INTRODUCTION TO TRANSPORTATION

TALLEY

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PREFACE

The U.S. transportation system is rapidly changing. Railroads, truck carriers, and air carriers have been deregulated; other carriers such as intercity bus carriers will probably be deregulated in the future; government assistance funds to urban public transportation systems and intercity railroads are expected to decline soon; the transportation regulatory bureaucratic structure is undergoing change; and public concern about transportation safety and air and noise pollution has intensified. As a background for understanding these changes, the purpose of this book is to acquaint the reader with the U.S. transportation system and the role of its decision makers and users of transportation service.

Introduction to Transportation was written primarily out of my frustration at not being able to find a textbook that adequately provides the rationale or reasons for decisions made by transportation decision makers. Most current texts are largely descriptive in their discussion of the U.S. transportation system. In addition, they are oriented toward intercity freight transportation, with limited discussion of intercity passenger transportation and often no discussion of urban transportation.

The Introduction of this text contains a general discussion of how a country's transportation system is interrelated with its other systems. Part 1 deals with the theory of the transportation firm (production theory, cost theory, and objectives of the firm), and government regulation of and assistance to the transportation firm.

Part 2 examines freight users and passengers. Chapter 5, for example, considers both the logistics price and the money price incurred by a freight user. Chapter 6 considers the decision-making process of passengers in selecting passenger carriers; the impact of money prices, time prices, and congestion on these decisions is reviewed.

Part 3 considers the impact of transportation upon location (industrial and urban) and upon energy and the environment (energy consumption and pollution). A significant feature of Chapter 7 is the discussion of urban location; for Chapter 8, it is the discussion of energy conservation and pollution abatement alternatives.

Part 4 includes four chapters devoted to U.S. intercity freight carriers (rail, truck, pipeline, water, air, forwarder, and specialized small-shipment) and two chapters devoted to U.S. intercity passenger carriers (air, bus, rail, automobile, and water). A discussion of industrial structure, cost structure, operating characteristics, users, and regulation of carriers is presented. A

significant feature of Part 4 is that the discussion of intercity freight and passenger transportation is organized into separate chapters, thus enhancing the reader's understanding of intermodal competition and comparisons. This part also features discussion of the regulatory reform (or deregulation) related to railroads, truck carriers, and air carriers.

Part 5 examines mass transit, urban private carriers, paratransit, urban goods movement, and rural public passenger transportation. A separate chapter is devoted to the discussion of urban private and paratransit passenger services.

Part 6 includes a discussion of international transportation (air and water carriage), Canadian intercity carriage, and the future of U.S. transportation. The discussion of Canadian intercity carriage acquaints the reader with a foreign transportation sector with which to compare U.S. intercity carriage.

Each chapter concludes with a summary, a series of questions, and a list of suggested readings. The Instructor's Manual answers the end-of-chapter questions and provides a series of multiple choice and true-false questions for each chapter.

Many individuals have contributed to the development of this book. I have benefited from discussions with fellow employees at Overnite Transportation Co. and from similar discussions while serving as Faculty Fellow, National Aeronautics and Space Administration; Faculty Fellow, Transportation Systems Center, U.S. Department of Transportation; Industry Economist, Interstate Commerce Commission; Research Associate, Tidewater Transportation District Commission; and consultant to the U.S. Department of Transportation. In addition, past and present students have contributed to the development of this book, as have coauthors of my transportation research papers.

Individuals who have made special contributions to this book include Langley H. Smith, Overnite Transportation Co.; Joel Freilich, Douglas B. Lee, Jr., and Robert E. Thibodeau, Transportation Systems Center; Michael A. Redisch, Interstate Commerce Commission; A. Jeff Becker, Tidewater Transportation District Commission; and Thomas C. Campbell, Virginia Commonwealth University. I would also like to thank Vicky Curtis and Bonnie VanCleave for typing the manuscript.

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INTRODUCTION

Transportation is an activity that provides for the movement of goods or individuals from one place to another. Transportation creates value by creating **place utility**—moving goods to a place where they can be used. Goods are transported from where nature provides them or man produces them to where they can be consumed. Goods that are not in the place where they can be consumed cannot provide utility (or the ability to satisfy a human want). Similarly, a given location cannot provide utility to an individual unless that location is accessible by means of transportation.

Transportation is also an activity that creates **time utility.** Delays in arrival may be costly and wasteful. Goods or individuals that arrive at the right time have time utility.

Transportation is a means to an end and not an end in itself; i.e., transportation is a **derived demand.** There is little demand for passenger transportation aside from a desire to be in another place. There is no demand for freight transportation unless there is a demand for goods, and then only if increased utility results from moving such goods.

The function of passenger transportation is to supply the means of moving individuals from various origin-locations to various destination-locations. Passenger transportation is efficient if it minimizes the time and distance costs between these origins and destinations.

The function of freight transportation is to supply the means to bring together the resources used in production processes and to provide access to the markets for the resulting products.[1] Production usually calls for the change of location of many resources in order to bring them together in the right proportions to produce either industrial or consumer goods. Freight transportation is efficient if it minimizes the time and distance costs between producers, or between producers and consumers, in the movement of goods.

TRANSPORTATION AND INTERRELATIONSHIPS

An understanding of transportation is complicated by the fact that a transportation system is interrelated with economic, political, social, and environmental systems. Realizing that a single transportation improvement

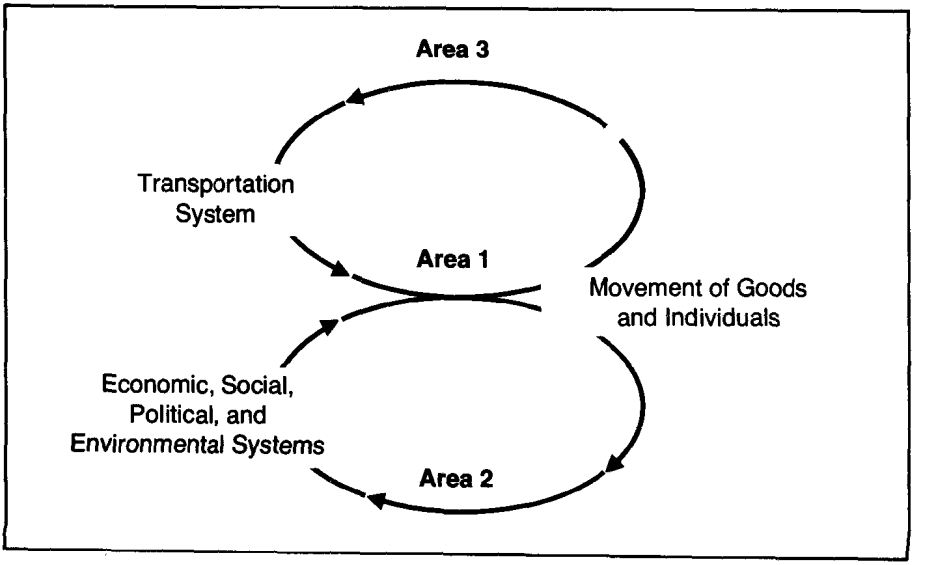
[1]Dudley F. Pegrum, *Transportation: Economics and Public Policy,* 3d ed. (Homewood, Ill.: Richard D. Irwin, Inc., 1973), p. 4.

can produce shifts in the pattern of markets for many goods, it becomes obvious that the entire economy is involved. Transportation improvements can also affect our social and political systems. Life in a modern city would be impossible without adequate transportation to bring *to* it the goods needed for its existence as well as to provide for the movement of goods and individuals *within* its boundaries. The construction of transcontinental railroads in the United States after the middle of the nineteenth century changed the U.S. political system by making the western territories accessible, thereby providing a basis for their eventual incorporation into the Union. Furthermore, transportation improvements can affect the environmental system. Emission controls on transportation vehicles have lessened air pollution emissions from such vehicles.

Movement of Goods and Individuals

Figure 1-1 depicts the interrelationships between a transportation system and the economic, social, political, and environmental systems of a region. The transportation system of a region includes all modes of transportation and their networks. **Networks** consist of the routes from origin to destination points in the region, the terminals, the transfer points, etc., of the various modes. Area 1 in Figure 1-1 suggests that the movement of goods and individuals in a region is determined by both the transportation system and the economic, social, political, and environmental systems of that re-

FIGURE 1-1 Interrelationships of Transportation and Other Systems



Source: Marvin L. Manheim, *Fundamentals of Transportation Systems Analysis, Volume 1: Basic Concepts* (Cambridge, Mass.: The MIT Press, 1979), p. 13.

gion. The transportation system affects such movement of goods and individuals through the (1) number and types of transportation vehicles available; (2) accessibility of the network to potential shippers, receivers, or passengers; (3) operating policies of the modes as to types of services offered and prices to be charged, etc.

Even though the transportation system has the ability and is willing to transport goods and individuals, the movement of goods and individuals will not take place unless users are willing to provide goods and themselves to the transportation system to be transported. Users of a transportation system must decide whether to make a trip at all, to what destination, at what time, and by what mode and route. However, these decisions are affected by the user's own economic, political, social, and environmental systems. The aggregate result of all individual decisions by users constitutes the demand for transportation.

Economic Impacts of Transportation

Area 2 in Figure 1-1 suggests that the movement of goods and individuals over time will cause changes in the economic, social, political, and environmental systems of the region. For the economic system, these changes may be evident in economic development, geographic specialization, large-scale production, changes in land values, or changes in location of industry.

Economic Development. Transportation has always been a major factor in the economic development of regions. Regions with adequate transportation have grown economically; those without adequate transportation have failed to grow. The economic development of the United States has paralleled the development of our transportation system. Before the development of railroads, overland transportation in the United States was both costly and slow. With the development of the steam locomotive, railroads were able to make cheap transportation available over vast areas of the country. Locklin concludes that this "cheap transportation was one of the basic facts on which the economic life of the 19th and 20th centuries was built."[2]

The importance of transportation to economic development is evident in the fact that programs designed to stimulate economic development of the less developed countries often emphasize transportation investments. Transportation investments have been significant economic development tools in the post–World War II period.[3]

Geographic Specialization. With adequate transportation, regions can specialize in the production of those goods for which they have a comparative advantage. The comparative advantage of a region can become operative

[2]D. Phillip Locklin, *Economics of Transportation*, 7th ed. (Homewood, Ill.: Richard D. Irwin, Inc., 1972), p. 1.

[3]Gary Fromm, ed., *Transport Investment and Economic Development* (Washington, D.C.: The Brookings Institution, 1965).

only when adequate transportation is available. If an adequate transportation system does not exist, a region cannot specialize in the production of those goods for which it is best suited in terms of available resources. Hence, the region will be forced to devote resources to the production of goods for which it does not have a comparative advantage. The results are economic inefficiency and a lower standard of living for the region in question. With an adequate transportation system, Florida can specialize in the production of citrus fruits and the U.S. South can specialize in tobacco and cotton.

Large-Scale Production. In order for a firm to be able to produce large quantities of its product at a single location or a few locations, an adequate transportation system must be available at reasonable cost to transport raw materials and other supplies from distant locations to the production site. In the United States, the growth of large-scale production in the nineteenth century was accompanied by the development and improvement of our railroad and water transportation systems. Since 1920, other forms of transportation have become available, and the trend toward large-scale production has continued.[4] If large-scale production provides benefits such as lower unit costs of production to society, then transportation will be partly responsible for such benefits.

Land Values. As land accessibility increases because of transportation improvements, the value of such land is expected to increase. Transportation improvements may be in the form of faster or less expensive means of transportation or both. If, for example, a two-lane road is replaced by a four-lane road, travel time to and from points in the area is expected to decrease on the average, since mobility in the area is now enhanced. Land adjacent to the new road also becomes more accessible, and hence its value is expected to increase.

The effect of transportation improvements on land values is not, however, always positive. For example, if a four-lane road is built not as a replacement for a two-lane road but over a generally parallel route nearby, property values along the old two-lane road may decline, since the land near the four-lane road is now more accessible. Land values may also decline if negative effects of transportation improvements such as noise and air pollution outweigh the improvement in accessibility.[5] This has been particularly true of residential property near airports.

Location of Industry. One of the major factors that influence the location of industry is transportation. Industries will locate their production and distribution sites at locations that are accessible to resources and/or to cus-

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[4]Donald V. Harper, *Transportation in America: Users, Carriers, Government* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1978), p. 6.

[5]Yitzhac Oron, David Pines, and Eythan Sheshinski, "The Effects of Nuisances Associated with Urban Traffic on Suburbanization and Land Values," *Journal of Urban Economics*, Vol. 1, No. 4 (October, 1974), pp. 382-394.

tomer markets. Whether industries locate their production sites closer to resource locations or closer to customer locations depends upon the transportation system available as well as on other factors. For example, if the finished product weighs less than the raw materials that are used to produce it, an industry may locate its production sites nearer the resource sites in order to save on transportation costs; conversely, if the product gains weight during production, the industry may locate nearer customer sites.[6]

Social and Political Impacts of Transportation

The movement of goods and individuals is also expected to cause changes over time in the social and political systems of a region. Changes in the social and political systems may be manifested in changes in national defense, the formation of and changes in political boundaries, and changes in the cultural characteristics of people of the region.

National Defense. It is well recognized that an adequate transportation system is vital to the national defense of a region. In fact, governmental expenditures designed to improve a region's transportation system have often been justified as improvements vital to national defense. In the United States, the national defense argument has been used to support public investment in inland waterway and interstate highway systems. During World War II, the U.S. government also used this argument to justify the construction of the Big Inch and Little Inch pipelines for carrying petroleum products from the Southwest to eastern states.

With transportation being vital to national defense, a region's transportation policy cannot be analyzed from an economic standpoint alone. Furthermore, direct governmental participation in improvements and in the supply of a region's transportation system is to be expected.

Political Boundaries. A factor contributing to the rapid growth of metropolitan areas in the United States after 1920 has been transportation improvements. Prior to 1920, virtually all employment in metropolitan areas took place in the center of the city, with residential neighborhoods surrounding this core. With the advent of the auto and extensive highway development, decentralization of metropolitan areas began. The geographic dispersion of city populations into sprawling metropolitan areas (and thus the growth of suburbia) accounted for much of the population loss experienced by U.S. central cities. With the development of employment and residential centers in the suburbs and the corresponding growth in highway development, the decline of U.S. central cities was ensured.

As discussed previously, transportation is an important factor affecting the location of industry. If such locations also become centers of trade, po-

[6]See Chapter 7 for a discussion of transportation and location theory.

litical systems such as towns or cities are likely to form. These towns or cities, however, cannot grow in terms of people or land area unless there is an adequate transportation system.[7] Developing adequate passenger transportation systems for our large metropolitan areas has become one of the most pressing problems of the present day and will have a vital effect on the political and economic structures of the cities of the future.[8] Transportation movements are expected to affect not only the size of political systems but also the land use (in terms of the amount of land devoted to housing and transportation, for example) of such systems.

Cultural Diffusion. A social effect of transportation improvements is greater mobility. In the United States, rural living is now more closely associated with urban living than ever before because of the greater mobility of our people. This has been primarily due to the advent of the auto and highway development. Not only is there greater mobility between rural and urban areas but there is also greater mobility within urban areas, as evidenced by the growth of our suburbs. With this greater mobility, a wider diffusion of urban culture and its social problems has resulted. At the national level, greater mobility from transportation improvements such as our interstate highway system has led to a diffusion of cultural patterns, a lessening of the differences between localities that characterized earlier periods in our history.[9] In addition, people are now more likely to take jobs farther from home, and industry is more likely to move to new areas.

Environmental Impacts of Transportation

Changes over time in the environmental system of a region are another effect to be expected from the movement of goods and individuals. For the environmental system, these changes may take the form of air and noise pollution.

Air Pollution. There is little doubt that transportation vehicles are air polluters. Vehicles powered by internal gasoline combustion engines produce four pollutants: carbon monoxide, gaseous hydrocarbons and benzene compounds, nitrogen oxide compounds, and nongases or heavier particles (the most important of which is lead).[10] However, attempts are being made to control exhaust emissions. During the late 1960s, U.S. automobile manu-

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[7]L. Legey, M. Ripper, and P. Varaiya, "Effects of Congestion on the Shape of a City," *Journal of Economic Theory*, Vol. 6, No. 2 (April, 1973), pp. 162-179; D.A. Livesey, "Optimum City Size: A Minimum Congestion Cost Approach," *Journal of Economic Theory*, Vol. 6, No. 3 (April, 1973), pp. 144-161; and Edwin S. Mills and David M. de Ferranti, "Market Choices and Optimum City Size," *American Economic Review*, Vol. 61, No. 2 (May, 1971), pp. 340-345.

[8]Dudley F. Pegrum, op. cit., p. 13.

[9]Dudley F. Pegrum, op. cit., p. 14.

[10]Roy J. Sampson and Martin T. Farris, *Domestic Transportation Practice, Theory and Policy*, 4th ed. (Boston: Houghton Mifflin Co., 1979), p. 42.

facturers began to introduce emission control devices on new vehicles. These vehicles emit lesser amounts of air pollutants than earlier vehicles without such devices.

Noise Pollution. Transportation activities also generate noise pollution. Residents of neighborhoods near airports, railroad yards, and major highways are definitely aware of transportation noise. Such noise pollution can be controlled or abated by soundproofing buildings, relocating neighborhoods, or relocating transportation facilities. Noise pollution can also be controlled through government regulation of noise levels permissible from transportation vehicles and facilities, and by technological advancements in transportation vehicles and facilities that reduce noise pollution.

Transportation System Changes

Changes in the transportation system are inevitable. These changes will influence, and will be influenced by, the economic, social, political, and environmental systems of the region. In response to actual or anticipated movements, the transportation system may develop new transportation services or modify existing services.

Service Improvements. As the volume of transportation movements increases, the operating characteristics of the providers of transportation services will be positively affected. In urban mass transportation, for example, frequency of service can be increased as ridership increases. When increased passenger revenues make it possible for the provider to increase the number of vehicle runs on a given route, the average waiting time per passenger decreases. This improvement in service is then expected to stimulate even greater ridership.

As movements increase, providers of transportation services will also be able to offer additional or specialized services such as express service, origin-to-destination deliveries without transfer from one vehicle to another, or refrigeration service for perishable commodities. In addition, movement increases and competition among providers for these increases are expected to be an impetus for developing new transportation technologies. For example, we have witnessed in recent years a number of new transportation technologies including slurry pipelines, container ships, supersonic aircraft, and urban people movers.

Service Deterioration. If the volume of transportation movements decreases, the operating characteristics of transportation providers will be affected negatively. For example, if ridership declines significantly, an urban transit firm will be expected to reduce frequency of service and might also have to reduce its number of routes. With a reduction in routes, the accessibility of its service is reduced. With a reduction in frequency of service and

accessibility, ridership will decline even further; this was the pattern of U.S. urban mass transportation until recent years. As movements decrease, there will no longer be an impetus for transportation providers to develop new technologies. However, if government thinks it should reverse the decline in movements, it may support and finance development of new technologies, as the U.S. government has done in financing research into the construction of more efficient vehicles for urban mass transportation.

The next section of this chapter examines the individuals and groups who so profoundly influence the transportation system—the decision makers.

DECISION MAKERS IN TRANSPORTATION

There are many individuals, groups, and institutions whose decisions interact to affect the transportation system; the economic, social, political, and environmental systems; and thus the movement of goods and individuals.[11] These decision makers may be classified as belonging to one of three groups: (1) providers of transportation service, (2) users of transportation service, and (3) government.

Providers of Transportation Service

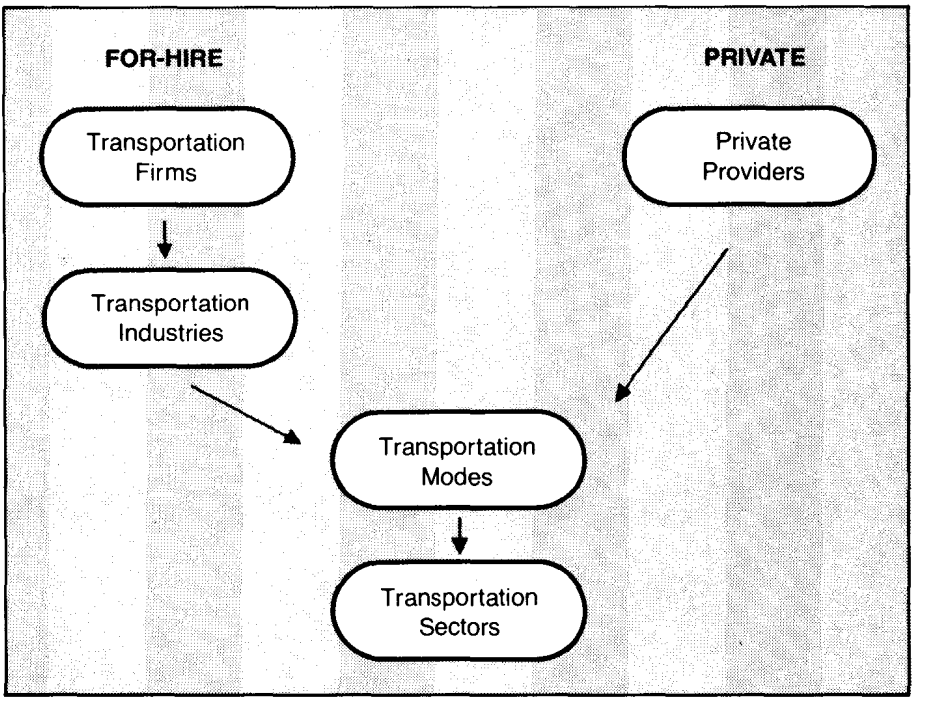
Providers of transportation service are obviously a group whose decisions have a major effect on the movement of goods and people. There are a number of ways to classify providers of transportation service.

Classifying Transportation Providers. Figure 1-2 shows that a transportation provider may be classified as for-hire or private. The for-hire providers are transportation firms such as airlines, railroads, trucking firms, pipelines, and bus firms that provide transportation service for others. Private providers include business firms, other organizations, and individuals who provide their own passenger and/or freight service by operating their own automobiles, trucks, airplanes, or other transportation equipment. The business firm may be a user of for-hire transportation service as well as an operator of private transportation service. Sears, Roebuck and Company, for example, operates its own private truck fleet for intracorporate hauling. However, the availability of a private truck fleet does not preclude Sears's using for-hire transportation service.

Transportation firms can be further classified as belonging to particular transportation industries. An **industry** is generally defined as being composed of a group of firms that are primarily in the same or closely related type of business activity. A **transportation industry** is composed of those transportation firms that provide the same type of service, such as rail

[11]Marvin L. Manheim, op. cit., p. 14.

FIGURE 1-2 Classification of Transportation Providers



freight, rail passenger, trucking, air freight, and air passenger industries. If a transportation firm provides both freight and passenger service, it will be considered a member of more than one transportation industry.

Transportation firms, industries, and private providers have also been classified as belonging to particular transportation modes. The term **transportation mode** identifies a general type of service—passenger service, for example, or freight service. Modes may also be classified as railroad, highway, water, or air, in which both passenger and freight services are provided. Pipeline transportation is still another mode.

Finally, transportation firms, industries, private providers, and modes may be classified as belonging to certain transportation sectors. A **transportation sector** is the region or area in which transportation providers operate. Such sectors may be classified as domestic intercity, urban, or rural as well as foreign or international. *As the terms are used in this book, the domestic sectors are the U.S. intercity, urban, and rural sectors; foreign sectors will be other than U.S. transportation sectors; and the international sector will include both U.S. and foreign transportation sectors.*

Competition. A transportation provider may face competition from intramodal and/or intermodal sources. **Intramodal** (or carrier) **competition** refers to competition of firms within a given mode. Examples of intramodal