had a range of 0.6 to 0.8. A full review of the literature on air travel price elasticity values can be found at https://www.iata.org/whatwedo/Documents/economics/Intervistas_Elasticity_Study_2007.pdf.

TABLE 2-1 Percentage of Interregional Trips by Travel Party Type and Trip Purpose

Travel Party Type	Business Purpose	Nonbusiness Purpose	All
One adult	76	34	44
Two or more adults	19	41	36
Travel party with at least one child	5	25	20
All	100	100	100
One adult	41	59	100
Two or more adults	13	87	100
Travel party with at least one child	7	93	100
All	24	76	100

SOURCE: McGuckin 2013.

Because many business trips are made by individuals traveling alone and many nonbusiness trips are made by people traveling together, such as vacationing families, knowledge of a trip's purpose and travel party type can be helpful in explaining mode choice. Of the roughly 25 percent of interregional trips made for business purposes recorded in the 1995 ATS, 76 percent were made by a single adult traveling alone, 19 percent by two or more adults traveling together, and 5 percent by a travel party involving at least one child (Table 2-1). In comparison, of the nearly 75 percent of interregional trips for nonbusiness purposes, only about one-third were made by a person traveling alone; adults traveling together and travel parties involving at least one child accounted for 41 percent and 25 percent of trips, respectively.

Mode Use and Travel Party Type

A strong relationship between mode use and travel party type can be seen in the ATS for interregional trips. Mode shares for travel parties consisting of a single person, two or more adults, and one or more adults traveling with at least one child are shown in Figure 2-5. The data points represent the mode shares for each party type when they are indexed to the mode share for all interregional travelers. For example, the bus mode share for single travelers is 50 percent higher than the bus mode share for all interregional travelers and three times higher than the bus mode share for people traveling with children. The comparison indicates that two

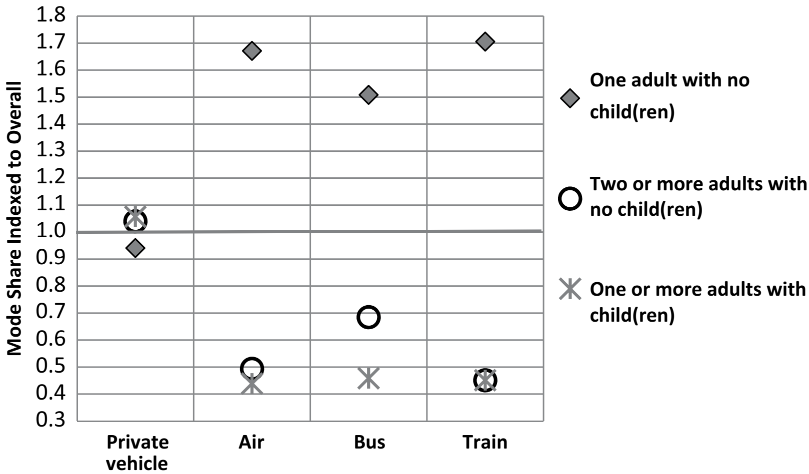

FIGURE 2-5 Interregional travel mode share for three travel party types indexed to the mode share overall, 1995 ATS. (SOURCE: McGuckin 2013.)

or more adults traveling together behave much like adults traveling with children in that both party types are far less likely than single travelers to travel by air, bus, or train.

Single travelers, as noted above, are more likely to be traveling for business than are people traveling in a group. Business travelers place a high value on time and can therefore accrue large benefits from modes having faster travel speeds or offering the ability to conduct work en route. Traveling long distances alone by private automobile does not offer these benefits, because the business traveler must concentrate on driving tasks. Conversely, because they are more likely to be traveling in groups and paying their own travel expenses, nonbusiness travelers may find the automobile mode, with its low cost per additional traveler, advantageous.

Variability in Interregional Mode Use by Region

The automobile dominates interregional trips when such trips are aggregated at the national level. However, the mode share for the automobile is generally lower for trips in which the origin or the destination consists of a large metropolitan area in the Northeast Corridor (NEC), which spans Boston, Massachusetts, to Washington, D.C. The ATS data

TABLE 2-2 Interregional Trip Mode Shares Nationally and in Selected Metropolitan Areas in the NEC and California, 1995 ATS

	Trips of 100 to 500 Miles, One Way: Mode Shares						
		Trips Not Made by Automobile, by Originating Metropolitan Area					
Mode	All Trips	National	N.Y.-N.J. (NEC)	D.C.-Va.-Md. (NEC)	Philadelphia, Pa. (NEC)	Los Angeles, Calif.	San Francisco, Calif.
Automobile	90						
Airline	7	68	39	57	61	76	90
Bus	2	19	34	15	15	12	7
Train	<1	5	24	23	15	6	1
Other	<1	8	3	5	9	6	2

NOTE: N.Y.-N.J. = New York–New Jersey; D.C.-Va.-Md. = Washington, D.C.–Virginia–Maryland; Pa. = Pennsylvania; Calif. = California.
SOURCE: McGuckin 2013.

in Table 2-2 indicate that trains and buses have a significant role for the nonautomobile travel originating along this 400-mile corridor. The pattern is different for interregional travel originating in California, where air transportation plays a much larger role. The long distances between cities in California may favor flying, while the generally shorter distances between cities in the Northeast may favor buses and trains. Since travelers using buses and trains depend on public transit or walking to access stations, the more compact and transit-oriented Northeastern cities may be conducive to the use of these surface modes. Furthermore, as discussed in more depth later in this report, the NEC has a tradition of travel by train and bus and levels of train and bus service that are unmatched by other regions.

Household Income and Composition

Rates of interregional trip making are strongly associated with a number of socioeconomic factors including household income and composition. Figure 2-6 shows the impact of income on interregional trip rates per capita. The 1995 ATS data show a positive relationship between income and annual trips per capita. People in the lowest income quartile averaged about half as many interregional trips per year as people in the highest

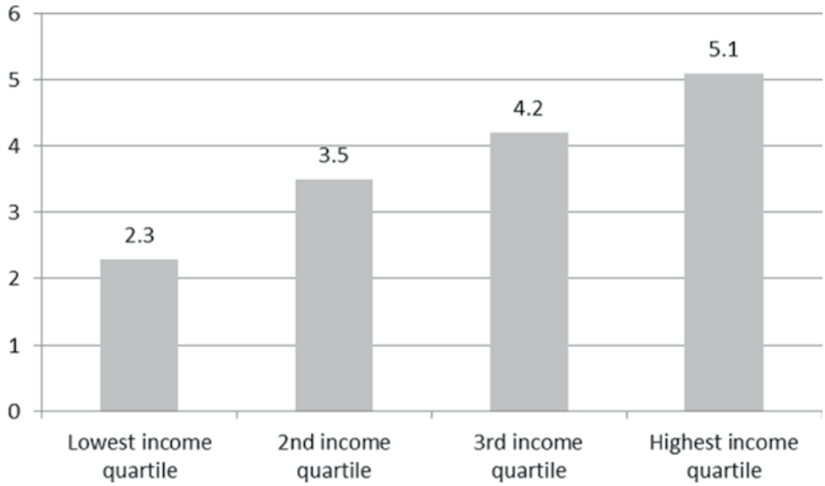

FIGURE 2-6 Annual interregional trips, 100 to 500 miles, per capita by household income quartile, 1995 ATS. (SOURCE: McGuckin 2014.)

income quartile.[13] The positive effect of income on interregional trips in the ATS is not surprising, since most studies of long-distance travel have estimated that as income increases, the number of long-distance trips increases at a faster rate (i.e., real household income growth of 1 percent leads to a 1 to 2 percent growth in trips made).[14]

The ATS data also indicate that household income is associated with the use of specific transportation modes. Figure 2-7 shows the share of trips made by automobile for lower- and higher-income households when the main purpose of traveling is to engage in recreational activities. Regardless of trip distance, travelers from lower-income households use automobiles for a higher share of their recreational trips. Even when round-trip distances reach 800 miles, travelers from lower-income households (<$25,000 annually in 1995 dollars) drive more than three-quarters of the time, whereas travelers from higher-income households (>$100,000) drive only about

[13] More information on these patterns is given by Mallett (2001).

[14] A comprehensive review of the literature by Gillen et al. (2002) suggests that the income elasticity for intercity travel is on the order of 1.5. Virtually all estimates of income elasticities for long-distance travel demand in the literature are above 1 and generally are between 1 and 2. See, for example, Gillen et al. 2002 (value of 1.5), Oum et al. 1986 (value of 1.5), Alperovich and Machnes 1994 (range of 1.6 to 2.1), and Njegovan 2006 (value of 1.5).

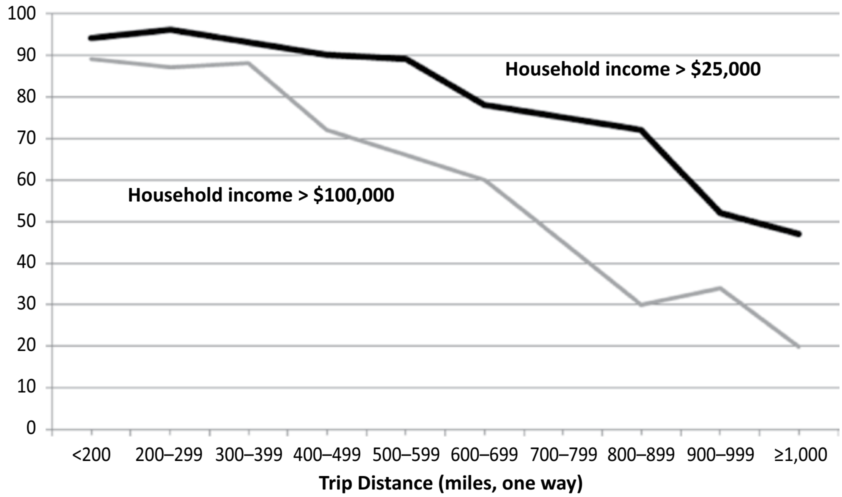

FIGURE 2-7 Percentage of all recreational trips by automobile for lower- and higher-income households (income in 1995 dollars), 1995 ATS. (Adapted from Mallett and McGuckin 2000, Figure 1.)

30 percent of the time. However, more than one-quarter of the low-income population surveyed in the ATS lived in a household without a vehicle. According to a review of the survey data by Mallett (2001), all households lacking a vehicle traveled less than households in the same income group with one or more vehicles, while trip making by low-income households was less than one-third of that of low-income households with one or more vehicles.[15]

Income is one of several household-related factors affecting the propensity to take interregional trips. According to the 1995 ATS, travelers from two-adult "couple" households average more trips per year than other households, particularly nonbusiness trips (Figure 2-8). People living in family households with children accounted for the next highest rates, with the variability affected by the age of the children. Family households tend to make fewer leisure trips than couple households, but they average more business trips. Single households average the fewest trips for both business and nonbusiness purposes, probably because they are more likely to contain retirees. Figure 2-9 indicates the effect of the

[15] More information on these patterns is given by Mallett (2001).

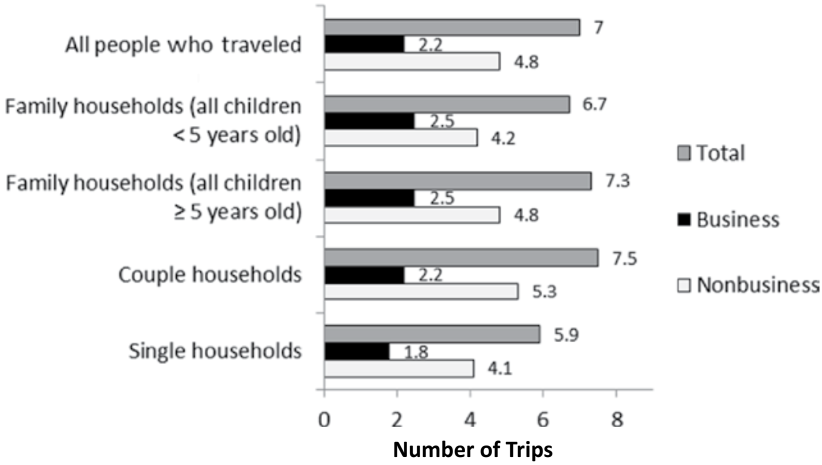

FIGURE 2-8 Average number of interregional trips per year by people who traveled for business and nonbusiness purposes, by household composition, 1995 ATS. (SOURCE: McGuckin 2013.)

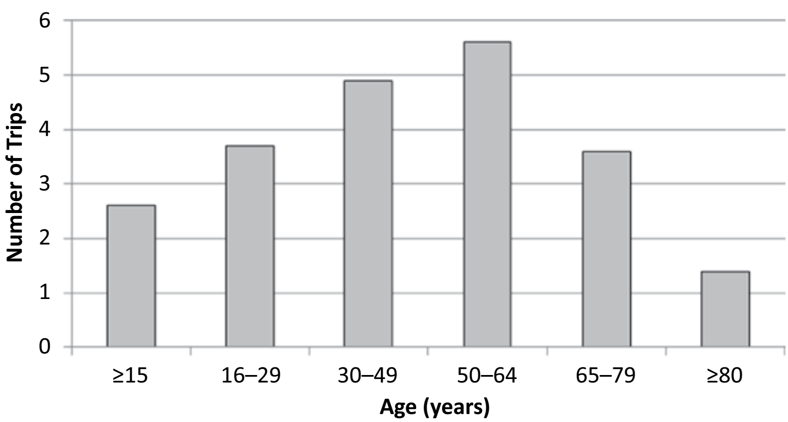

FIGURE 2-9 Annual interregional trips per capita, by years of age, 1995 ATS. (SOURCE: McGuckin 2013.)

age of the traveler on the number of interregional trips. People between the ages of 30 and 64 averaged the most annual trips.

SUMMARY

Long-distance trips recorded in the 1995 ATS are examined in this chapter to illustrate some basic interregional travel behaviors and patterns. Although they are now 20 years old, the ATS data remain helpful for general characterizations of the effect of factors such as household income, trip purpose, and trip length on the likelihood of people making an interregional trip and using particular modes for the line-haul portion of transportation.

The data indicate that trips made for business and nonbusiness purposes differ in fundamental ways that affect a traveler's choice of modes. They reveal how trip making varies according to household size and age composition. The data indicate that people traveling as families and in other groups for nonbusiness purposes have a strong tendency to use private automobiles for interregional trips under 500 miles; trips by bus, train, and airline are made disproportionately by people traveling alone or on business. Time-sensitive business travelers account for many of the interregional trips made by airline when market distances approach about 200 miles.

Despite the utility of the 1995 ATS for demonstrating such basic trip-making relationships, its contribution to understanding current travel behavior and activity is diminishing as transportation service options, socioeconomic conditions, and technologies continue to change. Transportation planners and public officials need up-to-date and detailed data on long-distance travel to inform their decisions. For example, reliable forecasts of demand for the long-lasting infrastructure used for interregional transportation are necessary. The chapters that follow make the importance of such information evident.

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USDOT	U.S. Department of Transportation

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3

Supply of Interregional Transportation

The 1995 American Travel Survey (ATS) is the last national survey indicating how the transportation system is used for interregional travel in the United States. The modal use patterns observed in the ATS, such as high rates of automobile and airline use, reflect both the transportation service attributes preferred by surveyed travelers and the choices available to them. Examples of service attributes are price, travel time, schedule frequency and reliability, ride comfort, service proximity, and safety.[1] In some interregional markets, travelers may choose among many competing service offerings; in others, their options may be few. Fast and frequent train service, for example, is available in relatively few places. Accordingly, observed modal use patterns are the outcome of traveler preferences interacting with the available transportation supply.

This chapter examines the supply of interregional transportation in the United States. The four main modes are automobiles, buses, airplanes, and trains. Each mode is described in a general way. How their services are supplied and the extent to which they are available in various parts of the country are discussed. Typical service attributes of the four modes are described, but the variability of the service offerings within each mode is also recognized. Airlines, for example, can schedule more frequent flights with smaller airplanes to accommodate travelers who demand frequent service, or they can schedule less frequent flights with larger airplanes to attract travelers seeking lower fares. The availability of the interregional transportation modes and their service offerings can vary considerably among regions of the country. Regional comparisons

[1] For examples of service attributes of interest to travelers, see the survey results from the *Northeast Corridor Intercity Travel Summary Report* (Northeast Corridor Commission 2015, 12).

of flight frequencies, average train speeds, and nonstop bus departures can sometimes show dramatic differences. The most striking variability is in passenger train service. In some corridors, particularly the Northeast, train service is frequent and scheduled at convenient times. In many others, including some that are heavily traveled, regular train service does not exist.

When the ATS was conducted 20 years ago, few could have predicted the ways in which the supply of interregional transportation would be affected by technological advances outside the transportation domain. The Internet, for example, has become commercialized, and smartphones and other portable electronic devices have been introduced on a mass scale. These developments have affected not only how travelers shop for bus, air, and train fares but also how they use and value the time spent traveling. Therefore, the descriptions of the modes conclude with a brief discussion of some of the changes that have taken place with respect to each.

AUTOMOBILES AND INTERREGIONAL TRAVEL

Widespread ownership of automobiles has undoubtedly affected how often Americans make interregional trips. In 2009, there were nearly two registered vehicles per household, up 5 percent since 1995 and 18 percent since 1977 (Table 3-1). In view of the heavy use of automobiles for commuting, shopping, and other local trip making, their utility for longer-distance travel is likely to be a secondary factor in most household decisions to obtain a car. Nevertheless, once a car is available, the added cost of using it for periodic out-of-town trips can be low.

TABLE 3-1 Vehicle Ownership and Licensing Rates from the 1969, 1977, 1983, 1990, 1995, 2001, and 2009 National Personal Transportation and National Household Travel Surveys

	1969	1977	1983	1990	1995	2001	2009	Percent Change, 1969–2009
Vehicles per household	1.16	1.59	1.68	1.77	1.78	1.89	1.87	61
Licensed drivers per household	1.65	1.69	1.72	1.75	1.78	1.77	1.88	14
Vehicles per licensed driver	0.70	0.94	0.98	1.01	1.00	1.06	1.00	42

The private automobile offers many advantages for out-of-town travel. Its door-to-door service can be convenient and save time and expense by avoiding the need for mode transfers and by providing a means of local transportation at the destination. For the elderly and others who find transfer between modes physically difficult, travel by car may be the only practical way to make longer trips. For those traveling for leisure activities, driving can provide the means for viewing scenery, shopping, and visiting attractions en route. The automobile provides secure stowage of luggage and can carry or tow recreational equipment such as skis, bicycles, and campers. It provides seating space at little extra cost for multiple travelers, allows for customized scheduling of departures, and offers the flexibility for unplanned schedule changes without fare penalties. These features can be particularly important for families trying to minimize their total transportation costs.

Among the costs incurred by travelers making long-distance trips by automobile are fuel expenses, added vehicle depreciation and maintenance, toll charges, and parking fees. If the time required for travel is made longer by driving, the motorist may incur additional expenses for overnight lodging and restaurant meals. The time devoted to operating the vehicle may be viewed as burdensome and unproductive compared with travel by commercial modes. It can deter business travelers who want to conduct work en route from using the automobile. Highway traffic congestion can reduce the utility of driving by requiring the inconvenient scheduling of trips at off-peak times.

The option of driving is not available to everyone. About 14 percent of people of driving age do not have licenses, a proportion that rises to nearly 30 percent in New York State because of low licensing rates in New York City.[2] Some licensed drivers are physically unable to drive long distances or feel unsafe or insecure driving outside their communities. Others lack access to automobiles. Some people cannot afford a private vehicle, and others choose to go without. According to the Census Bureau, nearly 10 percent of households do not own a car.[3] However,

[2] https://www.fhwa.dot.gov/policyinformation/statistics/2011/dl1c.cfm.

[3] Estimates for 2010, 2011, and 2012, U.S. Bureau of the Census, American Community Survey, Table CP04. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

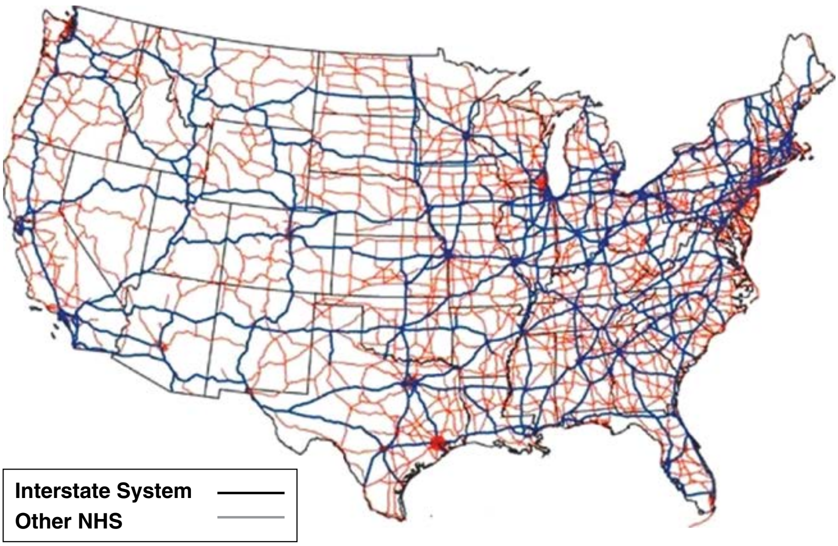


FIGURE 3-1 **National Highway System.** (SOURCE: Federal Highway Administration.)

some of those who lack an automobile may travel by rental car or in a vehicle owned by a family member or friend.

Regional Differences in Highway Reliability

The U.S. highway system is ubiquitous. Its high density in urbanized areas often means that multiple highway routings are available to those taking out-of-town trips. Most long-distance trips made by automobile use the Interstate highway system, which connects all of the country's largest cities with fairly direct routings with high traffic capacity (Figure 3-1). The 47,000-mile Interstate highway system alone accommodates nearly 25 percent of all miles traveled by cars and light trucks,[4] and presumably it accounts for an even higher share of miles traveled interregionally. Thousands of miles of other high-quality highways provide additional connections between the country's metropolitan regions.

[4] http://www.fhwa.dot.gov/policyinformation/statistics/2012/vm1.cfm.

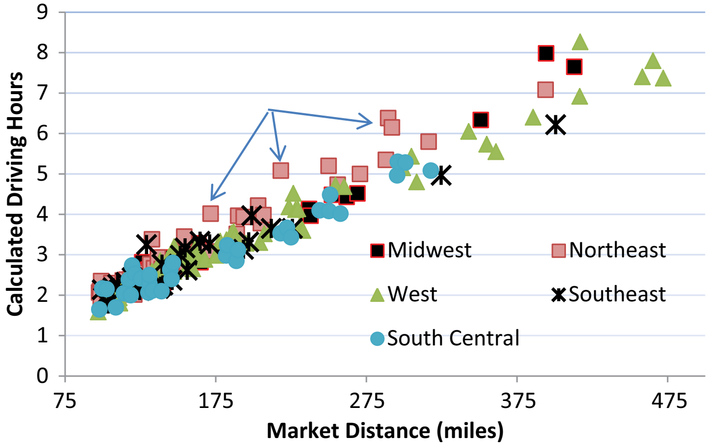


FIGURE 3-2 Nominal driving times in 200 of the most heavily traveled interregional city-pair markets. Travel times are calculated mainly on the basis of speed limits, with lower limits tending to signify urbanized areas. Northeast markets tend to have higher estimated highway driving times. (SOURCE: Google Maps.)

Estimates of the time required to drive between two metropolitan regions can be made by using trip planning software such as Google Maps and MapQuest. These programs select the most direct freeway route to calculate travel times mainly on the basis of posted speed limits and the assumption of no rest breaks or variability in travel speed due to weather or traffic conditions. In Figure 3-2, driving times from these calculators are plotted by market distance for 200 of the country's most heavily traveled interregional city-pair markets.[5] For markets of comparable distance, driving times tend be slightly higher in the Northeast, probably because of lower speed limits through high-traffic, urbanized areas. In general, however, travelers in all geographic regions have comparable access to highways that offer fairly direct connections between major cities.

Drivers seldom lack a reasonably direct highway route,[6] but traffic congestion can be a deterrent to driving longer distances. Episodic congestion

[5] See Chapter 4 for the means used to identify the 200 markets surveyed.

[6] Cases of circuitous highway routing are usually due to mountainous terrain or bodies of water (e.g., Cleveland, Ohio, and Detroit, Michigan, lack a direct routing because of Lake Erie).

occurs as a result of crashes, construction activity, and weather events. Recurrent congestion tends to be caused by high traffic volumes, which are more common on urban highways. Because most interregional trips begin and end in metropolitan areas, the potential for traffic congestion is highest at the start and end of the trip. Researchers at the Texas A&M Transportation Institute (TTI) and INRIX found that in 2014 one in four urban highway trips experienced delays from congestion and that drivers spend an average of 30 percent more time in their car when they travel during congested periods (Schrank et al. 2015, 8, 10). However, the TTI–INRIX data are for all highway trips, including local commuting. Longer-distance travelers may be able to adjust their travel times to avoid the commuting peaks.

The prospect of en route delays increases for trips in corridors that contain multiple urban areas, such as the corridor between Washington, D.C., and New York City. One way to gauge the potential for congestion-related delay is to examine annual average daily traffic (AADT) levels on the Interstate highways that connect metropolitan areas. Three examples of interregional highway corridors are given in Figure 3-3. All three have traffic volumes that are highest at their urban starting and ending points. The three markets differ in the pattern of traffic during the en route phase of the trip. In the case of I-10 between Los Angeles and Phoenix, traffic volumes are high near the two cities but drop off markedly during the more than 200 miles of connecting freeway traversing sparsely populated desert. I-75 west of Miami has relatively light traffic as it passes through 80 miles of parkland but then experiences high traffic volumes as it passes through several cities on Florida's Gulf Coast before reaching Tampa. I-95 between Washington, D.C., and Philadelphia is an example of an interregional highway corridor that is urbanized over nearly the entire route.

Figure 3-4 shows highways experiencing congestion during peak travel times. Regional variability in highway congestion is visible. The Northeast's I-95 corridor stands out in terms of the scope of peak congestion, which is almost uninterrupted from Boston, Massachusetts, to Washington, D.C. Large pockets of congestion can also be found in interregional corridors in the Great Lakes region, southeastern Florida, and southern and northern California. Although many of these corridors experience chronic congestion for considerable distances outside of the metropolitan areas, the congestion does not encompass the hundreds of miles of

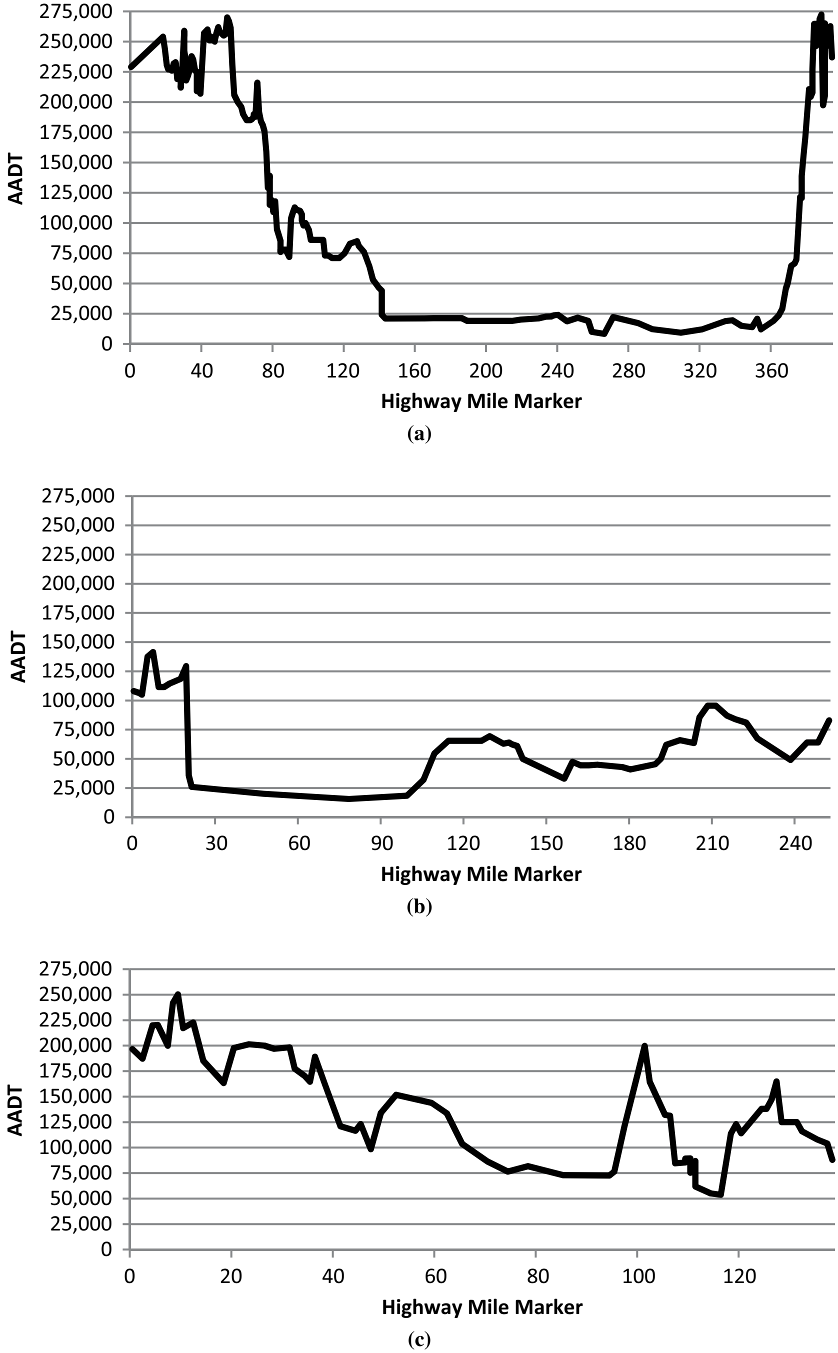


FIGURE 3-3 **AADT on selected Interstate highways connecting large interregional markets, 2011: (*a*) Los Angeles–Phoenix, I-10; (*b*) Miami–Tampa, I-75; and (*c*) Washington–Philadelphia, I-95.** (SOURCE: Compiled by the committee from data reported in the Federal Highway Administration's Highway Performance Monitoring System for 2011.)

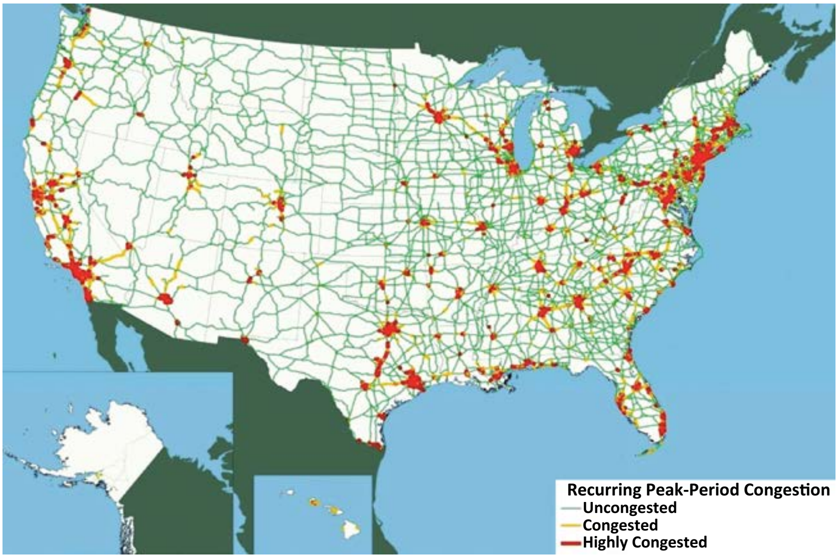


FIGURE 3-4 Peak-period congestion on the National Highway System, 2007. (SOURCE: Federal Highway Administration.)

highway corridor connecting other large cities, as experienced on I-95. Furthermore, as noted earlier, interregional drivers can control the times of the day and week they travel, and peak-period congestion may not be a good indicator of the conditions they experience en route.

The Changing Driving Experience

The building of the Interstate highway system during the second half of the 20th century made interregional driving faster, safer, and more reliable. Before the development of freeways, driving longer distances often involved traveling on meandering routes interrupted by traffic lights, through town centers, and on roads of widely varying capacity and quality. Today, the ability to drive hundreds of miles without encountering a single traffic light is taken for granted. Whereas driving on the Interstate system was once viewed as fast and dependable, growing traffic volumes may have eroded these benefits in some urbanized areas. From the perspective of the motorist traveling long distances, perhaps the most perceptible change in the freeway infrastructure over the past two decades has been the installation of regional electronic toll collection systems and the availability of real-time information on traffic conditions and routing alternatives. By reducing backups at toll booths and providing travelers with detour options, these innovations may have countered some of the congestion impacts and even added to the freeway system's time-saving advantages on some routes.

Vehicle advances have also been extensive over time and likely contribute to the popularity of driving for interregional travel. Among them are the introduction decades ago of dependable radial tires, quieter interiors, and air-conditioning. Over the past 20 years, electronic systems have proliferated in the automobile. They have increased its reliability and added features that can make driving less onerous for the driver and passengers (TRB 2012). Smartphones, Internet access, and video players help entertain passengers on longer trips. GPS may make driving less stressful on unfamiliar roads and during poor weather conditions. Motorists may have less fear of being stranded by mechanical failure, because modern cars are more reliable and mobile phones can be used to request emergency service. Other communications, sensing, and onboard electronics systems help drivers control the vehicle—for example, by taking evasive actions and maintaining safe following distances and lane positioning. Whether continued advances in these areas will allow fully automated driving to become possible is not yet known, but they could have far-reaching effects on longer-distance travel.[7]

Other technological advances could make driving a possibility for travelers who do not own or have access to a car, and perhaps for longer-distance trips. Smartphone applications such as Uber and Lyft have commercialized ridesharing. They use a smartphone's GPS to match a person's location with the nearest available driver. The ride is reserved, the fare calculated, and the charge automatically billed to a credit card. These services, as well as peer-to-peer car renting,[8] could find application for longer trips. Rental car companies have long offered discounts on weekend rentals to attract customers who need a car for occasional out-of-town trips. Carsharing programs, in

[7] https://www.enotrans.org/wp-content/uploads/wpsc/downloadables/AV-paper.pdf.

[8] Peer-to-peer car renting refers to the process whereby car owners rent their vehicles to others for short periods of time, usually facilitated by a website and a mobile application.

which subscribers share a fleet of cars, have been introduced in most of the country's largest cities, mostly for quick, local trips.[9] Investment by major rental car companies in such programs suggests an expectation of growth in the market, possibly in the direction of the cars being used for longer periods and for more out-of-town travel.[10]

These technology-aided developments have expanded local transportation options and perhaps made longer-distance airline and train travel more attractive by making rides to and from terminals easier to obtain. Whether variants of these car- and ridesharing services will become viable for longer-distance driving is not yet known. They provide examples of the difficulty of predicting the supply of interregional transportation.[11]

AIRPLANES AND INTERREGIONAL TRAVEL

Most air travel is on scheduled airlines that operate in networks connecting hundreds of cities in the United States and abroad. Nearly all flights are routed through an airline's hub airports, where passengers from multiple spoke airports are consolidated for connecting service to their destination cities.[12] From the perspective of airlines, a hub-and-spoke network is advantageous because it creates density economies by allowing travelers from numerous markets to share flights, thereby increasing aircraft occupancy. From the perspective of travelers, the consolidation of passenger traffic at hubs allows more frequent flights. For travelers beginning or ending their trips in these cities, frequent nonstop flights will be available to and from numerous destinations, including most large and medium-size cities in their respective regions. Only in markets where there

[9] http://tsrc.berkeley.edu/sites/tsrc.berkeley.edu/files/Carsharing%20Niche%20Market%20or%20New%20Pathway.pdf.

[10] For example, in 2013 Avis purchased one of the nation's largest carsharing programs, Zipcar. Enterprise operates a local carsharing program known as WeCar and has acquired a number of other local carsharing programs around the country, including PhillyCarShare in Philadelphia, Mint Cars On-Demand in New York City and Boston, and IGO CarShare in Chicago.

[11] http://tsrc.berkeley.edu/sites/tsrc.berkeley.edu/files/Ridesharing%20in%20North%20America%20Past%20%20Present%20%20and%20Future.pdf.

[12] The number of city pairs created in a hub-and-spoke network is equivalent to $\frac{1}{2}(x + x^2)$, where x is the number of spokes. Hence, a hub that has nonstop service to 50 cities can theoretically provide nonstop and one-stop service to 1,275 city pairs.

is high passenger demand will an airline schedule point-to-point service that bypasses one of its main hubs.

The main airports in the country's largest cities tend to serve as airline hubs.[13] In addition, many large metropolitan regions have multiple airports with scheduled airline service.[14] The New York metropolitan area, for example, is served by LaGuardia, JFK, and Newark Airports. While Los Angeles International Airport is the main airport in Los Angeles, the metropolitan region contains many smaller airports with significant scheduled service, including airports in Burbank, Ontario, and Orange County. During the past 20 years, airlines have added service at secondary airports such as in Providence and Manchester outside Boston, Islip outside New York, and Long Beach outside Los Angeles. Because these secondary airports often have excess gate and operational capacity, airlines incur reduced costs and can charge lower fares (Dresner et al. 1996).

Secondary airports are located close to suburban populations that are the source of substantial amounts of both leisure and business travel demand. Studies of airport use patterns have consistently shown that airport proximity is important in determining which airport travelers use in a multiairport region (Windle and Dresner 1995). For shorter-haul, interregional flights, the access time saved by being closer to a suburban airport may be even more important if it makes flying faster and more convenient than use of a surface mode. Indeed, during the 1990s, the term "Southwest effect" was coined after a study by the U.S. Department of Transportation found that initiation of a service by Southwest Airlines—often at low prices and from secondary airports—not only diverted passengers from hub airports but also attracted travelers who would have driven or not traveled at all (Bennett and Craun 1993).

[13] For example, Dallas, Miami, and Chicago are hubs for American Airlines; Houston, Chicago, and San Francisco are hubs for United Airlines; and Atlanta, Detroit, and Minneapolis are hubs for Delta Airlines.

[14] The Los Angeles–San Francisco market is served by flights between Los Angeles International Airport and San Francisco International Airport (SFO), Oakland International Airport and Burbank Bob Hope Airport, and John Wayne Airport (Orange County) and SFO. The Dallas–Houston market is served by George Bush Intercontinental Airport, Dallas–Fort Worth International Airport, Dallas Love Field, and William P. Hobby Airport (Houston).

Regional Differences in Airline Service Frequency

Unless distances are too short to make flying a time-saving option, large city pairs in the United States rarely lack scheduled airline service. Figure 3-5 shows the number of nonstop flights in 200 of the country's most heavily traveled interregional city-pair markets on the basis of traffic data collected by the Federal Aviation Administration (FAA).[15] Nonstop service is available in slightly more than half the city pairs. Most of the markets that lack service are separated by 100 to 150 miles, which is too short to generate a viable passenger demand. In cases where markets separated by short distances have scheduled air service, it is usually provided in a small commuter jet or turboprop scheduled for passengers connecting on longer-distance trips. For example, Delta Air Lines offers 18 commuter flights a day between Chattanooga and Atlanta, which are separated by less than 125 miles. Nearly all of the passengers on these commuter flights are on a connecting service.[16]

The interregional city-pair markets having the most flights per day usually involve large cities and distances of 200 miles or more. Airlines serving the 10 airport-pair combinations in the Los Angeles–San Francisco market offer more than 100 nonstop flights per day; travelers in the Detroit–Chicago and Dallas–Houston markets can choose from more than 60 flights per day. Boston–New York and Washington–New York are among the most densely scheduled airline markets in the country, despite abundant intercity train and bus service.

Short-haul flights may incur disproportionate schedule delays because weather and traffic conditions can make them the primary candidates for air traffic control holds.[17] However, the potential for such

[15] http://apps.bts.gov/xml/ontimesummarystatistics/src/ddisp/OntimeSummarySelect.xml?tname=OntimeSummaryBothData.

[16] In the first quarter of 2012 (on the basis of a review of U.S. Department of Transportation origin–destination data from its 10 percent ticket sample), an average of two passengers per day traveled between Chattanooga and Atlanta, when connecting traffic is excluded. Other examples are Augusta, Montgomery, and Birmingham; all are less than 150 miles from Atlanta, but each has 15 or more flights per day to and from Atlanta. Chicago–Madison (122 miles, 27 daily flights), Chicago–Champaign (125 miles, 10 flights), Chicago–Fort Wayne (140 miles, 13 flights), and Dallas–Tyler (109 miles, eight flights) are other examples of short-distance markets with frequent nonstop service only because of hub-related traffic. In 2012, these markets, plus Atlanta–Chattanooga, had a combined total of 45,000 flights (125 per day), but the travelers consisted almost entirely of connecting passengers. Each flight averaged less than one nonstop passenger.

[17] The reason is that short-haul flights can be released intermittently to fill gaps in the traffic stream of longer-haul flights.

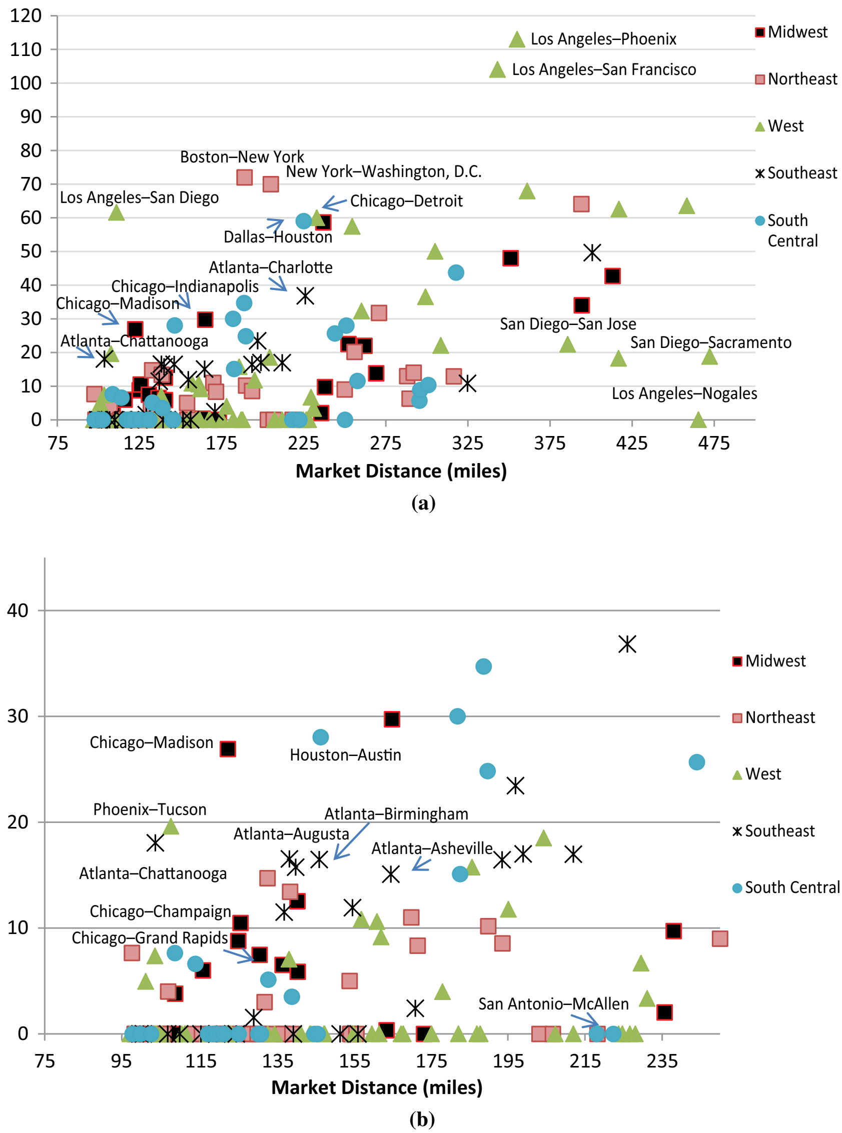


FIGURE 3-5 **Number of daily airline flights in interregional markets: (*a*) for all 200 and (*b*) with longer distance and very large markets excluded.** (SOURCE: http://apps.bts.gov/xml/ontimesummarystatistics/src/ddisp/OntimeSummarySelect.xml?tname=OntimeSummaryBothData.)

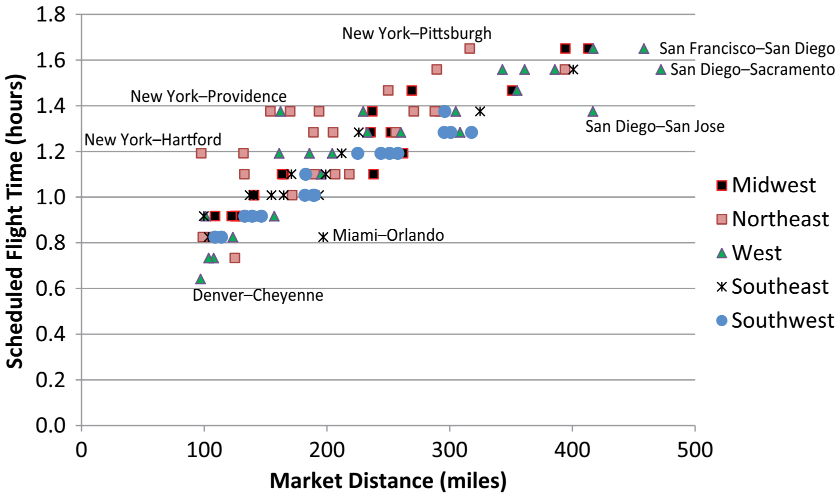


FIGURE 3-6 Scheduled flight times in interregional markets. (SOURCE: http://apps.bts.gov/xml/ontimesummarystatistics/src/ddisp/OntimeSummarySelect.xml?tname=OntimeSummaryBothData.)

delay is not uniform across the country. Figure 3-6 shows average scheduled flight times for 112 interregional markets that have airline service.[18] Markets in the Northeast and Southeast tend to have longer scheduled flight times than markets of comparable distance in the South Central and West regions. A longer scheduled flight time in one market than in another having comparable distance is usually due to the addition of buffer time by the airline in anticipation of recurrent delays. New York markets, as a rule, have the longest scheduled flight times per distance traveled.[19] For example, the scheduled flight time for New York–Providence is 27 percent greater than that for San Francisco–Fresno, even though the distances are about the same. Even when the schedule buffers in New York are taken into account, nearly 30 percent of flights scheduled for arrival at LaGuardia and Newark airports during 2013 were canceled or delayed by 15 minutes or more.[20] Flights into and out of New York traverse the most

[18] The 112 markets are those among the top 200 interregional markets having airline service. Many of the 200 markets are too near each other to support airline service.

[19] Most scheduled times exceed flying times as a result of this buffering.

[20] http://www.transtats.bts.gov/ot_delay/OT_DelayCause1.asp?pn=1.

congested airspace in the country. The congestion contributes to flight delays, and their frequency is exacerbated by severe winter and summer weather patterns that are more problematic in the eastern half of the country than in the western half. Airports with the highest on-time performance are concentrated in the West, with the notable exception of San Francisco International Airport, which suffers from episodic delays caused by fog.

While Americans fly mainly by commercial airline, some travel in private general aviation aircraft. In 2001, the last year for which general aviation passenger traffic data are available, private planes accounted for about 3 percent of person trips flown.[21] Travelers used general aviation more for short-haul than for longer-haul travel. The average one-way person trip length by private aircraft was about 500 miles, compared with 1,400 miles for airline trips. Individuals who choose private flying for interregional travel presumably value the convenience of a service that can access many more airports.[22] General aviation flights also offer nonstop itineraries, flexible schedules, reduced terminal time, and the potential for greater onboard productivity. Of course, travelers who fly by private airplane pay a substantial fare premium for its advantages.

The Changing Airline Industry

Smaller jets and turboprops are generally used by airlines for short-haul flights. According to FAA, airlines had been reducing flights using these smaller aircraft because of volatility in jet fuel prices starting in the early 2000s (Ryerson and Hansen 2010) and weakened business travel demand during the economic recession that followed.[23] Before these developments, short-haul airline service already had several competitive disadvantages with respect to the surface interregional modes. For example, the time consumed by ground access to the airport, security screening, transiting the airport to reach gates and baggage carousels,

[21] http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_42.html.

[22] There are about 5,000 public-use airports in the country, less than 10 percent of which have airline service.

[23] Jet fuel prices increased by 57 percent from 2007 to 2012, according to the Massachusetts Institute of Technology Airline Data Project (Wittman and Swelbar 2013).

and waiting to board the airplane can add a disproportionately large share of the total travel time required for a short-haul flight. These time requirements can be large collectively and can limit a business traveler's ability to devote travel time to work or other productive uses.

Airlines have sought to reduce the number and length of time penalties that can deter flying shorter distances. To make security screening less burdensome, airlines have been working with airports and the federal government to scale back the wait times that deterred flying after the September 11, 2001, terrorist attacks. For example, online check-in and preclearance lanes have been created, and security wait times are reported on the Internet. As is true for travel by other modes, the introduction of portable electronic devices has reduced the time penalties associated with flying. Travelers equipped with a mobile phone, tablet, or laptop can conduct work and remain connected to their workplace and family during their trip. They can also use these devices to stay productive and arrange travel alternatives in the event of severe delays or cancellations. Whether air travel is as accommodating to the use of these portable devices as are the other interregional modes is not clear, however.[24] A 2011 study of the share of passengers using portable devices found that airline passengers lagged passengers in other modes.[25] For example, about 35 percent of airline passengers were observed to use portable devices, compared with more than half of the passengers on intercity trains. This percentage may have risen in response to the recent relaxation of federal policy on the use of electronic devices in aircraft, despite the limits that remain on telephone calls.

The ability to make productive use of time spent traveling can be particularly important to business travelers, as explained in Chapter 2. For many leisure travelers, flying remains an expensive option for short trips in comparison with the surface modes, especially the bus and the car. Nevertheless, for price-sensitive leisure travelers, advances in computer and telecommunications technologies have had other benefits. In particular, the Internet has transformed how airlines price and market their

[24] According to data gathered by Schwieterman, Battaglia, et al. (2013), air travelers have been restricted in their use of electronic devices for an average of 40 minutes per flight because of prohibitions on their use before takeoff and landing.

[25] https://www.faa.gov/news/press_releases/news_story.cfm?cid=TW189&newsId=15254.

services. Travelers seeking low fares can readily search for and compare prices by using airline websites and third-party sites such as Expedia.com and Priceline.com. Airlines are using their websites and e-mail distribution lists to identify price-sensitive travelers and to offer them discount tickets for seats that would otherwise fly unoccupied. Online features such as electronic ticketing and remote check-in not only save time for travelers but also allow airlines to reduce administrative costs and travel agent commissions, which may translate to lower fares for some travelers.

These various examples of how airlines tailor their fare and service offerings to the interests of individual market segments illustrate why general characterizations about the service attributes of the transportation modes are unwise. Airlines, like carriers in other modes, use multiple strategies aimed at their various market segments. They can choose to supply a service that is relatively infrequent and low in price, or they can provide more costly, frequent service and charge higher fares accordingly. Even on a single flight, a price-differentiating airline can charge a range of fares and offer passengers different levels of travel comfort and convenience. Furthermore, the airline industry continually adapts to changes in the economic and demographic environment. In recent years, for example, some low-fare airlines that had operated from secondary airports have entered and added capacity to hub airports to attract more business travelers. Meanwhile, "ultra–low fare" airlines, such as Spirit and Allegiance, are offering leisure travelers heavily discounted base fares but charging many ancillary fees for checked luggage, carry-on items, and seat assignments (Wittman and Swelbar 2013).

Deregulation of the airline industry some 40 years ago gave airlines the flexibility to adjust their fares and service offerings rapidly. Airline traffic has grown substantially since then, and the federal government, state and local airport authorities, and airlines have sought to improve on-time performance and make flying more convenient and reliable generally. On the groundside, investments guided by the federal Airport Improvement Plan have been made to expand capacity at the country's major hubs by adding runways, taxiways, gates, terminals, and service facilities.[26] On the airside, a long-term air traffic control modernization

[26] http://www.faa.gov/airports/resources/publications/reports/media/fact_2.pdf.

program known as NextGen is intended to increase the utilization and capacity of a redesigned airspace (FAA 2014). FAA has predicted that these investments will lead to air service reliability improvements in most metropolitan locations. However, the agency has noted that the role of congestion management may need to be examined in some places where large additions to physical capacity are unlikely to be made, such as the high-density airspace serving Washington, Philadelphia, and New York (FAA 2007, 16). (Of the five U.S. airports with regulatory restrictions on daily takeoff and landing slots because of perceived capacity shortages, four are located in the Northeast: Reagan National, Newark, JFK, and LaGuardia.)

Flying by private jet and other general aviation aircraft remains expensive, but business models have been introduced in recent years intended to make this choice easier for companies and individuals. Business jet fractional ownership programs charge members a one-time signup fee, a monthly management fee, and an hourly fee to use an airplane. Some of the programs sell debit-like cards that entitle holders to a certain number of flight seat hours.[27] The cost for a 20-hour card can be on the order $10,000, which is equivalent to more than $500 per seat hour.[28] Such rates are high relative to most airline fares but are not out of line with the highest-priced tickets paid by business travelers.[29] In the belief that general aviation aircraft could have an even larger role in interregional travel over the next several decades, the National Aeronautics and Space Administration (NASA) is investigating technologies to make the aircraft easier and less expensive to operate and manufacture, including human–automation systems, new sensors and software systems, electric propulsion, and robotic composite manufacturing processes.[30] NASA believes that the development of these systems could yield some early benefits for airlines and eventually lead to general aviation aircraft that are affordable for on-demand, short-haul transportation services.

[27] http://www.sentient.com/jet-card.html.
[28] https://www.netjets.com/MarquisJetCard/.
[29] http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/aerospace_forecasts/2014-2034/media/2014_FAA_Aerospace_Forecast.pdf.
[30] http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140002448.pdf.

BUSES AND INTERREGIONAL TRAVEL

Interregional bus service is extensive in the United States when both scheduled and charter carriers are included. According to estimates by the American Bus Association (ABA), total miles traveled by charter buses are substantially greater—by about 50 percent—than miles traveled by scheduled carriers.[31] Total charter activity is probably even greater than implied by the ABA estimates because smaller charter operators are less likely to be members of the ABA. How much of reported charter bus mileage involves itineraries of 100 miles or more is difficult to ascertain because of the diverse range of services provided by these operators. An estimated 4,100 companies operate coach-style buses.[32] Most have fleets of 10 or fewer vehicles, almost all of which are used in charter service.[33] About 100 companies operate fleets of 50 or more vehicles; in these cases scheduled interregional service is likely to be their main line of business.

The largest intercity bus carriers are Greyhound Lines and Coach USA.[34] Greyhound Lines, long the country's largest scheduled bus operator, does not dominate the interregional market as it did 30 years ago. The carrier's national network extends to more than 2,400 stations, but a significant amount of scheduled bus service is provided by smaller carriers whose regional networks connect to Greyhound's trunk lines.[35] During the past decade, however, the interlining and network-based model for providing scheduled bus service has been challenged by a new business model emphasizing express service between the downtowns of large cities with few or no intermediate stops or connections to regional bus networks. These express operators have further exploited the economic advantages of low capital requirements and assets that are highly mobile by eliminating the fixed costs of stations, baggage handlers, and ticketing kiosks.

[31] ABA is the trade organization of the intercity bus industry. It has more than 1,000 members who operate charter, tour, fixed-route, and airport express services. Many smaller charter bus operators are members of the United Motor Coach Association.

[32] John Dunham and Associates, Motorcoach Census 2011, and http://www.buses.org/files/Foundation/Motorcoach-Amtrak-Comparison.pdf.

[33] http://www.buses.org/files/Foundation/Motorcoach-Amtrak-Comparison.pdf; http://www.buses.org/files/Foundation/Final_Motorcoach_Census_2011_7-3-2012.pdf.

[34] http://www.buses.org/files/Foundation/Motorcoach-Amtrak-Comparison.pdf.

[35] http://www.buses.org/files/Foundation/Final_Motorcoach_Census_2011_7-3-2012.pdf.

The city-to-city express bus model has its roots in the buses operating between the Chinatowns and other immigrant communities in New York, Boston, Philadelphia, and other large cities in the Northeast starting in the late 1990s (Klein 2009). By boarding and dropping off passengers curbside rather than paying for access to bus terminals and by avoiding stops en route, the Chinatown operators could charge lower fares than traditional network carriers and make trips faster. Having learned of these services through word of mouth, students and other bargain seekers from outside the immigrant communities started using the curbside buses, some of which began posting schedules and selling tickets over the Internet. The New York City Department of City Planning (2009) estimated that more than 250 intercity buses were departing and arriving each day in Manhattan's Chinatown district.

By the mid-2000s, the new curbside bus companies were providing service to locations outside immigrant communities (e.g., near universities and adjacent to major transit stations). Websites such as Gotobus.com expanded the customer base by making it easier to find and pay for service.[36] To attract more riders, competing carriers started varying their fares and practicing the yield management strategies used by airlines. They offered deeply discounted tickets (e.g., $1 plus a $0.50 reservation fee) to early purchasers while raising ticket prices for walk-up customers as seats began to fill. At the time, the deeply discounted fares created goodwill and positive publicity for bus transportation when short-haul air travel was becoming slower and more cumbersome because of increasingly restrictive security procedures (Schwieterman et al. 2011; Schwieterman et al. 2007).

The network and corporate bus companies responded to the growth in the curbside bus market. Coach USA introduced Megabus, which had already been operating in Europe, to the U.S. market in 2006 (Schwieterman and Fischer 2010). Megabus has since grown to serve markets in more than 30 states and Canada. Greyhound added express service on its main network and established an independent line, BoltBus, which served curbside locations, sold tickets mainly on the

[36] Bus booking websites similar to Gotobus have since been introduced, including Wanderu and Busbud.

Internet, and offered point-to-point service much like the earlier express operators. The established carriers purchased new buses with amenities such as synthetic leather seats spaced with ample leg room, video monitors, power outlets, reserved seating, and Wi-Fi service (Klein 2015; Schwieterman et al. 2015). Like the Chinatown buses, they boarded passengers at sites adjacent to downtown transit stations and universities. They structured Internet fares to promote advance purchases, including guarantees of some $1 seats (plus a small booking fee) on all routes. Some carriers hired greeters to meet passengers at boarding areas, but in general staffing was kept lean (Schwieterman et al. 2011; Schwieterman et al. 2007). By avoiding the operation of stations and ticket kiosks, the carriers could quickly and inexpensively enter new markets, experiment with new service features (including reserved seats in the case of Megabus), and add and withdraw capacity with little risk or capital expense.

Industry analysts have observed that riders attracted to the curbside buses have trended toward a younger demographic than riders who characterized the shrinking bus industry of the 1980s and 1990s (Klein 2015; Schwieterman et al. 2007; Schwieterman et al. 2011). Annual intercity bus ridership is estimated to have declined to less than 40 million by the 1990s, which was about one-quarter of the number of travelers using buses during the 1960s (Fischer and Schwieterman 2011). By the early 2000s, patronage consisted of a low-income demographic with relatively few female passengers, many of whom had come to view bus travel as unsafe (GAO 1992). Figure 3-7 tracks the growth in daily express bus departures since 2010. Although the rate of growth has slowed in recent years, the upward trend has remained, as bus companies have expanded into more interregional markets and as consumers have gained more awareness of the new service options.

Geographic Variability in Bus Service

According to ABA, more than 2,700 counties and cities across the country have at least some scheduled intercity bus service; only about 150 communities with populations of more than 25,000 lack any service.[37] Types and

[37] http://www.buses.org/files/Foundation/Motorcoach-Amtrak-Comparison.pdf. A map of intercity bus service can be found at http://www.aibra.org/pdf/usmap.pdf.

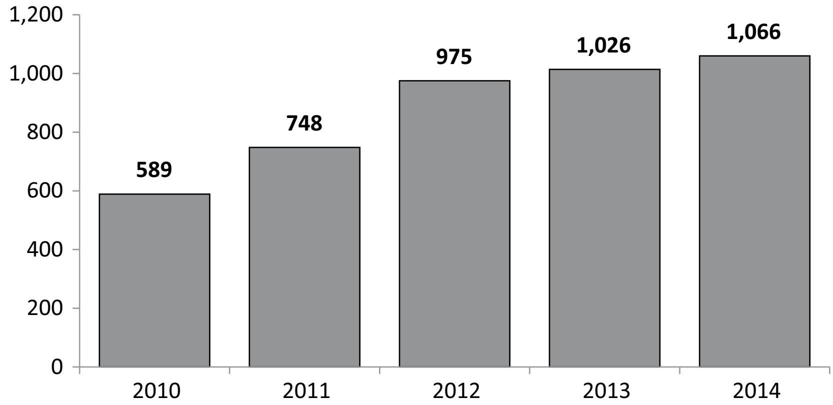


FIGURE 3-7 Number of daily bus departures by city-to-city express bus lines, 2010 to 2014. (Data provided by Chaddick Institute for Metropolitan Development, DePaul University.)

levels of bus service across markets and parts of the country are difficult to compare because of qualitative differences in service offerings, such as the number of connections and stops en route. For example, a trip by bus that involves multiple stops or that requires transfers is not necessarily comparable with a trip that can be made by a direct or express bus. Another factor complicating comparisons is the large number of bus operators providing service, including curbside operators, whose schedules are often fluid and posted only on the Internet. In such cases, accurate measurement of the amount of service being provided in the city pair can be difficult.

In Figure 3-8, the frequency of bus service is estimated for 200 of the country's largest interregional city-pair markets on the basis of a search of Internet timetables.[38] Some timetables were likely missed in the search. Only offerings of direct service were sought. Direct service was defined to include only those routings not requiring a transfer to another bus on the same carrier or a partner carrier (although single-line routes where the bus makes one or more intermediate stops were included). When service is defined in this restricted way, the variability in schedule frequency is high among the 200 city-pair markets. Nearly one-third do

[38] How these 200 markets were identified is explained in Chapter 4.

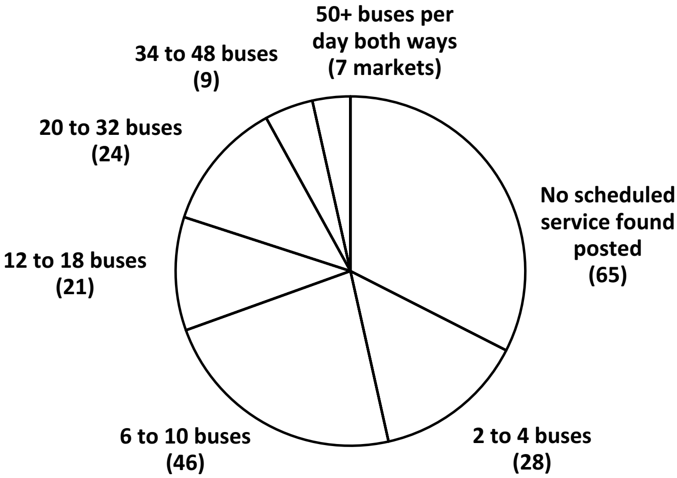
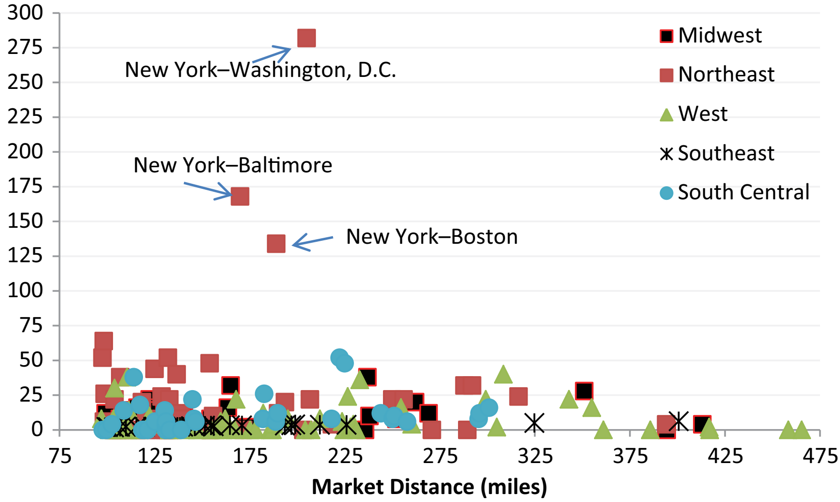


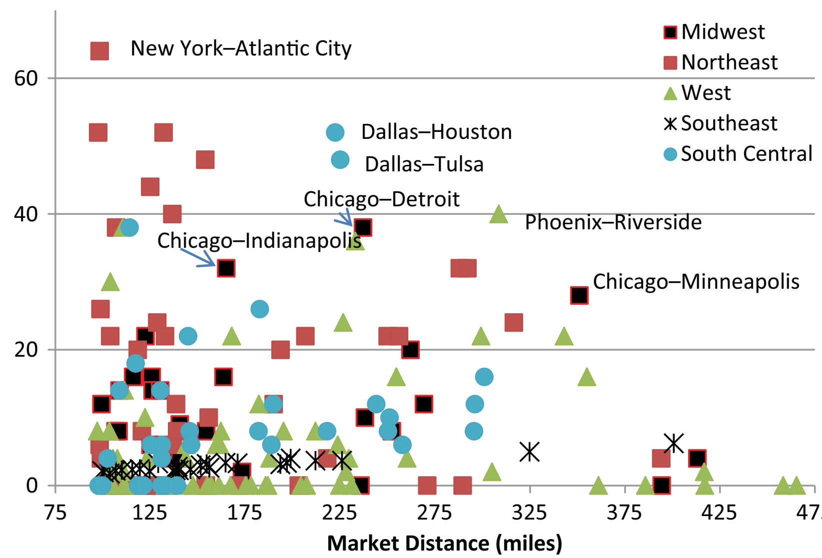
FIGURE 3-8 Frequency of scheduled (nonconnecting) bus service in top 200 interregional city-pair markets. (Data are from a review of schedules posted by operators on their websites, July 2014.)

not have any scheduled direct service, and nearly one-third have more than 12 direct service departures per day (i.e., six in each direction). A handful of markets, all in the Northeast, have more than 50 direct service buses per day, many of them providing nonstop express service.

Figure 3-9 shows the variability in direct service offerings across specific regions and markets. Some city pairs, among them New York City, have hundreds of departures per day; many other city pairs have a fraction of this total. New York's ability to fill buses is a function of its large population and its proximity to several other large Northeastern cities. In other regions, lower traffic volumes compel bus operators to structure their service offerings in network routings that require one or more transfers, which were not counted in the direct service data in Figure 3-9. As they have expanded into less densely traveled markets, even some of the larger express bus operators have had to structure their routes by using connecting services to provide enough service frequency to attract riders. For example, Megabus has established transfer hubs in Chicago, Atlanta, Pittsburgh, and Dallas (Schwieterman et al. 2011; Schwieterman et al. 2007). In addition, Megabus recently began selling through-service tickets via these hubs; previously,



(a)



(b)

FIGURE 3-9 Frequency of scheduled weekend bus service in top 200 interregional markets by distance and region: (*a*) all 200 markets and (*b*) excluding New York–Baltimore, New York–Boston, and New York–Washington, D.C. (Data are from a review of schedules posted by operators on their websites, July 2014.)

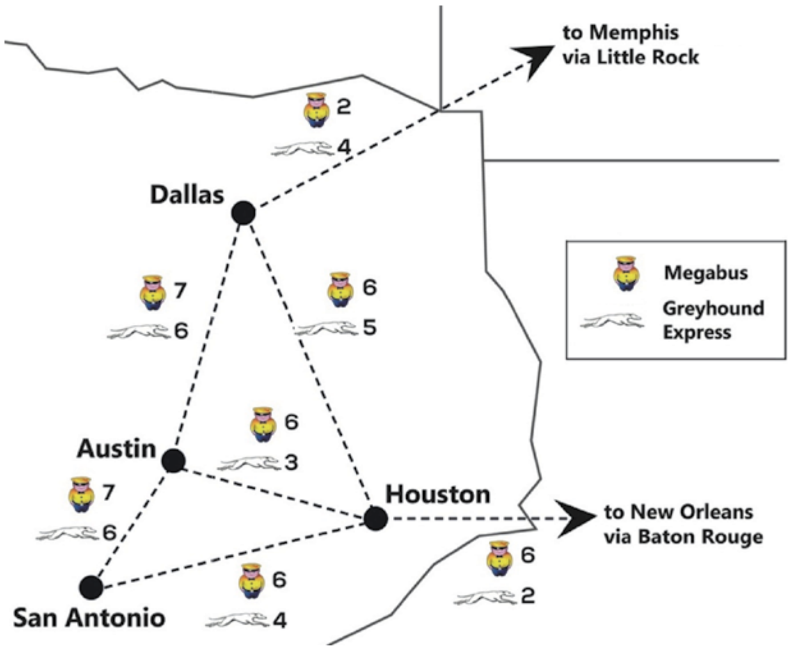


FIGURE 3-10 Megabus and Greyhound Express route structure in Texas, with the number of daily buses in each direction, July 2015. (SOURCE: megabus .com and greyhound.com.)

riders had to buy separate tickets for through travel. Figure 3-10 shows the route structures of Megabus and competitor Greyhound Express in Texas, where Austin, which has a large student population, serves as a hub for routings between the state's other large cities.

The Changing Bus Industry

The intercity bus industry has reestablished itself as an important mode of interregional transportation largely because of new service features, many of them originally introduced by carriers competing in the express bus market. A survey conducted in 2010 and 2011 yielded the following findings concerning express bus riders (Schwieterman et al. 2011):

- City-to-city express service has generated a large amount of new travel as opposed to diverting it from other modes and conventional buses.

Trips that would not have been taken on other modes or bus services were estimated to account for 22 percent of passengers. Only about one-third of riders reported that they had traveled on Greyhound in the past 12 months.

- Nearly half of all passengers were 18 to 25 years old. Almost three-quarters were 18 to 35.
- Ridership was more evenly split between male and female passengers than on Greyhound. Female travelers outnumbered male travelers by a 52 to 48 percent margin; male riders on Greyhound outnumbered females by 60 to 40 percent.
- About five in six passengers of express bus service are traveling for nonbusiness purposes.
- Express bus travelers are technologically adept. More than 90 percent reported that they plan to use electronic devices en route. Nearly half reported that they intended to use onboard Internet service during the journey.

These results, and those of another recent survey by Klein (2015), are consistent with ridership data provided to the study committee by BoltBus.[39] According to these data, 85 percent of the carrier's passengers travel for nonbusiness purposes, nearly 25 percent are students, more than three-quarters are under age 35, and about 60 percent are female. BoltBus has found that 30 percent of its riders had never before made an interregional trip on a scheduled bus.[40] Surveyed riders did not express a strong preference for curbside or intermodal station boarding locations, but they did emphasize the importance of being near public transit, which is how nearly two-thirds of the riders reported accessing the service.

An important feature of express bus offerings is avoidance of time-consuming intermediate stops. In view of the need for high traffic volumes, such point-to-point service is unlikely to become a standard offering in all interregional markets. Nevertheless, there is growing evidence that traditional network-based bus lines have benefited from the improving reputation of intercity buses and the service delivery innovations that express bus operators have introduced. Schwieterman,

[39] Presentation to the committee on February 14, 2013, by D. Hall, General Manager, BoltBus.
[40] Presentation to the committee on February 14, 2013, by D. Hall, General Manager, BoltBus.

Antolin, et al. (2013) report that Greyhound has been adding express routes, modernizing stations, adding onboard amenities, and experimenting with new ways for passengers to purchase tickets electronically and off site (e.g., at convenience stores).

Many corporate and network bus lines (as well as rail carriers) have learned from the early-adopter express bus operators and now provide onboard Wi-Fi as a standard feature and exploit new technologies such as smartphone applications to inform customers about schedule changes, delays en route, and other service issues. The latter capability is important for conveying information that was traditionally provided at bus stations and by call centers. Conversely, express bus operators have become more willing to pick up and drop off passengers at intermodal terminals and to partner with regional bus carriers in ticketing passengers for connecting service (Schwieterman, Antolin, et al. 2013). Luxury operators, such as LimoLiner and Red Coach, are also creating niches for premium services on heavily traveled routes. Such developments make predictions of how intercity bus services will evolve over the next few years difficult, and even more so over the next few decades. However, the bus has definitely reemerged as a mode of interregional transportation and merits consideration in the planning of the transportation systems intended to serve the country's interregional markets.

PASSENGER TRAINS AND INTERREGIONAL TRAVEL

Intercity passenger rail service in the United States is supplied almost exclusively by the federally created National Railroad Passenger Corporation, or Amtrak, in contrast to the other interregional transportation modes, which have many service providers. Amtrak operates about 300 regional and long-distance trains per day over about 21,000 miles of track. Most of the trackage is owned by private freight railroads (Figure 3-11).[41] Because of Amtrak's unique role in the provision of intercity train service, a brief review of its history and route structure is helpful before the availability of train service across regions of the country is compared.

[41] Alaska has passenger rail service running from Fairbanks to south of Anchorage, but the service is not connected to Amtrak and its continental system.

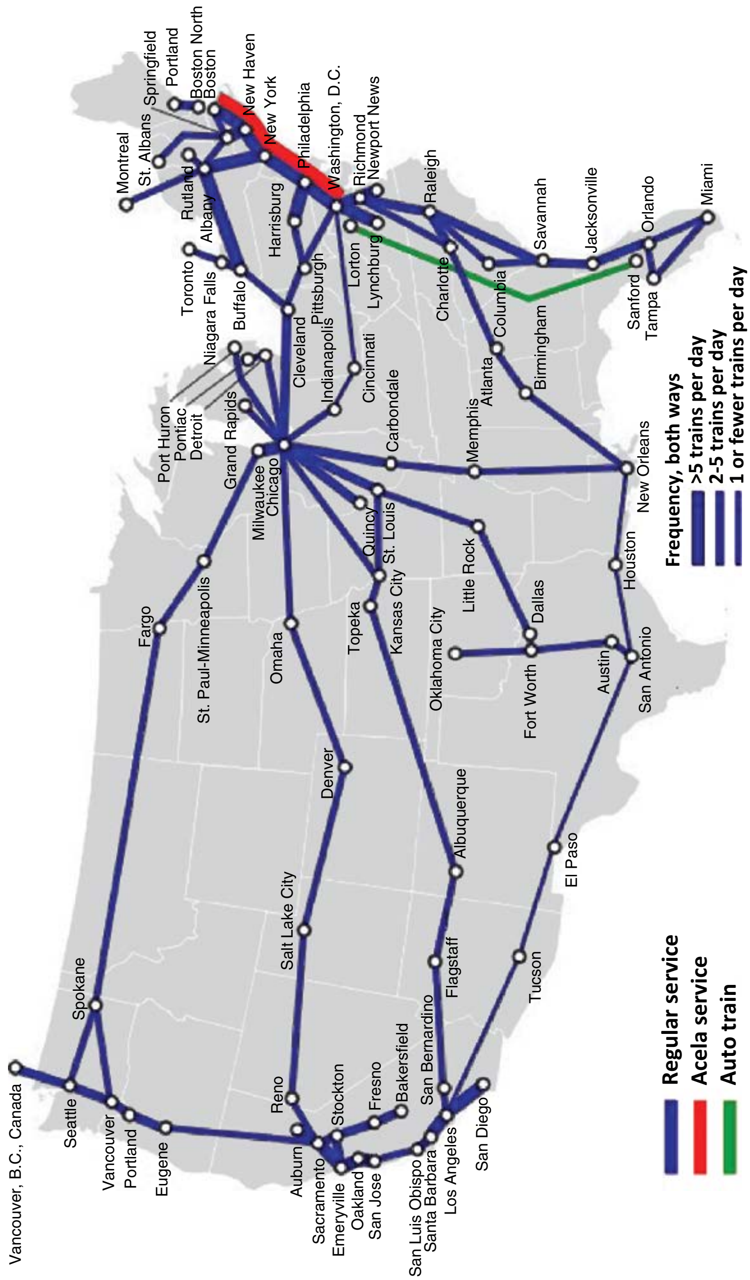


FIGURE 3-11 Amtrak passenger rail network.

Historical Circumstances Shaping Amtrak and Intercity Rail

Some of the country's youngest cities, such as those in Florida and the Southwest, have experienced most of their growth during the past half century. These cities, which became prominent after the highway and aviation networks had become ubiquitous, prospered far from traditional railroad and water routes. Nevertheless, through much of the 20th century, passenger trains operated in nearly all regions of the country. They had a formative effect on many cities such as Chicago, Atlanta, Minneapolis, and Dallas. As late as the 1960s, intercity passenger train service was still provided by dozens of private railroads, nearly all of which were also transporting freight.[42]

By the late 1960s, passenger trains were succumbing to traffic losses to automobiles and airplanes. Ridership had fallen by more than 75 percent since 1950 alone (AAR 1980; CBO 2003, xi). Amtrak, a quasi-public corporation, was formed through federal legislation in 1970 intended to relieve the private railroads of the financial burden of providing passenger service.[43] At the time, several railroads were bankrupt, including the large Penn Central, which had provided much of the rail service in the Northeast. Amtrak acquired passenger cars from the private railroads. In the case of the Penn Central, it acquired most of the bankrupt carrier's routes in the Northeast Corridor (NEC).[44] By law, the freight railroads that had divested their passenger service were required to provide Amtrak with access to their tracks at "avoidable cost" and to give Amtrak trains dispatching priority for any passenger service that was previously the responsibility of the private railroads.

After the private railroads divested their passenger service and were economically deregulated a few years later, they shed thousands of miles

[42] Keeler (1983) and Gallamore and Meyer (2014) provide brief histories of the regulation of freight railroads, their provision of passenger service, the creation of Amtrak, and the federal government's buyout of the Penn Central Railroad and creation of the Northeast Corridor.

[43] Rail Passenger Service Act of 1970, Public Law 91-518. The act authorized Amtrak to assume by contract the intercity rail passenger service obligations of railroads who wished to be relieved of these obligations as common carriers.

[44] The Railroad Revitalization and Regulatory Act of 1976 formed Conrail as a streamlined successor to the Penn Central Railroad in the Northeast.

of uneconomic branch lines to concentrate their movements over a smaller number of main lines that were maintained and upgraded specifically to accommodate expanded freight service.[45] These lines were made available to Amtrak as part of the freight railroads' legal obligation to allow the carrier to preserve preexisting passenger rail services. However, the central function of these lines was to serve freight trains, whose length and weight were growing.[46] Whereas the Amtrak-owned right-of-way in the NEC could retain a passenger orientation, circumstances differed elsewhere in the country, where freight lines were physically and operationally ill suited to frequent and fast passenger trains.[47] As in other parts of the country, train ridership in the Northeast had been dropping before the creation of Amtrak during the 1970s. However, Amtrak's ownership of most of the track in the NEC prevented passenger service from receding to the skeletal levels that characterized most other rail corridors, which were increasingly dedicated to the movement of freight.

Amtrak's Route Structure

Because the private freight railroads are obligated to provide Amtrak with track access only on routes that previously had passenger service, all other service additions must be negotiated by Amtrak. Such additions are rare, because freight railroads must be fully compensated for the loss of any capacity caused by Amtrak's trains, now or in the future. Nevertheless, a number of states provide subsidies to Amtrak to increase the number of trains on routes where there is a preexisting access obligation. Thus, Amtrak's route structure consists of the NEC, state-supported routes, and long-distance routes.[48]

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[45] A discussion of this history is given by TRB 2015, Chapter 1.

[46] Amtrak owns about 3 percent of the total track miles over which it operates.

[47] Roadbed design, banking, spacing for safety margins, ballast requirements, signal improvements to allow for higher-speed railroads, and numerous other factors must be changed when passenger and freight service are mixed at high levels of frequency (Dingler et al. 2009).

[48] In addition, Amtrak engages in related ancillary businesses, including operating commuter railroad services under contract; providing rail infrastructure access to commuter agencies and freight railroads; and performing rail services for other rail operators, both commuter agencies and freight railroads, on a reimbursable basis.

Northeast Corridor

About 80 percent of the 457-mile NEC rail right-of-way linking Washington, New York, and Boston is owned by Amtrak.[49] Short sections (10 to 50 miles) are owned by Metro-North Commuter Railroad and the states of Connecticut and Massachusetts. Through investments made over the past four decades, Amtrak has completed the electrification of the NEC lines and introduced higher-speed service on its Acela trains.[50]

The NEC crosses eight states and the District of Columbia. It is used by Amtrak as well as eight commuter[51] and four freight railroads, which creates a complex financial and operating environment. The approximately 150 Amtrak trains that operate per day over segments of the NEC transport more than 10 million passengers per year (Northeast Corridor Commission 2015). The corridor's commuter and intercity services transport more than 750,000 people each day, including the more than 35,000 per day transported by Amtrak.[52]

The following are Amtrak's major NEC markets:[53]

- Washington–New York (including service to Newark, Philadelphia, Wilmington, and Baltimore—226 miles): 37 trains per weekday in each direction at average travel times of 2 hours 45 minutes for Acela service (16 trips per day each direction) and 3 hours 30 minutes for conventional service (21 trips per day each direction). A subset of this market—New York–Philadelphia—is served by an additional 10 "Keystone" weekday trains in each direction.

[49] Amtrak owns or controls approximately 401 miles of the 457-mile NEC.

[50] Acela is capable of reaching speeds up to 150 miles per hour, and Amtrak's conventional trains in the NEC can attain speeds up to 125 miles per hour.

[51] Commuter rail operators, subsidized by state and federal funding, include Massachusetts Bay Transportation Authority (providing service into Boston), Shore Line East (providing service from eastern Connecticut to New Haven with connections to New York), Metro-North Railroad (providing service to New York from New Haven and intermediate points to New York City), Long Island Rail Road (providing service into Penn Station, New York, from Long Island), NJ Transit (providing service into Penn Station from New Jersey), Southeastern Pennsylvania Transportation Authority (providing service between Trenton, New Jersey, and Wilmington, Delaware, to Philadelphia), Maryland Mass Transit Administration (providing service to Washington Union Terminal from Perryville, Baltimore, and western Maryland), and Virginia Railway Express (providing service from suburban Virginia locations into Washington Union Terminal).

[52] http://www.nec-commission.com/reports/nec-and-american-economy/.

[53] The service data given below were obtained from Amtrak's website timetables for July 2014.

- Boston–New York (including service to Stamford, New Haven, and Providence—231 miles): 19 trains per weekday at average travel times of 3 hours 30 minutes for Acela service (10 trains) and 4 hours 45 minutes for conventional service (nine trains).
- Washington–Boston (457 miles): 18 trains per weekday at average travel times of 6 hours 45 minutes for Acela service (10 trains) and 8 hours for conventional trains (nine trains).

All Amtrak trains operating exclusively in the NEC are priced by using yield management, since the major competitors with Acela for high-yield business travelers are the airlines operating between Boston's Logan, Washington's Reagan National, and New York's LaGuardia Airports. With its ability to exercise control over its right-of-way in the NEC, Amtrak has greater opportunity in this corridor than elsewhere in its system to compete with other interregional modes by increasing train frequencies and reducing schedule times. Nevertheless, even on the electrified and passenger-oriented NEC lines, the capacity for interregional service is constrained by the congestion resulting from having to share track with eight commuter railroads and freight trains operating over portions of the corridor. Track-sharing arrangements, some originating in legislation, limit Amtrak's ability to charge access fees that cover the costs associated with maintaining and renewing the NEC facilities. Of course, allocating many of these costs and isolating the beneficiaries of specific infrastructure investments are difficult in a corridor serving local, interregional, and longer-distance traffic. Amtrak's own ability to contribute to the maintenance and renewal of the NEC lines is constrained by the abundant bus and airline service in the corridor, which creates a competitive limit on how high the railroad can raise its fare levels. Amtrak's capacity to make targeted investments in the corridor is further limited by having to use part of its NEC passenger revenues to help sustain its system operations more generally.

State-Supported Trains

Amtrak's legal right to access freight railroad tracks has prompted a number of states to provide financial support for Amtrak to increase passenger train frequencies and reduce travel times in corridors where Amtrak has access rights. State-supported service exists in California, Virginia, New York, North Carolina, Wisconsin, Illinois, Washington, and Oregon, and several routes are supported by more than one state. In total, Amtrak operates 28 state-supported services in 17 states. About 15 million riders used these trains in 2013. In view of the growth in state-supported funding for passenger service, in 2008 Congress mandated the development of a standardized policy for Amtrak reimbursement, applicable to all train services less than 750 miles in length outside of the NEC.[54] According to the policy, individual states must support approximately 83 percent of Amtrak's operating costs. State-supported routes and their subsidy levels are discussed further in Chapter 5.

Long-Distance Trains

Amtrak operates 15 long-distance routes (Figure 3-11). This service generally includes dining and sleeper car service over travel distances of up to 2,800 miles. The routes contain many station pairs that are in the 100- to 500-mile range, but the service is not designed for these markets and the scheduling of trains often does not produce the most convenient departure and arrival times for interregional travelers. Furthermore, service frequency is limited because most routes have only one train per day in each direction.

Geographic Variability in Rail Service

Amtrak's route structure leads to considerable geographic variability in interregional train service. In particular, the "regional" routes designed to serve 100- to 500-mile markets are concentrated in the Northeast, Midwest, and West. The Northeast alone accounts for 12 of the 20 regional routes, followed by five in the West, two in the Midwest, and one in the South Central region. All but one (Boston–Brunswick, Maine) of the Northeast regional routes serve New York City, while Chicago has the same dominant role for regional service in the Midwest. Of the five regional routes in the West, some of them state-subsidized, two are in northern California, one is in southern California, one operates between northern and southern California, and one is in the Pacific Northwest (Oregon and Washington State).

[54] Section 209, Passenger Rail Investment and Improvement Act of 2008.

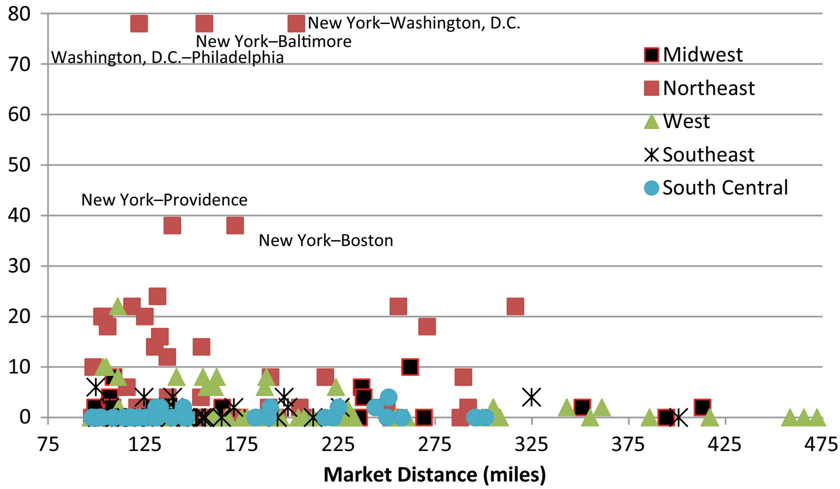
One state-subsidized train in the South Central region operates between Dallas and Oklahoma City.

The geographic concentration of regional trains creates substantial market variability in train service. Among the 200 most heavily traveled interregional city-pair markets,[55] 118 do not have any passenger train service, and 33 others are served by only one long-distance train per day in each direction. Figure 3-12 plots daily train service in the 200 markets. Regional schedules vary in the frequency of service. In the NEC, more than 75 trains operate daily between New York, Philadelphia, Baltimore, and Washington, and nearly 50 others operate between New York, Providence, and Boston. In Philadelphia alone, nearly 100 trains stop per day to connect to markets farther north, south, and west. Numerous medium-size cities, such as Wilmington, Providence, and Trenton, which are situated along the routes connecting Boston, New York, Philadelphia, and Washington, benefit from these passing trains. As a consequence, 33 of the 49 markets with the most frequent train service in the United States are located in the Northeast.

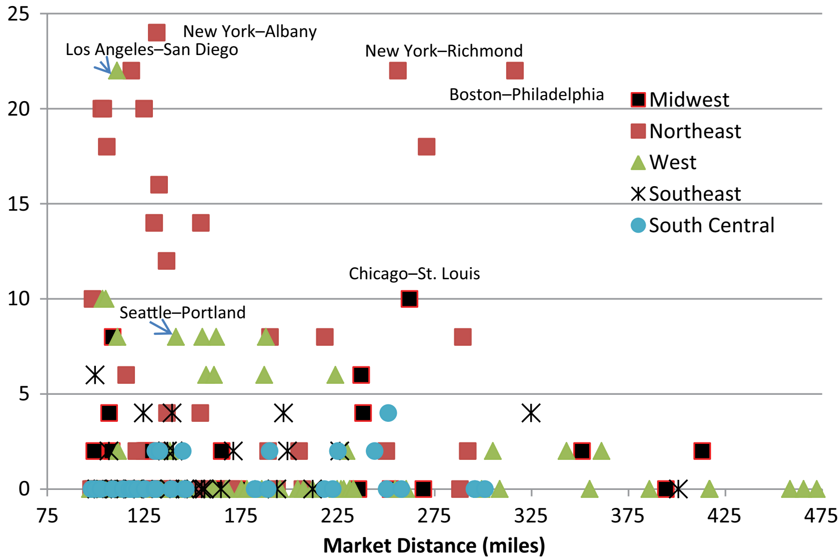
After the NEC, the interregional corridor with the most frequent train service is Los Angeles–San Diego, which is served by about two dozen trains per day. Farther to the north, eight to 10 trains per day stop in the Seattle–Portland corridor. Several daily trains connect through Chicago to provide service to Saint Louis (10 trains per weekday) and Detroit (six trains per weekday). Outside of the core service locations, passenger trains in the West, Midwest, Southeast, and South Central regions provide minimal service.

In general, the markets served by frequent trains enjoy the fastest service. Effective speeds (calculated on the basis of train schedules) between New York and Washington average between 60 and 85 miles per hour when Amtrak's Acela and regional trains are included. Indeed, the only interregional markets with average train speeds exceeding 60 miles per hour are all located in the NEC (on the basis of timetables and straight-line mileage for distance measurements) (Figure 3-13). Because Amtrak uses freight rail networks in all other regions of the country, its other

[55] See Chapter 4 for an explanation of how the 200 markets were identified.



(a)



(b)

FIGURE 3-12 **Number of daily Amtrak trains, both directions, in the interregional markets examined: (*a*) for all 200 markets and (*b*) excluding New York–Boston, New York–Providence, New York–Baltimore, and Washington, D.C.–Philadelphia.** (SOURCE: Amtrak website, accessed July 14, 2014.)

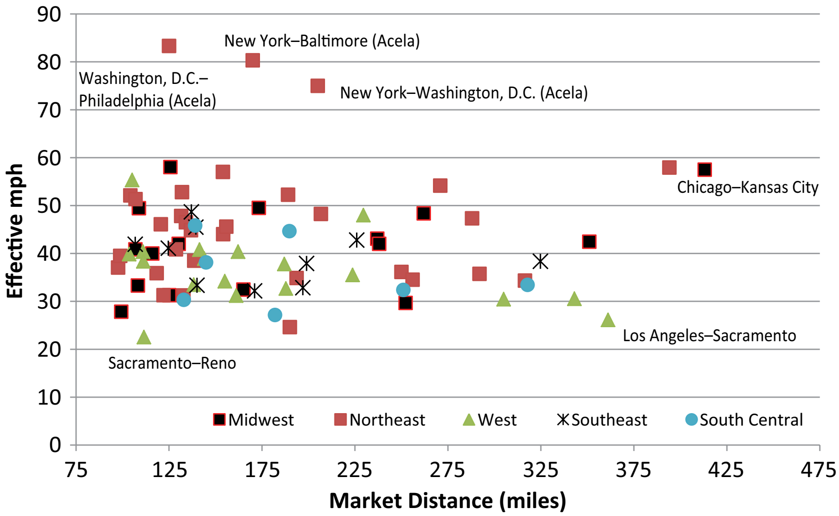


FIGURE 3-13 Effective travel speed (straight line, scheduled travel time) by rail in the top 200 markets. (SOURCE: Amtrak website, accessed July 14, 2014.)

trains operate at consistently lower speeds. In some markets, schedule speeds (calculated as above) average less than 30 miles per hour.

Evolving Role of Passenger Rail

Passenger rail is a potential beneficiary of the ongoing revitalization of many center cities in the United States, particularly those that have retained downtown train stations. The largest cities in the Northeast, as well as a number of cities in other regions such as Chicago, Saint Louis, Seattle, and San Diego, have strong downtowns with extensive public transit systems. These conditions can give interregional trains a distinct advantage for short-distance travel, especially for business travelers and others living in or visiting center cities. Whether intercity rail service itself can be a significant factor along with intercity buses in stimulating the revitalization of more downtowns is likely to depend on many factors, including changing patterns of urbanization; demographic and economic trends; transportation policy and funding; and the proximity of service to other cities in the region that have similarly situated train stations, comparable urban densities, and high-quality public transit.

The marketing of regional rail service continues to emphasize the comfort of train travel compared with that of automobiles, buses, and airlines. In general, trains offer passengers more seating space and allow greater freedom of movement (within and between cars), which can make travel time more productive and relaxing. Although passengers may have to wait at boarding areas, they do not have to wait in security lines similar to those at airports. Trains also allow riders to make uninterrupted use of their cell phones and other electronic devices. Amtrak's Acela service provides Wi-Fi and power outlets. Amtrak has partnered with states to make these amenities available on all regional trains.[56]

Outside the NEC, the prospect of significantly expanding passenger rail service—such as by scheduling more frequent and faster trains on existing routes or adding new routes—is complicated by Amtrak's need to use the freight rail network. Negotiated service expansions must often include infrastructure improvements such as new sidings, curve straightening, and new signal systems, as well as contributions to their maintenance. Such infrastructure upgrades can add significantly to the public subsidy burden. Accordingly, the question arises as to whether improving the freight rail infrastructure is more costly than building a new rail right-of-way to accommodate passenger service, particularly for any higher-speed services that would require major infrastructure upgrades. In the case of the state-subsidized routes, the general approach has been to make small, incremental investments in service expansions that can be more easily accommodated operationally and financially by all parties. This incremental approach has been pursued mainly in corridors where the freight railroads are asked to accommodate a few additional and slightly faster passenger trains per day. The applicability of this approach to a state contemplating a much larger service expansion is questionable. As discussed in Chapter 5, California has elected to forgo an incremental approach in favor of connecting its northern and southern cities with a new rail corridor that will be built specifically for high-speed trains.

[56] Amtrak estimates that Internet Wi-Fi is now available on all short-distance routes and is accessible to 85 percent of the railroad's ridership (http://www.amtrak.com/journey-with-wi-fi-train-station).

SUMMARY

This chapter has examined the attributes and availability of the transportation modes used for interregional travel in various regions of the country. Three modes of transportation are widely available: automobiles, airplanes, and buses. Passenger rail is used for some interregional trips, but its availability and quality are limited in most places.

The most widely available mode is the automobile. The country's highway system and automobile fleet are extensive. Travelers with access to an automobile can use it to make interregional trips with door-to-door service, unrestricted departure times, and low cost for each additional passenger. These attributes are unique to the automobile. Their appeal depends on the individual circumstances of the traveler and the potential disutility of driving caused by the risk of traffic delays en route, the requirement of finding parking at the destination, and lost productivity during the time spent driving. The data examined in this chapter suggest that the potential for encountering travel delays is greatest at the start and end of interregional trips because of high traffic volumes in urbanized areas. In parts of the country where interregional corridors pass through many urbanized areas, the potential for delays increases. New technologies, such as electronic toll collection systems and GPS navigation systems with real-time traffic monitoring, are changing the driving experience in ways that may counter some of the automobile's disadvantages for interregional trip making.

Intercity buses use the same ubiquitous highway network as automobiles and can provide services to a wide range of origins and destinations. They can also encounter traffic conditions that make service slow and unreliable in some markets. However, buses are constrained in where they can go and how frequently they can provide scheduled service because of their need to attract sufficient passenger traffic. Traditional regional bus networks rely on traffic flows from connecting and multistop service to fill buses and offer service frequency. In the nation's most densely traveled interregional corridors, bus operators are offering frequent, nonstop express service between high-demand downtown locations. When pickup and drop-off points are served by public transit, the bus can have an even wider market reach.

Express bus service is available in many parts of the country but has proved to be particularly well suited to corridors with characteristics similar to those in the Northeast. There, large cities are closely spaced, and downtowns have a strong commercial and residential presence and are well served by transit systems providing local access to bus lines. The advent of express service, made possible in part by the ability of operators to publicize schedules and sell tickets over the Internet, has contributed to the revitalization of the bus as a viable mode of interregional transportation.

In most city-pair markets of more than 200 miles, travelers have the option of flying. The price and availability of service depend on a number of factors, including the ability of scheduled airlines to fill flights with nonstop passengers as well as travelers connecting from more distant cities. Because many of the country's largest cities contain hub airports where airlines concentrate their connecting service, schedule frequencies can be high in many interregional travel markets. Secondary airports in many cities also offer lower-fare service attractive to leisure travelers. Flying is naturally suited to regions where cities are spaced farther apart, such as in the West, where many interregional corridors span more than 300 miles. Some closely spaced populous cities, such as those in the NEC separated by about 200 miles, have frequent airline service because of large volumes of time-sensitive business travelers. In this corridor, however, airline service is constrained by airway congestion, and it competes with frequent intercity rail and bus service. Travel by private general aviation aircraft is an expensive but viable option for some business travelers, and it has been expanded in recent years by business models such as fractional ownership programs. Whether general aviation can play a larger transportation role in the future is unknown, but such a role is envisioned by some researchers and technologists.

Finally, the supply of fast and frequent passenger rail service is concentrated in a few interregional markets. Most of the country's interregional trains operate in the NEC, where Amtrak owns most of the rail right-of-way. Elsewhere in the country, service is generally sparse and slow, and often nonexistent. A major deterrent to the expansion of passenger rail service outside the NEC is the ownership and heavy use of the only available rights-of-way by railroads transporting freight. In most of these markets, major corridor investments, including the building of new corridors, would be required to introduce substantially faster trains with service frequencies that can compete with airlines and other interregional modes. In general, the potential for such expansions is not promising because of the safety and operational conflicts presented by heavy freight traffic. The building of new corridors would almost certainly be required to accommodate high-speed service.

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CBO	Congressional Budget Office
FAA	Federal Aviation Administration
GAO	Government Accountability Office
TRB	Transportation Research Board

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4

Corridor Geography and Interregional Transportation

As explained in Chapter 3, the supply of interregional transportation services is not uniform across the country, except for the widespread availability and use of the automobile. High rates of car ownership, a low per passenger cost of driving, and the distinct service attributes of the car help explain its prevalence. There are marked regional differences in the availability of the other modes of interregional transportation—airlines, buses, and trains—especially in the case of passenger trains. These differences arise from many factors. One that is emphasized in this chapter is corridor geography, because it can be especially germane to the ability of a railroad to supply competitive passenger train service.

A generally favorable condition for both intercity rail and bus service is the existence of commercially vibrant, densely populated downtowns where train and bus terminals are connected to extensive public transit systems that make service access convenient. Some populous but relatively remote U.S. cities, such as Minneapolis and Denver, have strong downtowns and good public transit systems; however, they have minimal intercity train service in particular. For reasons explained in this chapter, their local conditions may be supportive of intercity train service, but their regional geography is not. Unlike buses, which can operate with competitive schedule frequencies with about 40 passengers per departure, competitive train service requires traffic volumes capable of filling 200 to 300 seats, or five- or six-car sets.[1] As discussed in the previous chapter, the density of train service is high in the Northeast Corridor (NEC), which contains some

[1] For example, the service-competitive Amtrak trains operating on Northeast Corridor routes average about 220 passenger miles per train mile and require trains sets of about 300 seats. See Federal Railroad Administration Rail Service Metrics and Performance: Quarter Ended June 2015, Table 5 (https://www.fra.dot.gov/eLib/Details/L17088).

closely spaced large cities as well as many smaller cities whose travelers can share the same train. The geography of the NEC thus favors the provision of efficient, single-line rail service with high traffic densities.

When large cities are dispersed and distant from one another, more interregional corridors are created, which are generally longer and less suited to efficient train service. They favor other modes such as airplanes that can collect and consolidate traffic in longer corridors and across a wide landscape. The positioning of cities in this dispersed manner is common in the United States, particularly in the interior. The significance of corridor geography for interregional transportation is apparent from the location of the country's 200 most heavily traveled interregional markets. In some parts of the country, numerous city-pair markets overlap to create densely trafficked corridors that, in turn, shape the interregional transportation system. In other parts of the country, the transportation system is shaped by a more dispersed traffic pattern. This chapter profiles the major corridors connecting cities in five large geographic regions—the Northeast, Midwest, South Central, Southeast, and West. The review does not account for all relevant factors, but it offers insight into why some interregional markets, especially those in the Northeast, have sustained significant intercity train service while others have not.

GEOGRAPHIC PROFILE OF U.S. INTERREGIONAL CORRIDORS

As discussed in Chapter 2, U.S. statistics on interregional travel are based largely on the American Travel Survey (ATS) conducted in 1995 and are therefore outdated. To compensate, the Federal Highway Administration (FHWA) provided the study committee with tables that estimate the number of long-distance person trips between city pairs in 2008. The estimates make use of airline and Amtrak ticket data and a model that calculates highway trips on the basis of relationships observed in the ATS and changes in population, households, and employment.[2] Despite data

[2] As noted in Chapter 1, when used in this report, "city" refers to the core-based statistical area (CBSA). The city identified (e.g., New York City) is the core city in the CBSA, but all travel, demographic, and economic statistics are based on CBSA values. The methods used by FHWA to estimate trip tables are described in the Appendix.

shortcomings and modeling error, these calculated trip tables offer a general indication of where the country's most heavily traveled interregional corridors are located and how their traffic is distributed among modes.

The tables suggest that about 200 interregional (100- to 500-mile) city-pair markets in the United States generate at least 1,000 person trips per day. A map of the 200 markets shows how they cluster in five broad geographic regions (Figure 4-1). Nearly one-quarter (48) are in the Northeast, which is defined as spanning New England to Virginia. An additional 28 are in the Midwest, centered on Chicago and involving other cities in states along the Great Lakes and the Upper Mississippi River (Figure 4-2). Atlanta and Miami anchor most of the 26 markets in the Southeast, and all 34 markets in the South Central are located in Texas and its neighboring states of Oklahoma and Louisiana. The remaining 64 are in the West, which encompasses the desert Southwest, California, and the Pacific Northwest.

Northeast

The Northeast has the country's oldest cities. The importance of rivers and ports for the country's early industry and transportation is evident in the urban geography of the region, which has many closely spaced cities along the Atlantic seaboard. Nearly all of the cities in this region matured during the 19th century, when railroads dominated interregional travel.

The close spacing of cities in the Northeast creates many short interregional markets. Straight-line distances range from 100 miles (Atlantic City–New York City) to 394 miles (Boston–Washington, D.C.), with a median of only 137 miles. Because of its size and central location in the region, New York City generates substantial traffic in pairings with the other large cities to the north (Boston, Providence, and Hartford) and south (Baltimore, Washington, and Richmond). New York also generates significant traffic flows with smaller inland cities such as Binghamton, Syracuse, and Rochester. Overall, New York City dominates interregional travel in the Northeast. It is part of 26 of the top 48 city-pair markets.

The central position and role of New York City are evident in Figure 4-3. The axis running from Boston through New York to Washington

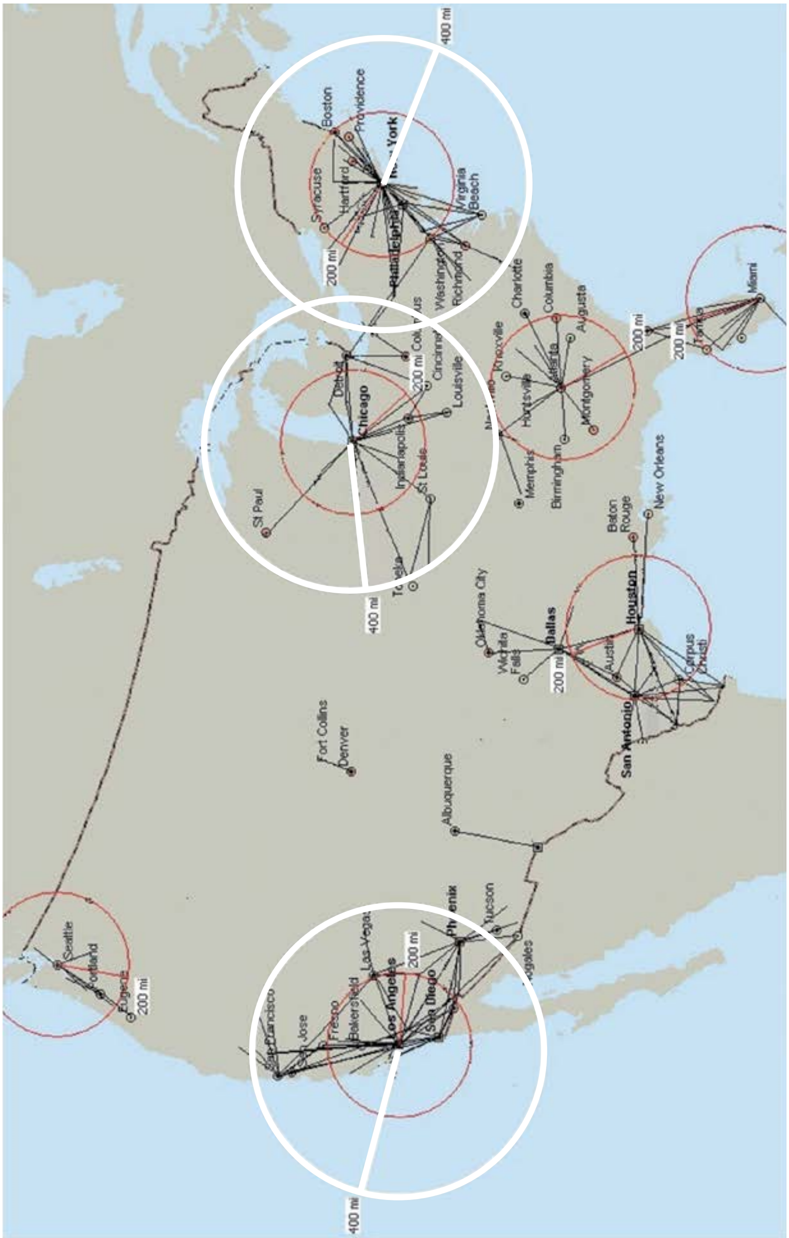

FIGURE 4-1 Location of 200 of the most heavily traveled interregional city-pair markets.

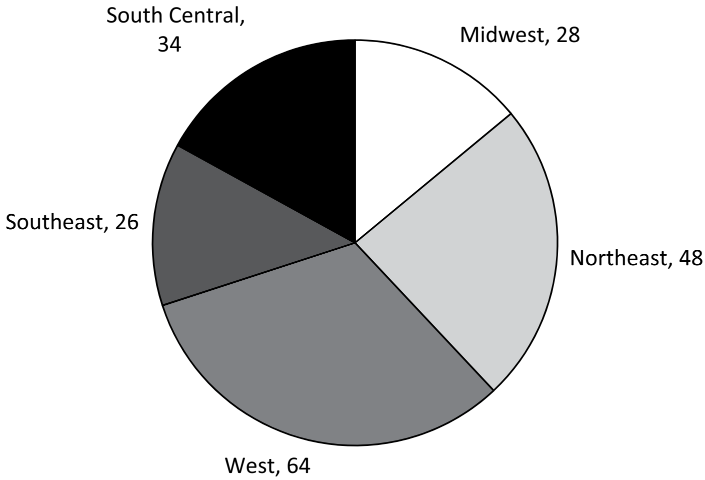

FIGURE 4-2 Regional distribution of 200 of the most heavily traveled interregional city-pair markets.

is the spine of the 400-mile NEC. Of the 48 travel markets concentrated in the region, 21 contribute to the traffic flowing through the NEC. Seven of the eight most heavily traveled markets in the Northeast are among these 21.[3] Because so many trips begin or end in centrally positioned New York, interregional trips in the NEC average less than 175 miles.

The many overlapping Northeastern markets create traffic densities on the NEC that allow the frequent scheduling of train service. The Northeast has the highest use of passenger trains in the country, with 11 of the country's top 15 rail markets being in the region. The New York–Washington market has the highest rail mode share (25 percent) in the country. There are several other interregional markets in the NEC that span less than 100 miles (and are thus not included among the 48 interregional markets) but have similarly high ridership, including New York–Philadelphia and Baltimore–Philadelphia.

[3] The 21 markets only include those in which both cities in the pair are in Massachusetts, Connecticut, Rhode Island, New Jersey, or Maryland or those involving one of the following cities: New York, Washington, Philadelphia, or Richmond. Markets involving locations north, west, and south of the NEC, such as Harrisburg, Scranton, Albany, Portland (Maine), Virginia Beach, Syracuse, Rochester, and Buffalo, are not included among the 21.

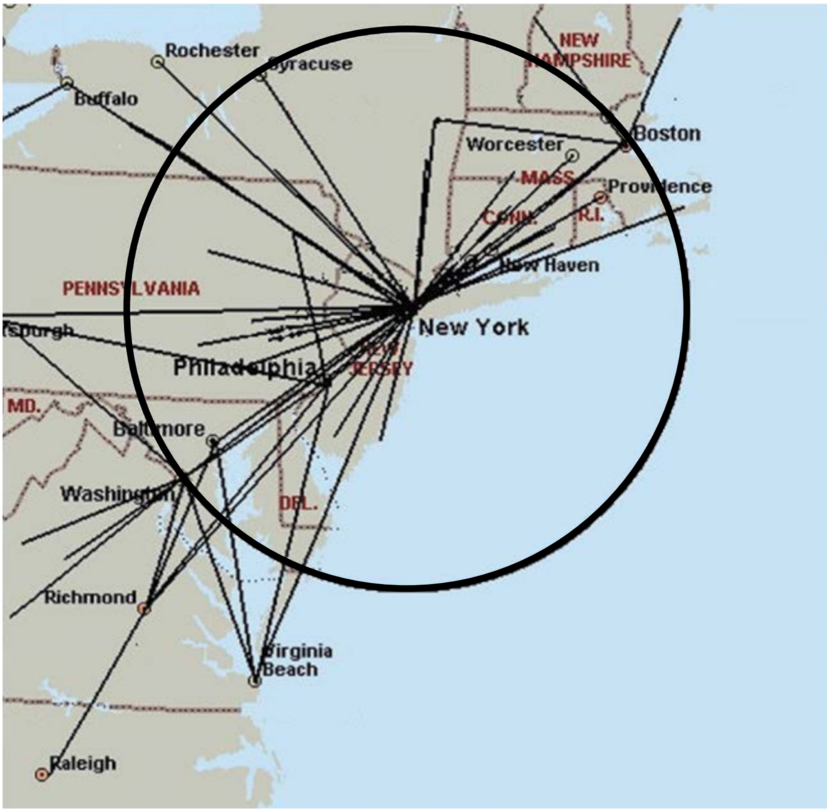

FIGURE 4-3 Top 48 interregional markets in the Northeast (radius of circle = 200 miles).

As has been noted, factors besides the close spacing and linear alignment of cities contribute to the high levels of train ridership in the NEC. They include good public transit systems, relatively low car ownership among center-city residents, and downtowns that have remained densely populated and a locus of commercial activity. Nevertheless, even with these favorable local conditions and a dense travel corridor, the automobile is dominant in the NEC. For example, the combined markets of Washington–Philadelphia, Baltimore–New York, and Washington–New York generate more than 20 million trips per year, but about 85 percent are made by car.

Midwest

Like New York City in the Northeast, Chicago has a dominant role in interregional travel in the Midwest (Figure 4-4). Chicago's dominance results from its large population and base of economic activity and from its historical position as a regional rail and Great Lakes transportation center. Chicago was a junction for more than a half dozen railroads during the late 19th century and prospered as a hub for rail movements of passengers and freight. Many of the largest cities in the Midwest, such as Indianapolis, Kansas City, and Saint Paul, benefited from being junctions on major rail lines linked to Chicago.

In the same manner as New York, Chicago attracts large numbers of travelers from small and medium-size cities within 150 miles, such as Fort Wayne, Grand Rapids, and Madison. A key difference is that most of the large cities in the Midwest are relatively far from Chicago. For the most part, they are dispersed outside a circle that radiates 225 miles from

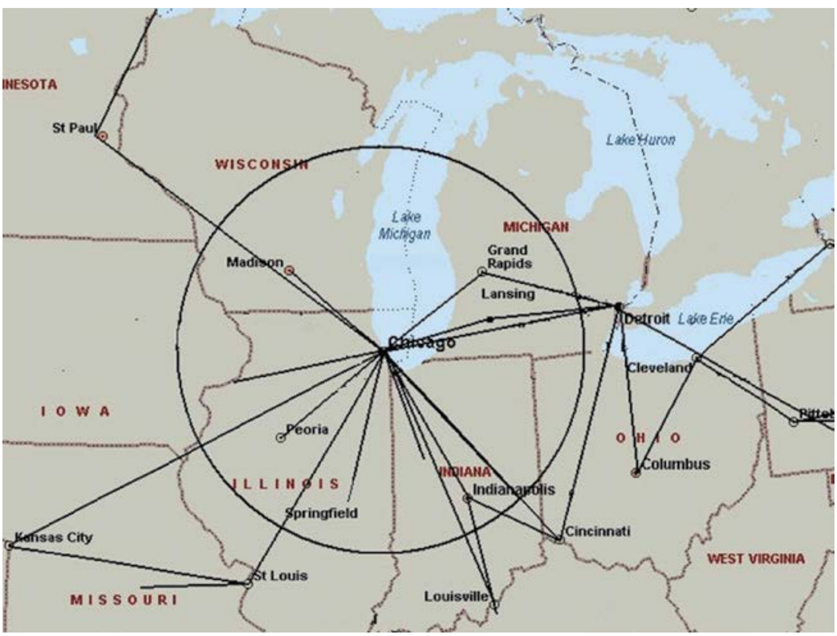

FIGURE 4-4 Top 28 interregional markets in the Midwest (radius of circle = 200 miles).

the city. Milwaukee is less than 100 miles from Chicago, and Indianapolis is 165 miles to the southeast. Detroit is the nearest large city, 240 miles to the east. Cincinnati to the southeast, Saint Louis to the south, Kansas City to the southwest, and Minneapolis to the northwest are all more than 250 miles from Chicago. In comparison, New York's position in the middle of the linear corridor between Boston and Washington places it within 200 miles of nearly all of the Northeast's largest metropolitan areas.

Perhaps because of longer distances between major cities in the Midwest, Chicago's largest markets have relatively high airline use. Six of the 15 interregional markets involving Chicago have air mode shares of 15 percent or more. Only five of the 26 New York markets have comparably high air mode shares. The two Chicago markets with significant rail mode shares are Saint Louis and Detroit, at 8 and 10 percent, respectively. Mainly because of these two markets, passenger rail accounts for nearly 3 percent of all trips in the 28 Midwest markets.

Southeast

Atlanta and Miami dominate the 26 Southeast markets (Figure 4-5). The 11 Atlanta markets have a spatial pattern similar to the Chicago markets. Both cities are encircled by smaller "spoke" cities that are among the country's earliest rail junctions. Many of the cities encircling Atlanta, including Chattanooga to the north and Birmingham to the west, grew from small towns after they were connected to railroads converging in Atlanta. These cities are located only 100 to 175 miles from Atlanta, a manageable distance for travel by train as well as by car and bus. However, all of these markets are dominated by highway travel, and there is virtually no passenger rail service in the region. The largest cities in the Southeast that are within 500 miles of Atlanta are Charlotte and Orlando. These cities generate significant travel to and from Atlanta both by automobile and by airplane because of the long distances involved (225 to 400 miles).

Florida is its own subregion. It accounts for 14 of the 26 markets in the Southeast (Figure 4-5). Most are anchored by Miami; three exceptions are Orlando–Atlanta, Orlando–Sarasota, and Tampa–Jacksonville. Unlike Atlanta, Miami did not rise to prominence as a railroad terminal, even though rail lines were extended to South Florida during the late 19th century.

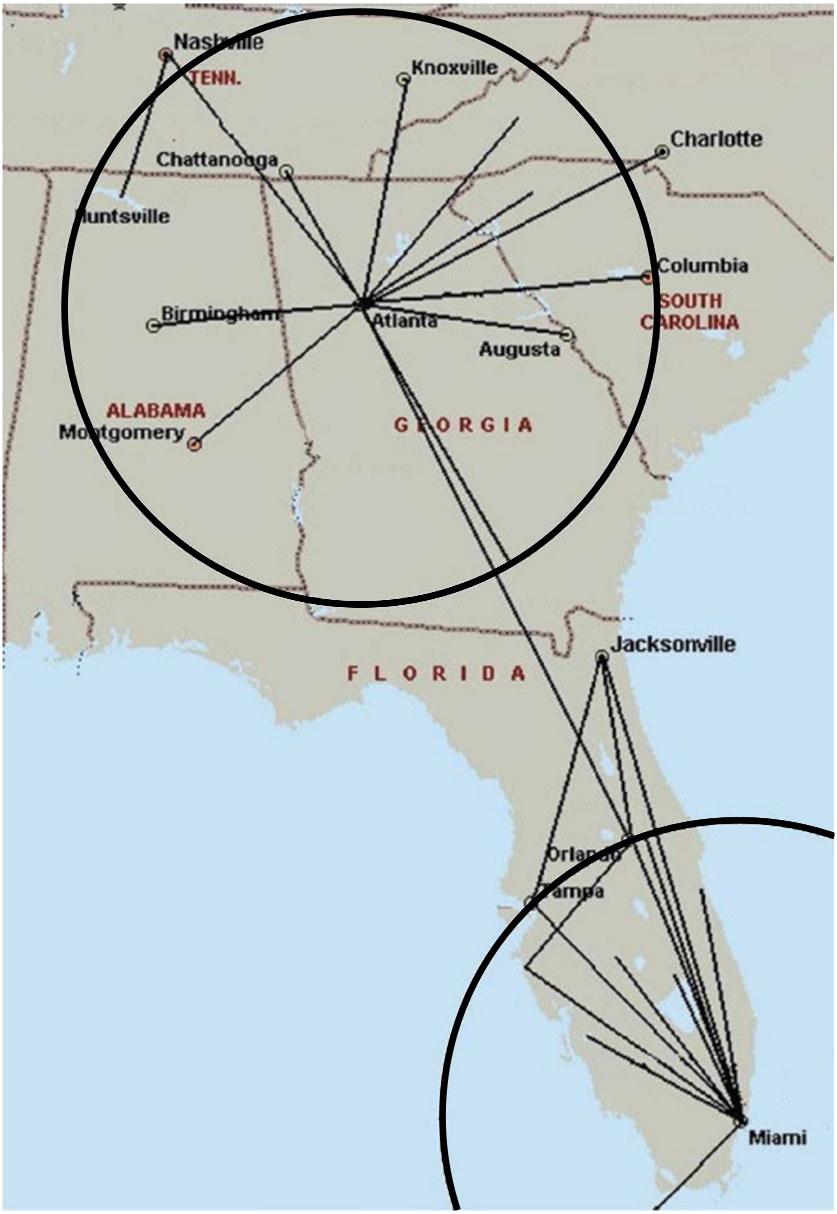

FIGURE 4-5 **Top 26 interregional markets in the Southeast** (radius of circle = 200 miles).

Miami and two of Florida's other largest cities, Orlando and Tampa, prospered during the middle of the 20th century after passenger railroads were no longer a primary mode of interregional transportation. These cities are located far from the population centers of the East Coast and developed later than most others in the East, after the jet airplane made them more accessible and air-conditioning made them more livable.

Thus, the effects of past transportation technologies continue to be felt in the interregional markets farther north, but they are largely absent from the markets of Florida. Rail accounts for 2 to 3 percent of Miami–Tampa and Miami–Orlando trips, but otherwise trains are not widely used for travel in Florida. Automobiles account for more than 90 percent of trips in all but two of the 11 Miami markets, while one-quarter of Miami–Jacksonville and Miami–Tampa trips are made by air.

South Central

Except for Tulsa–Oklahoma City, all of the 34 heavily traveled interregional markets in the South Central region involve cities in Texas (Figure 4-6). The dominant cities in the region are Houston, Dallas, and San Antonio. The three are sometimes referred to as the "Texas triangle," with each city pair forming a triangle side that is 190 to 250 miles long. All three were important rail hubs during the late 19th century; however, they experienced their greatest population and commercial growth during the 20th century after the introduction of the automobile and development of the Interstate highway system. Today, several major Interstate highways converge in Dallas, Houston, San Antonio, and Oklahoma City. The 34 South Central markets generate the highest automobile mode shares among the 200 markets examined, with a median automobile mode share exceeding 97 percent.

Automobile use is especially high between the large Texas cities and the many smaller cities bordering Mexico. Rail accounts for only 0.1 percent of total trips, the lowest regional rail mode share in the country. In total, fewer than 100,000 trips were made by rail in 2008 in the South Central markets, which is equivalent to less than 5 percent of the annual ridership between New York and Washington alone. The region's largest rail market, Dallas–Oklahoma City, accounted for half of these rail trips. The Dallas–Oklahoma City rail mode share is slightly more than

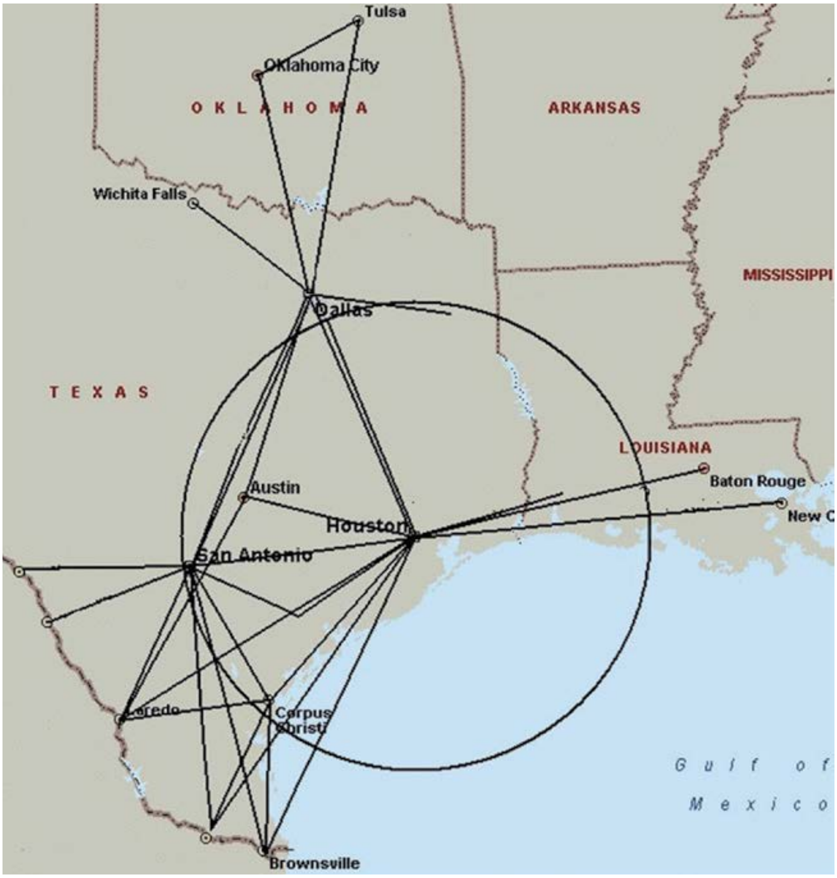

FIGURE 4-6 Top 34 interregional markets in the South Central United States (radius of circle = 200 miles).

3 percent; the next highest, for Dallas–San Antonio, is less than 1 percent. Airlines are a major means of transportation between the hub cities of Dallas and Houston and the spoke cities of Austin, New Orleans, Brownsville, San Antonio, and Tulsa.

West

The West encompasses by far the greatest area of the five regions examined. It consists of three major subregions: the desert Southwest, the

California coast, and the Pacific Northwest. The region contains some of the country's oldest cities, such as San Francisco, as well as some of its newest and fastest-growing ones, such as Las Vegas and Phoenix. The latter cities are located far from navigable waters and railroad hubs. Unlike the Northeast and Midwest, no single city dominates the 64 markets (Figure 4-7). The most heavily traveled interregional corridor in the West is the short-haul (110-mile) San Diego–Los Angeles market.

Because of high traffic volumes between San Diego, Los Angeles, and Riverside, the short-haul Southern California markets account for 20 percent of the trips in the 64 interregional markets in the West. More than 94 percent of them are made by automobile. Nevertheless, Los Angeles–San Diego has the region's highest rail ridership. Arizona also contains a number of very short-distance markets, such as Phoenix–Flagstaff and Phoenix–Tucson. However, Phoenix lacks passenger rail service. Most of the short-haul trips in Arizona are made by car.

Only 14 percent of all trips made in the 64 Western markets are between the populous northern (San Francisco, Sacramento, and San Jose) and southern (Los Angeles, Riverside, and San Diego) cities of California. Although the Los Angeles–San Francisco market accounts for the second-largest number of trips among city pairs in the region (after Los Angeles–San Diego), the long distance (350 miles) between the two cities deters travel by surface mode. As discussed in Chapter 3, airline service in this market is extensive. Nearly 60 percent of Los Angeles–San Francisco trips are by airline, and most of the rest are made by car.

Further to the north, Seattle and Portland are the principal cities in a half dozen markets accounting for about 13 percent of trips in the West region. Because most of the cities in the Pacific Northwest are separated by less than 150 miles, demand for air travel is limited, and the rail and highway modes account for most trips. Seattle–Portland has the highest rail mode share, at 7 percent, among the 64 markets in the West.

COMPARISON OF CORRIDOR GEOGRAPHIES

The length, shape, and traffic densities of the corridors formed by the relative position of cities in a region can affect the viability and service levels of the interregional transportation modes. The effects are evident

FIGURE 4-7 Top 64 interregional markets in the West (radius of circles = 200 miles)**.** (Two markets farther to the east, Denver–Cheyenne and El Paso–Albuquerque, are not shown.)

in the NEC and in other parts of the world. The classic corridor for passenger rail service is the Tōkaidō in Japan. This corridor, created by a series of large cities that line central Japan's Pacific coast, is often referred to as a "string of pearls" (Nash 2014). Figure 4-8 shows the 350-mile routing of central Japan's high-speed railway, the Tōkaidō Shinkansen, as it connects the large cities located between Tokyo and Osaka. Among these cities are six with metropolitan populations of more than 1,000,000 and two with populations of more than 500,000.

The Shinkansen was built more than 50 years ago specifically for high-speed service (speeds exceeding 150 miles per hour). It was developed to replace a circuitous and poor-quality narrow-gauge rail line that had become overcrowded with both passenger and freight traffic (Kurosaki 2014). The high-speed line was expected to be competitive with airlines and to create a large increase in transportation capacity in one of the most densely traveled corridors in the world (Nash 2009). Only 5 years after service was inaugurated, the line transported more than 80 million passengers per year. Subsequent additions to the line connecting cities to Osaka's south and the addition of new high-speed lines to the north and west of Tokyo have increased annual ridership by tens of millions. The Japanese high-speed system now transports more than 150 million riders per year (Kurosaki 2014; Nash 2014). This high-speed network now spans most of Japan. Because of high traffic densities, the original Tōkaidō line and its southern extensions are believed to earn revenue sufficient to cover their operating expenses and to pay for asset maintenance and renewal.[4]

The term "string of pearls" has been used to describe linear, multi-market travel corridors in the United States, including the NEC and California's north–south intrastate corridor. However, the demographic and geographic conditions of Japan's Tōkaidō corridor have no strong parallels in the United States. In Figure 4-9, the metropolitan population of the Tōkaidō corridor is compared with the metropolitan populations of several linear travel corridors in the United States. The Japanese

[4] Whether subsequent line additions have produced revenues sufficient to cover capital replacement costs is less clear, but the independent railway companies that operate them are able to earn off-setting revenues from other sources, such as real estate investments near train stations (Kurosaki 2014, 121).

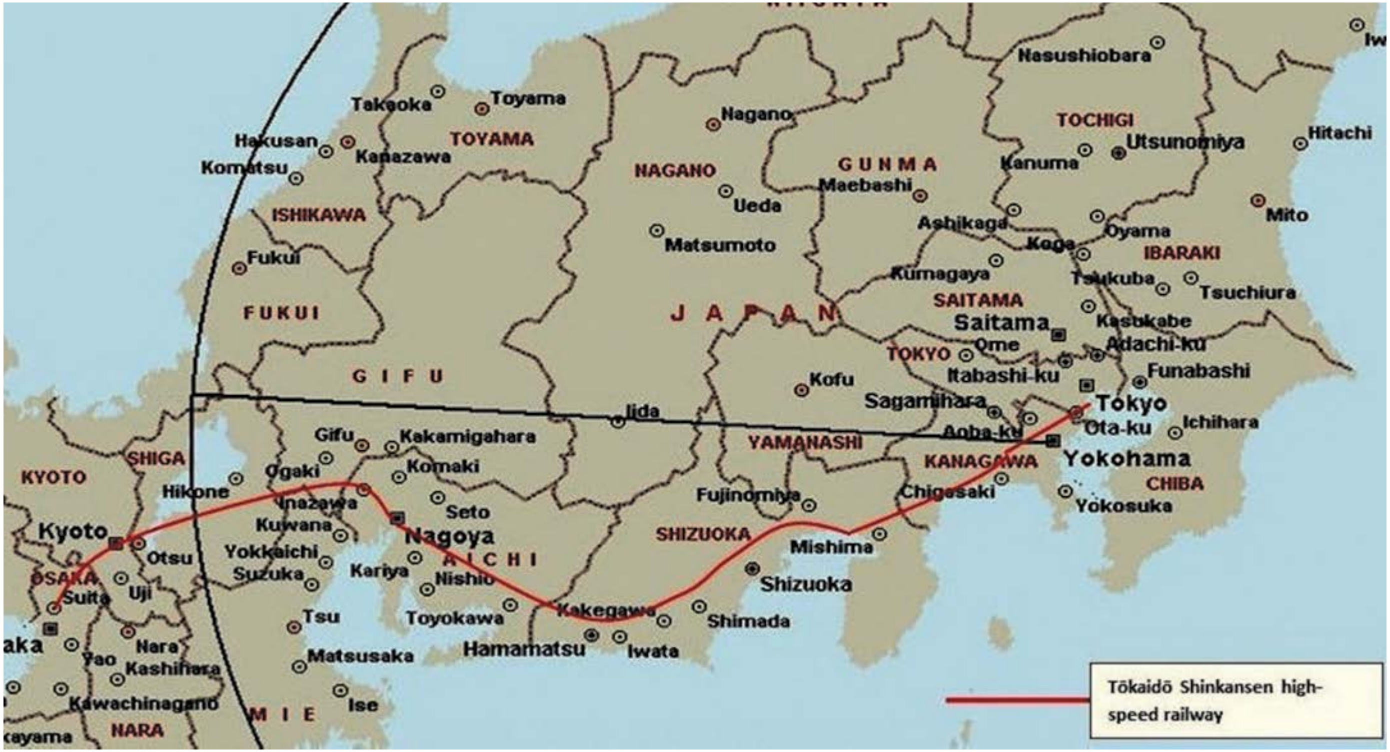

FIGURE 4-8 Tōkaidō high-speed rail corridor serving central Japan's string-of-pearls alignment of metropolitan areas (radius of arc = 200 miles).

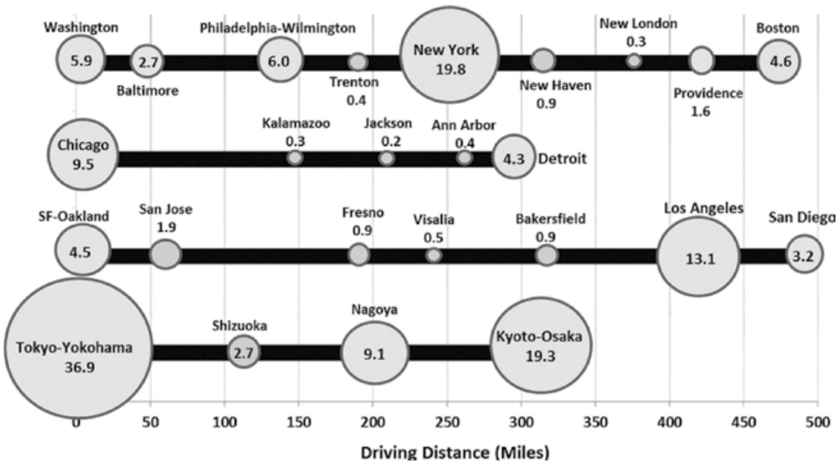

FIGURE 4-9 Populations and distances of metropolitan areas in selected interregional corridors in the United States compared with Japan's Tōkaidō corridor. [Populations are in millions. (Adapted and updated from GAO 2009, 13–14.)]

corridor is much denser, since it connects about 65 million people, which is roughly twice as many as the NEC and California corridors.

Many other U.S. corridors have even less in common with the Tōkaidō or its string-of-pearls configuration. In most regions of the United States, cities tend to be dispersed rather than linear, and the resulting corridors are more aptly described as having radial (i.e., hub-and-spoke) or triangle-like shapes. The traffic corridors in the five regions already discussed are grouped according to these patterns below.

The NEC and Other Linear Corridors

The NEC contains five of the country's 25 largest metropolitan areas: New York, Philadelphia, Washington, Boston, and Baltimore. It contains three other cities—Providence, Richmond, and Hartford—with metropolitan populations of more than 1 million. The longest distance separating any two neighboring cities among the eight is less than 150 miles. This conurbation creates corridor traffic densities unmatched by any other region of the country. As shown in Figure 4-10, the region has many city pairs with rail mode shares of 5 percent or more.

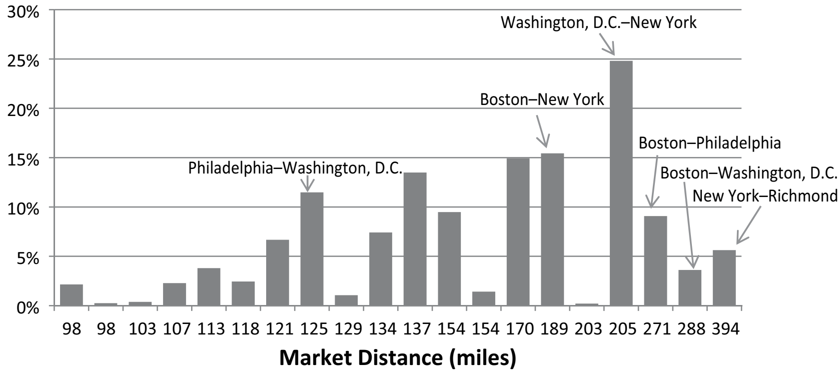

FIGURE 4-10 Rail mode shares in the NEC by market distance. [Horizontal axis is not to scale. (Estimates are based on FHWA trip tables, 2008.)]

Several linear corridors can be found in other regions, as shown in Figure 4-11. None is as densely populated or traveled as the NEC. California's north–south corridor bears some resemblance to the NEC.[5] It runs from San Diego and Los Angeles in the south through the Central Valley to San Jose, San Francisco, and Sacramento in the north. Its length is comparable with that of the NEC, but the two corridors differ in some respects. The NEC has two of the region's largest cities, Boston and Washington, anchoring its ends, and New York is in the middle. Most interregional trips in the NEC are fairly short (less than 200 miles), because they either start or end in centrally positioned New York.

The central position of the heavily populated New York metropolitan area differentiates the NEC and California corridors. New York's position creates many 100- to 200-mile markets, which are well suited to conventional rail service. In contrast, California's corridor lacks a large, centrally located city, and therefore the corridor's market distances tend to be longer. Its traffic flows are generated mostly from the northern and southern endpoint cities, which are separated by 300 to 500 miles.

[5] The 21 California corridor markets include all city pairs between San Diego, Riverside, and Los Angeles; between these cities and cities in the Central Valley; and between San Francisco, San Jose, and Sacramento and the Central Valley, San Diego, Riverside, and Los Angeles.

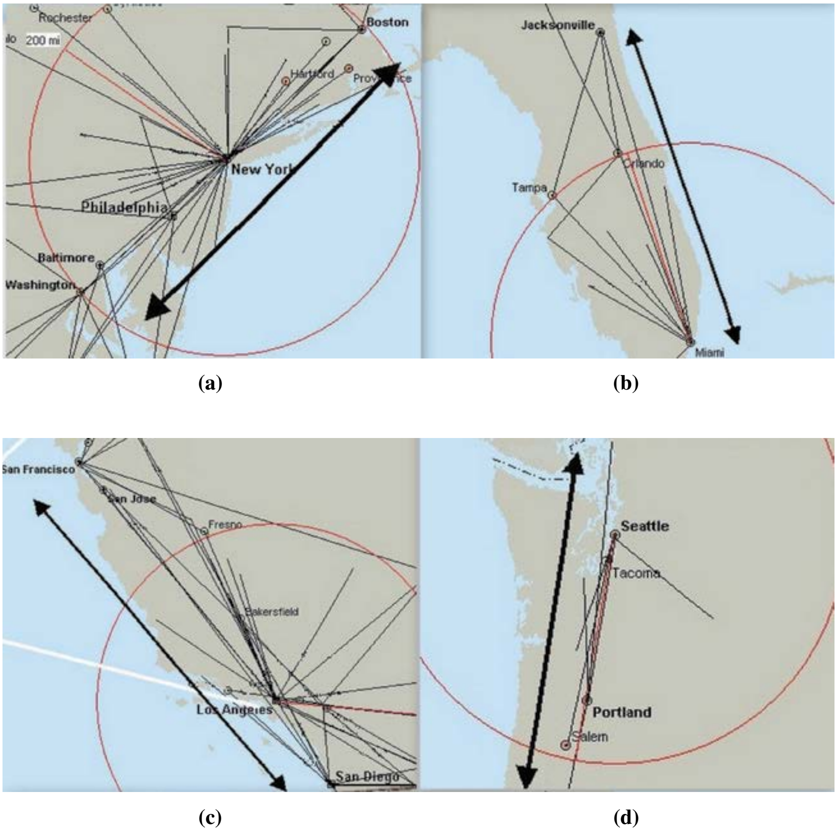

FIGURE 4-11 Linearly aligned interregional corridors in (*a*) the Northeast, (*b*) Florida, (*c*) California, and (*d*) the Pacific Northwest (radius of circles = 200 miles).

The potential for generating the many shorter-haul trips conducive to conventional rail is therefore smaller in the California corridor, where the longer interregional trip distances have stimulated interest in higher-speed rail.

Figure 4-12 shows that trips in California tend to occur in either the very short (≤125-mile) or very long (≥300-mile) markets, whereas trips in the NEC are more evenly spread among short- and middle-distance markets (100 to 250 miles). Only the NEC's Boston–Washington (394-mile) market spans a distance comparable with those separating

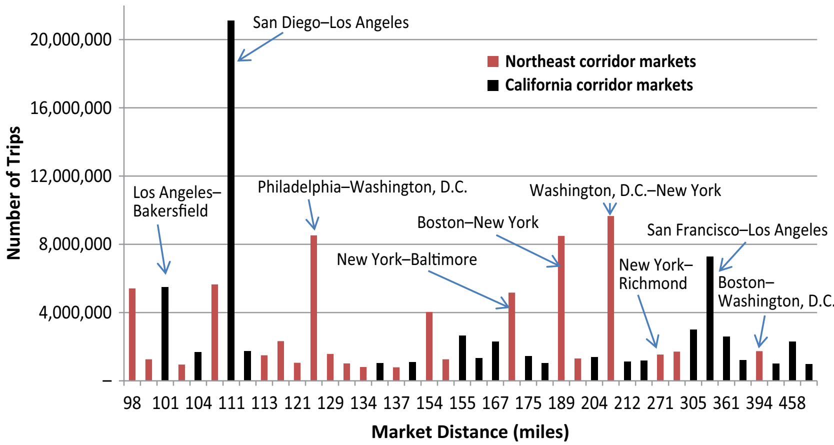

FIGURE 4-12 Total annual trips, all modes, in 2008, by market distance in NEC and California corridor. [Horizontal axis is not to scale. (Estimates are based on FHWA trip tables, 2008.)]

the major cities of southern and northern California. Like the California markets, this NEC market has a high airline mode share (61 percent).

Another string-of-pearls corridor configuration can be found in the Pacific Northwest, which has a north–south corridor extending from Bellingham, Washington, to Eugene, Oregon (Figure 4-11). Five of the six largest interregional markets in the Pacific Northwest are located on this corridor. The Pacific Northwest corridor is 325 miles long, but the average interregional trip is only 133 miles because most trips are between Portland and Seattle. The short distance between these two large cities, as well as the presence of a few other cities in between, helps explain the relatively high rail mode shares in the region.

Florida has a straight-line interregional corridor that extends along the Atlantic Coast for 325 miles from Miami to Jacksonville and encompasses the intermediate point of Orlando (Figure 4-11). However, this corridor accounts for only about one-quarter of the trips in Florida's 14 largest interregional markets. Many more trips are made between Miami and the Gulf Coast cities that fan out to the city's west and northwest. Three of the five most heavily traveled markets in Florida are between Miami and the cities of Naples, Fort Myers, and Tampa–Saint

Petersburg. Most of Florida's cities are not configured in a string-of-pearls alignment.

Radial Corridors in the Midwest and Southeast

Although Chicago is the dominant city in the 28 large markets in the Midwest, it neither centers (as in New York) nor anchors (as in Los Angeles) a densely trafficked linear corridor connecting most of the largest cities in the region. Instead, Chicago is encircled in nearly all directions by many small, medium, and large cities (Figure 4-13). As noted earlier, the largest Midwestern cities are generally located at least 225 miles away, and they are far from one another. Furthermore, their connecting routes to Chicago have few intermediate cities that can add substantial rail traffic volumes.

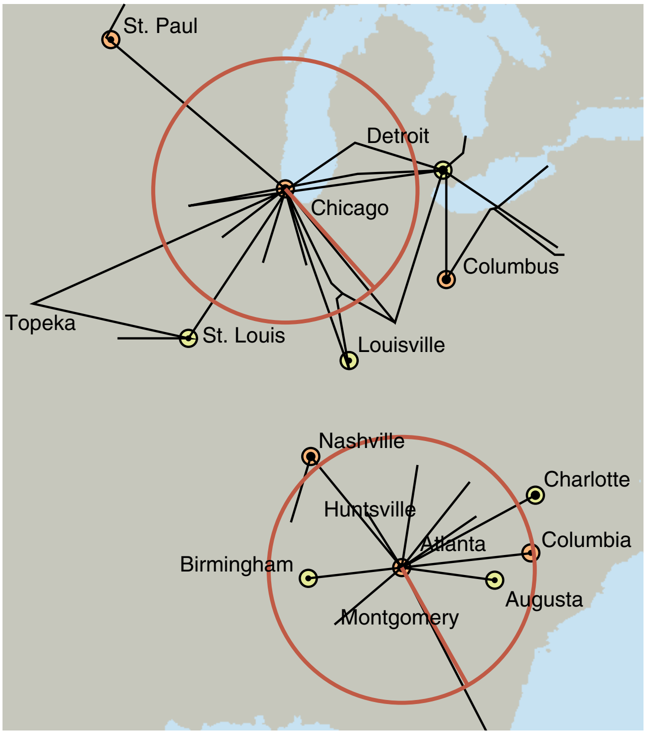

FIGURE 4-13 **Radial shape of Chicago and Atlanta interregional corridors** (radius of circles = 200 miles).

In the Southeast, Atlanta's largest markets fan out in a manner similar to those of Chicago and create a radial configuration. Atlanta's spoke corridors involve mostly smaller cities located 100 to 175 miles away (Figure 4-13). The potential traffic densities in the spoke corridors are reduced by the small size of the encircling cities and high use of the automobile, which is also well suited to distances of 100 to 175 miles.

Texas and Desert Southwest "Triangles"

The markets in the South Central region are not dominated by a single city but by the three largest cities in Texas: Houston, Dallas, and San Antonio. As noted earlier, the three form the vertices of a triangle, sometimes called the Texas triangle (Figure 4-14). Because the three cities are located 190 to 250 miles apart, they generate a mix of highway and air traffic. Each is also the largest city in pairings with a number of smaller cities positioned to the north (e.g., Oklahoma City), east (e.g., Baton Rouge), south (e.g., Corpus Christi), and southwest (e.g., Laredo). With the exception of Austin's location between Dallas and San Antonio, none of the smaller cities falls within one of the Texas triangle's sides, which limits the concentration of traffic in a corridor.

A corridor geometry that resembles the Texas triangle is formed in the desert Southwest by the roughly 200-mile corridor legs that join Los Angeles, Phoenix, and Las Vegas (Figure 4-14). As in Texas, the three do not include many intermediate markets to create overlapping traffic.

SUMMARY

Comparisons of the most heavily traveled interregional markets in the United States indicate that their size and relative position within interregional corridors can affect the modes of transportation available. The region with the most modal diversity is the Northeast. The preservation in the NEC of rail lines devoted largely to passenger service is unique to this region, and it has contributed to passenger rail being an important mode of interregional transportation. Rail service there also benefits from the region's large cities being closely spaced and aligned linearly to create a series of relatively short (less than 200 miles) and overlapping interregional markets that can be served in a single rail corridor.

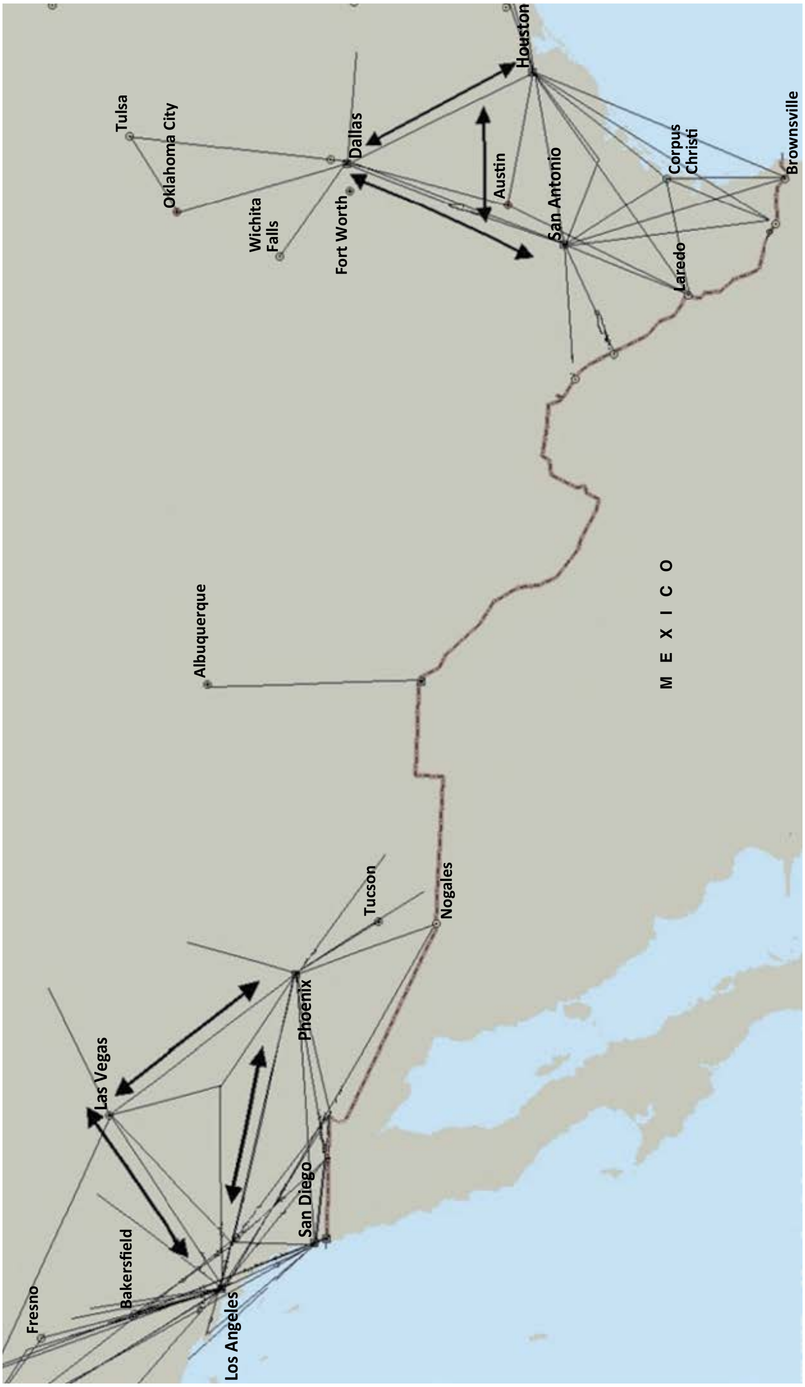

FIGURE 4-14 Triangular shape of Texas and Southwest interregional corridors.

New York City's central position in the NEC is particularly important, because it has created many short-distance (100- to 200-mile) markets that can be served by rail.

The Japanese experience with passenger rail has particular relevance to the NEC. It confirms that the relative position of cities in a corridor can be important in providing frequent and efficient train service. The closely spaced and linearly aligned large cities along the east coast of Japan, sometimes referred to as a string of pearls, is the classic configuration for efficient passenger train service and the site of the world's most heavily used passenger railway. The Tōkaidō high-speed line was built more than 50 years ago to serve travelers in this corridor after the existing poor-quality line became overcrowded with passenger and freight traffic.

In many parts of the United States, cities are distant from one another and dispersed. They form multiple and lengthy travel corridors that are not as conducive to passenger rail as the overlapping, short-haul markets that characterize the NEC. The interregional corridor in California that runs from the southern cities of San Diego and Los Angeles to the northern cities of San Francisco and Sacramento is most comparable with the NEC in overall length and in the size and number of city-pair markets, but not in their close spacing. In particular, the California corridor lacks a large metropolitan area centering it in the same manner as New York City, whose large size and central position generate many short-haul trips suited to service by rail. Currently, air travel is dominant in the California corridor because of the long distances between the state's southern and northern population clusters. In addition, many airports serve the state's large metropolitan areas, and their dispersed locations, more so than downtown train stations, tend to reflect the state's decentralized urban populations and sites of tourism and commerce.

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Abbreviation

GAO Government Accountability Office

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5

Public-Sector Role in the Provision of Interregional Transportation in the United States and Europe

As discussed in Chapter 3, the provision of interregional transportation in the United States is a public- and private-sector enterprise. Privately owned automobiles and buses use a road network that is planned, built, and maintained by state and local governments with funding obtained mainly from taxes on motor fuel and other fees levied on highway users by federal and state governments. Aircraft owned and operated by commercial airlines and privately owned and operated general aviation aircraft fly between airports run by state and local entities. They use the federally managed airways and air traffic control system, which are funded primarily from taxes and other fees paid by airlines and their customers.[1] Intercity passenger train service is provided almost exclusively by Amtrak, a quasi-public corporation created by the federal government. Amtrak's train operations are paid for with ticket revenues supplemented by federal and state funds, while the equipment and track in the Northeast Corridor (NEC) are publicly subsidized. Most of the other track used by Amtrak belongs to private freight railroads, which charge for its use according to access requirements established by the federal government.

The many public and private entities controlling and providing aspects of interregional transportation create a complex environment for funding and coordinating investments in transportation infrastructure and services. Most transportation infrastructure serves multiple purposes, which makes the environment even more complicated. For example, track is shared by short- and long-distance freight trains, regional commuter railroads, and intercity trains; freight-hauling trucks, intercity

[1] Military and government-owned aircraft also use these airports and the air traffic control system.

buses, local commuters, and motorists traveling longer distances are commingled on the highways; and flights are shared by short-haul passengers and longer-haul travelers making connections. Public facilities like Boston's South Station, New York's Port Authority Bus Terminal, and San Francisco's Transbay Terminal accommodate intercity bus, rail, and transit services.

The funding environment is discussed first, because it can dominate the planning and coordination of transportation infrastructure investments. Governments fund most of the fixed infrastructure of roadways, airways, runways, and terminals. These funds are derived mainly from users paying motor fuel and airline ticket taxes. The revenues from these fees are credited to trust fund accounts and mainly disbursed to state and local governments according to formulas. The disbursements, for the most part, can only be used to pay for projects in the specific mode. In the case of Amtrak, total revenues from passengers, who are not taxed, have never been sufficient to cover all operating and capital costs, and the federal government and states subsidize the railroad's operations and capital expenses. Accordingly, Amtrak's ability to make investments in the infrastructure it needs to provide rail service in the NEC and other interregional corridors is examined.

Consideration is then given to the planning environment, particularly to the coordination of transportation plans and decisions at an interregional level. The planning of highways is largely a state and local responsibility. However, federal law requires state and local governments to coordinate their plans for urban transit and highway investments from a metropolitanwide perspective. Interregional transportation corridors, which often span multiple states and metropolitan areas, are not subject to similar coordination requirements. The federal government has a more direct role in the planning of aviation infrastructure because of its exclusive authority over the design, management, and operation of the nation's airspace. State and local governments exercise primary responsibility over the planning and prioritization of airport investments.

The influence of transportation funding on the planning environment is evident. In general, the user-based financing of the public highway and aviation systems, coupled with assurances that user revenues are reinvested in their respective systems, has provided a predictable stream of funds for highway and aviation development. A disadvantage of this approach is its reinforcement of the already strong tendency of mode-specific transportation agencies to plan and program transportation on a mode-by-mode basis. Because Amtrak lacks such a steady and sufficient stream of revenues derived from users, it faces continuing challenges in the planning and prioritization of its intercity rail services and capital investments.

To conclude the chapter, the approach used for providing interregional transportation in the United States is contrasted with the approach in Europe, particularly with regard to intercity passenger rail. The focus of the discussion is on rail because its often large public investment requirements create special challenges in the multijurisdictional setting that characterizes most U.S. interregional corridors. A number of factors have favored the provision of passenger rail service in Europe, only a few of which can be discussed in depth here. An important consideration is the tendency of distances between major cities in most European countries to be shorter than in the United States. National-level transportation planning in Europe therefore will naturally focus on the interregional scale, that is, on 100- to 500-mile corridors. In comparison, U.S. city-pair markets span distances ranging from a few hundred to more than 2,000 miles. They create a mix of short-, medium-, and long-haul corridors that are legs of extensive highway and air transportation networks. However, a number of heavily traveled 100- to 500-mile corridors in the United States are possible candidates for more interregional passenger train service. The European approach and experience in providing passenger rail are therefore summarized. The European experience can help inform U.S. decisions about when and where to invest in this interregional mode.

PUBLIC FUNDING OF INFRASTRUCTURE BY MODE

Highways

Nearly all travel by private automobiles and buses in the United States takes place on the public road network. The backbone of this network, the Interstate highway system, accounts for less than 3 percent of public road lane mileage but includes the main routes used for most interregional travel and accounts for about 25 percent of all vehicle miles traveled.[2] With rare exceptions, the Interstate highways and other public roads are owned, operated, and maintained by state and local governments with funding assistance from the federal government.

As noted above, most highway funding is derived from users. The federal Highway Trust Fund obtains revenues from fuel taxes and other fees imposed on motorists. Most states levy additional user-based taxes and fees, as well as tolls, to pay for their highway programs. The revenues dedicated to the federal Highway Trust Fund could be used only for highway projects until 1983, when Congress made public transit projects eligible. Although Highway Trust Fund revenues continue to be used primarily for highway projects, Congress has from time to time approved other related uses such as paying for bicycle and recreational trails and for environmental mitigation. Disbursements, for the most part, can only be used to pay for projects in the specific mode.[3] In recent years, the revenues credited to the federal Highway Trust Fund have fallen behind program disbursements, which has reduced funding predictability and required the annual appropriation of general fund revenues to supplement highway spending.[4]

In 2013, federal, state, and local governments spent more than $200 billion on capital improvements, maintenance, operations, and traffic enforcement on the public road system.[5] This large public investment is made with varying degrees of coordination among federal, state, and local governments. Within large metropolitan regions, coordination is both complicated and essential, since dozens or even hundreds

[2] http://www.fhwa.dot.gov/policyinformation/statistics/2012/.

[3] A dedicated trust fund provides more certainty than reliance on the general fund; funds deposited in trust funds are considered guaranteed because they are not subject to congressional appropriations. The trust fund contract authority means that funds can be obligated in advance of an annual appropriation, which is valuable for projects that can take several years to complete, since the total funds for a given project do not need to be available at the project start date.

[4] During the past decade, user fee revenues have not kept pace with federal authorization levels, in part because of the slowing of growth in gasoline and diesel consumption due to increases in vehicle fuel efficiency and a reduction in vehicle miles traveled. Because Congress has not increased the level of user fees or decreased authorizations, transfers from the general fund to the Highway Trust Fund have been required five times since 2008 (Nigro and Burbank 2014).

[5] Federal Highway Administration, *Highway Statistics 2013*, Table PT-3C (http://www.fhwa.dot.gov/policyinformation/statistics/2013).

of local authorities have responsibility for aspects of the system. The federal government has long required, as a condition for aid, the prioritization and programming of urban transportation systems through a metropolitanwide planning process that is "comprehensive, continuous, and coordinated."[6] The planning must be multimodal, to include public transit, and extensive interagency and interjurisdictional involvement (sometimes multistate) is required.

Today, more than 350 metropolitan planning organizations (MPOs) monitor traffic conditions, carry out forecasting, and develop short- and long-range transportation plans in accordance with this requirement. Each year, the federal government provides an average of $300 million for MPOs to carry out their responsibilities.[7] Highway and public transit projects are the main subject of this planning because they are the modes most directly eligible for federal aid from the Highway Trust Fund. However, the federal government does not impose similar coordination requirements for the expenditure of highway funds from an interregional perspective.

Airways and Airports

Airlines must cover their own capital and operating costs from passenger revenues. In addition, passenger revenues contribute nearly all of the funding for the public aviation infrastructure. This infrastructure, including airways and airports, is supplied by a mix of public-sector agencies.

The Federal Aviation Administration (FAA) has exclusive responsibility for the airways. The National Airspace System consists of the terminal and en route airspace and the navigation, surveillance, and communications infrastructure that make up the air traffic control system. Airport and Airway Trust Fund revenues are also used to pay for the National Airspace System. As noted above, these trust fund revenues are derived from taxes and fees paid by airlines and their passengers.[8]

[6] Federal-Aid Highway Act of 1962.

[7] http://www.fhwa.dot.gov/map21; http://www.fta.dot.gov/documents/FTA_Funding_Summary_Fact_Sheet.pdf.

[8] In 2014, user taxes contributed $13.5 billion to the Airport and Airway Trust Fund, mainly from a 7.5 percent federal tax on airline fares and a $4.00 flight-segment fee (http://www.faa.gov/about/office_org/headquarters_offices/apl/aatf/media/14).

Airports are the responsibility of state and local governments. There are about 500 commercial-service airports in the United States. Most are owned and operated by county and municipal governments or by special-purpose authorities created by states. Although the country's largest commercial-service airports are publicly owned, they are largely self-sufficient. They derive substantial revenues from concessions; public parking; landing fees; and the rents charged for gates, terminal space, and other facilities used by airlines and other aircraft operators and support units.[9] In addition, the 40 largest airports are allowed by federal law to levy a passenger facility charge that is folded into the price of an airline ticket. These revenues can be used by airports for capital projects.[10] The Airport and Airway Trust Fund also pays for the federal Airport Improvement Program, which provides grants to airport authorities for a variety of purposes, including runways, navigation aids, and noise abatement programs.[11]

Amtrak and Intercity Rail

According to the original plan for Amtrak, it was to be managed as a for-profit company that would be free of federal subsidies within a few years.[12] Timetables for self-sufficiency were established, including requirements for the railroad to report on the profitability of each route and to make plans for withdrawing service from money-losing routes (CBO 2003). At the same time, Amtrak was designed to have public service functions. It was to be overseen by a politically appointed board of directors, required to provide discounted fares for classes of riders, and required to maintain a network of long-distance routes that had for years been losing money for the private railroads unable to compete with airlines (CBO 2003). Therefore, Amtrak does not have the autonomy to

[9] More details on airport financing are given by Sengupta (2007).

[10] For example, noise abatement procedures for an airport can reduce available capacity during certain hours of the day and restrict the use of departure and approach paths that pass over residential areas.

[11] These direct and state block grants are apportioned through funding formulas and awarded through competitive applications.

[12] The Amtrak Improvement Act of 1978 amended Amtrak's statute to provide that the company be "operated and managed as a for-profit corporation" instead of the original "shall be a for-profit corporation."

structure its business and services in a manner that would enable it to be managed like a for-profit company. Indeed, it faces substantial restrictions on this ability, which are evident from an examination of Amtrak's revenue and cost profile.

Table 5-1 indicates that Amtrak carried 31 million passengers in Fiscal Year 2014. Its systemwide load factor, or passenger miles per seat mile, was slightly more than 50 percent, and the average trip length was 215 miles. The average ticket revenue per passenger was about $71, and total ticket revenues were slightly less than $2.2 billion. The cost data reported in the table are for Amtrak's train operations and maintenance expenses, including fees paid for accessing freight lines. They do not include costs associated with infrastructure maintenance and renewal, such as on the NEC right-of-way. The $2.2 billion earned from ticket revenues covered about 83 percent of Amtrak's expenditures on train maintenance and operations. When income from other sources such as food and beverage sales and the public subsidies provided by states is counted, 97 percent of the carrier's expenditures were covered.

Systemwide averages do not reveal the considerable variation in revenue-to-cost ratios by type of route. Table 5-1, which is based on calculations by Amtrak, disaggregates revenue and traffic data for the NEC (Acela, the Northeast Regional routes, and special trains), state-subsidized, and long-distance routes. It also allocates costs across the three route types. The three incur similar average costs per passenger mile, but average ticket revenue per passenger mile varies considerably. These revenues were substantially higher on the NEC and covered 162 percent of allocated costs. When other revenues, which do not include state subsidies, are factored in, the NEC routes covered 167 percent of costs. The revenue-to-cost ratios suggest that the NEC routes generate enough net income to contribute to part of the corridor's maintenance and capital costs not included in the allocated cost figures.

The other routes did not perform as well. Ticket revenues covered only 59 percent of the operating and maintenance costs of the state-supported routes, but state subsidies, which accounted for most of the other revenue, brought the ratio to about 92 percent. In comparison, ticket revenues on long-distance trains covered only 48 percent of their costs. Because it does not have a source of subsidy for these routes,

TABLE 5-1 Amtrak Traffic and Performance Metrics, Fiscal Year 2014

Metric	Amtrak Systemwide	NEC	State-Supported	Long-Distance
Passenger trips (millions)	30.92	11.64	14.73	4.54
Average trip length	215	166	132	607
Passenger miles (millions)	6,655	1,929	1,948	2,758
Total revenue ($ millions)	2,551	1,232	755	564
Ticket revenue ($ millions)	2,189	1,191	487	511
Other revenue ($ millions)	362	41	268	53
Fully allocated operating and maintenance costs ($ millions)	2,632	735	825	1,072
Passenger trip share (%)	100	38	48	15
Passenger mile share (%)	100	29	29	41
Ticket revenue share (%)	100	54	22	23
Fully allocated cost share (%)	100	28	31	41
Ticket revenue/total revenue (%)	86	97	65	91
Ticket revenue/fully allocated cost (%)	83	162	59	48
Fully allocated cost per passenger trip ($)	85.12	63.11	56.00	235.96
Fully allocated cost per passenger mile ($)	0.40	0.38	0.42	0.39
Ticket revenue per passenger trip ($)	70.79	102.27	33.06	112.48
Ticket revenue per passenger mile ($)	0.33	0.62	0.25	0.19
Ticket revenue shortfall per passenger trip ($)	14.33	(39.15)	22.94	123.48
Ticket revenue shortfall per passenger mile ($)	0.07	(0.24)	0.17	0.20

SOURCE: http://www.amtrak.com/ccurl/243/158/Monthly%20Performance%20Report%20-%20September%202014%20(Preliminary%20and%20Unaudited).pdf, pp. A-3.5, C-1.

Amtrak must use the excess generated from the NEC to cover the revenue shortfall on the long-distance routes, which averaged $123 per passenger. In effect, most of the excess revenues generated from the NEC, which accounted for 38 percent of Amtrak's passenger trips, were used to cover the deficits incurred by providing service to the 15 percent of Amtrak riders who made long-distance trips.

Similarly, route-specific data indicate wide variations in revenue-to-cost ratios. Figure 5-1 shows the ratios by individual route, with the average passenger trip length on the horizontal axis. The circle sizes

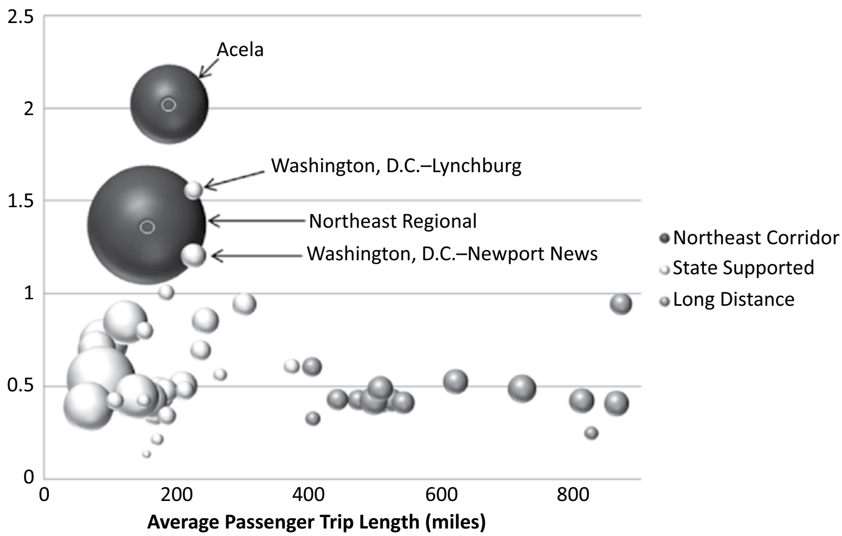

FIGURE 5-1 Ratio of Amtrak ticket revenues to fully allocated operating costs by average passenger trip length, Fiscal Year 2014. [SOURCE: http://www.amtrak.com/ccurl/243/158/Monthly%20Performance%20Report%20-%20September%202014%20(Preliminary%20and%20Unaudited).pdf, pp. A-3.5, C-1.]

are scaled to the number of riders on the route. The figure shows that five Amtrak routes had ticket revenues that exceeded their costs, while the remaining 47 routes had ticket revenues below their costs. The figure indicates that Acela had the highest ratio, with ticket revenues twice as high as costs. For the other NEC regional trains, ticket revenues exceed costs by about 37 percent. The state-supported routes varied considerably in the ratio of ticket revenue to costs. Three had ticket revenues that exceeded costs; the remaining 26 routes had ticket revenues that were less than costs. The three with revenues exceeding costs are between Washington, D.C., and locations in Virginia, with continuing service to New York. They could be viewed as southern extensions of the NEC. All long-distance routes had ticket revenue deficits relative to costs [one of them, the Auto Train, had ticket revenues covering almost all of its costs (95 percent)]. The data for each route are shown in Figure 5-2.

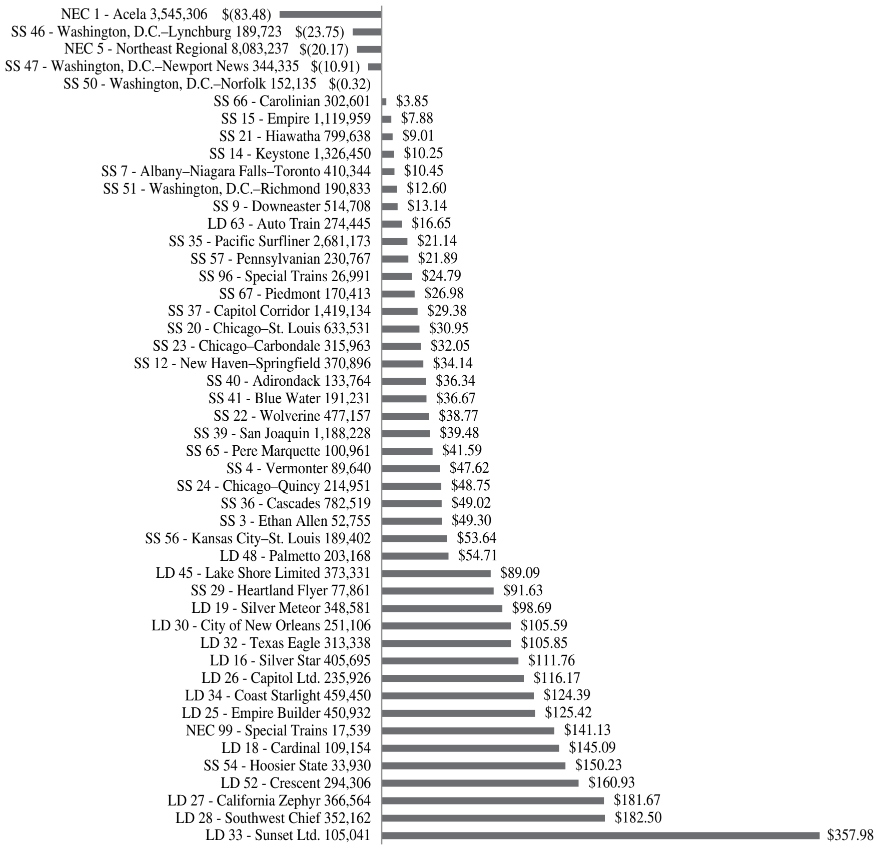

FIGURE 5-2 Amtrak ticket revenue shortfall per passenger trip, in covering fully allocated operating costs by route, Fiscal Year 2014. (Prefixes: NEC = Northeast Corridor, SS = state-supported, LD = long distance. The number after the prefix is the Amtrak route number, and the number immediately after the route name is the number of passengers carried.) [SOURCE: http://www.amtrak.com/ccurl/243/158/Monthly%20Performance%20Report%20-%20September%202014%20(Preliminary%20and%20Unaudited).pdf, pp. A-3.5, C-1.]

Mode-Neutral Project Funding and Financing Opportunities

At the federal level, there are few transportation financing and grant programs designed specifically to broaden modal and jurisdictional eligibility. One financing program is the Transportation Infrastructure

Finance and Innovation Act (TIFIA) program, which provides federal credit assistance to surface transportation projects, including intercity passenger rail, some types of freight rail, and intermodal freight transfer facilities. TIFIA offers three types of financial assistance to applicants: loan guarantees, secured loans, and lines of credit provided to public authorities and private entities completing projects sponsored by public authorities. The leveraging of public investments is intended to lower the cost of borrowing by private entities; for example, the Federal Highway Administration claims that a $1 billion TIFIA authorization will support about $10 billion in actual lending capacity.[13] TIFIA was first authorized in 1998 and was significantly expanded by Congress in the last surface transportation reauthorization (Moving Ahead for Progress in the 21st Century Act). It reached $1 billion in Fiscal Year 2014.

Another federal transportation grant program that seeks to broaden modal eligibility is the Transportation Investment Generating Economic Recovery (TIGER) discretionary grant program administered by the U.S. Department of Transportation. The grant program's eligibility criteria are designed to encourage state and local governments, in conjunction with private-sector partners, to pursue multimodal and multijurisdictional projects that are ineligible for funding through traditional federal transportation programs. TIGER funding levels are small relative to the mode-specific federal funding programs (they have averaged about $1 billion per year since the program's inception in 2009). The program's concept is unique among federal transportation programs. For example, program grants can be used to fund port and freight rail infrastructure projects that are otherwise ineligible for federal funds. TIGER grants can also be made directly to public entities other than states, including municipalities, counties, port authorities, Amtrak, and MPOs. Because of the high demand for TIGER grants, fewer than 5 percent of project applicants receive funding, and the U.S. Department of Transportation has had to develop rigorous selection criteria for choosing among the applicants (Feigenbaum 2012). The

[13] https://www.fhwa.dot.gov/ipd/tifia/.

TIGER grant program could be a model for the funding of projects having an interregional dimension and fewer modal restrictions. Its popularity could be an indication of substantial interest in such funding opportunities.

A recent report of the National Cooperative Rail Research Program (NCRRP) reviews options for funding intercity passenger and freight rail projects (CPCS et al. 2015). The options considered range from dedicated sales and property taxes to more demand-based pricing of fares. The report also examines project financing methods such as revenue bonds, government loan programs like TIFIA, and public–private partnerships. The information in the NCRRP report offers a starting point for public officials interested in funding and financing interregional transportation projects.

ARRANGEMENTS FOR COORDINATING INTERREGIONAL TRANSPORTATION PLANNING

The combination of federal, state, and local governments having responsibility for the provision of transportation infrastructure creates a complex environment for the planning of investments in transportation, even within individual modes. As has been noted, in the case of highways and transit, the federal government has instituted a requirement for the creation of MPOs, which engage in multimodal planning of transportation systems serving metropolitan areas. The purpose is to counter the tendency for public investments to be programmed on a mode-by-mode and community-by-community basis. However, MPOs have a state and local orientation and therefore do not necessarily need to consider the effect of highway and transit development on the functioning of interregional transportation systems and corridors.

One reason for the lack of formal coordination and planning mechanisms at the interregional level is that many interregional trips span multiple states. The division of federal transportation programs also contributes to the fragmentation of transportation planning and programming. The federal highway and transit programs use the same trust fund and are authorized under the same legislation that mandates MPOs. However, the federal aviation program and its trust fund are authorized in separate legislation developed by congressional committees different from those responsible for the surface modes. The federal statutes that govern Amtrak and appropriate funds to cover the operating and capital costs of intercity passenger rail derive from yet another set of congressional committees. Each of these mode-based funding programs comes with its own eligibility restrictions, allocation formulas, and authorization periods. The differences reinforce the mode-specific decision-making structures and complicate efforts to plan transportation investments in a well-coordinated and modally integrated manner.

Modally diverse state transportation agencies can assume an important role in planning and conducting objective appraisals of interregional transportation policy and investment options. For example, the Florida Department of Transportation is assessing the safety implications and public benefits of plans by the Florida East Coast Railroad to upgrade existing freight railway lines and construct 30 new miles of line to provide passenger service for 230 miles between Orlando and Miami.[14] The Texas Department of Transportation has periodically reviewed plans to improve the state's interregional transportation system, including a proposal that would have created multimodal corridors containing separate highway lanes for cars and trucks and separate rail lines for high-speed passenger and freight trains.[15] However, even when an interregional corridor spans only a single state, there is evidence that modal "silos" tend to hinder multimodal planning and decision making. In California, after voters approved funding for a high-speed rail system, the mission of the California High-Speed Rail Authority (CHSRA) evolved from promoting the system to planning and implementing it. The planning and implementation have proceeded outside the context of a comprehensive statewide transportation plan. In May 2013, the chairman of an expert panel charged by the state to review CHSRA's development plan remarked that "early development of the California high-speed rail project put the cart before the horse. Instead of having high-speed rail emerge from a statewide transportation context considering interregional competition and urban connections, the high-speed

[14] http://www.allaboardflorida.com/.

[15] http://ttc69.files.wordpress.com/2008/02/ttc_report_full.pdf.

rail proposals were essentially free-standing with little recognition of the need for access to stations or connectivity to conventional and commuter rail."[16]

Both formal and informal means are available to states to coordinate their transportation plans and priorities on a multistate basis. Multistate compacts have been used to plan transportation improvements having interregional impacts, such as the rail compact formed by North Carolina and Virginia. In addition, coalitions of public and private entities have been formed to advocate improvements in the performance of particular transportation corridors that serve broader regions. For example, in the 1990s, transportation agencies and operators in the Northeast formed the I-95 Corridor Coalition, which has expanded to cover the length of the corridor from Maine to Florida. The coalition provides a forum for addressing transportation system management and operations issues of common interest to agencies and users. Similar coalitions have been formed for other major Interstate highways, such as the I-85, I-80, and West Coast corridor coalitions.[17] In addition, regional councils of governors and legislators will often develop multistate strategies to guide highway development and investment decisions. The Coalition of Northeastern Governors has an ongoing program to facilitate the exchange of information and to promote opportunities for closer coordination of highway and transit assets in the Northeast.[18]

The combination of federal, state, and local responsibilities for the provision of aviation infrastructure creates an especially complex institutional environment for the development of air transportation capacity to serve interregional markets. FAA invests in the NAS on the basis of its interest in ensuring that the aviation system operates in a safe, orderly, and efficient manner at the national and international scale. FAA investments must be informed by airport investment plans for runways, taxiways, and terminal capacity. These development plans are, in turn, the product of many local interests, including those of airlines, concessionaires, and

[16] http://www.cahsrprg.com/files/22_version_of_lst_statement_for_may_28_2013_submitted_version.pdf.

[17] The Federal Highway Administration maintains a list of these regional coalitions at http://www.ops.fhwa.dot.gov/freight/corridor_coal.htm.

[18] http://www.coneg.org/programs/trans.htm.

communities. Local community interests, such as noise abatement and environmental protection, can influence airport planning and development substantially.

In some metropolitan regions, a single county-, city-, or state-authorized special-purpose authority may operate all or most of the large commercial-service airports, such as the Port Authority of New York and New Jersey, the City of Los Angeles, and Metropolitan Washington Airports Authority. However, the airports in a metropolitan region may compete for airline tenants and passengers and thus may have little incentive to collaborate in their planning of capacity. With financial support from FAA, some airport authorities in the same metropolitan region have collaborated on their development plans; for example, by jointly developing forecasts for regional air travel demand and using the results to coordinate their airport investments and ensure that they are not duplicative. According to the Government Accountability Office, such regional plans are usually developed by MPOs but are only sometimes integrated with the planning of other transportation modes.[19] FAA does not condition airport grant eligibility on such planning, at either the metropolitan or the interregional level.

To assist with the planning of NEC rail investments, Congress established the NEC Commission, whose members include the eight states served by the corridor. The long-range planning document that currently guides NEC rail investments, known as the NEC Master Plan,[20] was created by Amtrak in collaboration with the state members of the NEC Commission and the Federal Railroad Administration (FRA) in 2010. With additional assistance from FRA, the NEC Commission is developing an implementation plan to identify investment opportunities consistent with the master plan. Sources of funding for the capital investments remain elusive. As discussed in Chapter 3, the eight commuter railroads that operate in the NEC are required to pay Amtrak access rates that are designed to recoup only "avoidable" costs, and thus they do not contribute to capital costs. Congress has called for reforms to these

[19] http://www.gao.gov/products/GAO-10-120.

[20] The Northeast Corridor Infrastructure Master Plan, prepared by the NEC Master Plan Working Group, May 2010. http://www.amtrak.com/ccurl/870/270/Northeast-Corridor-Infrastructure-Master-Plan.pdf.

reimbursement agreements,[21] but whether the states and their respective commuter railroads will be in a position to contribute substantially more to Amtrak's capital program for the NEC rail right-of-way remains to be seen. The lack of a shared funding commitment hinders the planning and prioritizing of investments in the multipurpose NEC rail line.

While the NEC Commission is made up of members from eight state departments of transportation, its emphasis is on passenger rail rather than on planning transportation services generally in the corridor. Nevertheless, the commission's state department of transportation membership could provide a framework for examining transportation investment opportunities more generally and from a multimodal perspective in the NEC. To support the NEC Commission, FRA has created the NEC Future Program, which provides technical analyses of market conditions and environmental impacts for the evaluation and prioritization of NEC investments through 2040. The NEC Future Program has so far concentrated on rail. A broadening of its analytical role and an expansion of its dialogue with operators of intercity buses, airlines, and airports appear to be natural steps toward supporting a more comprehensive and modally diverse planning role for an interregionally focused NEC Commission.

In sum, neither the U.S. transportation funding approach nor its institutional environment has favored the development of transportation systems from an interregional perspective. For transportation systems that have a strong interregional dimension, such as intercity passenger rail, this situation can be problematic. As discussed in the next section, circumstances differ in Europe. Cities that are considered distant in a European country, such as Paris–Marseille in France (about 400 miles), Madrid–Barcelona in Spain (about 300 miles), and London–Glasgow in Great Britain (about 350 miles), are separated by roughly the same distance as the Los Angeles–San Francisco (about 350 miles) and Washington–Boston (about 400 miles) corridors. These and other interregional corridors in the United States span a single state or group of states; intercity markets that would be considered distant can span two or three time zones and more than 2,500 miles.

[21] Passenger Rail Investment and Improvement Act of 2008, Section 212.

National-level transportation system planning in Europe is therefore more likely than in the United States to be at the interregional scale—a scale of 100 to 500 miles that is also suited to intercity rail.[22] The early development of high-speed rail in Europe was entirely at the national level and used domestically produced technology (Nash 2009). These domestic systems have been increasingly integrated across European Union (EU) member countries with the aim of creating a trans-European rail network. The high-speed lines linking Paris, Brussels, and London have been the greatest success to date. Nevertheless, integration is complicated because the funding, planning, and delivery of service are affected by the decisions of individual member countries. For example, a recent article (*Economist* 2015) reports how the EU "is finding it hard to transform a bunch of national rail monopolies into a pan-European market in which operators compete across borders." The institutional challenges are being addressed by the EU, which has established requirements for open access to new operators and common technical standards for new infrastructure and rolling stock. Therefore, an examination of how passenger rail systems have been provided in Europe can provide insights relevant to the provision of interregional transportation in the United States (Nash 2009).

Before the European experience in providing intercity rail is discussed, the rationale for not similarly examining the provision of rail in another continental-size country, China, is mentioned. Since 2008, China has added more than 12,000 miles of high-speed lines and 1,200 train sets. High-speed trains in China carried more than 800 million passengers in 2014 and accounted for more than half of worldwide high-speed traffic.[23] China's longer-range plan is for high-speed lines to serve 90 percent of cities with populations of 500,000 or more (Wu 2014).

There are many reasons to study China's experience in developing and operating high-speed railways, but there is little to be gained in terms of policy insight. China's form of government allows infrastructure decisions to be made in a centralized manner that bears no relation to the policy

[22] Rodrigue and Notteboom (2010) provide a qualitative comparison of the configurations of the European and North American transport and logistics networks. They discuss several relevant contrasts, including the tendency of European infrastructure projects to be designed on a scale that is more national than continental.

[23] http://www.uic.org/High-Speed-History.

environment of the United States. Early evaluations of China's investment in a high-speed rail network suggest that major uncertainties were overlooked or considered irrelevant by decision makers. Among them was whether the projected traffic would materialize to enable repayment of substantial amounts of debt and whether the added investment in faster service would be cost-beneficial in regions where travelers have low valuations of travel time (Wu et al. 2014). Such a decision-making environment is not germane to the United States, where political, economic, and demographic conditions are more closely aligned with those of Europe. Furthermore, the Chinese transportation system bears little resemblance to that of the United States. It serves a population having much lower income,[24] motor vehicle ownership rates,[25] and airline usage.[26]

EUROPEAN EXPERIENCE WITH PROVISION OF INTERCITY RAIL

Table 5-2 compares mode shares for all travelers in interregional markets in the European Union with modes shares for travelers in the 200 most heavily traveled interregional markets in the United States. In some respects, interregional travel patterns in Europe today resemble those of the United States. In both places, the automobile is the dominant mode by a large margin for trips of less than 300 miles (about 500 kilometers). Car ownership rates in the United States have long been higher than in European countries, but the gap has been closing (Berri 2009).

Similarly, in both the United States and Europe, air travel accounts for a substantial share of trips longer than 200 miles (about 300 kilometers). However, there is a notable difference in the use of passenger rail across all distances. Rail mode shares are in the single digits for all mileage levels in the United States and typically below 3 or 4 percent. Rail shares in

[24] According to World Bank data for 2014, China's gross domestic product per capita was $7,594, compared with $54,630 in the United States.

[25] According to World Bank data for 2010, China averaged 58 vehicles per 1,000 people, compared with 797 in the United States (http://web.archive.org/web/20140209114811/http://data.worldbank.org/indicator/IS.VEH.NVEH.P3_).

[26] According to World Bank data for 2014, air passengers in China totaled 390 million. The corresponding figure for the United States, which has only 23 percent of the population of China, was 763 million (http://data.worldbank.org/indicator/IS.AIR.PSGR).

TABLE 5-2 Interregional Mode Shares in the European Union and for Travelers in the Top 200 U.S. Markets

Jurisdiction and Distance	Auto	Bus	Air	Train	Other
European Union, 150–199 km	78.2	6.6	11.9	0.8	2.5
European Union, 200–249 km	74.9	6.0	13.1	2.1	3.9
United States, ~160–240 km[a]	94.4	2.8	2.6	0.3	na
European Union, 250–299 km	66.5	7.9	17.0	4.8	3.8
United States, ~240–320 km[b]	88.1	3.3	4.2	4.5	na
European Union, 300–499 km	60.2	7.8	18.2	10.6	3.2
United States, ~320–480 km[c]	74.4	5.4	6.7	13.5	na
European Union, ≥500 km	29.2	5.9	8.7	53.2	3
United States, ~480–800 km[d]	41.9	3.1	1.0	54.1	na

NOTE: Mode shares are percentages; na = not applicable ("other" applies only to European Union).
[a]100–149 miles; [b]150–199 miles; [c]200–299 miles; [d]300–500 miles.
SOURCE: Directorate for Energy and Transport 2014 for EU data; Federal Highway Administration trip tables discussed in Chapter 4 for U.S. data.

Europe are between 12 and 18 percent for distances up to 300 miles and are nearly 10 percent even for longer trips. In short, Europe's passenger railways have retained a substantial market share for domestic interregional trips, particularly in the largest city-pair markets of individual countries, such as Paris–Lille, London–Manchester, Madrid–Barcelona, and Frankfurt–Cologne (Crozet 2014; Nash 2014).

There are many possible reasons why passenger rail is more prevalent in Europe than in the United States. After World War II, Europe's historic cities were preserved, and damaged cities were rebuilt with land use restrictions to retain compact designs. Narrow, congested roads and scarce parking limited the attraction of cars. The low level of household incomes after the war led to low automobile ownership levels and a public willingness to tax motor fuel and automobiles as luxury goods. By the time automobiles were widespread in the 1960s and 1970s, most cities were already mature. Meanwhile, motor fuel taxes were kept high[27] as

[27] Country-by-country motor fuel prices are given by the International Energy Agency (2015, Tables 9, 10, and 11, pp. 374–376).

European cities invested in public transit systems, which tend to function well in compact cities (TRB 2001). The combination of good public transit and city centers that continued to be major attractors of business, shopping, and leisure trips gave downtown train stations locational advantages over airports, which tended to be located on the edges of metropolitan areas because of noise and land requirements. In addition, most major European airports impose stronger regulatory controls on takeoff and landing slots to address concerns over capacity shortages than do airports in the United States. Such supply constraints may limit the ability of airlines to offer competitive flight frequencies for short-haul trips that can be made by rail and other interregional modes (Gillen and Morrison 2008; Starkie 2008).

A thorough review of these and other geographic, demographic, historical, and policy-related factors that have contributed to differences in rail use and availability in Europe and the United States is beyond the scope of this study. However, a review of some of the factors can offer insights that may be useful for interregional transportation planning in the United States.

Public Investments in Passenger Rail Infrastructure

As discussed in Chapter 3, after World War II, the use of passenger rail declined precipitously in the United States as automobiles and airlines attracted travelers. Rail did not experience the same magnitude of decline in Europe. When European rail corridors experienced declining freight traffic after World War II, many were upgraded with public investments for more intensive use by passenger trains. Today, the major cities of Europe are linked by a network of interconnected passenger rail corridors. Freight continues to be transported by rail in many European countries, but traffic volumes and mode shares do not resemble those of the United States. According to Furtado (2013), the rail share of the freight transportation mode split (including truck and water), on the basis of ton-miles, was about 37 percent in the United States and less than 10 percent in the EU.

European investments in substantially upgraded and new higher-speed passenger lines have usually been made in corridors that already had high train ridership (Preston 2014). Because their rail networks are devoted mainly to passenger trains, service levels could be expanded incrementally over time to a point where capacity limits and the demand for major service and infrastructure investments became evident. In this regard, Europe has followed the Japanese approach in building the Shinkansen, which was the first high-speed railway in the world (Kurosaki 2014; Nash 2014). When the Shinkansen was being planned in the 1950s, central Japan's existing Tōkaidō trains were heavily used, but travel was slowed by narrow-gauge tracks that often meandered to circumvent the mountainous coastal terrain (Kurosaki 2014). Although construction and operation of a line specially built for high speed were expected to be costly, Japan was confident that the rail service would attract substantial ridership because of the already large base of train ridership (Toshiji 2007). In short, the national governments of Europe and Japan have made large investments to create integrated networks of passenger trains. For the most part, their investments in new or substantially upgraded passenger rail lines have been made in markets already having significant rail service and demonstrating high rail ridership.[28]

European governments have invested in a mix of conventional and higher-speed passenger trains (Nash 2009). Programs to upgrade heavily used conventional rail systems, such as those in Great Britain, Germany, and Sweden, have resulted in average speeds of about 90 miles per hour, top speeds of about 125 miles per hour, and scheduled service at least hourly in many markets (Givoni 2006; Ellwanger and Wilckens 1994). Examples of these upgrades are tilting trains that allow faster speeds through curves and the addition of new track sections to circumvent bottlenecks. The faster trains typically share track with freight trains, but the freight volumes are generally not large enough to pose major traffic conflicts. In some cases, such as where chronic capacity shortages arise because of high volumes of freight or commuter traffic or where existing infrastructure is of poor quality and difficult to upgrade, new passenger lines have

[28] The construction of the Channel Tunnel and its high-speed rail line (HS1) to London could be considered an exception to this approach. Ridership in the London–Paris and London–Brussels markets had previously been served by airline and combinations of ferryboat, bus, and rail services. The HS1 line has not met original ridership forecasts. The overestimation appears to have resulted from the London–Paris–Brussels markets not experiencing the anticipated growth in travel demand, in part because of the advent of low-fare airlines offering service to more distant cities (Booz and Company 2012).

been built. The new lines are not constrained by existing infrastructure and are typically built for nonstop services scheduled for speeds of 125 to 150 miles per hour (Givoni 2006). According to the World Bank, as of 2010 Europe had about 3,400 miles of high-speed lines on which trains regularly travel with a maximum speed of 150 miles per hour or higher (Amos et al. 2010, Figure 1).

France decided to invest heavily in high-speed rail lines in the 1970s and now has more passengers using high-speed trains than any other European country. Although construction of the Train à Grande Vitesse (TGV) led to faster intercity service, a main reason for the French decision to invest in the system was to free capacity for regional service on the existing rail network and to curb congestion on the country's main highways.

The French experience has demonstrated the benefits of integrating high-speed rail services into the mostly conventional national rail network. The TGV provides frequent, high-speed service between Paris and several major French cities and connects to the junctions of conventional lines that can accommodate high-speed trains operating at reduced speeds to access more French cities. For example, the trains that first ran on the high-speed line built between Paris and Lyon were able to continue on conventional lines to reach Marseille, Nice, and Montpellier (new high-speed lines have since been built on these routes). This purposeful integration has allowed the high-speed trains to access traditional stations in many more cities without the need for expensive reengineering. The French high-speed system thus differs from the Japanese system, whose high-speed trains can only operate on dedicated lines because of the narrow gauge of the country's conventional lines.

The original Paris–Lyon line now accommodates more than 150 trains per day operating at a cruising speed of about 200 miles per hour. According to Crozet (2014, 75), only the high-traffic routes serving Paris earn enough revenue to contribute to the TGV's maintenance and capital replacement costs. Trains operating in smaller city-pair markets such as Lille–Lyon and Lyon–Nantes are generally cross-subsidized with revenues earned from the Paris markets because of the lighter traffic in the former markets.

More recently, Spain has invested heavily in high-speed rail. Because its cities are arranged radially around Madrid, Spain has had to construct four separate high-speed main lines (plus some spurs) to serve a number of individual city pairs (i.e., Madrid–Barcelona, Madrid–Seville, Madrid–León, and Madrid–Valencia) (Nash 2014; de Rus and Inglada 1997). In this sense, the geography of Spain is comparable with that of Midwestern regions of the United States, with long distances between the major cities and limited intermediate population centers (Nash 2009).

Efforts to fund rail infrastructure privately have had mixed success in Europe. Both the Channel Tunnel and the high-speed line linking it to London were conceived as being private ventures requiring no government funding. However, in both cases financial difficulties compelled government contributions; for example, the track access charges imposed on some forms of traffic were subsidized. The private company that was awarded the franchise for the high-speed line between London and the Channel Tunnel sought government underwriting of the debt. No direct public subsidies have been provided to the Channel Tunnel operator, but the rail infrastructure at each end of the tunnel was subsidized. Although evidence indicates that private-sector involvement has aided the development of passenger rail infrastructure in Europe, it has not eliminated the need for substantial government funding.

Throughout Western Europe, the rail infrastructure is owned by government. Great Britain is the only country without a publicly owned passenger train operator; however, most other European countries have divided their once vertically integrated national rail companies into separate organizations responsible for train operations and rail infrastructure (Mizutani et al. 2015). For instance, Sweden, the Netherlands, and Denmark have established separate operational and infrastructure companies; France, Germany, and Italy have established subsidiaries within a government-owned holding company. These divisions have been required by EU law, which mandates nondiscriminatory access for freight and international passenger operators, ensured by an independent regulator. The EU is considering proposals to extend this access requirement to all passenger train services (Mizutani et al. 2015).

In Great Britain, where there is no national rail carrier, almost all intercity trains are operated by private carriers under franchise agreements. The franchised passenger train operators pay for access to the infrastructure on the basis of a variable charge covering marginal cost plus a lump sum contribution to the fixed costs of the system. In addition, on the most profitable routes, bids for franchises offer a premium to the government, which in some cases covers the remaining fixed costs. However, high access charges have discouraged competitor entry into the market for passenger services on the Channel Tunnel (Nash et al. 2013). Entrants who might otherwise make use of underused capacity have also been discouraged by the stringent safety conditions for trains, which have had the practical effect of prohibiting the use of standard rolling stock by large operators such as Deutsche Bahn.

Many passenger railways in Europe were long protected from competition from intercity buses. Train operators did not compete with buses to the degree that they competed with airlines (Van de Velde 2009). For example, French bus operators were not allowed to enter markets served by the French national railway, and German law restricted competition by bus operators on routes that parallel intercity railways. In contrast, Great Britain has not provided railroads with protections against bus competition since the intercity bus industry was deregulated and opened to competition in 1980. National Express, once a government-run bus line, now competes with the railroads as well as with Megabus and other low-cost bus companies (Van de Velde 2009). Despite the competition from the deregulated buses, intercity passenger rail demand has remained high and continued to grow in Great Britain.[29]

The bus–rail competitive landscape in Europe has been changing in recent years, as new EU regulations require the opening of domestic portions of international travel routes to competition through cabotage by bus operators from other countries. Because the regulatory changes were adopted recently, information on their implementation and effects on bus and rail competition is limited.

Assessments of the Public Benefits and Other Effects of Passenger Rail Investments

The first four high-speed lines in France served more than 15 million passengers per year shortly after opening (Nash 2014). Experience has

[29] U.K. Office of Rail and Road, Passenger Rail Usage, Statistical Release for Quarter 1, 2015–2016, October 1, 2015 (http://orr.gov.uk/__data/assets/pdf_file/0009/19377/passenger-rail-usage-2015-16-q1.pdf).

caused some analysts to conclude that break-even volumes (i.e., volumes yielding benefit–cost ratios greater than 1) for new high-speed lines are on the order of 10 million passengers per year (de Rus and Nombela 2007; Nash 2014; Graham and Melo 2010). However, the specific break-even point can vary with construction costs and the value attributed to savings in time. Construction costs can be especially important to benefit–cost ratios (Campos et al. 2009). For example, France made use of existing surface routes to allow high-speed trains to access stations in the main cities, which lowered construction costs, and benefit–cost ratios have been shown to be above 1 (Nash 2014). In comparison, construction of the high-speed rail line from London to the Channel Tunnel required the building of expensive new approaches to the city's train stations, including long stretches of tunnel because of the region's topography and high urban densities (Nash 2014). The hub-and-spoke structured high-speed corridors in Spain (centered on Madrid) have annual ridership levels of about half the benchmark 10 million figure. According to de Rus (2012), the benefit–cost ratios for the Spanish lines are below 1, despite relatively low construction costs.

For the most part, the European intercity rail systems have been competitive with air travel in interregional markets. Table 5-3 shows examples of before-and-after studies of mode split for high-speed lines in France (TGV), Spain (AVE), and Germany (ICE). All three have led to travelers shifting from air to rail. As shown in Table 5-4 (which also includes some Japanese corridors), rail attracts more passengers than

TABLE 5-3 Mode Shares Before and After Introduction of High-Speed Rail Service

	High-Speed Rail Service					
	TGV Sud-Est		AVE Madrid–Seville		ICE Hamburg–Frankfurt	
Mode	Before	After	Before	After	Before	After
Airplane	31	7	40	13	10	4
Train	40	72	16	51	23	51
Car and bus	29	21	44	36	57	45

NOTE: Mode shares are percentages.
SOURCE: de Rus 2009.

TABLE 5-4 Rail Share of Rail–Air Market and Rail Station-to-Station Travel Times, European and Japanese Corridors

Interregional Corridor	Year	Travel Time	Straight-Line Distance (miles)	Effective Average Travel Speed (miles per hour)	Rail Mode Share (%)
Paris–Brussels	2006	1 h 25 min	165	116	100
Paris–Lyon	1985	2 h 15 min	240	107	91
Madrid–Seville	2003	2 h 20 min	245	105	83
Brussels–London	2005	2 h 20 min	200	86	60
Tokyo–Osaka	2005	2 h 30 min	250	100	81
Madrid–Barcelona	2009	2 h 38 min	315	120	47
Paris–London	2005	2 h 40 min	215	81	66
Tokyo–Okayama	2005	3 h 16 min	335	102	57
Paris–Geneva	2003	3 h 30 min	255	73	35
Tokyo–Hiroshima	2005	3 h 51 min	420	109	47
Paris–Amsterdam	2004	4 h 10 min	270	65	45
Paris–Marseille	2000	4 h 20 min	410	95	45
London–Edinburgh	1999	4 h 25 min	335	76	29
London–Edinburgh	2004	4 h 30 min	335	74	18
Tokyo–Fukuoka	2005	4 h 59 min	550	110	9

SOURCE: Nash 2014.

air when the station-to-station travel time is under 3 hours, and it continues to attract a significant market share up to travel times of about 4 hours. When travel times are about 2 hours, rail largely eliminates air from the market, although sometimes airlines book space on rail for their connecting passengers and some major airports [such as Charles de Gaulle, Schiphol (Amsterdam), and Frankfurt] are served directly by high-speed trains. In general, conventional rail that averages 125 miles per hour competes effectively with air for distances of up to 300 miles; newer high-speed lines offering faster average speeds are competitive for longer distances. However, for trips that start and finish well outside Europe's main metropolitan areas, travel by train may be less convenient if a transfer to a slower local train is required. There is evidence that low-cost airlines have learned to exploit this market by providing direct service between cities that are located off the main railroad lines (Dobruszkes 2009).

SUMMARY

The provision of interregional transportation in the United States is a public- and private-sector enterprise whose funding, planning, and operations differ by mode. For the most part, private individuals and companies supply the transportation service, and the federal, state, and local governments supply the transportation infrastructure. The mix of public- and private-sector responsibilities creates a complex environment for coordinating the provision of transportation, especially where interregional corridors span multiple states.

Taxes and other fees paid by transportation users are an important source of funding for aviation and highway system infrastructure. User-based financing has a long history in the United States. It provides a reliable source of revenue for system investments and ensures that those who benefit directly from the investments bear much of the cost. User-based financing has the disadvantage of contributing to a general tendency for transportation planning and programming to be undertaken on a mode-by-mode basis because user revenues must be reinvested in the source mode. To limit the tendency for mode-specific transportation decision making at the metropolitan level, the federal government has long required that large public investments in urban highway and transit systems be coordinated on a metropolitanwide basis by a mode-neutral planning body as a condition for federal aid. This aid is derived from a single account, the Highway Trust Fund. There are no similar conditions for federal aid to be used for interregional transportation corridors, in part because the funding for each of the interregional modes is derived from different revenue sources and trust fund accounts.

User-based financing is not practiced in passenger rail. When rail passenger revenues exceed operating costs in the heavily traveled NEC, the excess is usually used to cover operating deficits incurred elsewhere in the rail network instead of being retained as capital for the Amtrak-owned NEC. The federal and state governments appropriate general funds to cover any remaining deficits incurred by Amtrak's operations as well as its capital projects. Passenger rail poses special challenges for system funding and planning because it lacks both a dedicated capital fund and a means of governance that aligns with multistate routes. In the United States, few institutional structures align with transportation systems that are regional in scope rather than local or national.

National governments in Europe have made passenger rail a priority to a greater extent than in the United States, in part because the compact size of these countries creates many shorter-haul interregional markets suited to this mode of travel. Despite geographic, historical, and policy differences, the European experience in supporting passenger rail offers insights into the conditions that would encourage the use of rail for interregional markets in the United States. Experience there suggests that rail is more competitive when it serves cities having neighborhoods, employment centers, and travel attractions close to downtown train stations and extensive, well-functioning transit systems that make station access convenient for travelers. In cities having these characteristics, downtown train stations are more convenient to access than are the airports located on the edges of metropolitan areas. Europe's experience also suggests that trains must be capable of providing 2- to 3-hour downtown-to-downtown service with a high degree of schedule frequency to compete effectively with airlines in most interregional markets.

As in Japan, European investments in upgraded and higher-speed passenger rail lines have usually been made in corridors that already have high train ridership. Because their rail networks are devoted mainly to passenger trains, service levels can be expanded incrementally to a point where capacity limits and the demand for major service and infrastructure investments become evident. During the past 40 years, a number of European countries have upgraded their conventional passenger rail networks to allow trains to average about 90 miles per hour and reach top speeds of about 125 miles per hour. In some cases where there are capacity shortages because of high volumes of commuter trains or where existing infrastructure is of poor quality and difficult to upgrade, completely new passenger rail lines have been built to average speeds of 150 miles per hour or higher. European and Japanese experience indicates that the break-even volume, in social benefit–cost terms, for the construction of a new high-speed line is on the order of 10 million passengers per year.

The European experience with passenger rail has more relevance to the NEC than to other U.S. travel corridors. As in Europe, the NEC's publicly owned rail right-of-way is oriented toward passenger trains, which minimizes the impact of freight traffic on Amtrak's ability to add trains and reduce schedule times. The demand for trains in the NEC is well established; the conventional regional trains and premium-service Acela trains transport about 10 million riders per year. The uncertainties associated with investments in upgraded or new passenger rail services will always be large. However, the high levels of train use in the NEC minimize these uncertainties in comparison with other U.S. corridors, few of which have any competitive train service on which to base assessments.

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Abbreviations

CBO Congressional Budget Office
TRB Transportation Research Board

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6

Data and Analytical Tools for Interregional Transportation Planning and Decision Making

Countering the tendency to plan and program public investments in transportation on a mode-by-mode basis is a challenge. Mode-based funding exacerbates this challenge. Coordination in the interregional context is complicated further because of the large number of modes involved and because of the many federal, state, and local governments with infrastructure and operating responsibilities. Even though many policy goals—such as providing efficient service, relieving congestion, and protecting the environment—may be shared among these public entities, there may be few means of furthering them through actions coordinated at the corridor or interregional level.

The importance of a rational system of transportation planning and decision making has long been recognized in the urban context. Analysts have summarized the steps of urban transportation programming as consisting of (*a*) inventorying existing travel and activity patterns, (*b*) developing models of local transportation supply and demand relationships, (*c*) formulating options, (*d*) forecasting the effects of each option on travel, (*e*) evaluating each option on the basis of economic and other criteria, and (*f*) implementation (Button 2010, 397). Carrying out these steps requires an institutional arrangement for transportation planning and decision making under which consensus can be reached on goals and options and objective analyses can be undertaken. Although metropolitan planning organizations (MPOs) had existed in many urban regions for decades,[1] their requirement as a condition for federal highway and transit aid expanded their use. They helped overcome inherent obstacles to

[1] For example, the New York Regional Planning Association was founded in 1922.

the following of these steps in metropolitan regions that can consist of numerous municipalities, counties, and transportation authorities.

The increase in the influence of MPOs has stimulated demand for improved travel data and analytical tools applicable to urban transportation.[2] In addition to requiring the MPO process, the federal government supported the development of databases and tools.[3] Thus, in the urban setting there is now an extensive base of research and practitioner guidance on the factors influencing travel behavior and demand, modeling and forecasting techniques, surveying and sampling methods, and project appraisal techniques such as benefit–cost analysis. The development of urban transportation planning tools has helped improve the analyses in support of decisions (Cambridge Systematics et al. 2012, 1). There are no similar coordinating mechanisms for transportation planning and decision making when interregional corridors cross multiple states; hence, there is less institutional demand for travel data, models, and evaluation techniques. In addition, in contrast to the metropolitan level, where public entities provide much of the transportation infrastructure and services, there is a substantial private-sector role in the interregional domain. Data collected and models developed by the private sector may be kept proprietary (Miller 2004).

In short, the data and analytical tools used for planning, evaluating, and developing transportation projects in the interregional domain are seldom derived from an ongoing transportation planning and priority-setting process. Analysis and evaluation are typically undertaken on an ad hoc basis; for example, a specific modal option for a corridor, such as the building of a high-speed rail line, might be assessed (Miller 2004). In this regard, the process is the antithesis of the multimodal, multioption, system-level approach used at the metropolitan level (Horowitz 2006). Indeed, the MPO approach has become more comprehensive over the years as urban transportation planners have assumed more project evaluation and programming responsibilities. In addition to planning highway and transit capacity expansions,

[2] Statewide and metropolitan transportation planning processes are governed by federal law (23 USC §§134–135). MPOs were first required by the Federal-Aid Highway Act of 1962 and became much more influential in metropolitan transportation planning and decision making after enactment of the 1991 Intermodal Surface Transportation Efficiency Act.

[3] One example is the 20-year program of federal support for TRANSIM (Transportation Analysis Simulation System), which is an integrated set of tools developed to conduct regional transportation system analyses.

they now develop and assess options for managing travel demand and for achieving policy goals such as curbing greenhouse gas emissions; meeting air quality standards; and expanding community access to health care, jobs, education, and affordable housing.

In the remainder of this chapter, some of the analytical and data capabilities needed to inform transportation planning and decision making in the interregional context are described. As in the case of the MPOs, institutional mechanisms are necessary to create a demand for and to ensure regular use of these capabilities. Further consideration is given to that necessity in Chapter 7, which contains the study recommendations.

EXAMPLES OF ANALYTICAL TOOLS

Travel Demand Forecasting Models

There are three broad types of travel demand models. *Aggregate models* predict the number of trips taken in a geographic area on the basis of trip production and attraction factors. *Disaggregate models* estimate the probability with which a utility-maximizing individual (having certain quantifiable characteristics) will undertake a trip between a specific origin and destination by using a specific mode and a specific route. In *highly disaggregate, activity-based models*, travel behavior is analyzed in the broader context of participation in activities, often through the use of travel diaries.

Travel demand forecasting models used in the urban setting are typically hybrids of the three types. Most urban travel demand forecasts start with an aggregate model to estimate the total number of trips originating and ending in defined geographic zones or areas.[4] Model inputs (or variables) used to explain trip production include household size, automobile ownership, and income. Trip attractions are chiefly workplaces and retail outlets but may include other household concentrations, schools, parks, airports, and education or recreational destinations. The models typically require data from a number of sources such as household surveys;

[4] This step refers to estimation of trips on the basis of "productions" (households are the most important source of production) and "attractions" (places of employment or retail establishments are obvious attractors).

census statistics; and bus, airline, and rail passenger counts and ticket sales. Additional models (which can be either aggregate or disaggregate) are applied to divide the total trips among specific origin–destination pairs (e.g., trip distribution or destination choice models),[5] by mode (e.g., logit mode choice models), and by route (e.g., network assignment models). For example, the probability of choosing among modes and routes may be modeled as a function of the characteristics of individuals, trip purposes, and the relative costs of alternative modes. Activity-based models may be used to predict travel behavior from the perspective of the individual or households so that travel induced by a new mode or service or by other changes in the transportation system can be evaluated (see Pinjari and Bhat 2010).

Disaggregate and activity-based models are generally favored for more sophisticated evaluations of policy alternatives in more complex situations because they can better address traveler-specific trade-offs among alternatives having different characteristics with respect to time, price, and level of service. For example, when a metropolitan area with severe congestion is not meeting air quality standards, urban planners interested in assessing specific policy options such as variable tolling or bus rapid transit may desire a travel forecasting process that is sensitive to price and allows for the analysis of mode choice by time of day (Cambridge Systematics et al. 2012, 1–4). Such models require detailed information from representative samples of households to obtain statistically valid information on activities and preferences.

As in the metropolitan setting, the kinds of forecasting models that are most appropriate to the planning of interregional transportation are likely to depend on specific circumstances and the availability of travel data. Heavily traveled and modally diverse corridors such as the Northeast Corridor, where many alternatives involving complex conditions need to be assessed, may have characteristics that favor disaggregate models. Miller (2004, 94) suspects that earlier interregional demand

[5] The standard approach to estimating trip distribution is a gravity model, so named because the gravitational force between two bodies increases with the mass of each body and decreases with the distance between them. Trips are negatively affected by some measure of "impedance" or friction affecting the desirability of a trip between the two points, such as distance, travel time, cost of travel, or a combination of such factors.

forecasts have been developed by using aggregate models because they were constructed for a specific study with limited data, usually by proponents of a new investment in corridor infrastructure. The goal of these models is often to predict the number of trips in the corridor and the changes in mode shares in response to the investment rather than to assess a more varied and complex set of investment and policy alternatives.

As noted above, aggregate models are usually limited in their ability to portray or analyze the decisions of individuals, the effects of travel time valuations, and the utility of modal service attributes such as reliability. Miller (2004) is thus skeptical of the ability of aggregate models to account for a number of important demand factors, such as the effect of access and egress time and cost on airline and passenger rail mode shares (especially in relatively short interregional markets), and for details such as toll and fuel price levels, airline pricing strategies, and delays at airports due to security. Miller acknowledges that disaggregate models can present their own challenges. For example, data on relatively infrequent long-distance trips can be difficult to obtain, at least in comparison with data on the many regular trips made by households that inform urban transportation planning. The accurate portrayal of transportation system choice sets (i.e., level of service attributes, frequencies, prices) is also problematic for an entirely new system. These and other data-related issues are discussed below as they pertain to interregional travel.

In contrast to the metropolitan context, no standard model structures or parameter values apply to interregional corridors. Default, or rule-of-thumb, coefficients compiled from empirical data are transferable among urban transportation settings when locally specific data are not available for model development.[6] Similar standardization could prove valuable for modeling interregional travel demand, especially where regular data collection and analysis activities are not practical. Miller (2004) believes that the lack of entities responsible for ongoing evaluations of interregional transportation leads to a dependence on consultants whose

[6] Default coefficients are encouraged by the Federal Transit Administration in the New Starts process. Various reports (e.g., Martin and McGuckin 1998, Cambridge Systematics et al. 2012, Schiffer 2012) that compile typical ranges of coefficients and parameters are available to assist modelers, but practitioners are cautioned in the use of these values in the absence of good local validation data.

model specifications are often proprietary and not subject to continued review and improvement by users. In studying ridership estimates for the planned California High-Speed Rail System, the Government Accountability Office (GAO) concluded that "there are no industry standard or established criteria for developing or evaluating intercity passenger high-speed rail ridership forecasts" (GAO 2013, 23). GAO criticized the Federal Railroad Administration for not having established guidelines on acceptable approaches for developing reliable system ridership and revenue forecasts (GAO 2009).

In the United States, the modeling of interregional travel may be most advanced in states that enclose major interregional corridors, such as California. The most recent version (Version 2.0) of the California Statewide Travel Demand Model, released in 2014, integrates short- (under 100-mile) and long-distance (over 100-mile) personal travel models on the basis of more than 5,400 zones within the state and more than 50 external zones. The model's long-distance component uses data from the 2012 California Household Travel Survey to consider five travel modes and five time periods of the day. It models long-distance travel choices in terms of whether to engage in such travel, trip purpose, party size, duration, destination, main mode, access mode, and egress mode. The model is sophisticated and includes feedback loops to take into account the impacts of traffic congestion on these choices (as well as short-distance travel choices). A consequence of this detail is that the California model is computationally intensive. Five iterations are typically required to reach equilibrium, and run times are several days.

To support state highway and transportation planning, the Federal Highway Administration (FHWA) has undertaken a comprehensive review of long-distance transportation demand models, including those used in 10 states and several from abroad (FHWA 2012). The report contained information on dozens of statewide models and found that many European countries have national transportation models that focus on interregional travel. FHWA found that the state models used many approaches, but most used aggregate models because of the ease of implementing them across the state and to aid in the comparison of results with those of models used by MPOs. The report indicates that most of the national models used by other countries for forecasting interregional travel are hybrids.

They contain logit choice submodels that describe mode choice and usually other choices such as access and egress modes, routings, and timing choices. FHWA described its review of the models as providing "foundational knowledge to support long-distance modeling."

Evaluation and Representation of Uncertainty

All forecasting models are subject to sources of error and uncertainty. Errors are introduced during the data collection process as a result of sampling and survey methods. In addition, future conditions must be specified for a long time frame. For example, most travel forecasting models use the results of other forecasts, such as projections of population, households, and employment. Because these projections are usually developed independently, they can have variances and introduce uncertainties that go unrecognized by the travel demand forecaster. Miller (2004) points out that in the case of interregional markets, modelers may face the additional challenge of obtaining independent forecasts of demographic and economic conditions because, unlike individual states or metropolitan areas, the interregional market may not correspond to available forecasting sources.

All forecasts have uncertainties that need to be evaluated and recognized for informed decision making. Single-point forecasts are seldom realistic, since all of the inputs on which the forecast is based are unlikely to occur as projected. Many quantitative methodologies are available for associating a probable variance with each input factor (e.g., probability distributions for future conditions and modal parameters) and producing an expected error range for the final forecasts.[7] Presenting model results with probability distributions, or an estimate of error, allows users to derive a point estimate (e.g., midpoint of the confidence interval) or to use a range defined by the confidence limits. In either case, the reliability of the model outputs will be clearer to users. Evaluation of the model structure and its estimates by independent peer reviewers may also be warranted, along with the development of reference cases based on the history of forecast outcomes for similar projects.

[7] Adler et al. (2014) provide a more detailed discussion of these methods.

The documented tendency for systematic biases in transportation forecasts is another consideration. In researching the accuracy of travel forecasts, analysts have found that many of them used to promote transportation projects (i.e., procure approval and funding) have produced substantial overestimates. Button et al. (2009) evaluated ridership forecasts for 47 urban transit projects completed from 1970 to 2005. They found that 34 overestimated ridership (by more than 50 percent in 18 cases). Bain (2009) evaluated more than 100 toll road projects worldwide and found that traffic volumes averaged 25 percent lower than originally forecast. Flyvbjerg et al. (2002) studied hundreds of transportation projects in many countries, including highways, urban and intercity rail projects, and bridges built over more than 50 years.[8] They found that patronage is far more likely to be overestimated than underestimated and that costs are far more likely to be underestimated. Rail projects had the largest patronage overestimates and cost underestimates. In the 14 intercity high-speed and conventional rail projects studied by Flyvbjerg et al., project costs were underestimated by an average of 45 percent, and ridership overestimates were of the same magnitude. Flyvbjerg (2007) concluded that large cost underestimates combined with large ridership overestimates (and large standard deviations in both cases) result in a particularly high level of uncertainty and risk for rail projects in comparison with the other modes.

The frequency of high and low forecasts should be about equal if methods are unbiased. Researchers have characterized the empirical evidence of demand overestimates and cost underestimates as being indicative of "optimism bias" or even a tendency for strategic misrepresentation by proponents to gain project support (Flyvbjerg et al. 2005). To counter this phenomenon, Flyvbjerg and COWI (2004) have recommended that institutional checks and balances be introduced to develop independent forecasts. Two ways of doing this are by establishing peer reviews and by making empirically based risk assessments on the basis of data obtained from different projects (i.e., preparing probability distributions of the accuracy of project estimates). In the context of urban transportation planning, well-established model structures with known elasticities and interrelationships can be referenced and compared with those in the

[8] Fifty-eight of the total 258 transportation infrastructure projects studied were rail projects.

model used for a project. That capability is less clear for the modeling of interregional corridors.

Evaluations of the forecasting accuracy of models are critical before they are applied as standard tools for policy analysis, such as benefit–cost evaluation. Such evaluations would be highly misleading if they were based on faulty or misrepresented forecasts of demand, revenue, and costs.

Project Evaluation Methods

Transportation investments can have so many first- and second-order economic, social, and environmental impacts that evaluation criteria and methods must be diverse. Some impacts that need to be considered in terms of both their magnitude and their distribution by location and by social group are as follows [partial list developed by Goeller (1974)]:

- *Transportation service impacts* that occur to the users of systems, measured by trip volumes, door-to-door trip times and costs, changes in system congestion as traffic is diverted, and changes in traffic safety;
- *Financial impacts* on operators and the public sector, including the cost of building and operating vehicles and infrastructure in addition to the revenues from fares;
- *Environmental and energy impacts* such as increases or reductions in noise, air pollution, and greenhouse gas emissions, requiring consideration, among other factors, of whether the new or improved service reduces congestion on highways, on railways, or at airports and makes use of fuel-efficient technology;
- *Economic impacts* due to changes in employment and income in the region, including jobs added during construction, from system operation, and from multiplier effects; and
- *Community impacts* due to changes in activity patterns, property values, and tax bases and due to businesses and households displaced by system construction.

Benefit–cost analysis is an established method for evaluating such impacts. It is required for large transportation projects undertaken with public funds in the European Union (EU).[9] The EU guidelines for benefit–

[9] Benefit–cost analysis is required for projects of €50 million more (European Commission 2008).

cost analysis for large transportation investments require an investigation of a project's net impact on economic welfare in comparison with alternative actions or scenarios (business as usual, do minimum, do something, and do something else). The evaluation is to be undertaken by considering whether an investment yields incremental social benefits that exceed incremental costs. The EU guidelines explain how to conduct such evaluations for specific types of transportation investments, including highway, airport, and high-speed rail projects (European Commission 2008, 82).

The EU has developed Europe-wide models, such as TRANS-TOOLS,[10] for use in forecasting for such appraisals. Many European countries have their own national transport models and routinely apply benefit–cost analysis to projects requiring government investment. Great Britain, where benefit–cost analysis has been undertaken from a welfare-maximizing perspective according to standardized methods for many years, is an example. All projects requiring government funding, including all highway projects and virtually all rail infrastructure projects, are appraised in accordance with the online guidance provided in WebTAG (Web-Based Transport Analysis Guidance).[11]

Benefit–cost analysis is also required in the United States for most federally funded projects.[12] However, as GAO (2013) points out, there are multiple federal guidelines for valuing public benefits, and none is designated for use in analyzing high-speed rail projects. For example, high-speed rail service that reduces congestion on highways or at airports and makes use of fuel-efficient technology may provide environmental benefits (i.e., reduced pollution and greenhouse gas emissions), but there are no standards for valuing these effects. Similarly, the appraisal of new infrastructure to serve interregional travel demand requires assumptions about traveler valuations of time. Traditionally, the time spent traveling has been regarded as a penalty or disutility, with leisure and business time valued at percentages of the wage rate. Assumptions about travel time can

[10] Tools for Transport Forecasting and Scenario Testing. http://energy.jrc.ec.europa.eu/transtools/TT_model.html.

[11] https://www.gov.uk/guidance/transport-analysis-guidance-webtag.

[12] Executive Order 12893 states that expected benefits and costs should be quantified and monetized to the maximum extent practicable when federal infrastructure investments in transportation, water resources, energy, and environmental protection are evaluated.

be particularly important for benefit–cost evaluations—for example, by giving priority to transportation investments that save the more highly valued time of business travelers. As communication technologies change to allow for more productive use of time spent in travel, new guidelines on time valuation assumptions and methods may be warranted.

Other intangible effects, such as economic development benefits, can be difficult to estimate, and methods for evaluating them have not been standardized. There are no standardized ways for assessing and weighting distributional or equity impacts, knowledge of which may be important along with a project's total net cost or benefit.

GAO (2009) reviewed existing plans for 16 intercity rail passenger investments in the United States. The agency found that most of the project sponsors cited a variety of public benefits of the projects, such as congestion relief or emissions reductions, but a formal benefit–cost analysis was carried out in only four cases. Of the four analyses, none compared the proposed project with alternative modal investments, such as airport or highway expansion, although GAO (2009, 27) noted that "the proposed high speed rail line between Los Angeles, California, and San Francisco, California, has created a rough comparison of high speed rail investment with stated investment needs on the highway and air modes." A benefit–cost assessment of California's high-speed rail plan by Brand et al. (2001) found positive benefits when both user and nonuser benefits were considered.

The Federal Transit Administration (FTA) has had to confront the difficulty of monetizing all public benefits and costs in assessing urban transit projects proposed for "New Starts" grants. To do so, the agency has shifted the emphasis away from quantifying total net benefits and net costs to measures aimed at showing the distribution of benefits and costs according to defined socioeconomic accounts or categories, including mobility improvements, environmental benefits, operating efficiencies, land use effects, and economic development.[13] Proposers assign and support qualitative values, such as high, medium, and low, for each impact category, including one category that addresses user benefits on the basis of travel time savings to users of the regional transit system. For each

[13] http://www.fta.dot.gov/documents/FY12_Evaluation_Process%281%29.pdf.

impact category, FTA has predetermined weights that are used to rank projects. The Federal Railroad Administration has consulted with FTA to develop more standardized evaluation criteria for intercity passenger rail grants.

DATA NEEDS

Data are required for constructing travel demand forecasting models and for applying and validating them. Collecting such data for interregional trips is more challenging than for local trips because of their relative infrequency and high potential for mode transfers.

The necessary data can be considered in both macro and micro terms. Macro, or aggregate-level, data are required for forecasting total travel demand in an interregional market. Such data may include household income, employment status, number and size of households, automobile availability, and other socioeconomic attributes of the population. In forecasting interregional travel demand, the relevant study area boundaries or populations of interest must be identified. They may not correspond to the official statistics routinely collected by public agencies such as the Census Bureau. Transportation planning organizations such as MPOs can obtain such data over time for their respective metropolitan regions, but this may not be the case for an interregional market that lacks such a coordinating body.

The term "microdata" refers to individuals' characteristics and behavior. These data are usually obtained from surveys of individuals or households. As noted in Chapter 2, the value of the 1990s-era American Travel Survey database in supporting detailed and region-specific evaluations of travel demand is highly questionable because of its age. Such data must often be collected specifically for a proposed project. If the project involves a type of service that already exists, revealed preference data—that is, data based on the observation of travel behavior—may be used. The collection of revealed preference data can be challenging for interregional markets because (*a*) standard household surveys may not capture this infrequent travel and (*b*) private carriers who serve these markets (e.g., buses and airlines) may be reluctant to provide information such as traffic counts or ticket sales (Miller 2004).

When a new mode of transportation is being considered, model developers may need to use stated preference surveys. Representative trip makers are asked to make hypothetical choices between the proposed mode and existing or proposed alternatives across a range of scenarios. California is proceeding with its plan to build a high-speed passenger railway in reliance on ridership forecasts that are based largely on assessments of existing airline traffic and analyst efforts to develop realistic choice-set scenarios for stated preference surveys (Corey, Canapary, and Galanis Research 2005). These scenarios require many assumptions about the future attributes of the new service as well as those of modal alternatives, such as wait times, ease of access and egress, schedule frequencies, fares, and travel and transfer times (Cambridge Systematics 2006). Considerable attention must be given both to sample selection and size and to the design of these surveys and their scenarios to avoid inadvertently biasing respondent choices. The risk of bias may be greater when stated preference surveys and experiments are conducted by project proponents as opposed to ongoing planning entities that have no predisposition to a particular outcome or solution and that may be more inclined to have their survey instruments made public.

The Transportation Research Board committee that produced *How We Travel: A Sustainable National Program for Travel Data* (TRB 2011) recognized the need for up-to-date and representative data on interregional travel behavior. In its report, the committee urged the U.S. Department of Transportation to establish a National Travel Data Program, a key component of which would be a national program for passenger data collection and analysis. This proposal may be compared with the British National Travel Survey, which is continuous and surveys around 20,000 individuals in 8,000 households each year.[14] The passenger data survey would collect information on how, why, when, and where people travel and on factors affecting personal travel such as car availability, driver's license holding, and access to key services. It would provide detailed information on travel behavior and the ability to track how such behavior changes over time. By aggregating data from adjacent

[14] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/243957/nts2012-01.pdf.

years, geographical detail could be provided with reasonable accuracy, and—as in the British survey—the data could be used both for monitoring and for key inputs to statewide models and a national travel model.[15]

Finally, other data needed for modeling and evaluating interregional travel and transportation options are detailed descriptions of the existing system's capacity, speeds, service levels, cost, and traffic congestion for the line-haul and local highway and transit networks. In particular, the attributes of the available set of transportation alternatives and all their characteristics, or choice sets, need to be well described for the corridor or region. As noted earlier, access and egress availability must be represented correctly in models and in stated preference surveys, particularly for shorter-haul interregional trips, whose beginning and ending phases can account for a significant portion of total travel time. The competitive advantage of upgrading rail and air travel speeds may be reduced or nullified if terminals have poor transit access or are located in areas that are difficult to reach because of highway congestion (Miller 2004). Similarly, peak and nonpeak representations of highway and transit service levels are needed to establish the realistic choices available to travelers in deciding to use a common carrier service or to drive.

SUMMARY

Intergovernmental and multimodal planning and programing procedures have guided the development of metropolitan transportation systems for decades. They have helped improve the capacity to analyze urban travel demand and to evaluate transportation initiatives with regard to policy goals. In comparison, the planning and evaluation of transportation projects to accommodate interregional travel take place largely outside the multimodal context. These activities are often pursued by proponents of new modes and services who lack a broader policy perspective and who have limited incentive and ability to assess alternatives.

[15] Another model is the French National Travel Survey, which is conducted every 10 years. The survey consists of a computer-assisted personal interview, a 7-day travel diary, a more detailed follow-up questionnaire about long-distance trips taken during the past 3 months, and more thorough monitoring (via GPS) of travel by a small (750- to 1,100-person) subsample of respondents. See Roux and Armoogum 2011.

The experience with metropolitan planning indicates that an ongoing structure for multimodal and multijurisdictional decision making would help improve the capacity to prioritize policy goals, forecast travel demand, collect relevant data, and formulate and evaluate alternatives. The large number of active MPOs has prompted the development and refinement of standard methods for forecasting travel demand, assessing policy and investment options, and collecting data. The federal government, which mandates the MPO process, has provided leadership and resources to aid in these planning, analysis, and data collection efforts. Examples of the modeling, evaluation, and data capabilities required to inform transportation planning from an interregional perspective are given in this chapter. The project-specific, ad hoc approach to planning in this sector has not furthered these capabilities, whose development is hindered by a lack of ongoing institutional demand. The experience at the metropolitan level suggests that the creation of new institutions responsible for planning at the interregional level is essential to stimulating that demand.

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Abbreviations

FHWA	Federal Highway Administration
GAO	Government Accountability Office
TRB	Transportation Research Board

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7

Summary of Findings and Recommendations

Most long-distance trips begin in one metropolitan region and end in another 100 to 500 miles away. These short- to medium-length trips, which are referred to as "interregional" in this report, account for about three-quarters of all long-distance trips. A number of developments in recent years have emphasized the importance of this largest segment of long-distance travel. Two of them are California's plan to invest more than $60 billion in a new high-speed rail line connecting the state's northern and southern cities and the emergence of express bus lines serving the interregional corridors of the Northeast and expanding to other parts of the country. In these and other cases where new transportation services—some requiring large public investments—are being considered, interregional travel behavior, service options, and traffic flows need to be well understood. However, the 100- to 500-mile trip has been largely neglected in data collection, research, and transportation planning.

This study reviews

- *Interregional travel behavior and patterns*, including traveler and trip characteristics and factors that influence travel choices, such as service price, accessibility, convenience, comfort, frequency, reliability, safety, and travel time;
- *The supply of interregional transportation infrastructure and services* by automobile, airplane, bus, and train;
- *The characteristics of interregional travel markets and corridors* that affect their suitability for service by particular modes of transportation, including spatial and demographic conditions as revealed by experience in the United States and in other industrialized countries;

- *Planning, programming, and funding challenges* that arise in the provision of interregional transportation, including those associated with forecasting travel demand and evaluating public benefits and costs associated with long-term government commitments to interregional transportation systems such as passenger rail; and
- *The data and analytical capabilities* needed to plan and program transportation investments to serve interregional travelers.

The review confirms a general lack of information on this component of long-distance travel. The crossing of multiple states and metropolitan regions by many interregional travel corridors is suggested as a contributing factor. The scarcity of information on corridor traffic can combine with the practice of state-by-state and metropolitan-specific transportation planning to cause the chronic neglect of modes oriented to serving these multijurisdictional trips in the provision of infrastructure from a corridor-level perspective.

Intercity bus and rail systems have a strong interregional orientation. Both are sometimes used for trips as short as 30 or 50 miles, but less use is made of them for trips exceeding about 300 miles. The modest capital requirements of intercity bus services reduce the difficulty and the risk of entering and exiting from markets, which attracts private operators and lessens the need for public-sector planning and investment. In the case of the more capital-intensive intercity rail, government involvement is usually extensive, both in supplying the assets and in operating the service. The scarcity of detailed and up-to-date data on trip making and the absence of organizations and sources of transportation funding that align with interregional corridors are impediments to planning and investing in rail service. Significant attention is therefore given in this report to passenger rail.

Key findings from the study are summarized next. Deficiencies in travel data are discussed first. They hinder all but the most basic characterizations of interregional travel in the United States and impede the evaluation and planning of transportation infrastructure and services to accommodate this market. Despite the data shortcomings, enough information exists to describe the availability and use of the major transportation modes for interregional travel at a general level. The dominance of the automobile and the heavy use of airlines for interregional trips have been documented in this report, along with the recent proliferation of express intercity bus services. The limited availability of passenger rail in part explains the relatively small share of the country's interregional trips provided by that mode. The study's review of intercity rail service in the Northeast Corridor (NEC), Europe, and Japan offers insight into the prospects for increasing this mode's role.

Although better travel data are needed for informing transportation investment decisions, evidence in this report indicates a significant gap in the decision-making capacity itself. The absence of funding sources and institutions that align with interregional corridors contributes to this deficiency. Experience at the metropolitan level suggests that overcoming this deficiency will help stimulate demand for better data and the use of state-of-the-art analytical tools to inform decisions. The chapter concludes with recommendations on how the federal government can help improve long-distance travel data, support the development and application of state-of-the-art analytical tools, and provide incentives for the creation of interregional planning entities to inform sound regional and corridor-level transportation decision making.

KEY FINDINGS

Because of outdated travel behavior survey data, long-distance travel is not nearly as well understood as local travel.

Understanding of long-distance travel in the United States is informed mainly by the American Travel Survey (ATS), a national survey of long-distance trips conducted in 1995. Changes in demographics, the economy, and technology suggest that these 20-year-old data may no longer be indicative of long-distance travel behavior. Since 1995, the country's population has grown by 20 percent, become older, and continued to shift toward the newer metropolitan regions of the South and West, where transportation options differ. The average size of households has declined, the number of households with children has grown more slowly than the number of households without children, and the Internet has changed the relationship between information and travel. In addition, the transportation landscape has changed. Express bus companies offering curbside pickup and drop-off are serving short-haul, interregional markets in ways that were not anticipated just a few years ago. With the aid of state government subsidies, train frequencies have been increased in a number of interregional corridors. The deregulated airline industry has evolved, with discount carriers entering new markets. Travelers can now shop for transportation services on the Internet, a technology that had not been commercialized at the time of the ATS. With smartphones, tablets, and other portable electronic devices introduced in the past decade, people can work remotely and stay connected when they make trips out of town, which has undoubtedly had implications for travel demand. Even travel by automobile has changed markedly in 20 years. Advances in in-vehicle electronics and onboard communications, entertainment, and navigation systems have made trips by automobile safer, more comfortable, and more reliable, and thus the automobile is potentially more appealing for longer distances.

Certain travel relationships are unlikely to have changed fundamentally in 20 years. For example, there is little reason to believe that the tendencies of business travelers to select their transportation mode on the basis of schedule frequency, travel time, and reliability and of leisure travelers to place a greater emphasis on price have changed substantially since the 1990s. Nevertheless, a long-distance travel survey conducted today would likely reveal many travel patterns not observed in 1995, as would be expected after two decades of demographic, economic, and technological change. Use of data on travel behaviors observed a generation ago increases the uncertainty faced by today's decision makers in planning and investing in transportation systems intended to be used for decades to come.

The automobile is used for most interregional trips, especially by families and other people traveling together for nonbusiness purposes. Understanding the strong appeal of driving for nonbusiness travel is critical in planning transportation investments to accommodate interregional travelers.

The private automobile has many service attributes that are distinct from those of other modes used for interregional travel. It can be used to haul specialized luggage and gear (e.g., camping and sports equipment), provides a means of local transportation at the destination, and can accommodate multiple people at little extra cost. During recreational and leisure trips, driving can provide the opportunity for viewing scenery, shopping, and visiting attractions en route. Driving also allows for customized scheduling of trips and unplanned changes without fare penalties. Because of these service attributes and nearly ubiquitous household car ownership, the automobile is used for most interregional trips, especially those made by families.

The automobile's distinct service attributes have less utility to those who are traveling (*a*) alone and are thus unable to share fuel, parking, and toll expenses with others; (*b*) for business purposes and who place a high value on the time saved from faster travel and an ability to make productive use of time spent traveling; (*c*) on longer trips where the travel time advantages of airplanes and high-speed trains become compelling; and (*d*) to locations such as downtowns where the automobile is not needed for local transportation and where it may be costly to operate and park. Furthermore, driving is not an option for some travelers lacking access to an automobile or who feel unsafe or incapable of driving longer distances.

Airlines are seldom used for trips under about 200 miles, but they account for most of the longer interregional trips made by time-sensitive business travelers. They are used to an increasing degree by other travelers when distances reach several hundred miles and low-fare service is available.

Nearly all of the country's largest cities have hub airports offering frequent nonstop service to other cities located 150 or more miles away. Large interregional markets, such as San Francisco–Los Angeles, Washington–New York, Dallas–Houston, and Chicago–Saint Louis, have several dozen flights per day, including flights from secondary airports providing travelers with additional schedule time and location options. Airlines compete mainly with the automobile in most interregional markets, at distances that differ for business and nonbusiness travelers. The combination of frequently scheduled flights and multiple airport choices is especially attractive to business travelers as trip distances approach

200 miles. When distances exceed about 300 miles, air travel becomes increasingly competitive with the automobile for trips made by non-business travelers. In metropolitan areas with multiple airports, airline schedule options can be attractive for interregional trips that begin or end in suburban locations.

The time penalty associated with ground access to airports, security lines, and check-in makes air transportation generally less competitive for shorter-haul than for longer-haul trips. Where service reliability is reduced because of airway congestion and flight options are limited by airport capacity and use restrictions, such as at New York's LaGuardia Airport, the appeal of flying diminishes. Relatively fast and frequent train service in the NEC competes with airlines for a large portion of business trips, especially between New York and Washington, D.C. However, in most interregional corridors in the United States there are no transportation alternatives to airlines for time-sensitive business trips, since intercity train service in most markets is infrequent and slow.

Sparse interregional train service throughout much of the country can be attributed to a number of factors. One is the preponderance of trains operating over the lines of private freight railroads, which limits the opportunities for competitive schedule times and frequencies.

Train ridership exceeds airline passenger traffic between New York and Washington, D.C., where Amtrak's high-speed Acela service competes directly with airlines. The NEC contains some of the country's most populous metropolitan areas. Many have retained relatively strong urban cores, where downtown train stations are served well by public transit and are convenient to neighborhoods, businesses, government offices, universities, and entertainment attractions.

About 40 years ago, the bankruptcy of the Penn Central Railroad enabled Amtrak to purchase and preserve several hundred miles of right-of-way to be used mainly by passenger trains. This has been fundamental to the success of train service in the NEC. Although a number of interregional rail corridors outside the NEC—such as Chicago–Saint Louis and Seattle–Portland—have a modest amount of government-subsidized passenger service, the infrastructure there is owned and heavily used by freight railroads. Investments to make train service more competitive for travelers through more frequent and faster passenger trains operating on freight lines are generally not in the interest of the private railroads, who are concerned about interference with freight operations, their main line of business.

Amtrak's ability to exercise control over its right-of-way in the NEC gives it greater opportunity in this corridor than elsewhere to compete with other intercity modes by increasing train frequencies and reducing schedule times. Even on the passenger-oriented NEC rail lines, however, the capacity for intercity train service is constrained by having to share track with eight commuter railroads as well as freight trains operating over portions of the corridor. Long-standing track-sharing arrangements, some originating in legislation, limit Amtrak's ability to charge access fees that cover the costs associated with maintaining and renewing the NEC's rail right-of-way. Allocating many of these costs and isolating the beneficiaries of specific infrastructure investments are difficult in a multipurpose corridor serving local, interregional, and longer-distance traffic. Amtrak's ability to contribute to the maintenance and renewal of its NEC right-of-way is constrained by the abundant bus and airline service in the region, which creates a competitive limit on how high the railroad can raise its fares. Amtrak's capacity to make targeted investments in the corridor is further limited by having to use part of its NEC passenger revenues to help sustain rail system operations more generally.

The recent and largely unanticipated proliferation of intercity express bus services illustrates the uncertainties associated with forecasting the demand for interregional travel and with anticipating the ways in which demand will be met.

When the ATS was conducted in 1995, the intercity bus industry was in the midst of a long-term decline in ridership and service levels. Over the past decade the industry has been revitalized. Express bus services have proliferated in the wake of the popularity of buses operating from curbsides in New York and other major cities of the Northeast. The express bus appears to have filled a void in the low-fare and shorter-haul interregional market. It accommodates mostly solo travelers who lack access to automobiles, find driving too expensive or a car unnecessary at the destination, or want to make enjoyable or productive use of travel time through the use of onboard amenities such as Internet Wi-Fi.

Both the size of this segment of the interregional travel market and the capability of buses to serve it have been surprising. The intercity bus requires little capital investment and can quickly adjust schedules and service locations. Curbside service allows bus operators to reduce their fixed costs by dispensing with terminals and ticket offices. Customers can obtain schedule information and purchase tickets via the Internet, which allows carriers to provide more affordable fares and to adjust schedules and pickup and drop-off points. By providing point-to-point service, bus operators reduce schedule times and avoid the cost of coordinating a network of connecting bus lines. A high degree of asset mobility and low fixed costs allow ease of market entry and exit, which enables operators to explore new markets with less need for travel demand forecasting.

Once heavily concentrated in the Northeast, express bus lines have expanded to other regions. They now serve a wider mix of metropolitan locations, such as large universities and suburbs. The unanticipated popularity of these services shows how little is known about the demand for interregional travel and illustrates the uncertainty public officials face in assessing the benefits of adding new transportation capacity requiring large commitments of capital.

Despite the differences in geographic, historical, and policy settings, the provision of interregional transportation in Europe and Japan can inform U.S. decisions, particularly with regard to when and where to invest in intercity passenger rail.

The sparse passenger train service in the United States contrasts with its extensive availability in Europe and Japan. The cost of driving, including the price of motor fuel, is substantially higher in Europe and Japan, which tends to make train service more price-competitive. The combination of good public transit and strong city centers has given rail locational advantages over airports, which are often located on the edges of metropolitan areas because of noise and land requirements. In addition, to a greater extent than in the United States, most major European airports have imposed regulatory controls on airline takeoff and landing slots because of concern over capacity shortages. These supply constraints may be limiting the ability of airlines to offer competitive flight frequencies for the short-haul trips that can be made by rail and other intercity modes.

Despite these geographic, historical, and policy differences, the European and Japanese experience offers insights into the conditions conducive to investments in passenger rail to serve interregional markets in the United States. Experience in Europe and Japan suggests that rail is more competitive when it serves cities having neighborhoods, employment centers, and travel attractions near train stations and extensive, well-functioning transit systems that make station access fast and convenient for travelers. The centers of large Japanese and European cities are major attractors of business, shopping, and leisure trips and focal points of public transit networks. Thus for many travelers, downtown train stations are more convenient to access than are the airports located on the edges of metropolitan areas because of noise and land restrictions. In interregional corridors as long as 200 to 500 miles, Japan and the countries of Europe have found that trains must be capable of providing 2- to 3-hour downtown-to-downtown service with a high degree of schedule frequency to compete effectively with airlines.

Experience in Europe and Japan also indicates that the size and relative position of cities in a travel corridor can be important in providing frequent and efficient train service, particularly when a corridor consists of two or more large cities or a string of cities that can be served by a single line. Unlike buses, which can offer frequent service with as few as 40 passengers per trip, schedule-competitive rail service requires the demand to fill some 200 seats. The closely spaced and linearly aligned large cities along the east coast of Japan's Honshu Island, sometimes referred to as a "string of pearls," is the classic configuration for competitive passenger train service and the site of the world's most heavily used passenger railway, the Tōkaidō high-speed line.

Both in Europe and in Japan, investments in substantially upgraded and new higher-speed rail lines have usually been made in corridors that already have high train ridership. Because their rail networks are devoted mainly to passenger trains, service levels can be expanded incrementally to a point where capacity limits and the demand for major service and infrastructure investments become evident. During the past 40 years, a number of European countries have upgraded their conventional passenger rail networks to allow trains to average about 90 miles per hour and to reach top speeds of about 125 miles per hour. The use of tilting trains for higher speeds through curves has been one way of accomplishing this. In some cases, particularly where there are capacity shortages because of high volumes of commuter trains or where existing infrastructure is of poor quality and difficult to upgrade, new rail lines have been built. When a new rail corridor is to be added, the incremental cost of designing and building it to accommodate even faster intercity trains may not be high. Nevertheless, trains capable of averaging 150 miles per hour or more have invariably required large investments in lines specially built for high speeds, with the necessary grade separation, curvature, and gradient. European and Japanese experience indicates that the break-even traffic volume, in social benefit–cost terms, for the development of a new 300-mile, specially built high-speed line is on the order of 10 million passengers per year; this figure varies with the circumstances of each line.

The European and Japanese experience with passenger rail has more direct relevance to the NEC than to other U.S. travel corridors. The NEC is unmatched in the United States in having so many large and closely spaced cities in a single corridor. The string-of-pearls alignment of the corridor's cities is the classic configuration for efficient passenger train service. In addition, most of the NEC cities have retained strong downtowns served by extensive public transit systems. In the same manner as in Europe and Japan, the NEC's publicly owned rail right-of-way is oriented toward passenger trains, which allows Amtrak to schedule intercity trains at speeds and with frequencies that would not be possible on facilities intended mainly for the transportation of freight. There is a large and well-established demand for passenger trains in the NEC; the conventional regional trains and premium-service Acela trains transport about 10 million riders per year. For public officials contemplating major rail upgrades, uncertainties concerning the demand and public benefits associated with the required public outlays may be substantial. These uncertainties are reduced when a large and well-established ridership base already exists.

Other large cities in interregional corridors in the United States have characteristics that may be conducive to expanded passenger rail service. Cities such as Chicago, San Francisco, Saint Louis, and Pittsburgh have vibrant downtowns that are well served by transit. The interregional corridor in California, extending from San Diego to San Francisco, approximates the string-of-pearls configuration, although it is longer than the NEC and contains fewer large intermediate cities. However, it lacks a large base of train ridership to inform rail investment decisions, and public officials in these cities and corridors face considerable uncertainty about the prospects of the investment attracting the necessary ridership demand. In contrast to the NEC, where most of the rail right-of-way is owned by Amtrak, the rail lines in most U.S. corridors are owned by freight railroads. Their operating requirements may preclude even the gradual expansion of train service to introduce competitive levels of schedule frequency and travel speed.

California officials are planning the construction of an alternative right-of-way dedicated to trains able to provide high-speed passenger service for most of the corridor's length. Heavy investment in an untested passenger rail market is unusual by European and Japanese standards. Success largely depends on reliable forecasts of ridership based on data collection and analytical techniques such as surveys of individuals to ascertain their preferences in response to hypothetical service scenarios. California is proceeding with its plan despite the substantial uncertainties associated with not having a large rail ridership base that can reveal traveler demand. Ridership forecasts are based largely on airline traffic flows and analyst efforts to develop realistic choice-set scenarios for stated preference surveys. Most other interregional corridors in the United States present the same data and analytical challenges. The planned high-speed system in California is confined to a single state, which facilitated its approval. Most other interregional corridors in the United States pass through multiple states, and an institutional structure that could undertake the necessary data collection, analysis, and planning and that could make major investment decisions is lacking.

Because interregional travel corridors often span multiple states, many lack the coordinated planning and funding structures needed to ensure that investments in transportation capacity are made from a corridor-level perspective.

Numerous public and private entities are responsible for aspects of interregional transportation. In the case of highways and aviation, private individuals and companies supply the vehicles and operate the transportation services; federal, state, and local governments have varying responsibility for funding, planning, and operating most of the fixed infrastructure of roadways, airways, and airports. The coordination of the government's responsibilities is made easier when a 100- to 500-mile interregional corridor is contained within a single large state such as California or Texas. However, it remains challenging because a diverse set of federal and state agencies can have jurisdiction over individual transportation modes.

Much of the transportation infrastructure in the United States is funded and planned by mode-specific programs and agencies. The traditional approach to funding highway and aviation infrastructure relies on revenues generated largely from fuel and ticket taxes that are credited to trust fund accounts intended to provide a stable funding source. Revenues are disbursed to state and local governments by using formulas and discretionary grants. Among the advantages of such dedicated accounts are the placing of the burden of paying for the public good directly on the users and the relative reliability and predictability of the flow of revenues. A disadvantage is that trust funds can reinforce a mode-specific approach to transportation planning and programming.

The combination of mode-specific transportation funding and multistate corridors can be particularly problematic for investments in intercity passenger rail. Amtrak's public funding derives mainly from general fund appropriations by Congress and states, since revenues credited to highway and aviation trust funds cannot normally be used to pay for interregional rail infrastructure and services. Obtaining public funding and approvals for system investments is a continuing challenge for Amtrak, particularly as it tries to modernize the multistate and multipurpose NEC. More generally, the absence of planning and funding structures corresponding to the country's interregional corridors means that regular evaluations of transportation needs and options are not undertaken.

To encourage the development of urban transportation systems that are integrated and function well across a metropolitan region, the federal government has long required state and local authorities to

coordinate their urban highway and transit investments. Although such coordination is often challenging to implement, its goal is to guide transportation investments from a multimodal and multi-jurisdictional perspective that is informed by sound data and objective analysis.

Experience with the metropolitan planning organization (MPO) process indicates that an ongoing structure for multimodal and multijurisdictional decision making is conducive to the development of travel databases and analytical tools. The development and refinement of standard methods for travel demand forecasting, for assessing policy and investment options, and for collecting requisite data have been prompted by MPOs. The federal government, which mandates the MPO process, has provided leadership and resources to aid these efforts. The relative scarcity of data and analytical tools for interregional corridors is due in large part to the lack of interregional entities seeking such data and tools on a regular basis.

In the United States, the NEC is unique in having many of the geographic, demographic, and demand conditions that European and Japanese experience suggests are favorable to public investments in intercity rail. However, perhaps more than for any other U.S. corridor, its multijurisdictional setting complicates the provision of intercity rail and its coordination with the corridor's other transportation modes.

This study did not examine each of the country's interregional corridors in depth, but many findings point to circumstances in the NEC that are unique in the United States and deserving of special policy attention. The NEC is characterized by the following:

- Numerous large metropolitan areas in the region are
  - Well connected economically and socially, which creates densely trafficked interregional rail, air, and highway routes;
  - Located within 100 to 300 miles of each other and positioned in a linear fashion that suits service by a single rail line;
  - Served by extensive public transit systems capable of providing convenient access to downtown train and bus stations; and

  - Centered on cities whose downtowns are major origins and destinations for interregional travelers.
- It has an electrified rail right-of-way that is devoted to passenger rail and is thus able to accommodate frequent, fast trains without being unduly encumbered by freight trains.
- Its rail and bus ridership levels are comparable with those of corridors in other countries where sustained investments have been made to develop competitive rail service, in some cases by investing in high-speed trains.
- Several major airports in the area have regulatory limits on daily flights, and there is general difficulty in expanding airport and airway capacity.
- Its transportation infrastructure spans numerous states—too many to have generated a highly coordinated program contributing to the infrastructure's development but too few to have strong national-level support.

The geographic, demographic, and travel demand circumstances of the NEC set it apart from other U.S. interregional corridors. The NEC presents far less uncertainty with regard to the potential for passenger rail investments, including investments in high-speed service, to confer benefits. However, the difficulties inherent in coordinating the planning and priority-setting of multistate corridors in general have hindered development of the NEC, particularly the maintenance and modernization of its passenger rail system. The rail right-of-way in the NEC has been the subject of special federal funding programs for decades. These efforts have often proceeded without the benefit of multimodal and corridor-level development plans.

The special circumstances of the NEC are a reason for treating it differently from other interregional corridors. The committee is not in a position to identify the NEC's infrastructure priorities. Nevertheless, the experience in the NEC is characteristic of the challenges that arise in the planning, funding, and programming of transportation infrastructure from an interregional perspective. The actions recommended below are intended to address these challenges both in the NEC and in the country's other interregional corridors.

RECOMMENDATIONS

In the absence of institutions and funding programs that align with interregional travel markets, there is little ongoing planning and evaluation of transportation investment priorities from a corridorwide perspective. This situation may have contributed to the scarcity of interregional travel data and analytical tools for informing decisions requiring lasting public financial commitments, such as the development of high-speed railways.

The recommendations that follow are intended to help fill these gaps by (*a*) providing detailed and current data on long-distance travel behavior and activity, (*b*) furthering the analytical tools needed to inform public investments in interregional corridors, and (*c*) encouraging the formation of interregional planning bodies to help guide the investments. The long-standing metropolitan planning process not only offers a model for the interregional setting but also reveals the importance of leadership by the U.S. Department of Transportation (USDOT), to which the committee directs its three recommendations.

> *Recommendation:* **To inform public investments in transportation capacity to serve interregional and other longer-distance travelers, USDOT should support the establishment of a national data program focused on observing and understanding the behavior of long-distance travelers and the transportation services available to them.**

Data on travel behavior are required for forecasting and analyzing the demand for public-sector investments in transportation infrastructure and services. Observing interregional and other longer-distance trips can be especially challenging because they represent a small portion of all trips, and their study requires creative means of surveillance. Standard surveys of individual and household trip making can be too coarse to capture many of these relatively infrequent trips; the repeated use of ad hoc surveys to assess individual investment proposals can be duplicative and costly. Data from the last national survey of long-distance travel are now 20 years old and no longer reliable for informing decisions about investments intended to serve travelers decades into the future. Box 7-1 gives examples of the activities, choices, and behaviors that an updated

BOX 7-1

Examples of Long-Distance Travel Survey Data Needed for Informing Transportation Planning and Decisions

- Origin and destination of trip
- Purpose of trip—whether for business or nonbusiness reasons, with added details such as whether the trip was for leisure, a medical purpose, or a family visit
- Transportation modes used, including line-haul modes and modes for accessing and egressing terminals
- Other modes that were available and considered as alternatives
- Time required for travel, including time spent on specific trip segments, such as during access and egress, waiting at transfer points, and during check-in and security screening
- Travel party size and type, including household membership and relation of travelers in party
- Key traveler descriptors, including age, sex, education, race, worker status, automobile ownership, and individual and household income
- Expenditures on fares and other out-of-pocket items such as tolls and fuel
- Motor fuel prices at time of trip (coded from secondary sources)
- Residential and employment densities at origin and destination (coded from secondary sources)

long-distance travel survey could help capture to inform transportation planning and decision making.

The Transportation Research Board's *Special Report 304: How We Travel: A Sustainable National Program for Travel Data* (TRB 2011) recommended that USDOT establish a National Travel Data Program, a key component of which would be a national program for passenger data collection and analysis. The report proposed that a large-scale household travel survey be conducted every 10 years and be supplemented by more frequent in-depth surveys. This committee does not know whether the recommended approach is the most desirable one. Technological developments are expanding opportunities for data collection, and other approaches may deserve consideration, such as the British National Travel Survey's continuous survey of travel by individuals and households. The recommended USDOT data program would be expected to pursue the data collection strategy that best balances the objectives of obtaining detail and ensuring reliability and currency within budgetary constraints.

Data on transportation options as well as on why, where, and how people travel long distances are important. For example, the observation that few travelers use passenger train service in corridors where it is so infrequent or slow as to be almost nonexistent does not indicate how they would utilize a more competitive service. The availability and attributes of the long-distance modes can vary significantly by region of the country, as documented in this report. A more definitive characterization of the supply of transportation service offerings would be helpful in understanding the results of the recommended long-distance travel survey. For example, data on the choices travelers face in terms of service attributes such as frequency, speed, and cost, as well as data on local transportation access and egress options and the options available for those who lack access to a car, would be helpful. A national data program could offer guidance on characterizing interregional service offerings and on using the data for analytical and planning purposes.

Recommendation: **USDOT should support the development and application of state-of-the-art analytical tools for planning and prioritizing interregional transportation investments, including methods for representing the uncertainties that can accompany decisions to invest in long-lived transportation systems that require forecasting of public benefits and traveler demand.**

Investments in interregional transportation can involve large capital outlays for infrastructure intended to serve travelers decades into the future. The prospect of large capital commitments and the uncertainties of future travel demand may cause decision makers to postpone or neglect investments in infrastructure that would have conferred public benefits. Conversely, they may elect to proceed with large investments informed by evaluations of benefits, including forecasts of future patronage, that do not materialize. The decision to invest in a high-speed rail system illustrates the dilemma. In most U.S. corridors, intercity rail service is skeletal, and the demands of freight traffic impede the incremental addition of service to build a larger ridership base. Therefore, the forecasting of demand for a high-speed rail system must rely on alternative information-gathering methods such as stated preference surveys. The lack of an existing ridership base introduces additional uncertainties into a forecasting and evaluation process that is already complicated.

Uncertainty accompanies most large investments in transportation. Many of the analytical tools needed to inform decisions have been developed and are used regularly for transportation planning, particularly by MPOs prioritizing urban transportation investments. As discussed in Chapter 6, travel demand forecasting models have been improved substantially over the past 40 years, driven in large part by the demand from hundreds of MPOs. USDOT played an important role in the advancement of these models. It took the lead in developing urban travel forecasting methods and software. The committee believes that USDOT can play a similar role in adapting existing analytical tools for the interregional context. For example, USDOT can identify the types of forecasting models and specifications that are best suited to interregional corridors by surveying the analytical methods used by states and other countries and in other settings, such as urban transportation. To aid decision making, USDOT can help in identifying appropriate techniques for representing uncertainty and provide information relevant for many other needs, such as estimating the value of time, characterizing the service attributes of modes and their demand elasticities, and quantifying societal benefits and their incidence.

The Federal Highway Administration, as discussed in Chapter 6, has reviewed the travel demand forecasting models used by state departments of transportation and by other countries. It describes its efforts as providing "foundational knowledge to support long-distance modeling." This work offers an example of how the federal government can help in advancing the state of the practice of interregional transportation planning and analysis. Great Britain's Department for Transport has established formal guidelines for evaluating candidate investments in intercity rail, highway, and airport infrastructure. The guidelines are located on one government website, known as WebTAG,[1] to provide easy access by public officials. USDOT could provide similarly accessible guidance.

Recommendation: **USDOT should create, by seeking the authority from Congress as necessary, the incentives for states to collaborate in developing multimodal, interregional transportation planning and decision-making organizations. The incentives should be designed to allow states to choose whether to form such organizations and to provide the flexibility to structure them and define their responsibilities in ways best suited to meeting corridor-specific interests and needs.**

A goal should be to encourage a transportation planning and decision-making process from an interregional perspective that is mode-neutral and informed by sound analysis. Because the supply of interregional transportation is a joint public- and private-sector enterprise, the involvement of the private sector in the process will be critical in informing the organizations' planning and priority-setting. Planning and programming should be undertaken in a manner that does not routinely favor or neglect specific modes. All relevant modal interests should be involved, including private carriers of passengers and freight, as well as the planning organizations that serve the states and metropolitan regions in the corridor. These planning and decision-making entities could have a prominent role in identifying corridor-level capital spending priorities, planning specific projects aligned with these priorities, and applying for and aggregating funding for desired projects from multiple revenue sources.

The involvement of intercity bus companies, airlines, and railroads would help state and local transportation planners identify opportunities for increasing interregional service options and improving their performance for travelers. Broad participation will also counter tendencies

[1] https://www.gov.uk/transport-analysis-guidance-webtag.

for mode-specific biases in project evaluations. Although the focus of this study is on passenger travel, most interregional transportation systems are also used to move freight. A broadly construed interregional planning body could help coordinate the use of these systems more effectively for passenger and goods movement, and broader policy interests such as congestion and climate change mitigation could be considered. Multistate compacts or regional organizations already in existence, such as the I-95 Corridor Coalition and the NEC Commission, could widen the participation of various modes, and their planning and priority-setting roles may be strengthened by USDOT's incentives.

Access to transportation funding will be critical in motivating the creation of these entities and ensuring a mode-neutral orientation. Federal funding eligibility that is contingent on or made easier for projects developed by interregional planning bodies could stimulate and sustain interest. Mode-specific transportation planning has a long history in the United States. Its practice has been reinforced by federal and state transportation funding programs that depend on taxes and other revenues generated by highway and airline users and credited to highway and aviation trust funds. Restrictions on how the revenues credited to these trust funds are allocated, including eligibility criteria for specific modal projects, would be difficult to change fundamentally, since there are valid reasons for the restrictions. However, there is precedent for allowing limited diversions of trust fund revenues to other modes. An example is the Mass Transit Account of the Highway Trust Fund. Even if a significant easing of trust fund restrictions is not practical or desirable, a substantial amount of public funding for transportation infrastructure is unrestricted and derived from general fund appropriations, such as funding for intercity passenger rail and for highway and transit spending not covered by trust fund revenues.

Congress has at times demonstrated an interest in supporting transportation projects in ways that place fewer restrictions on modal eligibility. The Transportation Investment Generating Economic Recovery grant program administered by USDOT is an example. Through such programs, interregional transportation projects developed on the basis of a long-range multimodal plan could be given funding priority. While only certain elements of such a modally diverse plan might be funded through the alternative programs, mode-specific funding could presumably be used to implement much of the rest.

CONCLUDING COMMENTS

Transportation infrastructure in the United States is seldom planned, constructed, or operated with interregional travelers in mind. However, from time to time the country's interregional corridors are the subject of proposals for large transportation investments, particularly the supply of more frequent and faster passenger train service. Illustrative of this interest are the Obama administration's 2009 plan to devote economic stimulus funds to intercity rail projects across the country[2] and California's program to invest in high-speed rail. Meanwhile, in the NEC, frequent intercity train service already exists, is heavily used, and is competitive with other modes. Prioritizing and paying for the large capital requirements of the corridor are long-standing challenges. In all of these cases, decisions have or are being made with potentially lasting impacts on the availability of transportation service and the funding for future capacity.

Fifty years ago, the building of the Interstate highway system and the granting of federal aid to assist cities in maintaining and providing mass transit transformed urban transportation. That transformation generated public policies intended to bring about a multimodal and multijurisdictional planning process underpinned by more rigor, rationality, and coordination in the programming of major transportation investments. In contrast to the goals of this metropolitan process, the provision of interregional transportation appears to be deficient. Basic information on travel behavior and demand and the analytical tools needed for planning and prioritizing major investments are lacking. The actions recommended in this report are intended to address this deficit and to aid in the development of a well-informed and well-guided interregional transportation planning and programming capacity.

[2] On February 17, 2009, President Obama signed the American Recovery and Reinvestment Act, which included more than $8 billion in grants for intercity and high-speed rail projects. For more details on the plan, see USDOT 2009.

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Abbreviations

TRB Transportation Research Board
USDOT U.S. Department of Transportation

TRB. 2011. *Special Report 304: How We Travel: A Sustainable National Program for Travel Data.* National Research Council of the National Academies, Washington, D.C. http://onlinepubs.trb.org/onlinepubs/sr/sr304.pdf.

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APPENDIX

Federal Highway Administration Trip Table Estimation Method

In view of the unlikelihood of a new American Travel Survey (ATS) being undertaken soon, the U.S. Department of Transportation's Federal Highway Administration (FHWA) partnered with other modal agencies to estimate the number of long-distance (≥100-mile) person trips made in 2008. The FHWA trip tables are based on data for actual (ticketed) trips made by airline and train and on estimates for trips made by automobile and bus (scheduled, tour, and charter). Counts of trips by airline and train are accurate because they are derived from records of ticket purchases; ground access surveys are used to assign the air and train trips to specific county origins and destinations. Long-distance trips made principally by automobile and bus are more difficult to estimate in the absence of actual or survey-derived trip data for these modes. To compensate for the lack of data, FHWA used the 1995 ATS data to estimate the number of automobile and bus trips made in 2008. Linear regression equations were developed that explained the 1995 ATS results on the basis of 1995 Census Bureau employment and demographic data. Estimates for 2008 were then made by using 2008 Census Bureau data as input for the explanatory variables in the equations.

According to the FHWA tables, about 2 billion long-distance person trips were made in 2008. As in 1995, more than three-quarters of long-distance trips were estimated to have been made by automobile, nearly 20 percent by air, and 3 to 4 percent by rail and bus. The 2 billion total trips in 2008 are a 100 percent increase since 1995 and a 50 percent increase since the 2001–2002 National Household Travel Survey. The amount of long-distance trip making by rail grew the most on a percentage basis, up nearly 250 percent from 1995 to 2008.

The updated FHWA trip tables are the only comprehensive data set from which estimates of intercity trips by mode can be made that take into account economic and demographic trends since 1995. The FHWA trip calculations for 2008 are examined in more detail below. The focus is on trip making in the most heavily traveled intercity markets in the 100- to 500-mile distance range.

AIR AND RAIL TRIPS

Airline and rail trips are estimated by using 2008 Amtrak station-to-station ticketing data and the U.S. Department of Transportation airline ticket sample (known as Databank 1B), which contains itinerary data for one in 10 tickets purchased.

AUTOMOBILE TRIPS

The following trip generation and distribution equations were developed by using 1995 Census Bureau population, household, and industry employment [Quarterly Census of Employment and Wages (QCEW)] data to explain the 1995 ATS results. To obtain results for 2008, 2008 Census Bureau data were used as inputs for the explanatory variables in the equations. Special generation models were developed to account for tourist and cross-border trip making in relevant locations.

Trip Generation Model

Linear regression models were estimated by using employment and population variables to predict 1995 ATS trips at the state level. The production and attraction equations by trip purpose are shown in Equations 1 to 4.

$$\text{Business trip productions} = 0.47692 \times \text{Census population} \quad \left(R^2 = 0.90\right) \tag{1}$$

$$\text{Nonbusiness trip productions} = 2.19893 \times \text{Census population} \quad \left(R^2 = 0.95\right) \tag{2}$$

$$\text{Business trip attractions} = 1.09773 \times \text{QCEW employment} \qquad (R^2 = 0.89) \quad (3)$$

$$\text{Nonbusiness trip attractions} = 6.573 \times \text{QCEW leisure and hospitality and service providing industry employment} \qquad (R^2 = 0.91) \quad (4)$$

Trip Distribution Model

The balanced productions were distributed by using a destination choice model. The multinomial logit formulation for each trip purpose is shown in Equations 5 and 6. The trips are distributed from zone *i* to zone *j* on the basis of the share of zone *i* among all possible zones in the choice set.

$$\text{Business}_j = 0.536 \times \left[\ln\left(\text{households}_i\right) + 2 \times \ln\left(\text{employment}_j\right)\right] - 2.81 \times \ln\left(\text{distance}_{ij}\right) \quad (5)$$

$$\text{Nonbusiness}_j = 0.584 \times \left[\ln\left(\text{households}_i\right) + 2 \times \ln\left(\text{employment}_j\right)\right] - 2.47 \times \ln\left(\text{distance}_{ij}\right) \quad (6)$$

Special Generators

To estimate trips to national parks, at cross-border points, and to places such as Las Vegas and Orlando that attract a large portion of visitors not necessarily captured by the ATS, the models use data from the National Park Service; the Bureau of Transportation Statistics (for cross-border inbound trips); and visitors bureau data from Las Vegas, Niagara Falls, and Orlando. The generated values are allocated to their production and attraction zones on the basis of the nonbusiness trip distribution (Equation 6).

BUS TRIPS

To derive bus trips for 2008, the following trip generation and estimation equations were developed, and 2008 Census Bureau data on population, households, and industry employment were used as inputs for the explanatory variables. Special generation models were developed to account for tourist and cross-border trip making in relevant locations.

Trip Generation

Trip generation rates were estimated by using the 1995 ATS:

Age (years)	Income	Vehicles 0	Vehicles 1+
Under 18	<35,000	0.062	0.097
	35,000–75,000	0.872	0.155
	>75,000	0.868	0.156
18–64	<35,000	0.342	0.474
	35,000–75,000	0.619	0.263
	>75,000	0.411	0.151
65 and older	<35,000	0.679	0.212
	35,000–75,000	1.045	0.190
	>75,000	1.051	0.097

Trip Distribution

The bus passenger destination choice model is formulated as follows and was estimated by using the 1995 ATS data:

$$T_{ij} = 1.41 \times \ln(\text{households}_i) + \ln(2 \times \text{employment}_j) - 2.34 \times \ln(\text{distance}_{ij})$$

where

T_{ij} = trips between origin i and destination j,
households_i = number of households in origin i,
employment_j = number of employees in potential destination j, and
distance_{ij} = distance between origin i and potential destination j (miles).

Special Generators

Trips from the following two sources were added:

1. Cross-border entry points between the United States and Canada and between the United States and Mexico. The actual number of border

crossings by persons traveling by bus in 2008 is reported in the Bureau of Transportation Statistics–Transportation Security Administration database. On the basis of information from Statistics Canada about the destination state of Canadians entering the United States, the model developer used a factor of 0.75 to convert border crossings into long-distance trips.

2. Trips destined for popular recreation locations outside of large metropolitan areas not likely to be addressed adequately by the ATS. The ATS indicates the state and metropolitan statistical area (MSA) of a trip end but does not indicate the location of trips outside of MSAs. Trips were added to account for travel to National Park Service locations and for a limited number of other destinations such as Niagara Falls, Orlando, and Las Vegas. On the basis of information from National Park Service visitor surveys, the model developer used a factor of 0.05 to estimate the total number of visitors arriving by bus and a factor of 0.88 to convert total visitations to long-distance trips.

Study Committee Biographical Information

Martin Wachs, *Chair*, is Distinguished Professor Emeritus of Civil and Environmental Engineering and Professor of City and Regional Planning, University of California. He was Director of the RAND Transportation, Space, and Technology Program and Professor at the Pardee RAND Graduate School. Before joining RAND in 2005, he was Director of the Institute of Transportation Studies at the University of California, Berkeley, and spent 25 years at the University of California at Los Angeles, where he served three terms as chairman of the Department of Urban Planning. He is author of more than 150 articles and four books on subjects related to the relationships between transportation, land use, and air quality; transportation needs of the elderly; techniques for the evaluation of transportation systems; and the use of performance measurement in transportation planning. His research also addresses issues of equity in transportation policy, problems of crime in public transit systems, and the response of transportation systems to natural disasters, including earthquakes. His most recent work focuses on transportation finance in relation to planning and policy. He has chaired many Transportation Research Board (TRB) study committees, including the Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program, the Committee for a Study of Urban Transportation Congestion Pricing, and the Committee on Determination of the State of the Practice in Metropolitan Area Travel Forecasting. He has served on many other TRB committees, including the TRB Executive Committee, which he chaired in 2000. He holds a bachelor's degree in civil engineering from the City University of New York and a master's degree and a PhD in transportation planning from Northwestern University.

J. Barry Barker is Executive Director of the Transit Authority of River City in Louisville, Kentucky. He was previously General Manager of Metro in Akron, Ohio, and Assistant General Manager for Marketing and Management for the Greater Cleveland Regional Transit Authority. He is a former chair of the Transit Cooperative Research Program (TCRP) Oversight and Project Selection Committee, has served on several TCRP panels, and was a member of the National Research Council (NRC) Committee for a Study of Contracting Out Transit Services. He has chaired the National Transit Institute Board and served on the Easter Seals Project ACTION National Steering Committee, the TRB Executive Committee, and the Subcommittee on Planning and Policy Review. He is chair of TRB's Transit Research Analysis Committee. He is a National Associate of the National Academies and recipient of the 2012 Sharon D. Banks Award for Humanitarian Leadership in Transportation. He earned a bachelor's degree in engineering from Case Western Reserve University and a master's degree in public administration from Cleveland State University.

John C. Bennett has more than four decades of experience in rail and public transportation policy and planning analysis. He retired from Amtrak as Assistant Vice President for Policy Management in 2011. He held several other executive positions at Amtrak, including Assistant Vice President for Policy Standards and Business Integration and Vice President for Transportation Planning and Policy for the Northeast Corridor. He has experience in strategic planning for intercity railroads and commuter railroads in the private and public sectors and in capital program management. While at Amtrak, he aided in the development of the Northeast Corridor Strategic Business Unit's Strategic Plan, which supported development of higher-speed rail service in the corridor. Before joining Amtrak, he was Vice President of Infrastructure and Systems at the Long Island Rail Road and held senior management positions at the consulting firms KPMG Peat Marwick and Booz Allen Hamilton. He was a member of the Passenger Rail Working Group of the National Surface Transportation Policy and Revenue Study Commission. He holds bachelor's and master's degrees in civil engineering from the University of California, Berkeley.

Alan J. Bing retired in 2011 as Technical Specialist for ICF International. His area of expertise is railroad freight and passenger train technologies and systems. He is a past chair of the TRB Committee on Passenger Rail Equipment and Systems Integration and the Committee for Review of the Federal Railroad Administration's R&D Program. He was also a member of the TRB Committee for Assessment of Federal High-Speed Ground Transportation R&D. He was principal investigator for the National Cooperative Highway Research Program (NCHRP) project that developed the *Guidebook for Implementing Passenger Rail Service on Shared Passenger and Freight Corridors*. He holds a PhD in mechanical engineering from the University of Nottingham, United Kingdom.

Matthew A. Coogan is an independent consultant and director of the New England Transportation Institute. He has expertise in transportation behavior and intermodal transportation planning and specializes in the deployment of new transportation technologies. He has served as principal investigator for numerous studies of high-speed rail, conventional rail, aviation, and highway intercity travel. From 1983 to 1991, he was Undersecretary for Transportation for Massachusetts, where he was project director for the Central Artery–Third Harbor Tunnel Project and cochair of the Coalition of Northeastern Governors High Speed Rail Task Force. From 1973 to 1979 he was Assistant Secretary of Transportation, and from 1979 to 1983 he was Senior Project Coordinator for the Boston Redevelopment Authority. He served as a member of the TRB Committee for a Study of High-Speed Surface Transportation in the United States and the Committee for the Critique of the Federal Research Program on Magnetic Levitation Systems. He holds a bachelor's degree from Harvard University.

Thomas B. Deen (NAE) is former Executive Director of TRB, a position he held from 1980 to 1994. In that position, he led efforts to create the $150 million Strategic Highway Research Program and began TRB's policy studies program. Before joining TRB, he was Chairman and President of Alan Voorhees and Associates, a transportation engineering and consulting company with clients worldwide. He served as chief planner of the Washington Metro subway system during its development in the

1960s. During this period he pioneered development and application of planning methods used worldwide in succeeding decades. His areas of expertise are surface transportation technology, performance, economics, financing, planning, and project feasibility. Since retiring from TRB, he has served as chairman of a committee preparing a national strategic plan for intelligent transportation systems, vice chairman of a national committee recommending safe methods for transporting radioactive waste from nuclear power plants to a geological repository, and chairman of a committee recommending transportation improvements for the Washington, D.C., region, including the building of the Intercounty Connector in Maryland. He was also cochair of a Maryland committee recommending approaches to building a magnetic levitation train system in the Northeast Corridor and chairman of a committee investigating the causes of a deck construction failure on the Chesapeake Bay Bridge. Other committees he has served on include the Committee on the Federal Funding of Transportation Improvements in Defense Base Closure and Realignment Commission Cases, the Committee for the Strategic Highway Research Program 2, the Committee for a Determination of the State of the Practice in Metropolitan Area Travel Forecasting, and the Committee for a Study on Transportation and a Sustainable Environment. In 1998 he was elected to the National Academy of Engineering. In 2003 TRB established the annual Thomas B. Deen Distinguished Lectureship in his honor, and in 2009 he was awarded the Frank Turner Medal. In 2011 he was presented the ITS Hall of Fame Award, in 2014 he was elected an honorary member of the Institute of Transportation Engineers, and in 2015 he was named a member of the University of Kentucky Hall of Distinguished Alumni. He holds a bachelor's degree in civil engineering from the University of Kentucky and completed 1-year graduate programs at the University of Chicago and Yale University.

Genevieve Giuliano is Professor and Senior Associate Dean of Research and Technology in the School of Policy, Planning, and Development, University of Southern California (USC). She is also Director of the METRANS joint USC and California State University at Long Beach Transportation Center. In 2009 she was named the Margaret and John Ferraro Chair in Effective Local Government for her work in regional transportation policy. Her research focuses on the relationships between land use and transportation, transportation policy analysis, and information technology applications in transportation. She has published more than 140 papers on these and other topics. She serves on the editorial boards of *Urban Studies* and the *Journal of Transport Policy.* She is a past chair of the TRB Executive Committee and was named a National Associate of the National Academies in 2003. She received the TRB William Carey Award for Distinguished Service in 2006 and was the Thomas B. Deen Distinguished Lecturer in 2007. She has served on numerous TRB and NRC committees, including the Panel on Mitigation for America's Climate Choices.

Mark Hansen is Professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley, and codirector of the National Center for Excellence in Aviation Operations Research. His research interests include transportation economics, policy and planning, air transportation, and public transportation. He has written extensively on air transportation network flows, the impact of aircraft size on airline demand and market share, and aviation delays and operational performance. He was a member of the TRB Committee on Airfield and Airspace Capacity and Delay. He earned a bachelor's degree in physics and philosophy from Yale University and a master's degree in city planning and a PhD in transportation engineering from the University of California, Berkeley.

Keith L. Killough is Assistant Director for Travel Demand Modeling and Analysis and Chief of the Multimodal Planning Division of the Arizona Department of Transportation. Before joining the state transportation department in 2008, he was Director of Information Services for the Southern California Association of Governments (SCAG), where he was responsible for implementing travel simulation models and applying quantitative analyses to support regional transportation and air quality management planning. Before joining SCAG, he was owner of a consulting company specializing in transportation planning and modeling. Previously, he was Deputy Director for Countywide Planning for the Los Angeles County Metropolitan Transit Authority. He has also worked for the Southern California Rapid Transit District, where he headed the Planning and Policy Analysis Section. He chairs the TRB Joint Subcommittee on Statewide Travel Demand Forecasting and the NCHRP

Panel on Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models. He was a member of the TRB Committee for Review of Travel Demand Modeling by the Metropolitan Washington Council of Governments. He earned a bachelor's degree in urban studies and planning from the Massachusetts Institute of Technology (MIT).

Charles F. Manski (NAS) has been Board of Trustees Professor in Economics at Northwestern University since 1997. He was previously a faculty member at the University of Wisconsin–Madison, the Hebrew University of Jerusalem, and Carnegie Mellon University. His research spans econometrics, judgment and decision, and the analysis of social policy. He is author of *Identification for Prediction and Decision* (Harvard 2007), *Social Choice with Partial Knowledge of Treatment Response* (Princeton 2005), *Partial Identification of Probability Distributions* (Springer 2003), *Identification Problems in the Social Sciences* (Harvard 1995), and *Analog Estimation Methods in Econometrics* (Chapman and Hall 1988). He is coauthor of *College Choice in America* (Harvard 1983) and coeditor of *Evaluating Welfare and Training Programs* (Harvard 1992) and *Structural Analysis of Discrete Data with Econometric Applications* (MIT 1981). He is a member of the Committee on Deterrence and the Death Penalty of the Division of Behavior and Social Sciences and Education of the National Academies. He is a member of the National Academy of Sciences, Fellow of the Econometric Society, Fellow of the American Academy of Arts and Sciences, and Fellow of the American Association for the Advancement of Science. He holds a bachelor's degree and a PhD in economics from MIT.

Nancy A. McGuckin is an independent consultant with expertise in travel behavior. She recently completed forecasts of travel by older Americans, migration and immigration patterns and trends, and nonwork travel for the National Surface Transportation Policy and Revenue Study Commission. She previously worked for Barton-Aschman of Parsons Transportation Group, where she developed travel and ridership forecasts for major investment studies, including high-speed rail systems in Shanghai, San Juan, and Bangkok. She specializes in social and demographic indicators of travel demand and integrates data from safety, health, economic, energy, time use, and other pertinent sources to develop the context for planning and policy initiatives. She has extensive experience in working with large national databases, including the National Household Travel Survey, the American Travel Survey, the American Housing Survey, and the American Time Use Survey. She earned a bachelor's degree in geography and political science from the University of Texas at Austin.

Paul F. Morris is President and CEO of Atlanta BeltLine, Inc., a major sustainable urban renewal project that is developing a network of parks, trails, and transit services supporting more than $20 billion of inner city reinvestment along a former rail corridor circling the downtown of Atlanta, Georgia. Before assuming this position, he was Deputy Secretary of the North Carolina Department of Transportation, where he was responsible for administering the nonhighway modal divisions, including rail, aviation, ferries, ports, and public transportation. In this position, to which he was appointed in 2011, he served as the department's central point of contact for transportation initiatives involving the North Carolina Railroad and the Ports Authority. He has served as President of Greenleaf Strategies, LLC, and as Executive Vice President and Global Director of Strategic Consulting and Sustainability for Parsons Brinckerhoff, Inc., where he assisted government entities in 25 states and 10 foreign countries with integrated project and policy development initiatives. He was a member of the city of Raleigh's Passenger Rail Task Force, charged with advising the city council on intercity passenger rail service. He earned a bachelor's degree from the University of Oregon and undertook graduate studies in planning and development at the Harvard Graduate School of Design.

Christopher A. Nash retired in 2014 as Research Professor in the Institute for Transport Studies, University of Leeds. His research interests are in rail transport, transport pricing, and transport externalities. He has written extensively on rail passenger transportation, including high-speed rail. He had been on the faculty of the University of Leeds since 1975 and previously at the University of Southampton. He has acted as adviser to many bodies, including the European Commission High Level Group on Transport Infrastructure Charging, the European Union Committee of the House of Lords, the Transport Committee of the House of Commons, and the Railways Group of the European Conference of Ministers of Transport. He is a member of the Editorial Board of the

Journal of Transport Policy and Economics, the *South African Journal of Transportation and Supply Chain Management*, the *International Journal of Transport Economics*, and the *International Journal of Green Economics.* He earned a PhD in transport economics.

Clinton V. Oster, Jr., is Professor Emeritus and former Associate Dean for Bloomington Programs at the School of Public and Environmental Affairs, Indiana University. His research has centered on aviation safety, airline economics and competition policy, air traffic management, energy policy, and environmental and natural resources policy. He has coauthored five books on various aspects of air transportation, including *Deregulation and the Future of Intercity Passenger Travel* with John Meyer and *Managing the Skies: Public Policy, Organization, and Financing of Air Navigation* with John Strong. He has chaired or cochaired several NRC committees, including the Committee for the Study of Traffic Safety Lessons from Benchmark Nations, the Committee on the Federal Employers' Liability Act, the Committee on the Effects of Commuting on Pilot Fatigue, and the Committee on the National Aeronautics and Space Administration's National Aviation Operational Monitoring Service Project. He was a member of the Committee for a Study of Federal Aviation Administration Air Traffic Controller Staffing, the Committee for Guidance on Setting and Enforcing Speed Limits, and the Committee for a Study on Air Passenger Service and Safety Since Deregulation. He holds a bachelor's degree in engineering from Princeton University, a master's degree in public affairs from Carnegie Mellon University, and a PhD in economics from Harvard University.

Joseph P. Schwieterman is Director of DePaul University's Chaddick Institute for Metropolitan Development, which promotes effective urban planning. His research and professional interests are in public policy, transportation, urban planning, geographic information systems, and economics. He has published extensively on the economics of intercity transportation. He recently authored a book on the abandonment of American railroads, *When the Railroad Leaves Town*, and led student researchers in an analysis of intercity bus usage. The latter research led to the influential paper The Intercity Bus: America's Fastest Growing Transportation Mode, which was reported in a *Chicago Tribune* article, "Get on the Bus" (December 24, 2007). He is a long-standing contributor to TRB, having served on the Committee on Aviation Economics and Forecasting. He earned a bachelor's degree in industrial management from Purdue University, a master's degree in transportation from Northwestern University, and a PhD in public policy from the University of Chicago.

Katherine F. Turnbull is an Associate Director of the Texas Transportation Institute of the Texas A&M University System, where she heads the System Planning, Policy, and Environment Research Group. In addition, she is a Visiting Assistant Professor in the Department of Landscape Architecture and Urban Planning at Texas A&M University. Her research focuses on transit, transportation planning, travel demand management, and intelligent transportation systems. She is active in TRB and the Institute of Transportation Engineers. She is past chair of TRB's Planning and Environment Group and served as chair of the High-Occupancy Vehicle Committee for 6 years. She was a member of the TRB Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program and chair of the Steering Committee for the Conference on Travel Demand Management Innovation and Research. She is currently chair of the Institute of Transportation Engineers Transit Council and a member of the ITS America Coordinating Council. She holds a bachelor's degree from the University of Minnesota, a master's degree from the University of Wisconsin, and a PhD in urban and regional science from Texas A&M University.

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