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Consequences of the Development of the Interstate Highway System for Transit

This TCRP digest presents the literature review for TCRP Project H-13A, "Consequences of the Development of the Interstate Highway System." The aim of this project is to determine the effects of the interstate highway system on urban and suburban areas, focusing particularly on the effects for public transportation as an industry and as a service. The research phase of the project includes a comparative case study analysis of selected U.S., German, and Canadian cities analyzing the broad context in which interstate and similar highway projects were developed, their intended and unintended consequences, and their effects on public transportation systems and use. Judy Davis, Parsons Brinckerhoff Quade and Douglas, Inc., prepared this digest.

INTRODUCTION

This digest summarizes what is known about the consequences of the interstate highway system for public transportation as an industry and as a service. The review also considers the effects of the interstate highway system on the pattern of urban development and on transportation policy and planning because these factors also influence the transit industry and service. By identifying the gaps and omissions in the literature, the review shows the need for additional research.

Considerable literature on the effects of automobility on American life exist. Recent books on the subject include the following:

- Jennings, J., ed., *Roadside America: The Automobile in Design and Culture*, Iowa State University Press, Ames, IA (1990);
- Lewis, D. L. and L. Goldenstein, eds., *The Automobile and American Culture*, University of Michigan Press, Ann Arbor, MI (1983);
- McShane, C., *Down the Asphalt Path: The Automobile and the City*. Columbia University Press, New York, NY (1994);
- Nadis, S. and J. J. MacKenzie, *Car Trouble*, Beacon Press, Boston, MA (1993); and

- Wachs, M. and M. Crawford, eds., *The Car and The City: The Automobile, The Built Environment, and Daily Urban Life*, University of Michigan Press, Ann Arbor, MI (1992).

In contrast, research that focuses on the effects of the interstate highway system is limited. The only large-scale study of the effects on the interstate highway system on urban areas was sponsored by the U.S. Departments of Transportation and Housing and Urban Development in the 1970s. It examined the effects of beltways on land use and urban development (Payne-Maxie and Blayney-Dyett, 1980). Much of the analysis of the effects of the interstate highway system is found in books and articles on suburban development and general transportation policy. This review relies on works of respected historians, geographers, and policy analysts who have studied transportation and urban patterns of development. This review avoids the more controversial accounts of the interstate highway system that appeared in the early 1970s, such as Kenneth Schneider's *Autokind vs. Mankind*, Norton, New York (1971), Helen Leavitt's *Superhighway-Superhoax*, Double Day, Garden City, New York (1972), Ronald Buel's *Dead End*, Prentice Hall, Englewood Cliffs, New Jersey (1972),

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A.Q. Mowbray's *Road to Ruin*, Lippencott, Philadelphia, Penn. (1972), and Emma Rothschild's *Paradise Lost*, Random House, New York (1973).

Some research has identified the effects the interstate highway system has had on nonmetropolitan development, including work by Humphrey and Sell (1975), Lichter and Fuguitt (1980), Briggs (1981), and Moon (1987). Improvements in travel had an effect on the people, economy, development patterns, and lifestyles of rural areas. But except on the urban fringe, these changes do not reflect the relationship between transit and interstate highways. This review, therefore, focuses on what happened in medium- to large-sized cities, including changes that occurred at their urban fringes. The two main positions about the effects of the interstate highway system on transit are as follows:

1. The interstate highway system biased transportation investments in favor of urban freeways, reducing transit's ability to compete with the automobile.
2. The interstate highway system facilitated the suburbanization of households and jobs, creating origins and destinations that were difficult for conventional transit to serve.

The literature makes it clear that the interstate highway system was only one of many factors supporting the trends of increased automobile use, suburbanization of population and jobs, and declining transit effectiveness. The difficulty for any research lies in sorting out the role of the interstate highway system relative to the other factors.

To understand the effects of the interstate highway system, Section 1.1 reviews the context in which the interstate highway system was developed and considers how that

context changed during the era of interstate highway building (1956-1980). Section 1.2 outlines four prototypes for major cities in the interstate highway era with varying patterns of freeways, transit, and land use. Section 1.3 presents evidence from the literature on how the interstate highway system has affected transit use in U.S. cities, and the types of cities that have developed around this system. Section 1.4 compares the experience with limited access highways and transit in U.S. cities with those in Canada, Australia, and Europe.

1.1 CONTEXT OF URBAN INTERSTATE DEVELOPMENT

In 1956, Congress passed the Interstate Highway Act authorizing the largest public works project in the history of the country. The act authorized 40,650 mi (later expanded to 42,796 mi) of Interstate and National Defense Highways to be built by 1972 and provided \$24.8 billion in funds for the period from 1957 to 1969. Economic growth during the 1950s made financing a large, peacetime public works project feasible (Altshuler et al. 1981).

One innovation of this act was treating the interstate highway system as a single project with multiple-year funding. Previously, Congress had provided aid for highways on an annual or biannual basis in varied amounts depending on the federal budget, the need to provide jobs, and other factors (Federal Highway Administration 1977).

A second innovation was the method of funding. The Highway Trust Fund Act, passed simultaneously with the Interstate Highway Act, designated all federal gas and other vehicle-related taxes to highway construction and maintenance. Previously, these funds had been deposited in the general fund and highway federal-aid dollars were

apportioned from the general fund. The federal designation of funds followed the practices of many states that had designated gas taxes exclusively for highway use. Highway advocates were thus able to argue that users paid for the construction of these projects (Federal Highway Administration 1977, Dunn 1981).

Table 1 summarizes the chronology of legislation relating to interstate highway building from 1944, when the system was first authorized, to 1980, when the system was 95 percent complete. Changes in policies during the interstate highway era affected the construction of interstate highway system and the nature of transit systems.

Highway Congestion Was the Urban Transportation Problem of the 1950s

In the 1950s, the public and elected officials considered highway congestion the main urban transportation problem. Rapid growth of automobile ownership and the suburbanization of the population produced congestion in central business districts (CBDs) and on the routes to and from them during peak periods. Cities and counties tried to reduce this congestion by expanding arterial streets and building expressways and parkways. The new and expanded facilities, however, encouraged more suburban growth and rapidly became congested. As a result, limited-access, high-speed free-ways were proposed as a solution to congestion.

Highways were regarded as a public good that should be built and maintained by government to serve the most "democratic" of transportation choices—the automobile (Foster 1992). Federal funds for highway construction were first authorized in 1916. However, prior to the interstate highway era, most federal and state transportation funds were spent on rural roads. Urban highways were

TABLE 1 Chronology of federal legislation on interstate highways, transit, and the environment during interstate highway building years, 1944-1980

Year	Interstate Highways	Transit	Environmental
1944	Federal-Aid Highway Act authorized Interstate Highway System, but no funding designated.		
1956	Federal-Aid Highway Act authorized 41,000 miles of National System of Interstate and Defense Highways to be built by 1972. Authorized spending \$24.8 billion from 1957 to 1969. Increased federal share of program to 90%. The Highway Revenue Act increased gas and other motor vehicle taxes and created the Highway Trust Fund by earmarking gas, tire, and truck/bus weight taxes solely for highway construction and maintenance.		
1961		Housing Act of 1961 authorized \$50 million in low-interest loans for transit projects, \$25 million for demonstration projects, and a study of transit needs.	
1962	Federal-Aid Highway Act mandated metropolitan planning to receive urban highway funds.		
1964		Urban Mass Transit Act of 1964 authorized capital grants for up to two-thirds of the net project costs of constructing, reconstructing, or acquiring mass transit facilities.	
1966	Section 4(f) of the Federal-Aid Highway Act prohibited building federally funded highways in parks, wildlife refuges, and historic sites unless there were no other reasonable alternatives.	Amendments to the Urban Mass Transit Act added federal assistance for planning, engineering, and design needed to apply for capital grants and authorized a study of new transportation systems.	

TABLE 1 Chronology of federal legislation on interstate highways, transit, and the environment during interstate highway building years, 1944-1980 (cont.)

Year	Interstate Highways	Transit	Environmental
1969			National Environmental Protection Act required an Environmental Impact Statement (EIS) for all federally funded actions that would significantly affect environment.
1970	Federal-Aid Highway Act required states to consult with local officials on urban highway projects. It also required more attention to social, economic, and environmental factors.	Urban Mass Transit Assistance Act established a long-term federal commitment to transit projects with multi-year commitments to projects.	Clean Air Act Amendments required states to develop state implementation plans (SIPs) for nonattainment areas. The preparation and review of these plans often occurred outside the traditional transportation planning process.
1973		Federal-Aid Highway Act authorized substitution of mass transit projects for interstate highway projects with an 80% federal match. Transit dollars came from the general fund, not the Highway Trust Fund.	
1974		National Mass Transportation Assistance Act authorized federal assistance for transit operations (50% federal match, local tax support required).	
1976	Federal Aid Highway Act allowed substitution of other highway projects for interstate highway projects.		
1977			Clean Air Act Amendments required that states review SIPs. Many urban areas required to develop transportation control measures.
1978	Surface Transportation Act for the first time combined funding for highways and transit in one measure.	Surface Transportation Act expanded federal transit operating assistance.	

Sources: Jones 1985, Weiner 1992

regarded as local routes that should be funded locally. The first federal funding for urban roads was approved as public works projects during the Depression more to provide jobs than to deal with urban transportation issues. The Federal-Aid Highway Act of 1944 was the first highway act to provide funds dedicated to urban highways (Kemp and Cheslow 1976).

The interstate highway system was authorized by Congress in 1944 to connect regions and major metropolitan areas (see Table 1). Congress, however, did not provide special funds for interstate highways, and few were built (Owens 1966). Prior to 1956, there was long debate about whether interstate highways should go around or through urban areas. The Automobile Manufacturers Association (AMA) was a major supporter of interstate highways within cities. The AMA commissioned a report by Wilbur Smith and Associates (1961) on cities and highways, *Future Highways and Urban Growth*. This report laid out the reasons for building interstate highways in cities.

The Wilbur Smith report pointed out that the largest future market for automobiles was in cities. Not only were urban areas the most rapidly growing parts of the country, but many urban households did not yet own automobiles. The report contended that CBDs needed radial freeways to survive and that express buses on these freeways were the transit of the future. The AMA also argued freeways were needed in cities for civil defense purposes. The civil defense argument that freeways would help people leave the city in the event of a nuclear attack helped convince Congress that federal dollars should be spent on "local" projects like urban highways (Schwartz 1962, St. Clair 1986, Flink 1988).

Transit Was Mostly a Private Business in the 1950s

In contrast to highways, transit was viewed as a profit-making, taxpaying business. In 1960, only 38 cities had publicly owned and operated transit systems. All but seven of these covered operating expenses with fares, and the industry as a whole made a profit after taxes (Jones 1985, St. Clair 1986, Smerk 1991).

The popular view was that transit was a dying industry except in the largest cities. In fact, 194 medium-sized cities did lose their transit service between 1954 and 1963. Except for the peak during the wartime years, ridership had been declining since the late 1920s (Hinton 1985). Private transit companies were surviving but not doing well. Regulations on service, routes, wages, and other operating conditions made it difficult for them to make a profit. Companies were not replacing aging equipment and facilities. As a result, service was often unreliable and uncomfortable Jones 1985).

Early Urban Interstate Highway Planning Did Not Consider Broader Urban Issues

At the beginning of the interstate highway era, highway planning was largely done by engineers seeking low-cost, gentle curving routes. Interstate highways were built to rural standards so high speeds could be safely maintained at all times. This required more land than other types of highway design. Urban interstate highways were often planned by state highway agencies with little consideration for broader metropolitan area plans.

When selecting routes, transportation agencies consulted with mayors, other public officials,

and major institutions, but rarely with the public. Social and environmental concerns played little role in decisionmaking. Lower-cost routes often went through poor neighborhoods and city parks. The disruptions were greatest in the inner cities where many homes and businesses were displaced by these massive projects. In the suburbs, interstate highways could often be built on undeveloped or partially developed land, causing less disruption to established patterns of living (Altshuler et al. 1981, Flink 1988, Rose 1990).

Changing Nature of the Urban Transportation Problem

Congestion continued to be an issue in the 1960s and 1970s. However, attention was also given to the decline of transit, the disruptions of urban freeway building, and automobile safety. Later, concerns about environmental and energy issues increased as the nation celebrated Earth Day and responded to the Organization of Petroleum Exporting Countries (OPEC) oil embargoes. Transit financing became an issue as more and more systems became publicly owned, and state and local governments sought funds to maintain and expand service. As automobile use increased, concern about the mobility of people without cars became more significant (Altshuler et al. 1981, Smerk 1991).

The environmental movement emerged in the late 1960s and early 1970s. The National Environmental Policy Act of 1969 required environmental impact statements for federally funded projects with major impacts. This changed the rules for planning interstate highways. The Clean Air Act Amendments of 1970 required that states develop state implementation plans (SIPs) for

nonattainment areas. As a result, air-quality agencies became involved in transportation issues (Weiner 1992).

Freeway revolts had erupted in 12 cities by 1970. What began as reactions of the people directly affected by the disruption of massive highway projects on neighborhoods and communities, snowballed and became a rallying cry for civil rights activists, environmentalists, urban neighborhood preservationists, and downtown business groups. Many groups feared that interstate highways aided growth in the suburbs and fostered downtown and urban neighborhood decline (Jones 1985, Kemp and Cheslow 1976, Dunn 1981). Eventually, the freeway revolts resulted in the withdrawal of some interstate projects and the substitution of other transportation projects. In 1973, the rules were changed to allow transit projects to be substituted for interstate highway projects that were not considered essential for the system. In 1976, the rules became even more flexible, allowing some interstate funds to be expended on other highway projects (Weiner 1992, Edner and Arrington 1985).

Federal Government Becomes Involved in Transit Financing

In the 1960s and 1970s, transit was embraced by many groups as a solution to the problems of central city decline, urban poverty, environmental degradation, suburban sprawl, and transportation for the elderly. These groups began lobbying for federal support for transit. The Housing Act of 1961 included the first support for urban transit by authorizing \$75 million for demonstration projects and loans. It also authorized a study of transit needs. Lyle C. Fitch and Associates wrote *Urban Transportation and Public Policy* in 1964 for Congress. This report established the case for federal capital assistance for mass transit and

contended that transportation investments were distorted by federal and state aid that favored highways. The federal government needed to get involved in transit financing to solve an urgent urban problem, to complement other federal urban efforts, and to balance federal spending on urban highways. Lyle C. Fitch and Associates recommended federal matching grants or loans for state and local agencies for capital improvements for transit.

The Urban Mass Transit Act of 1964 enacted many of these recommendations by authorizing the first federal capital grants for transit. A long-term federal commitment to transit was made in 1970 when multiyear projects were authorized. Cities used federal funds to help acquire private transit systems and to improve and expand these systems. Federal assistance for transit operations began in 1974 (Altshuler et al. 1981, Weiner 1992).

Transit ridership increased in the 1970s for the first time in the post-World War II period as a direct result of improvements in urban transit. However, the large-scale federal, state, and local subsidies required to obtain this improvement raised many concerns about the efficiency of transit (Smerk 1991).

Coordinated Planning of Federally Funded Programs

As the number of federal programs addressing urban issues expanded to include urban interstate highways, transit projects, urban renewal, and model cities, the federal government saw a need for coordination at the metropolitan level to avoid duplication of effort or contradictory programs.

The federal government promoted regional cooperative efforts such as clearinghouses for federal grants and metropolitan planning organizations (MPOs) for transportation

planning. Federal legislation required joint planning of highways and transit after 1973 (Smerk 1991, Weiner 1992).

Conclusions About the Context of the Interstate Highway Program

Throughout the interstate highway building era, there was a focus on planning and building the interstate segments that often downplayed examination of other possible solutions to congestion. The federal funds available exclusively for the construction of interstate highways encouraged their construction as the way to meet urban transportation needs. A decade later, the provision of federal capital assistance without operating assistance for transit encouraged bus purchases and construction of rail systems, but no changes occurred in scheduling, routing, or transit management (Kemp and Cheslow 1976, Altshuler et al. 1981, Jones 1985).

Many cities used the designated federal funds to build extensive radial and beltway interstate highways. These large-scale projects created massive disruptions in developed areas. In the late 1960s and early 1970s, increased activism supporting neighborhood preservation, downtown revitalization, social and economic development for minorities, and environmental concerns combined with the disruptions of interstate highway building to change attitudes and laws affecting the interstate highway system. At the same time, public opinion changed from viewing transit as a private enterprise to seeing it as a solution to various other urban problems, including congestion. Public agencies acquired failing private transit companies, and the federal government became involved in subsidizing transit through the newly created Urban Mass Transit Administration. Changes in public attitude led to

changes in federal policy, including the following:

- Halting the construction of urban interstate highway segments and delaying the completion of others for years;
- Substituting transit and other highway projects for interstate highway projects;
- Shifting urban highway decisionmaking from state highway departments to newly created MPOs;
- Using an interdisciplinary approach to transportation planning that considered the social, economic, and environmental impacts of transportation investments;
- Establishing public ownership and operation of most transit systems;
- Granting new federal, state, and local subsidies for transit; and
- Giving transit and highways separate federal agencies and rules.

These changes-in transit financing, transportation planning rules, environmental legislation, and public perceptions of transportation problems-affect the evaluation of the relationship between the interstate highway system and transit. This relationship is not a simple one because the context in which it was formed was also changing. In addition, as the international comparisons later in this digest show, while U.S. cities were building interstate highways, governments and citizens in other countries were making decisions about urban highway and transit investments that diverged from the American point of view. Their investments reflect different attitudes and policies toward urban development, transit, and highways.

1.2 PROTOTYPES OF URBAN FORM IN THE INTERSTATE HIGHWAY ERA

In *Great Cities and Their Traffic*, Thomson (1977) identified five prototypical

ways in which cities could develop, depending on the nature of their investments in highways and transit and their land use policies. Of these prototypes, one applies mainly to large cities in Asia, South America, and Africa, but four are applicable to cities in the United States and to other developed countries. Although Thomson wrote this book, on the basis of his observations of cities around the world, nearly 20 years ago, the prototypes he developed reappear with minor variations in regional visions in the United States and Canada today. Thus, these prototypes are relevant to an examination of the relationship between the interstate highway system and transit systems.

Thomson's four types of cities, listed from most to least accommodating to the automobile, are as follows:

- Fully motorized cities,
- Weak-centered cities,
- Strong-centered cities, and
- Traffic limitation cities.

Fully Motorized Cities

Fully motorized cities are designed to ensure the free flow of automobile traffic. Small cities (200,000 to 300,000 people) can retain a traditional city center and be fully motorized. However, in larger cities there would be too much congestion if a substantial amount of employment were located in a dominant center. Therefore, a large, fully motorized city must have multiple centers or a dispersion of activities. Thomson theorized that the ideal form for a fully motorized city is a grid system with freeways forming the primary network connecting dispersed centers. Secondary roads move traffic, including buses, between the freeway corridors while distributor and access roads provide access to jobs, shopping, recreation,

and homes. Thomson identified Los Angeles, Detroit, Denver, and Salt Lake City as examples of fully motorized cities where private motor vehicles are the primary mode of travel. Since the 1970s, three out of four of these cities have retrofitted their cities with rail systems as part of a strategy to strengthen the city's center.

Weak-Centered Cities

Weak-centered cities have a CBD that retains many of the cultural and economic functions traditionally associated with city centers. Because the city center is too large for all workers to arrive by car, it depends on transit for a substantial share of commuters. These cities have, however, built radial and beltway freeways whose intersections are attractive locations for industrial and commercial development and result in a multiplicity of centers. Hence, a tension exists between retaining the CBD as the center of the region and letting it become one of many centers, thereby becoming a fully motorized city. Maintaining CBD primacy requires policies that encourage (1)

development in the center and discourage it elsewhere and (2) investments in a commuter transit system to the city center. Thomson listed Melbourne, Copenhagen, San Francisco, Chicago, and Boston as examples of weak-centered cities in the 1970s.

While the U.S. cities on this list of weak-centered cities may have been weakly centered compared to cities in other countries in the 1970s, they are some of the more strongly centered cities in the United States in the 1990s. All three have extensive rail and bus transit systems serving the CBD. All had extensive growth in CBD office space in the 1980s. Countering this centralization, suburban activity centers or edge cities have also developed in these regions. Cities like Cleveland and Kansas

City, where the central city has declined relative to the rest of the region, are probably better examples of weak-centered cities today.

Strong-Centered Cities

Strong-centered cities have retained the city center as the heart of the region. The center is supported by radial freeways and high-capacity transit that make the city center the most accessible place in the region. There are no beltways that confer the same regional accessibility at interchanges that occurs in the city center. Instead, small subcenters develop along the radial transportation routes to serve local markets and use the labor force from nearby areas for non-central functions. Cities can remain strongly centered only as long as the quality of peak-period transit is roughly equal to that of peak-period driving. Without this balance between transit and automobile use, pressure would mount to move functions out of the CBD to locations where automobile access would be better. Thomson considered Paris, Tokyo, New York, Athens, Toronto, Sydney, and Hamburg examples of strong-centered cities in the 1970s.

Traffic Limitation Cities

Traffic limitation cities are designed to minimize the need to travel by private automobile. These cities have a hierarchy of centers ranging from neighborhood centers to the CBD that provide goods and services to ever larger parts of the region. Major subregional centers are linked to each other and to the city center with high capacity transit. Thus, most travel can be made by walking to a nearby center or using transit to reach a higher order center. Automobile use is also restrained with high parking charges and priority systems for transit, bicycles,

and pedestrians. Freeways serve mainly as a means of leaving the city for the countryside or other cities and are only built near the region's edge. Automobile traffic in the core of the city uses arterials. According to Thomson, traffic limitation cities of the 1970s included London, Singapore, Hong Kong, Stockholm, Vienna, Bremen, and Goteborg. As the TCRP Project H-1 research reported, Ottawa-Carleton and Vancouver in Canada and Curitiba in Brazil have become traffic limitation cities (Parsons Brinckerhoff et al. 1996).

These prototypes illustrate that a combination of transportation investments and land use policies determine the degree to which actual cities fit a prototype. The building of urban beltway and radial freeways has combined with the neglect of transit systems and few controls on suburban development in many U.S. cities to produce weakly centered or fully motorized cities. Many cities that have grown rapidly since the 1950s have few miles of interstate highways, but they have developed either other freeways or arterial networks that support full motorization. Many Australian cities have followed a pattern similar to that of U.S. cities. In contrast, Canadian cities, such as Vancouver and Ottawa, have adopted traffic limitation strategies that emphasize use of transit and support a hierarchy of centers. The next sections review the literature that supports these conclusions.

1.3 INTERSTATES AND TRANSIT IN U.S. CITIES

During the interstate era, urban areas in the United States became more spread out, multi-centered, and dependent on the automobile. The question of interest here is—What was the role of the interstate highway system in fostering or supporting

these trends? The interstate highway system was not the only force at work. For example, cities like Phoenix and Orlando have become fully motorized cities without extensive networks of interstate highways or even other freeways. Many other factors are involved in the way cities have developed, including individual preferences for living in suburbs, higher incomes, widespread automobile ownership, and few limits on suburban development (Altshuler et al. 1981, Jackson 1985, Linneman and Summers 1993).

The interstate highway system reduced the competitive advantage of transit in two ways. First, it biased transportation investments in favor of high-speed, limited-access highways. This enhanced automobile travel at a time when transit service was already declining and further encouraged use of the automobile and reduced use of transit. Second, it facilitated the suburbanization of households and firms. The dispersed, low-density pattern of development in most suburban areas is difficult to serve efficiently with transit.

Reduced Competitive Advantage of Transit by Improving Automobile Travel

Interstate Highway Funding Biased Transportation Investments

One effect of the interstate highway system was to bias transportation investments in favor of building urban limited-access highways rather than pursuing other solutions to urban transportation problems. Dunn (1981) analyzed U.S. and European transportation policies and concluded that the U.S. emphasis on highways was largely a result of designating motor vehicle taxes exclusively for highway construction. The earmarking must be considered part of the interstate highway system because it occurred simultaneously

with authorizing the interstate highways. Dunn argues that this earmarking of funds allowed the United States to build the best highway system in the world and created the powerful argument that car users pay their own way. It, however, meant that little was invested in other modes until the freeway revolts of the 1960s and 1970s focused attention on the environmental and social consequences of automobile use, including the decline in transit services and use.

The lack of balance in federal transportation funding was a key argument used in the 1964 Lyle Fitch report prepared for Congress urging federal support of transit. The report maintains that the Highway Trust Fund distorted transportation decisions by making funds available for highways but not for transit. Transportation decisions were made on a piecemeal basis rather than being based on a systemwide, multimodal analysis of problems and solutions (Lyle C. Fitch and Associates 1964).

The interstate highway funding formula also biased decisions in favor of the limited-access interstate highways. Congress set the funding formula for interstate highways at 90 percent federal and 10 percent state and local funds compared to 50 percent federal and 50 percent state and local funds for other federally aided highways. Meyer and GomezIbanez (1981) point out that this made interstate highways a more attractive investment to local areas, despite their higher costs, than construction or improvements in other projects eligible for federal aid. This funding formula created incentives to build interstate highways rather than invest in other highways, develop transit service, improve existing facilities, or consider other transportation alternatives. The construction of high-speed radial and beltway interstate highways encouraged use of the automobile.

Interstate Highways Improved Automobile Travel

The interstate highway system was intended to link cities with highspeed travel routes and to improve traffic flows in and around cities. Beltways were originally designed as part of the through traffic system, but they became the carriers of enormous amounts of local traffic as well (Payne-Maxie and Blayney-Dyett 1980). In city after city, as networks were completed, interstate highways became the most highly used urban routes. In 1991, the 131 federal aid urbanized areas with populations of 200,000 or more had 8,505 miles of interstate highways. These urban interstate highways carried 26 percent of daily vehicle miles of travel within the urbanized areas although they made up only 1.8 percent of total road mileage (Federal Highway Administration 1992).

In an assessment of the economic impacts of the interstate highway system, Louis Berger International (1995) reports that three of the primary impacts of the interstate highway system have been to reduce travel costs, improve safety, and increase connectivity of regions. The interstate highway system has increased traffic capacity and travel speeds. A 365-mile trip that took 10 hours in 1956 took only 8 hours on the interstate highway system in 1970, a 20 percent reduction in travel time. The travel cost reductions had widespread effects on the economy, lowering the cost of consumer goods and improving the competitiveness of businesses. Furthermore, the interstate highway system has half the accidents per mile compared with travel on other types of highways. Interstate highways are safer because of limited access and wide lanes designed for high-speed travel. Improved safety is one of the reasons that trucking has become reliable. In addition, the interstate highway system increased connectivity of

regions and metropolitan areas spurring a growth in trucking and shift in logistics, such as to just-in-time deliveries.

Garrison and Souleyrette (1996) argue that transportation innovations that lower travel costs and increase connectivity, which the interstate highway system does, spur companion innovations. Transportation is essential for moving goods and people. Improved highways, for example, allowed the use of the larger trucks. This changed the nature of the warehousing industry by supporting the replacement of dispersed locations that served multiple clients with consolidated locations operated by individual retailers.

In urban regions, the interstate highway system has facilitated greater use of cars and trucks. Meyer and Gomez-Ibanez (1981) points out that the underpricing and overinvestment in peak-period highway capacity to downtowns encouraged the use of the automobile for these trips. But Kemp and Cheslow (1976) notes that improvements in travel conditions were often short-lived. Interstate highways created the expectation that there would be free-flowing traffic at high speeds at all times. The benefits to travelers were often less than expected because of latent demand. Some interstate highways rapidly became congested during peak periods because the improved travel conditions encouraged more travel or caused shifts in travel from other routes, times, or modes.

In an analysis of the politics of the interstate highway system, Rose (1990) finds that many people became disillusioned with the benefits of improved travel once they realized that interstate highways also had social and economic consequences that had not been factored in when the system was designed. He says,

Without doubt, the net results of building a national freeway system included more rapid economic de-

velopment, enhanced speed and mobility for motorists and truck operators, and creation of an opportunity for millions of urban residents to relocate from central cities to suburban districts. By the mid-1960's, however, the frames of reference by which politicians, business leaders, and ordinary Americans judged the Interstate system began to change...In short, many Americans, including business and political leaders at both the local and national levels, were contending that economic development, transport efficiency, and suburban lifestyles no longer justified the social and physical destructiveness of the Interstate Highway System (pp. 101102).

One of the negative impacts of interstate highway building was to reduce the market for transit.

Interstate Highways Disadvantaged Transit Operations

As noted previously, the improvements in automobile travel that interstate highways provided occurred at a time when few investments were being made in transit. Ridership was declining. Few private transit companies had the resources to invest in new equipment or expand services as urban areas grew. The improvements made in automobile travel only compounded transit's problems (Pucher 1995b).

Vuchic (1981) argues that this created a cycle of worsening transit conditions. Improved automobile travel led to fewer transit riders. Fewer riders produced less revenue and resulted in service reductions. This in turn caused further defections to the automobile. One way to avoid the downward slide of transit was to simultaneously invest in both modes to maintain a balance between them, as some Canadian and European cities did, but most U.S. cities in the 1950s

and early 1960s only invested in highway improvements.

Direct competition between interstate highways and transit occurred on only a few long-haul commuter rail or rapid transit routes in larger cities. This reduced peak and especially off-peak travel. Fares in the peak period could not be raised to compensate for fewer riders because of the competition with interstate highways, which also lacked peakperiod pricing. For bus operations, the primary effect of interstate highways was increased congestion within the CBD because of the larger number of cars arriving there. This lowered the speeds of buses, making them less attractive to their main market: short-haul trips. If parking was available, short distance riders began driving to work because of the time advantage (Jones 1985, St. Clair 1986).

Supported Suburbanization of Households and Jobs

The second major effect of interstate highways on transit was to support the suburbanization of population and employment, which further eroded transit's market share. As a result of the dispersion of households and jobs, transit served the needs of fewer and fewer households. In 1990, the most common type of commuting trip (44 percent of all metropolitan commutes) began and ended in the suburbs. Only 20 percent of metropolitan commutes were from suburbs to the central city (Pisarski 1996). Meanwhile, transit has focused on bringing people to the CBD, where a smaller and smaller proportion of a region's workforce is employed.

Some researchers reach sweeping conclusions about the impact of the interstates on urban development and travel patterns. In his history of suburban development in the United States, Jackson (1985) says,

...the interstate system helped continue the downward spiral of public transportation and virtually guaranteed that future urban growth would perpetuate a centerless sprawl (p. 249).

Muller (1995) states,

The maturing freeway system was the primary force that turned the metropolis inside out after 1970, because it eliminated the regionwide centrality advantage of the central city's CBD. Now *any* location on that expressway network could easily be reached by motor vehicle, and intraurban accessibility swiftly became an all-but-ubiquitous spatial good (pp. 43-43).

Other authors are more cautious. Louis Berger International's (1995) analysis of the economic impacts of interstate highways reported that no studies have conclusively shown that the interstate highway system has changed the way cities develop. Rather, studies such as the Payne-Maxie and Blayney-Dyett (1980) study on beltways have found that interstates supported dispersed development only when other factors like regional economic growth, favorable tax rates, and zoning for higher levels of development were also present. Altshuler et al. (1981) believed that the Interstate Highway Act was one of many public policies that "accommodate(d) and reinforce(d) the majority taste for lowdensity living and for automobility (p. 24)." It points out that postwar patterns of location and travel were laid down between 1945 and 1960, before any significant amount of urban interstate highway was built.

A recent review of the impacts of highways on land use by the Transportation Research Board (1995) takes the middle ground. It concludes that highway expansion did influence urban form, but only in conjunction with other societal forces and public

policies supporting suburbanization. The study drew the following conclusions about the effects of highways on urban land use:

- Early highway capacity expansions, such as construction of interstate highways, dramatically reduced travel costs and increased access to undeveloped land. Lower land costs enticed households and firms to move to areas on the urban fringe that had improved accessibility.
- Highway capacity expansions interacted with population growth, rising personal income, increased automobile ownership, decreased cost of transportation, and land use policies to channel the location of growth within metropolitan areas.
- Additions to the highway system made at the same time a metropolitan area was growing influenced the location of residential and employment development because the corridor where the investments were made became more attractive for development.
- Additions to highway capacity that reduced the cost of travel supported sprawl when other conditions also supported dispersed development. The effect was greatest when access to large tracts of rural land on the urban fringe was improved.

In sum, the study finds that building highways, including the interstate network, in urban areas improved accessibility to suburban and exurban locations, facilitating the development of housing and employment at the urban fringe, and encouraging the expansion of metropolitan areas. The highways did this by interacting with a variety of other factors that supported dispersed development.

Interstate Highways Changed Urban and Suburban Accessibility

Highway improvements that reduce the time of travel enhance the ease of movement between the places they connect. Some activities clustered in areas adjacent to the new interstate highways because the nodes and corridors of the system have high visibility and accessibility. Locating at these nodes and corridors can reduce the cost of inputs to production, expand the available pool of labor, or extend the range of customers who can access the location. Thus, interstate highway corridors and intersections give businesses a competitive advantage. Other activities with less need to agglomerate have spread out as accessibility has become ubiquitous. Households used the accessibility advantage of interstate and other highways to move away from central locations to larger homes and lots in the suburbs. If other factors supported development in the areas with improved accessibility, development may have occurred sooner or been of a different character than would have otherwise occurred (Downs 1982, Giuliano 1995, Louis Berger International 1995, Transportation Research Board 1995).

Suburban activity centers have developed near the intersections of interstate and other major highways. Offices and retailing that have the greatest need for access will pay the most for these locations. Manufacturing, which also needs access to the roadway network for the flow of goods and workers, will locate nearby but not at the prime locations. The modern highway system has made the economies of business clustering together available in more locations than the streetcar system did. Thus, large cities have developed a number of specialized and general purpose

activity centers in addition to the traditional downtown (Deakin 1994, Moore and Thorsnes 1994).

Interstate highways have also supported the building of manufacturing plants in the suburbs where firms could take advantage of cheap land for spacious, one-story operations and ample loading and unloading areas. Interstate highways have given suburban manufacturing and warehousing advantages in moving goods and attracting workers. In addition, interstate highways have facilitated the development of suburban industrial parks that provide agglomeration economies and prestige locations within the suburbs (Muller 1981).

Interstate Highways Supported the Expansion of Metropolitan Areas

Interstate highways expanded the area within a 30- to 40-minute commute of the CBD. This expanded the labor shed and market area of metropolitan areas and gave households and firms more choices about where to locate (Rose 1990, Louis Berger International 1995).

Carlino and Mills (1987) found that interstate highways supported metropolitan growth in the 1970s, but their analysis does not support the idea that suburbs grew at the expense of central cities. They did a simultaneous equation analysis of population and employment change in all U.S. counties in the 1970s and found that people and jobs moved to counties with more intense interstate highway networks. The largest impact was on total and manufacturing employment. Counties with double the square miles of interstate highways per square mile of land had about a 6.0 percent increase in total and manufacturing employment. Population grew somewhat less. A

doubling of interstate density increased population density on average by 2.8 percent. Interstate highways are densest in central counties, followed by suburban, adjacent nonmetropolitan, and nonadjacent nonmetropolitan counties. The growth effects of interstate highways, therefore, declined with distance from the central city. The authors view the growth in population and jobs in areas with more interstate highways as an unintended consequence of the interstate highway system.

Other studies by Humphrey and Sell (1975), Lichter and Fuguitt (1980), and Rephann and Isserman (1994) have also found that interstate highways helped expand metropolitan areas. They studied the effects of interstate highways on population and employment growth in nonmetropolitan areas and found that interstate highway effects were greater the closer the area was to a metropolitan area. Some of this population growth in counties adjacent to metropolitan areas was due to increased commuting to the metropolitan area and some to expanding service jobs within the nonmetropolitan county. Rephann and Isserman (1994) reports that adjacent nonmetropolitan counties began having higher population and retail growth immediately after interstate highway construction compared with similar counties without interstate highways. The counties retained this advantage for the period of the study (at least a decade) and also began attracting more manufacturing as the population grew. All of these studies leave open the question whether interstate highways caused new development or were built in the path of new development (Forkenbrock et al. 1990), although the Rephann and Isserman time series matched pair study provides more conclusive evidence that interstates directed development than other studies.

Beltways and Radial Interstate Highways Changed Metropolitan Development

Beltways and radial interstate highway links confer their accessibility advantages on different locations. Radial interstate highways improved access to the CBD as well as to areas along their routes. One expectation of radial interstate highways was that they would support CBDs by improving access from the homes of suburban workers and customers (St. Clair 198, Muller 1995). Little thought appears to have been given to how beltways would influence development when they were originally designed, but once they were built, people became concerned about how they were affecting the economic health of central cities (Payne-Maxie and Blayney-Dyett 1980).

The Interstate Highway Act accelerated the development of beltways by requiring bypass interstate highway segments that later were developed into full beltways. According to Muller (1981, 1995), locations along suburban beltways have the same regional accessibility as the CBD. This has weakened the economic position of the CBD and encouraged the development of suburban activity centers at the most accessible sites, frequently the intersection of two interstate highways.

The Federal Highway Administration and U.S. Department of Housing and Urban Development jointly sponsored a study of beltways in the 1970s to test the widespread assumption that beltway construction was undermining other federal efforts to support central cities. The beltway study used a statistical comparison of 27 cities with beltways and 27 cities without them and detailed case studies of eight beltway regions. The study found little support for the hypothesis of suburban gains at the expense of central cities. The study found no statistically significant

differences between beltway and nonbeltway cities in regional economic growth, rate of suburbanization, CBD retail sales, and residential development locations. Some differences between the two types of regions were detected, but the differences were small. The impacts of beltways included the following:

- A small impact on employment, supporting a shift in jobs to the suburbs;
- A "one-time" effect on office location, drawing some offices out of CBDs; and
- A change in the location and timing of regional shopping malls, office parks, and industrial parks, but not the feasibility of these projects. Feasibility depended more on market conditions, land availability, and labor force locations.

The study further found that central cities could counter the negative effects of beltways with CBD revitalization and economic development programs. In addition, in some cities, beltways supported the development of suburban centers at interchanges and thereby lessened the amount of strip development (PayneMaxie and Blayney-Dyett 1980).

Some observers think the primary impact of beltways was in the 1980s, the decade after the beltway study. Muller (1995) divides the freeway era into five periods with different patterns of growth in each period. The first period of Bedroom Communities occurred prior to interstate construction (1945-1955). This was the period of rapid suburban residential development after World War II. Next came Independence (1955-1965) when regional malls and office parks began developing in the suburbs. The jobs developed in the suburbs at this stage were mostly population-serving jobs. In the third stage of Catalytic Growth (1965-1980), hotels, restaurants, and offices began to cluster

around regional malls in suburban activity centers. In the 1980s, High Rise/High Technology growth was spurred by a rapidly expanding computer industry, which preferred suburban locations, and an expansion of the service industry. Suburban downtowns with high-rise office buildings developed. Finally, the 1990s offer Mature Urban Centers as suburban activity centers diversify with more cultural, social, and economic functions.

Hughes and Sternlieb (1988) suggests that it took a whole generation of living with interstate highways before developers realized that the intersections of beltways and radial interstate highways afforded the same accessibility advantages as the CBD. Thus, it was not until the 1980s, when most interstate highways were complete, that high-rise office development along the beltways took off. In the 1980s, the circumferential highway corridors and, to a lesser extent, the radial corridors became the preferred locations for office development. In 1981, 51.4 percent of all office space in the 24 large metropolitan areas studied by The Office Network was in CBDs. By 1985, 56.5 percent was in the suburbs (defined as outside the CBDs). Furthermore, nearly two-thirds (63.5 percent) of office space under construction in 1985 was in the suburbs. Suburban offices were located on the interstate highway system or on other freeways to have access to a large, high-quality labor force. The 1980s' investments in suburban office corridors were also supported by the rapid growth of the service economy and tax laws that encouraged the development of offices.

Conventional Transit Does Not Serve Suburban Development Well

The Interstate Highway Act has indirectly affected the viability of

transit by facilitating a low-density pattern of residential development and the growth of multiple nuclei in the region. For the most part, transit service has not adapted to these trends. Most transit systems, including most new rail investments, have focused on the CBD. Suburban activity centers, in contrast, typically have poor transit access and nearly complete reliance on the automobile (Cervero 1985, 1989). There have been some efforts to develop transit to serve these new markets, including the development of express bus service and use of mini-buses and vans to connect neighborhoods to conventional transit (Pucher 1995b). But overall, transit serves a declining share of metropolitan area trips because it does not provide convenient connections between most people's origins and destinations. Muller (1995) identifies the transportation challenge for most urban areas in the 1990s as figuring out how to provide mobility in a polycentric region.

Conclusions About Interstate Highways and Transit in the United States

The literature supports the following conclusions about the consequences of the interstate highway system on transit:

- Federal funding influenced transportation investment decisions. The funding formula for interstates and the dedication of gas taxes to highway building encouraged the building of urban interstates instead of considering other means of meeting metropolitan transportation needs.
- The interstate highway system improved vehicle travel times, for a period of time, increasing the attractiveness of driving relative to using transit and reinforcing a downward spiral of transit ridership and service.

- The interstate highway system improved access to the developable land on the urban fringe, supporting dispersed, low-density development that is difficult to serve with conventional transit. Estimates of population growth induced by interstate highways are, however, low. A doubling of interstate highway mileage per square mile of the average county was associated with a less than 3 percent increase in population in the 1970s, holding constant other factors affecting population growth (Carlino and Mills 1989).

- Metropolitan market areas and labor sheds expanded into adjacent rural counties as interstate highways improved accessibility. The evidence suggests that population growth and population serving businesses first took advantage of this improved accessibility, followed by manufacturing firms using the decentralized workforce.

- Interstate highways facilitated the suburbanization of manufacturing, warehousing, and offices by supporting changes in production processes and logistics. As jobs moved to the suburbs, use of transit for work trips declined.

Once the interstate highway system was completed, suburban locations had the same regional accessibility as downtowns. Developers and businesses responded in the 1980s by building suburban downtowns with most if not all of the functions of CBDs. These downtowns, however, have little transit service and are nearly completely dependent on the automobile.

The net result is that improvements in access and travel from interstate highways combined with other factors, including limited investments in transit, to make most U.S. cities weakly centered or fully motorized. Radial interstate highways and transit systems helped the centers of weakly centered regions retain

some of their central functions, but these centers must compete with suburban activity centers at the interstate highway interchanges. Fully motorized cities have widely dispersed activities with the downtown being only one of many centers in the region. In both types of cities, transit cannot serve the majority of trips nearly as well as the automobile. As a result, most people who are able to drive do so.

Not every city in the developed world has taken this route. Some cities limited freeway building and invested in transit earlier to mitigate the effects of automobility.

1.4 INTERNATIONAL COMPARISONS

Many observers note that cities in Canada, Australia, and Europe are following U.S. trends of rising automobile use and expanding suburban development, but these cities are not yet as spread out or as automobile-dependent as U.S. cities. The older cities in these countries have a history of more compact development and greater reliance on transit, and some growing cities have developed around transit rather than the automobile. This section briefly reviews literature comparing transit use and limited-access highway building in U.S. cities and cities in these countries.

United States, Australian, and European Comparisons

Newman and Kenworthy (1989) assembled a set of data on the transportation and land use characteristics of 10 large U.S. cities, the 5 largest Australian cities, and 12 major cities in Western Europe.¹ The data for 1980, summarized in Table 2,

shows that U.S. and Australian metropolitan areas have similar population and employment densities for the region as a whole, but the inner cities (the urbanized area prior to World War II) of the largest U.S. cities are slightly more dense than those in Australia. In contrast, the European cities are much more compact, with regional population densities about 4.5 times greater than in the United States and Australia, and regional employment densities about 5 times larger. In addition, European inner cities are more than twice as dense as those in the United States. A greater share of the population lives in the inner city in Europe, and fewer jobs have been suburbanized.

Despite the similar densities in the United States and Australia, Australians have somewhat higher rates of transit use. Europeans are much more likely to use transit. In the large U.S. cities, people use transit about once every 6 days. In Australia, people ride transit about once every 4 days, and in Europe, once every day. The proportion of metropolitan area workers using transit for work trips in Australia in 1980 ranged from 12.0 percent in Perth to 29.5 percent in Melbourne. In the United States, the range was from 2.2 percent in Phoenix to 28.3 percent in New York. In Europe, mode shares ranged from 14.0 percent in Amsterdam (where twice as many bicycle or walk) to 46.0 percent in Stockholm. The Newman and Kenworthy data includes a measure of total road mileage, but no measure of the miles of limited access highway development, which is of more interest for this study.

This table obscures some of the differences among cities in each part of the world. New cities like Phoenix and Perth have much lower densities and transit mode shares than older cities like Chicago and Sydney, which developed extensively before the automobile era.

Using gasoline consumption per capita as their primary measure of automobile dependence (other measures such as transit mode share were highly correlated with this measure), Newman and Kenworthy illustrate the relationship between automobile dependence and urban density. U.S. cities clustered at the high gasoline consumption, low density end of the scale, Australian cities are also low-density but use less gasoline, and European cities have much lower gasoline consumption and higher density.

While reviewers commend Newman and Kenworthy for assembling data using consistent geographic definitions over time, they criticize the analysis for being simplistic. Critics question the validity of using gasoline consumption as the measure of automobile dependence, and they point out the lack of multivariate analysis of phenomena with many contributing factors (Gordon and Richardson 1989, Gomez-Ibanez 1991).

European Cities Vary in Emphases on Transit and Highways

Other analysis of European cities emphasize differences among them. Simpson (1994) reports that the experience with transit in Great Britain has followed the U.S. patterns, although a much less extensive system of limited-access highways has been built. As automobile ownership increased after World War II, the demand for roads increased. The response was a program of building "motorways" or freeways to adapt cities for the automobile. But a freeway revolt based on the social and environmental costs of freeway building led to the cancellation of this program in the early 1970s. Nevertheless, automobile ownership levels have continued to rise, and transit ridership has declined since the mid-

¹ Newman and Kenworthy also have data on Toronto, Moscow, and three Asian cities, but this discussion omits them. It is difficult to generalize from one city in Canada, and data from more cities is available elsewhere. The Asian and Russian cities are substantially different places from those covered in this review.

TABLE 2 Average values of urban form and transportation characteristics of major U.S., Australian, and European cities (1980)

	U. S. Cities	Australian Cities	European Cities
Cities Included	Boston; Chicago; Denver; Detroit; Houston; Los Angeles; New York; Phoenix; San Francisco; Washington, DC	Adelaide, Brisbane, Melbourne, Perth, Sydney	Amsterdam, Brussels, Copenhagen, Frankfurt, Hamburg, London, Munich, Paris, Stockholm, Vienna, West Berlin, Zurich
Metropolitan Density (persons/hectare)			
Population	14	14	54
Jobs	7	6	31
Inner Area Density			
Population	45	24	91
Jobs	30	27	79
Outer Area Density			
Population	11	13	43
Jobs	5	4	17
Proportion of population in the inner area	26.3%	16.4%	41.5%
Proportion of jobs in the inner area	36.3%	41.3%	59.9%
Transit mode split-work trips	11.9%	19.0%	34.5%
Automobile mode split- work trips	82.9%	75.7%	44.2%
Bike/walk mode split-work trips	5.3%	5.2%	21.0%

Source: Newman and Kenworthy 1989

based on the social and environmental costs of freeway building led to the cancellation of this program in the early 1970s. Nevertheless, automobile ownership levels have continued to rise, and transit ridership has declined since the mid-1960s. Outside London, transit is largely viewed as a social service for those without cars. In 1985, transit was deregulated, and public funds for transit were reduced.

Simpson looks to German and Swedish cities that have integrated transit and land use planning as models of better ways to proceed. The cities of Hamburg and Stockholm, for example, have developed around rail transit axes. An integrated feeder bus and park-and-ride system brings people to the rail system. Land uses in the corridors are controlled to maximize the accessibility advantages provided by the transit investments.

Pucher and Kurth (1995) report that many German cities adapted to the automobile in the 1960s and 1970s when West Germany was building the Autobahn, the second largest freeway system in the world. Nonetheless, some German cities have limited automobile access to their centers and invested in transit despite rising incomes and automobile ownership rates. Cities such as Hamburg, Frankfurt, and Munich and even dispersed regions such as the Rhein-Ruhr have experienced increased transit ridership since 1985 as a result of new programs to encourage transit use. Automobile mode shares are actually declining in Munich and Freiburg where automobile use in the central cities is restricted by high parking costs and limited supply, pedestrian only zones, and other measures.

Hamburg was a leader in developing a transit system that even attracted the patronage of the affluent. Since the 1960s, transit ridership has grown by 14 percent while the population has been stable

and automobile ownership has increased. Other German, Austrian, Swiss, and Dutch cities have followed Hamburg's example of coordinating transit systems so that consumers have a single schedule, map, and ticket for a system with multiple modes and providers. In addition, the quality of transit service has been upgraded. These regions also offer highly discounted passes that make transit use competitive with automobile use and carry an "environmental" designation emphasizing the role of transit in helping solve environmental problems. The quality service and cheap fares that encourage transit use have required increased subsidies for transit, a major issue for governments cutting spending in many areas (Pucher and Kurth 1995, Pucher 1995b).

Canadian Cities Have High Rates of Transit Use and Few Freeways

Canadian cities are often described as being more European than their U.S. counterparts. They have higher density, more land use regulation, higher rates of transit use, less highway development, and metropolitan governments (Ley and Bourne 1993).

Goldberg and Meyer (1986) compared the transportation systems of U.S. and Canadian cities in the late 1970s. They found that U.S. cities had more than 4 times as many freeway miles per capita as Canadian cities (1.3 miles of freeway per 1,000 persons in the United States compared with 0.3 miles in Canada.). On the transit side, Canadian cities had 2.5 times the service as U.S. cities (21.1 revenue miles per capita in Canada compared with 8.7 in the United States). Despite these differences in transportation investments, they also report that similarly sized cities in the United States and Canada had about the same rates of decentralization between 1950 and 1970, although the central areas of

Canadian cities remained more dense than those in the United States.

Perl and Pucher (1995) attribute the success of Canadian transit to Canadian governments' early investments in transit, which halted the post-World War II decline in use by 1960. By investing in transit earlier than U.S. cities did, Canadian cities had the easier task of maintaining ridership rather than trying to revive it as U.S. cities attempted in the 1970s. In addition, transit use was supported by a pattern of development in both urban and suburban areas, whereas in many U.S. cities, the suburbs grew while cities declined in population. The Canadian automobile-owning middle class had the option of living in either urban or suburban neighborhoods. In either case, it found transit convenient for getting to work in the CBD. Because freeway revolts halted most freeway construction in Canadian cities in the 1970s, transit remained more competitive with the automobile for work trips; however, Perl and Pucher are concerned that declining subsidies for transit during a period of fiscal austerity in the 1990s has reduced transit's competitive edge, which is reflected in declining ridership.

Bourne (1987) contends that there is a simultaneous relationship between the higher population densities of Canadian cities, limited mileage of freeways, and greater use of transit. He sees higher-density development as being a cause and an effect of high transit usage and limited freeway construction. Without high levels of transit use, congestion could overwhelm these dense centers. Because of high density, transit service was improved and the disruption of freeway building was avoided.

Conclusions About International Comparisons

Europe and Canada provide examples of regions that have

excluded freeways from city centers while investing in transit systems and subsidizing transit operations. Many have also regulated land use patterns to support their investments in transit. Despite high standards of living and automobile ownership levels, transit is competitive with the automobile for many trips in these regions. These strongly centered or traffic limited cities contrast with the weakly centered and fully motorized cities in the United States where automobile use is high and transit is considered an inferior mode of travel.

Pucher and his colleagues (Pucher 1995a, 1995b; Perl and Pucher 1995) contend that public policy has played a strong role in shaping these alternative patterns of development. European and Canadian governments have adopted transportation policies that differ from the U.S. government's. These policy differences include the following:

- **The public role in transit provision.** European and Canadian cities have longer histories of public ownership and investment in transit. Governments upgraded transit systems in the 1950s and 1960s, when transit was still regarded as a private business in most U.S. cities. Early public investments helped maintain ridership. By the time public agencies took over U.S. transit operations, service and ridership had declined, and public agencies faced the daunting task of rebuilding transit use.

- **Decisions about adapting cities to the automobile** or limiting automobile use in cities. U.S. cities overwhelming have been adapted to or built for automobile use. The decision to include radial freeways as part of the interstate highway system was a major step in accommodating automobile use in the city. In contrast, many Canadian and European cities have decided that extensive automobile use is not compatible with other goals for their city centers. They have kept high-

speed highways out of their central cities, relied on slower-speed arterials, and limited automobile use with high parking charges, controlled parking supplies, and traffic-calming programs.

- **Subsidization and taxation of automobile ownership and use.** European countries levy 4 to 10 times the taxes on automobile use than the United States does. In Europe, automobile taxation produces more revenue than is spent on roads. The ratio of automobile revenue to roadway costs ranges from 1.3 in Switzerland to 5.1 in The Netherlands. In contrast, user taxes pay only 60 percent of the roadway construction costs in the United States, largely because most local road construction is financed with general taxes. The high cost of automobile use in Europe makes transit a more competitive alternative.

- **Integrating land use planning with transportation investments.** Canadian and European cities have stronger land use controls than in the United States, and they have used this authority to organize development in ways that takes advantage of the accessibility provided by transit. City centers have retained a greater share of the region's jobs, subregional centers have been connected with transit, and even suburban development is more dense than in the United States. This land use pattern can be more efficiently served by transit than the lowdensity, dispersed pattern of most U.S. cities.

1.5 CONCLUSIONS

In the United States, the interstate highway system provided considerable funding for a specific solution to urban transportation problems. The federal funding formula encouraged states to build interstate highways as the solution to urban congestion. Building these highways reinforced a downward

spiral of transit service and use that was already underway and supported a pattern of development that is difficult to serve efficiently with transit. Most cities in the United States became weakly centered or fully motorized cities that are highly dependent on the automobile. Nevertheless, there have been some transit success stories in the United State during the interstate highway era both in cities with extensive interstate highways and in those that grew too recently to have received much interstate highway funding.

Canada and Germany provide examples of countries that took another course of action. Both have high standards of living, high automobile ownership levels, and increasingly suburbanizing populations. The countries built high-speed, limited-access freeways to connect cities, but limited these freeways within cities. Within urban regions like Vancouver, British Columbia; and Hamburg, Germany, the emphasis was on transit investments and supportive development patterns.

Further research is needed to determine why some U.S. cities have been successful in attracting riders to transit despite extensive automobility. What policies have these regions adopted and investments have they made that have mitigated the effects of interstate highway development? What lessons could be applied elsewhere? In addition, research is needed to understand the cultural, institutional, political, and economic factors that have contributed to the viability of transit in some places and its decline elsewhere. This research needs to look within the United States and beyond its borders to cities that have limited automobile use.

This research needs to carefully sort out the roles of the interstate highway system and of other factors on changes in transit service and use. In any social science research, causality is a difficult issue to resolve. The literature reviewed here often

assumed that interstate highways were an independent variable changing the dependent variable transit use. Yet there are usually competing explanations, contrary examples, and questions about which events preceded others that are not adequately addressed in the research.

Interstate highways were only one of many factors that contributed to the decline of transit, either directly by making driving more attractive or indirectly by facilitating suburban development. The literature has not clearly sorted out the role of the interstate highways relative to other factors. How much of the transit ridership decline was due to public neglect of transit in the 1950s and early 1960s, which probably would have occurred with or without the Interstate Highway Act, and how much was due to the increased attractiveness of automobile travel because of interstate highways? If the accessibility provided by interstate highways was a primary factor in the development of suburban downtowns in the 1980s, why does Garreau

(1991) find three existing and four emerging "edge cities" in Phoenix, a region with few interstate highways or other freeways? In other words, are interstate highways the key to making suburban locations as accessible as the city center or is it the more general provision of roads and widespread automobile ownership?

In addition, the literature has not clearly considered whether interstate highways were the cause or effect of other outcomes. Did building the interstate highways cause a decline in transit use or was a decline in transit use one of the reasons that more highways were needed? Did interstate highways cause suburbanization or were these highways a response to suburbanization? Most of the research reported here identifies associations between interstate highways and other outcomes but does not meet all the requirements of showing that interstate highways were a cause. It is particularly difficult to prove causality because transit was declining and households were suburbanizing

before any interstate highways were built. This makes it reasonable to contend that interstate highways were built to serve the new pattern of metropolitan development and to fill an existing desire for mobility. Yet, most researches frame the relationships in the opposite direction, saying that interstate highways caused suburbanization and the decline in transit use.

Research is needed that sorts out the sequence of events and identifies the multiple factors shaping the patterns of transportation and land use. The balance of this project will address some of these issues with case study analysis of selected cities in the United States, Canada, and Germany. The case studies, using cities with different policies regarding urban freeways and transit, will examine the outcomes these policies have produced. The study will also identify cultural, institutional, political, and economic factors that have contributed to transit viability in some regions and decline in others during the interstate highway era.

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