# HIGHWAY IMPROVEMENTS AND RURAL GROWTH:
*AN ANNOTATED BIBLIOGRAPHY*

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16. Abstract

The historical variation in research studies on rural growth and highway improvement over the last 40 years is both topical and methodological. One of the key difficulties in conceptualizing the relationship between rural growth and transportation improvement has been the complexity of rural growth. Population growth is part of rural growth, but since population growth depends directly on economic growth, these concepts have been intertwined since the 1950s. Similarly, economic and population growth affect land use changes. Thus, we conducted a very broad search of the literature to characterize the very multidimensional concept of rural growth and its relationship to the highway transportation system. In the report summary, we review the most significant of these studies and describe their findings. The Bibliography that follows describes each study in detail.

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# *Summary*

Since the era of the great western expansion and the construction of the nation's railroads, the relationship between transportation improvements and rural growth has long been noted (Gauthier 1970). With the completion of the interstate highway system in the 1950s, numerous research studies began to be conducted to clarify and specify the nature of that relationship. One of the key difficulties in conceptualizing the relationship between rural growth and transportation improvement has been the complexity of rural growth. Certainly, population growth is part of rural growth, but since population growth depends directly on economic growth, these concepts become intertwined. Similarly, both economic and population growth affect land use changes. This has necessitated a very broad search of the literature to characterize the very multidimensional concept of rural growth and its relationship to the transportation system. This ***Summary*** reviews the most significant of these studies and describes their findings. Bibliographic references for those studies described in the ***Summary*** are listed in **Literature Cited** (pages 23-32). Finally, each study is described in annotated detail in the ***Bibliography*** (pages 33-105).

**The Literature Search**

A previous literature search at Washington State University in Pullman that was conducted in the summer of 1999 revealed little published peer-reviewed, journal research literature on the issue of rural population growth and highway improvements. This lack of research was the basis for the support received from the Montana Department of Transportation (MDT) to produce this bibliography. To conduct the search, electronic transportation information resources were first located. These are presented in Table 1.

*Table 1.*

***Electronic Transportation Information Resources Used for This Project.***

| Transportation Information Resource | Electronic Address |
|---|---|
| ▪ American Association of State Highway and Transportation Officials (AASHTO) | http://www.aashto.org |
| ▪ United States Department of Transportation (USDOT), Bureau of Transportation Statistics | http://www.bts.gov |
| ▪ California Digital Library | http://www.melvyl.ucop.edu |
| ▪ USDOT, National Transportation Center, Directory of Transportation Libraries and Information Centers | http://www.bts.gov/ntl/tldir |
| ▪ United States Department of Agriculture (USDA), Economic Research Service | http://www.econ.ag.gov |
| ▪ University of California at Berkeley, Harmer E. Davis Transportation Library | http://www.lib.berkeley.edu/ITSL |
| ▪ University of California at Berkeley, Harmer E. Davis Transportation Library, INFOMINE, Scholarly Internet Resource Collections | http://infomine.ucr.edu/search/liberalsearch.html |
| ▪ International City/County Management Association (ICMA) | http://www.icma.org/othersites/ listdetail.cfm?CATEGORY_ID=20 |
| ▪ USDA, Economic Research Service, Links to Other Rural Development Websites | http://www.econ.ag.gove/briefing/ rural links/links.html |
| ▪ National Academy Press | http://www.nap.edu/browse.html |
| ▪ Iowa State University, Department of Sociology, Other Sites of Interest | http://socserver.soc.iastate.edu/orgs.html |
| ▪ Planning Institute of British Columbia | http://www.pibc.bc.ca |
| ▪ USDA, Economic Research Service, Site List | http://www.econ.ag.gov/othrsite/fred.htm |
| ▪ Southern Rural Development Center, Mississippi State University | http://www.ext.msstate.edu/srdc |
| ▪ The International Road Research Database (IRRD) | http://www.fizkarlsuhe.de/stn/Databases/irrd.html |
| ▪ USDOT, Federal Highway Administration, The Turner-Fairbank Highway Research Center | http://www.tfhrc.gov |
| ▪ Transportation Research Board | http://nationalacademies.org/trb |
| ▪ Transportation Science, Institute for Operations Research and the Management Sciences | http://www.sor.princeton.edu/~dhb/TS/index.html |
| ▪ USDOT, Bureau of Transportation Statistics, TRIS Online | http://tris.amti.com/search.cfm |
| ▪ Victoria Transport Policy Institute | http://www.vtpi.org |
| ▪ Western Rural Development Center, Utah State University | http://www.ext.usu.edu/wrdc |
| ▪ USDOT, WWW Virtual Transportation Library | http://www.dot.gov/internet/usadots.html |
| ▪ Northwestern University, Transportation Library | http://www.library.nwu.edu/transportation |
| ▪ Institute for Scientific Information, Web of Science | www.webofscience.com |

Specific transportation studies were located through these electronic information resources through the use of key term searches. With our key terms, alone or in various combinations, we began getting "hits", i.e., locating studies relevant to our topic, on the transportation websites we had identified. Our major key terms are listed in Table 2.

***Table 2.***
***Key Word Search Terms Used to Locate Transportation Studies for this Project.***

| Micro Level Terms | Macro Level Terms |
|---|---|
| Access control | Employment |
| Median | Economics |
| Commute distance | Quality of life |
| Public Transportation | Community |
| Twin Lane | Environmental |
| Telecommuting | Mobility |
| Technology | Population |
| Economic Shift | Service |
| Induced Traffic | Nonmetropolitan |
| Improvement | Transportation |
| Congestion | Change |
| Population density | |
| Capacity | |
| Elasticity | |
| Rural vs. urban | |
| Road Supply | |
| Induced Travel | |
| Particulate | |
| Pollution | |
| Emissions | |

Once references had been located, actual studies were requested Some of these were obtained from MDT's library in Helena. Other studies were obtained through the University

of Montana's (UM's) Mansfield Library interlibrary loan program and the Harmer C. Davis Transportation Library at the University of California at Berkeley, one of only two national repositories for government research on transportation.

Three previous but more limited bibliographies and the references they described were helpful throughout the course of the literature search. These were the Horwood, Zellner and Ludwig (1965), the Federal Highway Administration (1972), and especially, Brown (1999). Key studies cited in these three bibliographies are included in this report.

Once this phase of the search had been completed, another search check was conducted by entering the same terms into the UM Mansfield's Library Laser Database service, Academic Press Advanced. This search uncovered other studies, particularly in relation to population growth, that had not been identified directly in the transportation literature. All of these were published in scientific, peer-reviewed literature. Of the scores of studies located and reviewed, 115 studies were relevant to understanding the complex relationship between rural growth and transportation improvements, especially in Montana.

**Historical Framework of the Literature**

A review of these studies revealed that each period was characterized by particular research questions, variables of interest, and methodologies. Thus, the historical variation in research studies on rural growth and highway improvement has been both topical and methodological. We have summarized the historical trends in the Table 3.

***Table 3.***
***Historical Variation in Research Studies on Rural Growth and Highway Improvement***

| Period | Variables | Research Design |
|---|---|---|
| *1960s* | Bypasses<br>Urban circumferential (beltway) impacts<br>Controlled access impacts<br>Commercial property values, right of way relocation, land use changes<br>Urban population growth<br>Community values | Single case studies<br>Secondary data descriptive analysis<br>Before/after comparisons<br>Cross-case comparisons<br>Communities and neighborhoods as units of analysis |
| *1970s* | Limited/controlled access highways<br>Industry sector needs<br>Interchange land use and development<br>Labor supply<br>Interstate highway exit access<br>Employment rates<br>Income growth<br>Residential property values | Control community comparisons<br>Direct versus indirect impacts<br>Social impact assessment methodology<br>Secondary data longitudinal analysis<br>Multiple regression and statistical controls<br>Projected land use/land value estimation<br>Counties as units of analysis |
| *1980s* | Nonmetropolitan development<br>Industry location decisions<br>National economic competitiveness<br>Local economic development<br>Urban to rural migration trends<br>Per capita income shifts<br>Airport access<br>Commuting zones<br>Work location choices<br>Exurban sprawl | Route alternative evaluation<br>Benefit/cost analysis<br>Economic models<br>Projections, forecasting<br>Counties and census block tracts aggregated to states as units of analysis |
| *1990s* | Trraffic congestion<br>Commuting flows<br>Induced traffic vs. induced demand<br>Generated traffic<br>Public vs. private capital investment<br>Regional economic development<br>National economic productivity<br>Demand elasticity<br>Population redistribution<br>Public involvement | Longitudinal primary data collection, e.g. (VMT)<br>Geographic Information Systems (GIS) analysis<br>Time series analysis<br>Simultaneous models<br>Panel studies<br>Land use/transportation models<br>Economic simulation models<br>Counties aggregated to regions as units of analysis |

The findings in Table 3 for each period and the strengths and limitations of that period's typical research design are described in detail below.

**The 1960s**

Prior to the 1960s, research studies on the role of highway improvements in determining rural growth were limited in number. One of the few is Warner's (1958) review of 14 different studies of socioeconomic impacts of highway developments. Horn's (1960) study of the impact of rural secondary roads on rural residents of North Carolina is valuable for describing rural highway transportation patterns before the completion of the federal interstate system and almost universal automobile ownership. As Warner (1958) noted, most studies were highly descriptive and based on secondary data.

During the 1960s, nonmetropolitan population growth varied greatly across the country. In the West, nonmetropolitan places located near metropolitan areas increased the most in size (Fuguitt 1971). This was the era of suburban growth, especially in California. Economic growth accompanied population growth. Together, the sparsely populated five Rocky Mountain states (including Montana) accounted for only a little more than 2 percent of the nation's income at the time (United States Bureau of Public Roads 1964).

The two major variables of interest in reflecting rural growth were population mobility and economic production (United States Bureau of Public Roads 1964). The federal interstate highway system was being completed, and the number of transportation research studies on socioeconomic impacts increased. Highway controversies were common because of the taking of private land for rights-of-way and because of fear of retail business losses through bypass projects (see Michigan State University 1961; Horwood, Zellner and Ludwig 1965; and Lash 1965). As Skorpa et al. (1974) noted, most measured impacts included land use, land value,

business activity, industrial and manufacturing growth, and community social characteristics and attitudes.

State highway departments did not yet have extensively trained public involvement or social science personnel so most studies were contracted to universities or consulting firms. This fact coupled with the urban renewal era meant that most studies were done by sociologists. The unit of analysis was most typically the urban neighborhood (Burkhardt, Lago and Rothenberg 1971; Burkhardt 1984) or the rural community (Dansereau, Frey and Pashek 1963; Dansereau 1965) and variables of interest included changes in neighborhood interaction (Marshall Kaplan Gans and Kahn 1972) and community values (Falk 1968; Highway Research Board 1969; Shaffer 1967; Schimpler and Grecco 1968; Voorhees Associates 1965) as well as right-of-way dislocations (Thiel 1962; 1965) and the differential effects of highway projects on minorities, the elderly, and the poor (Federal Highway Administration 1972; 1974; 1976). Researchers often served as advocates for improved public participation processes (Lash 1965).

Computer statistical analysis was just in its infancy so studies were still descriptive. Often, they used qualitative methods including resident interviews and site observations. Resident surveys were also frequent. Maps commonly appear in the studies to illustrate the spatial land use changes, but spatial analysis was not yet common. Most studies relied on case study design with one or more cases and attempted to make pre and post measurements. These often relied on secondary data from the census, cities, and other sources to determine impacts in variables like land values before and after the highway project of interest (Skorpa et al. 1974).

**The 1970s**

The 1970s were distinguished by energy concerns because of the sudden rise of gasoline prices due to the OPEC oil embargo and the subsequent growth in energy boom areas, especially in the Rocky Mountain states. Because of the national recession, researchers were increasingly interested in the role transportation played in local economic development (Kuehn and West 1971). For the first time since World War II, demographers were noting a population shift away from the cities toward more rural areas, especially those adjacent to the cities (Beale 1975).

Similarly, rural residents' access to services (because of the completion of the interstate system), rising transportation costs, and the lack of alternative transportation systems to the automobile received research attention (Briggs 1975; Enders, Poston, and Briggs 1974). The role of controlled access highways on population growth in rural areas was also examined. In Pennsylvania, Humphrey and Sell (1975) found that places with highways grew faster than places without controlled access roads; the exceptions were those places that had experienced earlier access in the 1940s with the opening of the original Pennsylvania Turnpike. Even more striking was the fact that places where highways were eventually constructed were growing faster than places without them— even *before* the highways had opened. Although such findings are useful to understand rural growth in particular regions, the lack of studies that were national in scope made such results nongeneralizable to other parts of the country.

Two of the few national studies of the 1970s on the impact of the new interstate highway system on rural growth were the analyses of Briggs (1980) and Lichter and Fuguitt (1980). In specifically examining the impact of the highway system on the manufacturing sector, Briggs (1980) found that the presence of an interstate highway in a county lead to more

rural development along interstate corridors. This channeling produced only minor economic benefits to rural counties. Similarly, Lichter and Fuguitt (1980) determined that nationally, population growth was greatest in interstate highway counties. However, those highways were also constructed in counties that prior to 1950 had experienced higher than average rates of net migration than counties lacking the highways. In contrast to noninterstate highway counties, interstate counties had higher net migration and employment growth as direct effects of highway completion.

In the late 1970s, researchers began to realize the complex pattern of rural economic change. With the demise of unions and the relocation of industry to parts of rural America, new interest was generated in the role that highways played in changing the rural economy. In examining the decisions of firms to locate branch plants in rural Kentucky, Cromley and Leinbach (1981) found that town size and the availability of industrial sites was more important in explaining employment levels than labor supply. Access to controlled access highways was also a contributing factor so that transportation was an important, but not a determining, variable in explaining employment changes. In contrast, Carlino and Mills (1987) found that transportation was a crucial determining factor in changing population growth and employment during the 1970s. In reviewing the factors that affected U.S. county population and economic growth during the 1970s, Carlino and Mills (1987) determined that both employment and population densities were positively affected by the presence of limited access highways. They concluded that the interstate highway program significantly contributed to the national redistribution of population and employment in the U.S. in the 1970s. In employing a different analysis technique than Carlino and Mills (1987), McHugh and Wilkonson (1988) also obtained similar results, but found unionization a more significant variable. In examining the

period for 1970 to 1974, Harris (1990) determined that employment growth and income growth were positively related to highway access, but more so for metropolitan areas than for rural areas. Distance to a metropolitan area was a much greater determinant of rural growth than was the presence of highways.

Similar findings were obtained in studies conducted on a regional basis. Everly, Twark and Downing's (1987) study of rural Pennsylvania indicated that the economies of many rural communities along the interstates experienced large increases in residential, commercial, and industrial growth during the 1970s. Similarly, Palmquist (1982) found that improved highway access to residential areas in Washington resulted in property value increases of 15 to 17 percent greater than comparable properties that lacked the access advantage. He concluded that the extent to which this effect occurs depends on the degree of accessibility, especially in regards to work trips.

As suburbanization of housing and employment continued during the 1970s, some renewed attention was given to the role of beltways that often carried traffic around central cities and linked the suburbs. Payne-Maxie Consultants (1980) found that suburban beltways drew activity out of the central cities and negatively affected the tax base that the cities needed to deliver needed services to the disadvantaged and low income populations, the majority of whom lived in the central cities.

The controversies of the 1960s over interstate construction had made transportation officials and researchers much more aware of the need for obtaining information on highway projects from citizens potentially affected by highway projects. The passage of the National Environmental Protection Act in late 1969 reinforced the need for systematic, sound assessment procedures. As a result, many of the studies on the socioeconomic impacts of

highway improvement can be found in federal and state manuals and guidebooks for conducting social impact assessment (Llewellyn 1975; Planning Environment International 1975; Finsterbusch and Barker 1977; Koch, Moavenzadeh and Chew 1979; and Wolf 1979). Notably, many of these researchers were now employed by the federal government, especially in the now defunct Socio-Economic Division of the Federal Highway Administration.

In addition, researchers were taking advantage of the new computer statistical software opportunities and conducting more explanatory and less descriptive analyses, e.g., multiple regression and path analysis. As a result, research questions were being increasingly addressed in terms of direct versus indirect effects. More use of control communities were being used to measure before and after effects, a factor that improved quasi-experimental design. However, aside from social impact assessment methodologists, most researchers continued to rely on projections, estimations, and secondary data.

**The 1980s**

The next decade, the 1980s, was marked by great national economic change. Interest rates were high, corporations were downsizing and relocating factories overseas, and the economy was of major public concern. In the Rocky Mountain states, the energy boom came to a halt and dynamic in- and out-migration patterns occurred. As a result, the studies on rural growth and highway improvement during this decade were typically conducted by economists rather than sociologists. One of the most significant studies was Greenwood, Hunt and McDowell's (1986) analysis. Their analysis indicated as the economy rose, in-migration rose in response to higher paying job opportunities elsewhere. Over time, those jobs paid less as the economy fell, and out-migration increased. The cyclical interrelationships of population redistribution and employment were beginning to be better understood.

These trends are reflected in the American Association of State Highway and Transportation Officials (AASHTO) 1990 report, which emphasized the concerns of the organization about the role highways might be playing in the failure of the United States to keep pace with other nations. The report summarized not only existing studies but also 65 public forums conducted from 1987 through 1988 and identified transportation delays, traffic conditions, and decay of the nation's transportation infrastructure as major causes of the decline in U.S. economic productivity. The AASHTO (1990) report suggested that population growth and geographic shifts had caused travel time to lengthen over the 1980s since suburb-to-suburb commuting (as opposed to the suburb-to-city commuting of earlier periods) had become the dominant form of traffic. Moreover, this suburb-to-suburb traffic was running against the existing hub-and-spoke systems of the road and transit systems of the older cities and creating unprecedented congestion.

Nationally, the population shift that had begun in the early 1970s away from the suburbs of major cities had increased and continued to move most frequently to the more rural areas near metropolitan areas. This phenomenon had become known as "exurban sprawl" or the "population turnaround" and the relationship of highways in promoting or inhibiting it was one of the major topics of research on rural growth and highway improvement (Lamb 1983; Sanchez, Dueker and Rufolo 1987). In some cases, as in Oregon, urban development was found not to cluster along the state highway corridors; rather, the urban status of surrounding properties and the zoning classification had very significant effects on urban development (Sanchez, Dueker and Rufolo 1987). Similarly, Lamb (1983) concluded that there was no significant relationship between the distance of the most promising exurban centers to an urban

area and the success of those centers in absorbing population increases. Thus, continued growth not only in exurbia but also in traditionally rural areas was expected to continue.

Several studies of the 1980s indicated that the population and economic growth created in rural communities by interstate highways in the 1960s and 1970s was slowing or had become stabilized by the 1980s. Rephann and Isserman (1994) found that from 1963 to 1975, rural counties that had interstate highways but were isolated from urban centers experienced few positive growth benefits. These lack of benefits resulted from less viable residential location choices and the constraints on private and public services.

Because of the upheavals in the national economy, most of the transportation studies conducted in the 1980s concerned the role of highways in the shift of industrial sectors away from a national, industrial economy, which was based on manufacturing and production, to a global, postindustrial economy based on services. In examining the role of highways in firm location decisions, Blair and Premus (1987) found that new factors such as tax rates, education, and labor skills were more important in determining a company's location decision than traditional factors, including transportation. Similarly, Bartik (1985) found that the most significant factor in a firm's decision to locate was a state's sympathy to unionization and its tax policies. States that were sympathetic to unionization and had higher corporate tax policies were avoided.

Many studies of this decade focused on the implications of population and economic change for rural economic development efforts. The role of transportation in stimulating rural economic development was considered very important (Brown 1996). Forkenbrock and Plazak (1986) determined that of all 50 state departments of transportation, a majority (36) explicitly addressed economic development when planning highway improvements. However,

researchers were obtaining mixed results that indicated that with the changing economy, transportation was playing a less crucial role in rural economic development. Forkenbrock (1990) found that transportation improvements alone were not sufficient for economic development to occur since user fees and taxes over the long term often outweighed the short-term transportation savings benefits. Similarly, Hirshi and Summers (1982) determined that the number of interstate highway exits within a county did not stimulate employment in rural, nonbasic industries but that cash transfer payments did. Kusmin, Redman and Sears (1996) found that in contrast to transportation facilities, other factors were associated with improved county earnings. These included attractiveness to retirees, right-to-work laws, high levels of high school completion rates, and public education expenditures. To explain these findings, researchers were beginning to recognize the importance of intra- and inter-regional variation in highway investment on economic development (Rephann and Isserman 1994; Smith 1994). For example, in examining data for 1969 through 1988, Boarnet (1995a; 1995b) found that incremental additions to the interstate network was adding only small overall economic benefits to California counties.

Despite the evidence that the long-term benefits of highway improvements might be diminishing, many regional economic development studies of the 1980s discovered a variety of transportation benefits from attracting industry to providing commuting opportunities. In a multiple case study, Toft and Mahmassani (1984) determined that high technology firms considered not only transportation costs but also travel amenities such as time-to-work savings as critical in their location decisions. In Alabama, Liew and Liew (1984) measured the possible economic impacts for a proposed transportation project and concluded that the proposed project would reduce the cost of shipping commodities and stimulate the economy of

the region and the state. In Tennessee, Fox and Murray (1990) found that the presence of an interstate highway within a county was an important locational attribute that lead to more firms locating there. However, it was unclear as to whether the interstate highways were creating new economic activity or simply redistributing existing activity across different states. In Minnesota, Stephanedes and Eagle (1986) developed a model to predict job search destination choices of residents in four rural towns and determined that although travel conditions influenced job location choice, a resident's expected length of employment was the strongest determinant of the commuting decision.

In sharp contrast to the numerous social impact assessments of the 1970s, the 1980s produced few practical studies assessing the impacts of proposed highway projects and their possible alternatives. Two notable exceptions were studies by Buffington in Texas. Buffington (1991) and Buffington, Crane and Salleh (1991) demonstrated a much more developed and systematic form of social and economic impact assessment than had been practiced in the studies of the 1970s. Their consistent focus on evaluating different route alternatives is especially apparent.

Methodologically, the studies of the 1980s relied much more on economic modeling, e.g., export based models, variable input and output models, and simple random effects models, than earlier studies (Huddleston and Pangotra 1990). Aggregated secondary data were often used, and more studies aggregated county-level or even census-tract data and analyzed effects at the macro level of the state. Statistical analysis continued to become more sophisticated with logit and logistic regression models appearing. Some researchers were beginning to use Geographic Information Systems (GIS) spatial models as changes in land use patterns were once again important variables.

**The 1990s**

During the 1990s, the nation once again became economically competitive in the wake of international economic recessions, especially in Asia. The national "population turnaround" continued as rural areas adjacent to metropolitan areas grew, especially in the Rocky Mountain states (von Reichert 2000a). Between 1990 and 1996, the rural population grew by about 6 percent as a result of inmigration of people from metropolitan areas and abroad. In the nonmetropolitan West, the regional population increased 13 percent in only six years (between 1990 and 1996) (Economic Research Service 1997). Research studies on the national migration patterns were numerous, and more attention was paid to the impacts of specific public policies and social forces on migration rates. Major research topics were the role of natural amenities in "pulling" inmigrants (McGranahan 1999), the degree to which economic opportunities either "pulled" in-migrants or "pushed" out-migrants (Miller 1995), and how changes in the U.S. social welfare program affected migration in and out of cities (Cushing 1993). Similarly, in understanding the staying power of nonmetropolitan areas in producing population growth, researchers renewed questions about commuting behavior and its role in rural area growth (Tolbert and Sizer 1996; Green and Meyer 1997).

This nonmetropolitan economic and population growth continued to affect the old hub-and-spoke radial systems of the metropolitan areas, and traffic congestion remained a significant problem (Dunphy 1998; Urban Land Institute 1996). Numerous research studies addressed the extent to which traffic congestion was due to "generated" or "induced" traffic either produced or redistributed from one area to another because of highway improvements (Bonsall 1996; Cohen 1995; Dowling and Colman 1995; Goodwin 1996; Hansen 1995, 1998; Heanue 1998; Hills 1996; Mackie 1996; Lee, Klein and Camus 1998; and Litman 1999). The

general findings of these studies indicated that although traffic redistribution did indeed occur, new highway improvements generated more traffic than would have been the case without the improvements. Dowling and Colman (1995) found that travel forecasting models probably resulted in an underprediction of 3 to 5 percent in the number of trips induced by major new highway projects since a key impact on new highway capacity was temporal shifts in demand. Goodwin (1996) determined that an average road improvement in the United Kingdom induced an additional 10 percent of base traffic in the short term and 20 percent in the long term. Hansen (1995) found that in California counties, a 1 percent increase in lane-miles induced an immediate 0.2 percent increase in traffic and in two years, a 0.6 percent increase in traffic after the lane-miles were added. Hansen's (1998) studies indicated that adding road capacity generated more traffic at the aggregated highway network level than at the individual highway segment level and that most of this response occurred within five years of the capacity expansion. Litman (1999) concluded that generated traffic included diverted travel, induced vehicle travel, and destination changes. In the short term, most generated traffic was diverted travel; however, over the long-term, an increasing portion was induced vehicle travel that often occurred on roads with no added capacity.

The degree, however, to which this generated traffic was a site or regional specific phenomenon was still unknown. In addition, the travel behavior reflected by the concept "generated traffic" was a complex variable that was being measured by many indicators such as vehicle miles traveled (Hansen 1995), short-run versus long-run travel demand (Lee, Klein and Camus 1999), or fixed versus variable demand models for trips (Mackie 1996). The choice of indicator appeared to be influencing the findings for generated traffic. Hills (1996), for example, found that highway expansion resulted in a "fewer trips but further" phenomenon that

was also associated with the increasing scale and agglomeration of land-use activity such as large retail superstores and regional hospitals. He concluded that traffic due to extra miles run by vehicles diverting to new roads was not significant in the case of bypasses to small towns or the widening or upgrading of existing trunk roads but could well be significant where new routes were concerned. Heanue (1998) cautioned that many interrelated decisions impacted travel and that highway capacity expansion interacted with far more important variables in determining the network changes. These variables included population changes, household and employment growth, personal income changes, auto ownership rates, regional economic growth, and fuel price changes. He cautioned that sound studies require traveler, system, and travel data collected continuously over a relatively long period of time for comparable populations split into two groups (those affected by expansions and those not impacted).

During the 1990s, economists and demographers were focused on the question of whether "jobs follow people" or "people follow jobs". The role of commuting behavior and highway investment in explaining rural economic growth was a major focus of transportation studies. In the 1990s, rural counties were generally experiencing greater real earnings growth (Aldrich and Kusmin 1997), but high commuting rates out of (or into) the county were contributing to that growth (Aldrich, Beale and Kassel 1997). Many researchers were aggregating data beyond the county, and even the state, to the regional and national levels. Forkenbrock and Foster (1996) determined that state-level highway investment policies that emphasized maintenance and relatively minor improvements were likely to contribute to economic development more than new, high capacity highways. Nationally, Nadiri and Mamuneas (1996) determined that although the net social rate of return on total highway capital in the U.S. had been high (about 35 percent in the 1950s and 1960s), it had declined

considerably in the 1980s to only 10 percent. By the end of the 1980s, they had found no evidence of either under- or over-investment in highway capital and concluded that by the 1990s, the contribution of highway capital to U.S. economic productivity growth was relatively small.

Just as the 1960s and 1970s had been dominated by sociologists and the 1980s by economists, the 1990s was a decade in which many of the studies on transportation improvements and rural growth were conducted by geographers (Cromartie and Swanson 1996, Ghelfi and Parker 1997, Kilkenney 1998, Haughwout 1999). Renewed attention was being paid to public involvement (Richardson and Kostyniuk 1998; Unsworth 1994), planning models (Bond and Brooks 1997; National Association of Development Organizations 1998; Richardson and Kostyniuk 1998), and differential effects of transportation systems on low-income, minority, and other disadvantaged populations (Brown 1999; Forkenbrock and Schweitzer 1999; Peters and MacDonald 1994; Glasgow and Blakely 2000). As a part of this focus, increasing attention was being given to complete and alternative transportation systems rather than highways alone (Balog, Morrrison, and Hood 1997; Hoover 1994).

By the 1990s, the power of computer modeling as well as spatial analysis and statistical software was apparent. Time series analysis, panel studies, and economic simulation models were common as were GIS analysis and land use/transportation models. Computer power also increased the ability of researchers to aggregate data into larger regional and national units of analysis. State highway departments had become more sophisticated and systematic in collecting data such as California's VMT count program. In addition, more cross-references to international studies, particularly those in Europe and Canada, were appearing. However, as Heanue (1998) stressed, the need for multi-dimensional, longitudinal, and experimental

primary data collection was still apparent to provide more scientifically sound answers to the issues and the research questions.

Toward the end of the 1990s, studies began to indicate that the next decade, the 2000s, might bring significant economic and population changes to rural areas, especially to the Rocky Mountain states that had experienced a boom. With the 2000 census not yet available, there are no clear indications yet of what trends are emerging and what is to come in the 2000s. However, early indications are that a "counterurbanization" effect, that is the urbanization of rural areas in the form of self-contained communities, especially retirement communities, is occurring in some areas (Dahms and McComb 1999). These counterurban communities sustain their own transportation and telecommunications networks and yet link to the metropolitan areas. There are also signs of a "reurbanization" or center city renewal trend (Wong 1999). Cities such as Houston, Chicago and even Philadelphia predict significant population growth in the coming decade as the baby boom generation retires and seeks better public transportation and more cultural amenities than rural areas have to offer (Wong 1999). Finally, there are indications that the telecommunications –based, postindustrial economy is strengthening metropolitan dominance over rural areas since the major jobs in the information industries remain in cities (Cook and Beck 1991).

Thus, it is likely that transportation alone will not overcome the continued disadvantage of rural areas to urban dominance (Hart 1993). This is true not only nationally, but increasingly, globally (Wanmali and Islam 1995). How these emerging trends will affect rural growth in Montana and the implications of these trends for the transportation system in the state is the subject of the next section.

**Future Rural Growth Trends in Montana**

Fndings indicate that during the 1980s, Montana grew very slowly and toward the end of the decade, even declined (von Reichert 2000a). By the early 1990s, however, a rapid population boom occurred so that by mid-1999, Montana's population had increased 10.5 percent from 1990. However, within the state, this growth was extremely uneven and much of the state, especially the eastern half, lost residents (von Reichert 2000a). The trend that has emerged is one of several rapidly growing counties adjacent to metropolitan areas, most of which are in the western part of the state, and shrinking counties in the sparsely populated east, The result is an increasing east/west imbalance between Montana counties with already large and growing populations versus small and shrinking populations. Because these trends result from economic conditions that "push" people out from economically disadvantaged rural areas as well as the well established "amenity pull" that draws them to the rural areas adjacent to the metropolitan centers, we suggest that transportation investment alone is unlikely to alter the east/west population polarization pattern in Montana (see Figure 1).

The rapidly growing amenity counties of Ravalli, Yellowstone, Lake, Flathead, Lewis and Clark, Gallatin, and Missoula experienced 69 percent of Montana's population growth between 1990 and 1998 (von Reichert 2000a). However, the degree to which these counties will continue to grow is uncertain. More importantly, since many out-migrants from the eastern part of the state migrate within the state (von Reichert 2000a) and many out-migrants from outside the state are actually return migrants (von Reichert 1999b), the redistribution pattern of population within the state in shaping the east/west divide will become even more important to understand as future economic conditions change.

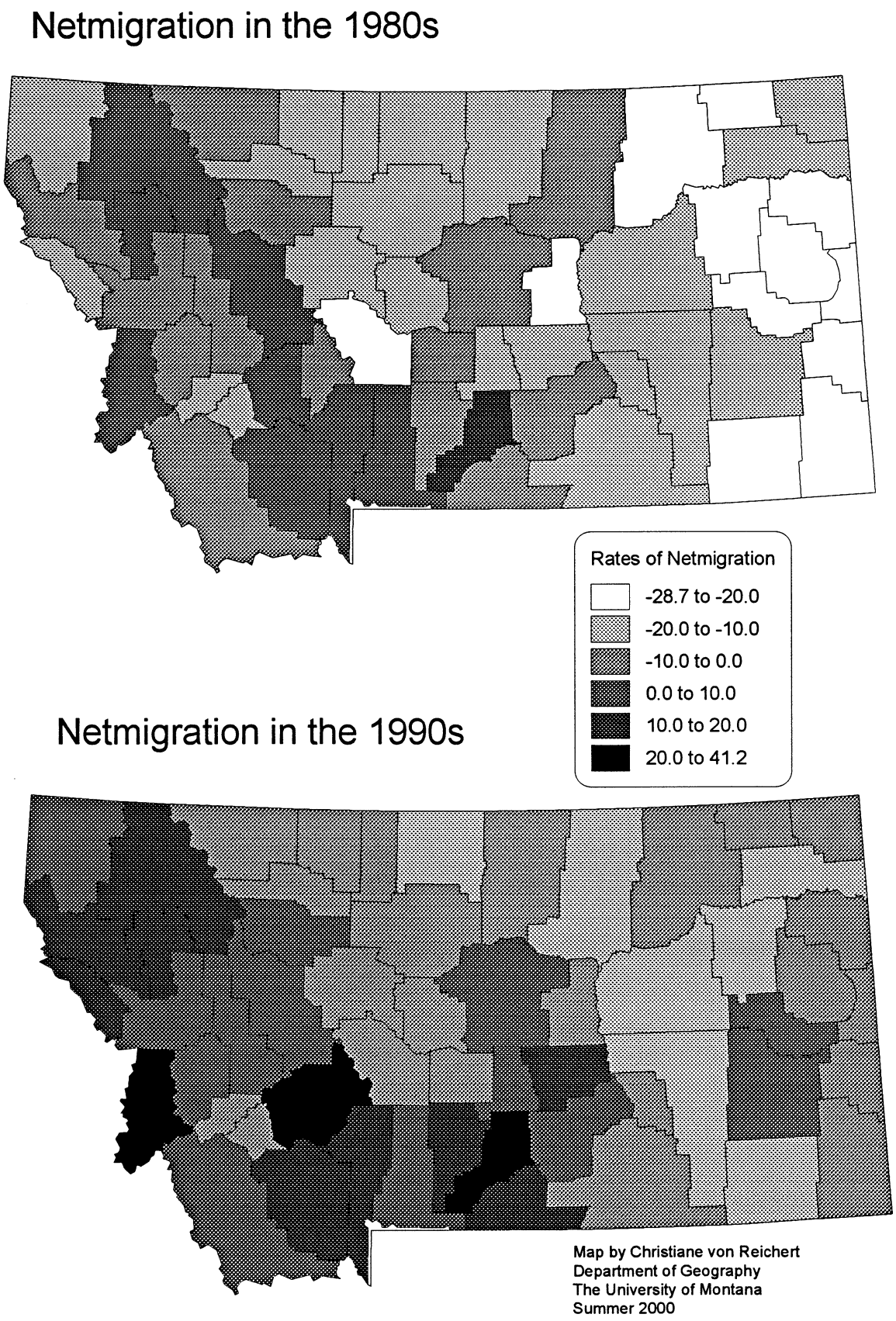


Figure 1. Netmigration rates from 1980 to 1999 in Montana.

**Recommendations**

We therefore suggest that with census 2000, a thorough analysis of the migration and commuting behavior in the counties currently most affected by highway improvements would be of great benefit to MDT. Such an analysis would determine how the past rural population trends of the 1980s and 1990s are changing and why people are either moving in or out of rural areas, especially in relation to highway improvements. This analysis would provide some basis for determining future population growth or loss trends.

In addition, a primary data collection effort to more fully understand why Montanans commute where they do and what the possible impacts are on the existing transportation network would also be a valuable effort. As apparent from the summary here, primary data collection and experimental, longitudinal research design is crucial to fully understand the relationship between rural growth and highway improvement. Such an effort would involve surveying residents in communities both affected and unaffected by highway changes over several years. Conducting such a survey in as close a timeframe as possible to census 2000 would make both secondary and primary data analysis most useful.

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# *The Bibliography*

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*Keywords: Transportation access, rural development, regional economic development, economic growth, economic factors, industry type impacts*

The authors reviewed an Economic Research Service (ERS) analysis (Kusmin, Redman and Sears, 1996) of the literature on potential indicators of county economic growth. They then tested those indicators against data for nonmetropolitan counties during the 1980s. This review examined rural county earnings for the period 1979 to 1989 and found that factors related to local and regional economic growth included attractiveness to retirees, right-to-work laws, excellent high school completion rates, good public education expenditures, and access to the interstate highway system. In contrast, factors associated with poor earnings growth included higher wage levels, concentrations of receipts of transfer-payments, and concentrations of small, independent businesses in the goods-producing sector. (Counties with higher concentration of African-Americans also experienced slowed earnings growth, but the reasons for this association were not identified from the analysis)

The mix of industries active in a county was also strongly associated with county earnings. Counties experienced significantly greater earnings growth if they had higher concentrations of employment in transport services, real estate, hotels, miscellaneous business services, education services, or state and local government. In the 1990s, nonmetropolitan counties generally experienced greater real earnings growth, and some of the factors associated with stronger or weaker growth may have become less significant.

Specifically, the major findings for the 1979 to 1989 period were that earnings in retirement counties grew 4.5 percent more than earnings in other counties. Earnings growth rates were significantly lower in areas with higher wage levels, i.e. a 10 percent difference in earnings per job was associated with a 2.35 percent difference in total earnings growth over 10 years. Earnings growth was greater in rural counties covered by state right-to-work laws; the estimated effect of these laws was a 5.2 percent difference in earnings growth. Economic growth was greater in counties with a more educated population; a difference of 10 percent in the high school completion rate among adults was associated with a difference of 3.3 percent in total earnings growth. Greater public education expenditures were conducive to higher earnings growth; an additional $1,000 in annual per-pupil expenditures was associated with an additional 3.8 percent in growth. Counties that had an airport with scheduled passenger service within 50 miles experienced 3.4 percent in additional earnings growth. Earnings growth was lower in counties where a higher percent of the goods-producing business establishments were small (fewer than 20 employees) and independent; in such counties, a 1.1 percent reduction in earnings growth could be experienced over the decade if 80 percent rather

than 70 percent of all county goods-producing business establishments were such small, independent businesses. An additional $100 in transfer payments per capita was associated with a 1.6 percent reduction in cumulative earnings growth. Finally, access to interstate highway interchanges contributed to earnings growth in rural areas; each such interchange within a county was associated with 0.42 percent in additional growth during the period.

**2.** Aldrich, L., Beale, C., and Kassel, K. (1997). Commuting and the Economic Functions of Small Towns and Places. *Rural Development Perspectives 12*(3): pp. 26-31. Washington, D.C.: Economic Research Service, United States Department of Agriculture.

*Keywords: Commuting, economic development, North Carolina, New York, Washington, Illinois*

Seventy-five percent of nonmetropolitan counties have average out-commuting rates of more than 35 percent. Commuting rates are higher east of the Mississippi and from smaller towns and places. Small towns and rural places may not experience local job opportunities (since residents commute outside the local community) or if they do, local residents may not experience those opportunities (since residents from outside the local town may commute in for those jobs). Separation of place or work from location of residence could result in new needs (such as housing, water, and sewer) that do not disappear when jobs do. Thus, tax revenues sources may also become separate from the source demand for needs. Through demographic analysis, the authors found that in North Carolina, higher commuting rates occurred in higher wage, higher housing-cost areas with an inverse relationship to distance. Other patterns are discussed for other states including New York, Washington, and Illinois.

**3.** American Association of State Highway and Transportation Officials. (1990). *Going and Growing: An Overview of the Relationship Between Transportation and Growth in America.* Washington, D.C. 10 pp.

*Keywords: Population growth, national productivity, national economic growth, transportation, United States*

Although this report is not a systematic review of the literature, it is a useful summary of the concerns of the American Association of State Highway and Transportation Officials (AASHTO) in 1990 about the role of economic growth in the United States failing to keep pace with other nations. (This was the time of the Japanese economic boom and the United State's decline in international competitiveness). The report summarized studies as well as 65 public forums conducted from 1987 and 1988 and presented other data from private and public officials. One of the main concerns of the report was transportation delays, e.g., federal estimates for delays on urban highways were more than 2 billion hours a year and in 1988, delays wasted 1.4 billion gallons of fuel and caused over $9 billion in user costs. In addition to net negative losses were lost positive growth opportunities. Evidence suggested that Americans were finding that

going the same distance as before was taking longer.

AASHTO suggested that population growth and geographic shifts had caused this lengthening of travel time since suburb-to-suburb commuting had become the dominant form of commuting rather than suburb-to-city. This suburb-to-suburb traffic was running against the existing hub-and-spoke systems of roads and transit typical of the older cities. In addition, in many places, transportation was no longer available and/or congestion had become a common occurrence. The effect for individuals was not only loss of productivity but also loss of quality of life including less time to spend with family, community, and in leisure. A recent U.S. General Accounting Office survey of business leaders in 13 metropolitan areas found that about half indicated that traffic conditions reduced productivity, caused poor punctuality and morale, and increased employee stress.

Environmental damages from congestion included gasoline waste and pollution. Nationwide, commuting by public transit declined 28 percent from 1970 to 1980 and had continued downward since. Similarly, while passenger air travel had doubled since airline deregulations in the 1970s, airport expansion had not kept up. As a result, the Federal Aviation Administration reported during this period, 21 primary airports experienced more than 20,000 hours of annual flight delay at a cost to airlines and U.S. business of $5 billion. These delays were expected to spread to 33 airports by 1997.

The pressure on corporate America to become more efficient in the expanding global economy had introduced a new element in the production-distribution chain: the requirement for 'just-in-time' delivery. However, the U.S. lagged in international productivity during the 1970s and 1980s. Experts claimed that much of the U.S. problem was its neglect of public infrastructure and that as much as 60 percent of the productivity decline in the U.S. could be attributed to neglect of core infrastructure. Since 1968, vehicle miles of travel had far exceeded total capital spending on U.S. roads and highways adjusted for inflation. Thus, the report concluded, the U.S. needed to invest again in its transportation system to increase national productivity.

**4.** Balog, J. N., Morrison, J. B., and Hood, M. M. (1997). Integration of Paratransit and Transit Services: Importance of Vehicle Transfer Requirements to Consumers. *Transportation Research Record*, No. 1571: pp. 97-105. Washington, D.C.: Transportation Research Board.

*Keywords: Paratransit service management, bus lines management, paratransit services, bus service, public participation, disabilities, ADA*

The paratransit requirements of the Americans with Disabilities Act (ADA) of 1990 required the creation and implementation of an effective public participation program so that all members of the community, particularly those with disabilities, could contribute to the improvement of transportation systems. The authors reviewed paratransit plans and plan updates submitted by fixed-route systems and found that effective public participation needed to be improved. These needs included outreach, consultation, opportunity for public comment, accessible formats, public hearings,

summarizing issues from the public comment period, and ongoing participation. Other channels were also discussed including use of the media, surveys of riders and other service providers, performance monitoring, and planning the public participation process schedule. Checklists of suggested activities are included in the study.

**5.** Bartik, T. J. (1985). Business Location Decisions in the United States: Estimates of the Effects of Unionization, Taxes and Other Characteristics of States. *Journal of Business and Economic Statistics, 3*(1): pp. 14-22.

*Keywords: Location decision, state policy, unionization, taxes*

This study is one of Brown's (1999) industrial location studies which examined how corporate decisions about the location for a new manufacturing branch plant is influenced by a state's rates of unionization, taxes, the number of road miles per state, and other variables. Using a conditional logit model and a 1982 Dun and Bradstreet database, Bartik found that the most significant factors in a business decision to locate was a state's sympathy to unionization and its tax policies. States sympathetic to unionization were avoided. States with higher corporate income taxes also were more negatively perceived. Some evidence was found that highway infrastructure attracted new business since a 10 percent increase in the number of miles of road increased new business location by about 4 percent. Brown's (1999) interpretation was that the number of road miles was a significant factor affecting the location of new plants during the 1990s with businesses more likely to locate where adequate roads already existed. Highway infrastructure, however, was not as significant in business location decisions as unionization and tax policies.

**6.** Beale, C. (1975). *The Revival of Population Growth in Nonmetropolitan America.* ERS-605. Washington, DC: Economic Research Service, United States Department of Agriculture. 15 pp.

*Keywords: Rural population growth, United States*

Between 1970 and 1973, the population of the United States grew faster in nonmetropolitan counties than in metropolitan counties. This trend had reversed the previous post World War II rural-to-urban pattern of migration to cities. Beale analyzed census data for population change by residence and found a 4.2 percent increase in population growth in nonmetropolitan counties as opposed to a mere 2.9 increase in metropolitan counties. Within the nonmetropolitan counties, counties adjacent to metropolitan areas grew at the greatest rate (4.7 percent), but population growth in nonadjacent, nonmetropolitan counties (4.7 percent) still exceeded that of metropolitan counties. He attributed this shift in population to the decentralization of manufacturing and other industry, the increased migration of retirees, the expansion of state colleges, more recreation activity, and the apparent higher birthrate in nonmetropolitan areas. In addition, urban areas were losing "their appeal" to most people.

**7.** Blair, J. P., and Premus, R. (1987). Major Factors in Industrial Location: A Review. *Economic Development Quarterly, 1*(1): pp. 72-85.

*Keywords: Industry location, transportation, tax rates, labor skills, education*

One of the industrial location studies reviewed by Brown (1999), Blair and Premus reviewed findings of the industrial location literature to assess which factors were most important in determining a firm's location. While traditional location factors, including transportation, were still important determinants in industrial location decisions, evidence from the 1980s indicated the importance of new factors, such as tax rates, education, and labor skills. The enhanced importance of these new factors was partly due to the increasingly tendency of many industries to become more mobile.

**8.** Boarnet, M. G. (1995). *New Highways and Economic Growth: Rethinking the Link.* UCTC No. 7: pp. 11-15. Berkeley, CA: University of California Transportation Center.

*Keywords: Express highways, economic growth, regional economic shift, California*

This was one of the aggregate economic studies reviewed by Brown (1999). Boarnet provided examples from a production-function study of California counties from 1969 through 1988. The author examined the effects of highway spending on local economic activity. Counties in California where highway spending rose between 1969 and 1988 experienced increased economic activity, but counties adjacent to them where highway spending did not rise experienced reduced economic output. Although increases in county economic output were higher in those counties that increased their spending for highways, county economic outputs were lower in counties that bordered those that increased their highway spending. Thus, increased highway spending in one county correlated with high economic output in that county but lower economic output in neighboring counties. The author argued that the effect of current and past highway construction follows the differences between marginal and total economic effects. Most of the interstate system was completed by the early 1970s, and the additions incrementally added since then to that network have produced only small overall economic benefits. These findings corroborated results of studies done at the University of Iowa and the University of Minnesota.

Together, the studies suggest that economic effects of highways are generally a redistribution of economic activity from one location to another. The policy implications are that taxpayers in one locality may be paying for highway projects that benefit residents in another locality and undermine economic growth in their own community. The author recommended a more cautious analysis of highway-generated economic benefits and/or a restructuring of the current funding system.

**9.** Boarnet, M. G. (1995). *Highways and Economic Productivity: Interpreting Recent Evidence*. UCTC No. 291. Berkeley, CA: University of California Transportation Center. 36 pp.

*Keywords: Economic development, highway infrastructure, econometrics, highway policy, regional economic shift*

This study reviewed the econometric literature, particularly production function and time-series studies, on public infrastructure and economic productivity, especially highway infrastructure. Although highways have comprised 32 percent of all non-military, American public capital, highway infrastructure has contributed little to state or national economic productivity even when controlled for unique state and year effects. The author noted that this did not mean that highways had no impact on the private sector economy but only that there has been no shortage of highways in terms of the United States' total economic performance.

Boarnet suggested that user benefits rather than economic impacts should be the basis for expanded infrastructure investment in highways. Nevertheless, in policy and planning, highways are thought to enhance economic growth. The author concluded that some economic development observed near highways might not actually be caused by the highways but instead by a shift of economic activity away from other areas. Thus, economic benefits should not be included in highway project analysis because those benefits likely represent a shift in economic activity rather than new growth. Estimates of economic benefits from highway projects should be viewed cautiously, and more attention should be given to using highways more efficiently rather than constructing new ones. Future research should study ways to expand the public-private highway provisions of the Intermodal Surface Transportation and Efficiency Act of 1991 (ISTEA) to more closely link local economic benefit assessment and local highway funding.

**10.** Bond, A. J., and Brooks, D. J. (1997). A Strategic Framework to Determine the Best Practicable Environmental Option (BPEO) for Proposed Transport Schemes. *Journal of Environmental Management, 51*(3): pp. 305-321.

*Keywords: BPEO, strategic environmental appraisal, environmental impact assessment, transport, sustainable development, methodology, Glocestershire, Massachusetts*

Social and environmental variables were stressed in a proposed appraisal framework methodology for identifying the best practicable environmental option (BPEO) from a range of transport options prior to project environmental impact assessment. A series of stages and methodologies were outlined in this appraisal framework. These included first identifying a checklist of environmental and social issue components by describing the alternatives, collecting environmental and social baseline information, and analyzing the components and actions. The second stage was to refine the list of components by identifying impacts. The third stage was to list impacts and impact matrices by conducting impact research. The fourth stage involved detailing a description of impacts by aggregating impacts into a single matrix for each alternative.

The final stage was to develop significance matrices by comparing matrices for each alternative.

Bond and Brooks presented a case from Glouchestershire in which six transportation alternatives were assessed through the framework. The role of public involvement, particularly in encouraging local groups to gather their own data to assist the baseline information gathering, was discussed.

**11.** Bonsall, P. W. (1996). Can Induced Traffic be Measured by Surveys? *Transportation, 23*(1): pp. 17-34.

*Keywords: Traffic estimation, traffic surveys, traffic congestion, induced traffic*

Bonsall addressed the feasibility of measuring induced traffic by means of surveys. He identified the problems inherent in measuring induced traffic including the: variability of traffic data, difficulty of determining what would have happened in the absence of a project, uncertainty in attributing cause, and difficulty in determining the most appropriate time to conduct surveys. Given these problems, he suggested ways to improve survey measurements of induced traffic. These included calculations for determining the appropriate sample size and control studies of traffic counts. Using these, he argued that it is possible to inexpensively and precisely measure the increases in traffic from a highway improvement and identify how much of that increase was due to rerouting. Basic traffic counts need to be supplemented by public transport surveys, registration plate marking, and/or road interviews, all of which increase cost.

**12.** Briggs, R. (1975). *Designing Transportation Systems for Low Density Rural Regions*. Occasional Paper. Austin, TX: Council for Advanced Transportation Studies, University of Texas at Austin. 54 pp.

*Keywords: Rural transportation systems, disadvantaged, transportation alternatives, Texas*

In 1973, section 147 of the Federal Aid Highway Act authorized the Federal Highway Administration and the Urban Mass Transportation Administration to conduct a rural highway public transportation demonstration program. Rural transportation studies were further stimulated in Texas after a 1975 court decision that required the Texas Department of Public Welfare to make transportation alternatives available to medical services for low income populations. This study described an attempt to design transportation alternatives for low-density rural areas in Texas and in doing so, clarify the conceptualization and measurement of need versus demand. The researchers found a considerable number of existing transportation options available including interregional and inter-state carriers (like Greyhound), taxi cab services, community action systems, state social services systems, and volunteer systems. However, these systems were seldom coordinated nor predictably funded.

Two study areas, one in east Texas and one in South Texas were chosen for

analysis. The researchers broke the study areas down into the smallest enumeration units practical (zip code units) and defined demand as satisfied demand of actual essential service usage rates from the U.S. Census and the National Center for Health Statistics. Total estimated demand was for the local area. This was then compared to the sum of all actual client visits to actual service facilities in the region. Transportation demand was derived from the demand for the essential services and the location of the service facilities relative to the location of the clients. This strategy proved successful for predicting an essential service like hospitalization, but not for multi-purpose trips like shopping.

To estimate the demand for trips in the area, the researchers determined the size of the transportation system target population within each area subdivision of the study region, estimated the frequency of trips per time period per member of the population, and assigned trips to the nearest community service center in the region. Using these strategies, the researchers estimated the total demand for a transit system in the east Texas study area. In the south Texas study area, a survey was employed to estimate the average number of trips into town per person per month by automobile and then reducing the total trips per person per month by the percentage of households who did not have an automobile and who could not make arrangements to have one available. Estimates using any of these strategies can only be evaluated against existing data, which are often lacking, or against urban data, which may be inappropriate.

The authors concluded that rural transportation has been oriented toward those unable to use automobiles, and door to door transportation has been necessary for certain subpopulations, e.g., the elderly and handicapped. A rural transit for the disadvantaged might well be feasible given the comparability of rural school bus transit systems that operate cheaper than urban systems because of the lower salaries in rural areas, smaller vehicles required, and perhaps higher average speeds. The degree to which passenger revenues can contribute to operating costs is difficult to estimate, but it is unlikely that passenger revenue will ever match costs. Nevertheless, improved transportation can reduce institutionalization of the elderly and the mentally disabled. In the end, it may be more appropriate to "plug the holes" with a paratransit system rather than designing a total, integrated transportation system.

**13.** Briggs, R. (1980). *The Impact of Interstate Highway System on Non-Metropolitan Growth Final Report*. DOT/RSPA/DPB-50-81. Washington, D.C.: Office of University Research, United States Department of Transportation. 125 pp.

*Keywords: Express highways, rural development, migration, interstate highways, industry-type impacts, intrastate migration, regional economic shifts*

One of the studies of industries reviewed by Brown (1999), Briggs examined the effects of the interstate highway system and other limited-access highways on the long-term demographic and economic development of nonmetropolitan areas from 1950 to 1975 with specific reference to the manufacturing sector. Using national-level census data on net migration and employment change, he found that the presence of an interstate

highway in a county lead to the channeling of nonmetropolitan development along interstate corridors and resulted in only minor economic benefits.

**14.** Brown, D. M. (1996). Rural America's Transportation Network: Issues for the 1990's. *Rural Development Perspectives, 11*(2): pp. 10-17. Washington, D.C.: Economic Research Service, United States Department of Agriculture.

*Keywords: Rural transportation, United States*

Because the highway network moves commercial goods to markets and provides many rural residents with access to jobs and services, transportation serves as a vital link to opportunities outside rural areas. However, parts of the rural transportation network are in disrepair. Balancing the need to improve transportation infrastructure with the decreasing availability of federal funding was the focus of this article. Brown noted that the responsibility for the rural road network lies almost entirely with local and state governments since local jurisdictions have controlled roughly 71 percent of the network and states have been responsible for another 22 percent. In growing areas, increasing demands have been placed on the rural road and bridge network. Where the local tax base is no longer sufficient to maintain the road and bridge network, new options have been needed. Brown emphasized that financing, planning, and institutional changes must be considered to foster local and regional economic development.

**15.** Brown, D. M. (1999). *Highway Investment and Rural Economic Development: An Annotated Bibliography*. No. 133. Washington, D.C.: Economic Research Service, United States Department of Agriculture. 26 pp.

*Keywords: Rural transportation, rural economic development, highway investment.*

Federal and state governments have recognized highway investment as an economic development strategy, especially in underdeveloped rural areas. The author reviewed 69 studies on the nature of this relationship. Most of the studies were conducted since 1979, but some earlier studies were also included. All the studies fell loosely into six categories including: aggregate economic studies, industrial location studies, studies of industries or sectors, studies of spatial and temporal effects as well as other studies. Most of the important studies related to population growth (23) are also reviewed in this bibliography and noted as included in Brown (1999).

Highway investments such as building new roads, widening existing ones, putting in new interchanges, or constructing bridges can result in benefits for rural residents including improved access to services and jobs and reduced transportation costs. If an improved highway network leads to expansion of a local area's economic base, it may also bring higher wages for workers and greater net income for local businesses. Highway investments can also involve development costs. Road construction projects or highway improvements may harm some areas if investment diverts economic activity from an already existing road within the region or results in "sprawl" in some previously undeveloped rural areas. Highway projects can also include a variety of unknown costs

such as highway maintenance. In addition, short-term economic effects, particularly those in the construction phase, need to be distinguished from long-term effects, especially at the regional level.

The economic costs and benefits of highway investments have been addressed in a range of studies. Some of these relied on regional development theory and focused on which highway policies have most effectively resulted in economic development, e.g., maintenance and minor improvements may be more cost-effective economic development strategies than new highway construction. Other studies have used regional growth theory that focuses on the economic factors thought to affect employment and income, e.g., factors that lead to economic development at highway interchanges. Still other studies have used growth pole theory that focuses on centers of economic activity thought to attract investment. These economists have argued that investing scarce infrastructure resources is more efficient in areas with some prior urbanization.

Although highways may be important in explaining rural growth, distance to an urban area has often been a much greater determinant of rural development. Isolated rural interstate counties and off-interstate counties have benefited little from interstate highway investment. Location theory studies have argued that transportation costs are a key determinant in industrial site costs so highways have the potential to either open up or close down underdeveloped regions. Trade theorists have explained highway investment impacts in terms of international and interregional flows of labor and capital based on comparative advantages, e.g., regions may tend to specialize in products that can be produced and transported more cheaply elsewhere. The major problem in summarizing these studies is determining whether economic growth arising from highway investment would have occurred even if the investment had not occurred. Another problem is whether highways have created new growth or redistributed old growth.

Econometric models have attempted to deal with these problems. These models have tended to examine the effects of transportation investment on industry output and employment. Most of these have occurred within a relatively narrow framework and have concentrated on examining the relationship between highways and a small number of economic variables such as growth in county employment, income, and population. Missing are studies that consider highway investment as part of regional economic growth, consider inputs in the production of goods and services, and include location decisions of households in their commuting patterns. Econometric models have also suffered from poor data quality. Input-output models have estimated the direct and indirect effects of highway investments based on a disaggregated industrial framework. Because of the lack of useful data, however, transportation cost data for these models have often been independently derived.

In general, studies have found that highways are a "necessary but not a sufficient condition" for generating rural economic development. What then are the other conditions required for growth? Currently, little consensus exists on which factors are most significant in determining rural growth. Better regional data would allow for

objective testing of hypotheses from alternative models of growth. Nevertheless, a few general conclusions can be made. One is that rural counties close to metro areas and with some prior degree of urbanization benefit economically, at least in the short term, by new highways, especially interstates. Two, highway construction expenditures benefit rural employment in the manufacturing and retail sectors, especially in the short term. Three, little consensus exists as to how highways affect rural areas in the long term since highways may merely redistribute development from other areas. Four, measuring the economic effects of highway investment is difficult because of the problems of isolating highway effects from other regional economic growth processes. Five, current data are inadequate for measuring the economic effects of highway investment, and better regional data, perhaps through the use of GIS applications, are needed.

**16.** Brown, D. M. (1999). *Will Increased Highway Funding Help Rural Areas?* ERS-AIB-753. Washington, D.C.: Economic Research Service, United States Department of Agriculture. 24 pp.

*Keywords: Rural roads, rural development, federal highways, federal transportation policy, TEA-21*

The Transportation Equity Act for the 21st Century (TEA-21) authorized greatly increased funding for major roads and has been the single largest public works bill ($171 billion over six years) in U.S. history. Rural areas in the U.S. should benefit from TEA-21, especially in the South. Many southern states have rural residents who receive less in per capita aid than those in other regions yet these states tend to be donor states and receive less in federal highway aid than they contribute in gas tax revenue.

Brown reviewed the implications of TEA-21 for state-level changes by county types. Because federal highway aid has continued to be allocated to the states, which then individually decide how to spend the money, it has been difficult to determine how TEA-21 funding increases will affect rural areas. Funding changes may benefit parts of the South, especially manufacturing and mining dependent rural counties. Because donor states like those in the South have relatively poor rural populations, more money to these states could help address rural economic inequities and finance improvements in areas with inadequate transportation infrastructure. Brown noted that for many rural households, the lack of transportation has limited access to employment opportunities as well as to health and childcare services and shopping. TEA-21 funding increases will probably benefit rural residents who have relied on transit for getting to and from medical appointments, childcare facilities, and jobs. Rural businesses, such as those in the service industry, that have relied on public transit for the transportation of their workers will also likely benefit. Nonmetropolitan service-dependent counties have been primarily located in parts of the West and Midwest. Changes will help address the growing highway demands associated with the rapidly growing areas of the South and West, possibly alleviate traffic congestion, and improve economic efficiency.

**17.** Buffington, J. L. (1991). *Economic Assessment of the Proposed Improvement of U.S. Highway 287 in Wichita Falls, Texas Executive Summary*. TX –91/1915-1F. College Station, TX: Texas Transportation Institute, Texas A&M University System. 248 pp.

*Keywords: Express highways. employment, forecasting, benefit-cost forecasting, Texas*

The authors assessed a proposed improvement of a state highway in Wichita Falls, Texas. The highway passed through Wichita Falls, a few blocks from the central business district and is a major route to Fort Worth. At the time of the study, the highway was a freeway on each side of town; the two freeway sections ended in the downtown area and traffic was routed on to two one-way streets before becoming a freeway again. To improve this design gap, five route alternatives were proposed including three bypass alternatives. The other two followed the existing route through the gap area. Each of these alternatives was evaluated to estimate the possible economic impacts. These impacts included the impact on different existing businesses, new development, employment, municipal tax revenues, and highway users. A total economic benefit-cost ratio was developed based on all economic impacts. Methodology followed that used in the Tarrant County study (Buffington, Crane and Salleh 1991). Data collected for the study included secondary descriptive data and primary interview and mail questionnaire data. Key descriptive data were collected on the study area including the existing and proposed routes. These data were similar to those collected in the Tarrant County study. These descriptive data were used in the literature search and review to select comparable case studies to estimate the various impacts for Wichita Falls. Copies of the surveys and interview protocols used in the study are included in the report and detailed findings for each survey and interview period are presented.

The authors concluded that based on all these findings, the proposed three bypass route alternatives would have required a considerable of amount of right of way that would have lead to large numbers of displacements of businesses and residents. This was especially true for two of the bypass alternatives. The findings indicated the strongest support for the existing route alternative 5, which was the elevated express lane alternative. The findings indicated that this proposed route alternative would produce the most positive overall economic impact on highway users and abutting businesses and residents of any of the five route alternatives considered. Of the impacts estimated on each route alterative, land use, land value, relocation, building construction impact on the economy and highway user impacts favored route alternative 5. The majority of the abutting businesses and residents also favored this alternative. The authors recommended that the chosen alternative should minimize the taking of large amounts of right of way, especially if those takings would displace large numbers of abutting businesses and residents. Of the three design options of route alternative 5, the design option that placed elevated ramps to and from two major streets was most supported by survey responses.

**18.** Buffington, J. L., Crane, L. M., and Salleh, R. (1991). *Estimated Economic Impact of the Proposed Improvement of State Highway 199 in Tarrant County, Texas*. College Station, TX-90/1904-1F. TX: Texas Transportation Institute, Texas A&M University System. 196 pp.

*Keywords: Road design, road construction, employment forecasting, population forecasting, Texas*

Some of the economic impacts from highway changes and improvements are not easily measured; of those that are measurable, some are easier to quantify than others, e.g., the decrease in cost and time in traveling a new, shorter route versus the resulting impact on business and property values. To obtain reliable estimates, it is necessary to look at comparable improvements and other locations and the impacts associated with them. Specifically, the authors followed five guidelines. First, they considered all the relevant highway and area characteristics in assessing economic impacts. Two, they determined which of the above characteristics were significant variables in measuring economic impacts. Three, they considered the techniques available for estimating economic impacts. Four, they collected sufficient data on the characteristics of the proposed improvements to use in selecting the most comparable findings of prior studies to estimate the impacts. Finally, they adjusted the findings of previous case studies to fit the proposed improvement area.

These guidelines were followed in assessing proposed improvements of a state highway in northwestern Tarrant County, Texas. The highway passed through small "satellite" cities as it lead into Fort Worth and terminated at the interstate in the downtown center. The proposed improvement was a full, limited access freeway with or without service roads. The objectives of the studies were to estimate the economic impacts of the proposed route and/or design alternatives. These included the impacts on different types of businesses, new development, construction, municipal tax revenues and highway users. The authors' data included general observations of several areas impacted by highway improvements made in the Fort Worth/Dallas area about 15 years prior to their study. Secondary data from other sources and descriptive data for the affected area were also collected. Descriptive data included the design of existing and proposed routes, average daily traffic (ADT), number and types of existing businesses, land use patterns dominating the exiting and proposed routes, distance to the city central business district (CBD), and current populations of the relevant affected cities. These data were used in a literature search and review of comparable case studies for use in estimating the various impacts described in the study of this report. Updates were made on the case data to reflect present conditions.

From their findings, the authors concluded that all of the proposed route alternatives would have required a considerable amount of additional right of way that would have lead to large numbers of displaced businesses and residents. The north route alternative would have produced the greatest positive or least negative economic impact on the abutting businesses and residents as well as the most positive impacts on business sales, land use changes, right of way costs, business relocation costs, new employment,

and income. In addition, it would have produced the most positive or least negative economic impact on abutting businesses and residents in a majority of the affected cities and it would have most positively impacted the two largest of the four small towns. The central route would have produced the most impacts on land values and residential relocation costs as well as the highest conventional highway user benefits to costs ratio. The south route alternative would have produced the most positive impact on city tax revenues and the highest amount of highway user benefits as well as proving the most economically feasible from an incremental point of view. Thus, no one alternative was the perfect route.

The authors recommended that the final selection of a route emphasize minimizing the total number of displacements, and since residential relocatees are helped more than business relocatees, the number of business displacements should be minimum. More weight should be given to the route alternative that would minimize the negative economic impacts on those most affected, namely, abutting businesses and residents.

**19.** Burkhardt, J. E. (1984). Socioeconomic Reactions to Highway Development. *Transportation Research Record*, No. 991: pp. 1-8. Washington, D.C.: Transportation Research Board.

*Keywords: Express highways, road improvements, social impacts*

Burkhardt described a case study methodology to examine the social and economic effects of highway improvements on the areas adjacent to the highways. The purpose of the study was to determine how the interaction of different types of highway projects with different community settings created specific impacts. Using secondary data supported by interviews and observations, he made before and after comparisons for impact and control groups in different case study communities (including Baltimore MD, Cleveland OH, Hartford CT, Wichita KS, and Wilmington DE). Controls for other external factors were also used. Direct effects such as the number of businesses impacted by the highway improvement were distinguished from indirect effect such as the relative land value price changes. In the impact areas, he found some frequent and consistent socioeconomic changes occurred. These included the main finding that general patterns or models are secondary to site-to-site variations. However, in general, decreases in neighborhood attractiveness did not necessarily occur. Fewer changes occurred during interim time periods, but were more often negative. Distance from the highway had a strong effect and while distance-related changes showed specific patterns, block-level changes were greatest.

**20.** Burkhardt, J. E., Lago, A., and Rothenberg, J. (1971). *Highway Improvement as a Factor in Neighborhood Change* (2 Vols). PB 200 129 (v.1) and PB 200 130 (v.2). Bethesda, MD: Resource Management Corporation. Unpaged.

*Keywords: Roads, social impacts, neighborhoods, social interaction, highway improvements, neighborhood cohesiveness, Philadelphia*

In this paper, Burkhardt focused on how highways affect the social and psychological character of neighborhoods and their residents. The author addressed what neighborhoods are, how to measure the level of "neighborhoodness" in an area, how to predict neighborhoodness from commonly available data, and how to estimate changes in the level of neighborhoodness that highway improvements can cause. Using interaction data for Philadelphia, he constructed an index of various variables to account for 73 percent of the variance in the social interaction from neighborhood to neighborhood. Because gathering interaction pattern data in all neighborhoods affected by highway improvements would have been costly, he used proxy "descriptor" indicators for interactions. These descriptors were obtained from the literature of experience as influencing social interaction. Burkhardt claimed a planner could use readily available data from mobility, percent land residential, and housing units per acre to estimate the social interaction occurring within a particular neighborhood. Comparing changes in the index for pre- and post-highway conditions would then indicate the magnitude of social change caused by the highway. No validation evidence for the index is reported.

**21.** Carlino, G. A., and Mills, E. S. (1987). The Determinants of County Growth. *Journal of Regional Science, 27*(1): pp. 39-54.

*Keywords: Metropolitan areas, population, urban economics*

One of the aggregate economic studies reviewed by Brown (1999), Carlino and Mills explored factors affecting U.S. county population and employment growth. One of the limitations of previous studies has been resolving the question of whether people follow jobs or jobs follow people. To surmount this problem, they used an econometric model of Steinness and Fisher (1974) to determine population and employment densities simultaneously. They applied this model to data for about 3,000 counties in the U.S. to analyze the effects of economic, demographic, climatic, and policy-related variables on the growth of population and employment during the 1970s. They found that differential county employment growth was explained in terms of economic and demographic conditions, but regional and policy-related variables mattered less. They determined that climate affected population growth as they found a population density preference for sunbelt states. Local government programs regarding education and tax policy also seemed to play a role.

In terms of transportation, Carlino and Mills found that during this period, total employment, manufacturing employment, and population densities were positively affected by the presence of limited access highways. The authors concluded that the interstate highway program contributed to a redistribution of population and employment

in the U.S. although this was not an original intention of the program. Their main finding is that since population and employment growth have been interrelated, local economic policy should formulate strategies to retain or attract population and employment will follow.

**22.** Cohen, H. S. (1995). Expanding Metropolitan Highways: Implications for Air Quality and Energy Use: Appendix B: Review of Empirical Studies of Induced Traffic. *Transportation Research Board Special Report*, No. 245: pp. 295-309. Washington, DC: United States Department of Transportation.

*Keywords: Induced traffic, traffic generation, highway capacity*

Cohen reviewed empirical studies of the effects of expanding highway capacity on highway system use. These studies included a) analyses of specific facilities that have tried to determine the traffic-generating effects of highway improvements, b) area wide measures of highway supply, and c) studies of individual or household travel behavior used to estimate changes in highway system use. Studies of international scope that covered the period between 1947 and the mid 1990s were selected. Findings from each of the studies were reported, but no generalizable results were described.

**23.** Cook, A.K. and Beck, D.M. (1991). Metropolitan Dominance Versus Decentralization in the Information Age. *Social Science Quarterly*, *72*(2): pp. 284-299.

*Keywords: Occupations, nonmetropolitan area, transportation, telecommunications*

Cook and Beck explored the changes in occupational distributions in large, small, and nonmetropolitan areas in the 1980s. They determined that earlier improvements in transportation and communications had allowed metropolitan areas to dominate surrounding communities. This urban dominance resulted in higher concentrations of managerial and professional occupations in those areas. In contrast, they noted that the rapid evolution of telecommunications and computer technologies might represent a new phase of development that enhances locational flexibility and deconcentration of the labor force, especially those workers closely related to decision making.

**24.** Cromartie, J. B., and Swanson, L. L. (1996). Census Tracts More Precisely Define Rural Populations and Areas. *Rural Development Perspectives*, *11*(3): pp. 31-39. Washington, DC: Economic Research Service, United States Department of Agriculture.

*Keywords: Counties, census tract, population growth, United States*

Accurate analysis of the economic and social problems currently facing urban and rural residents, as well as the implementation of programs to address them, have largely depended on how settlement is measured. Counties are too big in many parts of the nation to serve as building blocks for statistical areas used to analyze changing settlement

patterns. In this study, census tracts were used to identify metropolitan and nonmetropolitan components of a five-level "rural-urban continuum." The census-tract continuum provided a more precise territorial delineation of areas and classification of population in different types of areas than did the county-level continuum. This was a useful review of the limitations of using larger areas, like the county, in assessing population growth.

**25.** Cromley, R. G., and Leinbach, T. R. (1981). The Pattern and Impact of the Filter Down Process in Nonmetropolitan Kentucky. *Economic Geography, 57*(3): pp. 208-224.

*Keywords: Highway access, employment levels, branch plants, location decisions, employment changes, industry type impacts, community infrastructure, limited entry highways, Kentucky*

An important part of the changing economic activity in the United States has been the decentralization of branch plant operations to nonmetropolitan areas. One of the studies of temporal effects reviewed by Brown (1999), this article examined the role of transportation, industrial sites, labor supplies, and labor competition as determinants of the spatial development of branch plants in nonmetropolitan towns in Kentucky between 1950 and 1980. Cromley and Leinbach used data gathered for 103 metropolitan counties in Kentucky from annual industrial directories produced by the Kentucky Department of Commerce as well as preliminary data of the 1977 Census of Manufacturing. The authors found that community infrastructure, as measured by town size and the availability of industrial sites, rather than labor supply alone was important in explaining employment levels. Between 1970 and 1975, access to limited entry highways was a contributing factor to employment levels. Thus, transportation was an important factor in location decisions but the role of transportation was blurred by other, more critical determinants. Over the short term, employment changes were more a function of external rather than internal factors. The authors concluded that towns between 10,000 and 20,000 population size had the greatest potential for employment growth in the future.

**26.** Cushing, B. (1993). The Effect of the Social Welfare System on Metropolitan Migration in the US by Income Group, Gender and Family Structure. *Urban Studies, 30*(2): pp. 325-338.

*Keywords: Migration, welfare system, United States*

Cushing addressed whether decisions on out-migration from and in-migration to metropolitan areas in the US were affected by the social welfare system. His data were derived from the microdata from the PUMS B sample of the 1980 census. He examined income groups (poor versus non-poor) as well as gender and family status in relation to the migration decisions. He found that social welfare benefits essentially had no effect on out-migration decisions. Higher unemployment compensation benefits significantly inhibited out-migration of non-poor, female-headed households. In contrast, he

determined moderate support for the effect of those benefits on in-migration decisions, especially for low-income and female-headed households with children.

**27.** Dahms, F. and McComb, J. (1999). 'Counterurbanization', Interaction and Functional Change in a Rural Amenity Area—A Canadian Example." *Journal of Rural Studies, 15*(2): pp. 129-147.

*Keywords: Urbanization, population change, transportation, Canada*

Dahms and McComb conducted a case study of the South Georgia Bay, a nonmetropolitan area north of Toronto, Ontario. Their investigation revealed population changes due to desirable amenities, the construction of retirement condominums, and easy access to major cities via telecommunications. This 'counterurbanization' in Canada is discussed in the context of similar phenomena in the United States, the United Kingdom, and Australia. Factors contributing to counterurbanization include the perception of rurality, national and regional policies on housing and transportation, and economic and demographic conditions.

**28.** Dansereau, H. K. (1965). Five Years of Highway Research: A Sociological Perspective. *Highway Research Record,* No. 75: pp. 75-81. Washington, D.C.: Highway Research Board.

*Keywords: Highway improvements, population growth, community development, highway interchanges*

Five years of community studies were conducted in the early 1960s by researchers at Pennsylvania State University. The focus of these studies was to determine the effect of highway developments, particularly the role of interstate interchanges, on population change and community change. At the time, numerous proposed interchanges were planned for construction including 388 interchanges in eight cities, 31 boroughs, 23 first-class townships, and 155 second-class townships. Three community research sites were intensively studied. These in turn were broken down into six arterial and nonarterial interchange communities. All had long highway-related histories. The researchers obtained population data from the census, health departments, and tax and school records.

Of the six communities, the populations of arterial highway communities grew faster than did the populations of nonarterial communities. Those communities closest to larger population centers also grew the most. All six communities had attracted migrants, who on the whole were younger and better educated than nonmigrant residents. Although the economic growth patterns for the six communities was highly variable, the researchers concluded that a) new highway construction had probably attracted some firms and b) some of the migrants were probably attracted by these new jobs. These conclusions were primarily based on occupations, tax rosters, household interviews, and other records. The researchers also collected newspaper files and conducted surveys as well as interviews. From these data, they concluded that most citizens, both leaders and residents, supported recent highway developments and believed that the amount of

expenditure had been 'about right'. Finally, the researchers constructed an index of local government functions as an indicator of progress toward comprehensive community planning. Using the index indicated that highway communities tended to exhibit higher scores than did nonhighway communities. Nonarterial communities appeared to have lagged about 10 years behind those on arteries. The researchers noted that most previous studies had investigated the acceptance of local highway construction after, rather than before, it had occurred.

**29.** Dansereau, H. K., Frey, J. C., and Pashek, R. D. (1963). Highway Development, Community Attitudes, and Organization. *Highway Research Record,* No. 16, pp. 44-59. Washington, D.C.: Highway Research Board.

*Keywords: Highway development, community attitudes, population change, social characteristics, community complexity, Pennsylvania*

The authors followed up on a study that originated in 1958 to study highway impacts in Pennsylvania. Three sites in Pennsylvania were extensively studied in terms of major highway changes. These included completion of the Pittsburgh Interchange of the Pennsylvania Turnpike (1951), the opening of a 4-lane, limited-access thoroughfare into Pittsburgh and nearby boroughs, the widening of a federal highway in one of the communities from 33 to 50 feet (1957), the relocation of a federal highway away from a central business district (1953), and the construction of an interstate freeway in the area of another community. Two sources of data were used: attitude surveys conducted in all three communities and an index of community regulatory and policy changes that was weighted according to complexity. Results indicated that the study communities were changing in ways other than highway developments, e.g., government costs were rising, land uses were changing, school enrollments, were increasing, and new leadership was emerging.

The authors concluded that overall local attitudes were conditioned by economic and political events not solely by population changes. Highway changes in or near the communities studied were generally accepted and residents had adapted to the changes. The authors note that knowledge of population and population change, community social characteristics and attitudes are necessary to understand the relationship between highway development and community change.

**30.** Devres Incorporated. (1980). *Socio-Economic and Environmental Impacts of Low-Volume Rural Roads: A Review of the Literature*. AID-PN-AAJ-135. Washington, D.C.: Office of Evaluation Bureau for Program and Policy Coordination, U.S. Agency for International Development. 184 pp.

*Keywords: Roads, rural development, developing countries, industry type impacts, out-migration*

This study surveyed the literature on the socioeconomic and environmental impact of low-volume rural roads in developing countries. The review of the literature

found that rural roads almost always lead to at least some agricultural production increases. Additionally, rural roads influenced crop composition since farmers could be more responsive to evolving market opportunities. Roads also expanded technological innovation and the adoption of new agricultural tools and products. Roads encouraged the establishment of government service facilities as well as agro-industrial, industrial, and commercial enterprises. Similarly, they negatively impacted cottage industries that suffer from the competition of cheap goods transported into the area because of the road. Rural roads stimulated short-term employment during construction and promoted medium- and long-term employment by increasing the skills of those who worked on the road and of those who could now commute to nearby communities. Similarly, out-migration (especially of young men) occurred more frequently because of the "pull" of employment opportunities accessible by the road. Rural roads also increased land values, more intensive land use, and a larger number of land transactions. Marketing opportunities and increased consumption generally increased as a result of roads, but the ability of the poor to participate in these new patterns was often marginal. Low-volume roads strengthened nearby towns as administrative and economic centers and promoted commuting for permanent or short-term work. Finally, rural roads accelerated deforestation as a result of agriculture expansion and the exploitation of timber for firewood, charcoal, and lumber. These effects in turn have had indirect impacts on wildlife and watersheds.

**31.** Dowling, R. G., and Colman, S. B. (1995). Effects of Increased Highway Capacity: Results of a Household Travel Behavior Survey. *Transportation Research Record*, No. 1493: pp. 143-149. Washington, D.C.: Transportation Research Board.

*Keywords: Highway capacity, traffic surveys, trip generation, travel demand, California*

Dowling and Cohen examined whether travel behavior changes when road congestion and travel times are improved as a result of new highway capacity. They found that the causal change is complex and may occur over both the short- and long-term. Short-term impacts may involve changes in route choice, time of the day that trips are made, choice of transportation mode, trip frequency, trip chaining, and destination choice. In contrast, long-term impacts may include changes in auto ownership, residential location, choice of workplace location, and land development patterns. These changes have resulted from economic, demographic, and pricing changes affecting the population as a whole.

In their travel behavior survey of 700 urban California drivers, the authors asked respondents to relate hypothetical changes in congestion levels to their previous day's travel and activity patterns. Results indicated that congestion-relieving projects were likely to induce a small (3 to 5 percent), but not insignificant increase in trip generation. Specifically, over 35 percent of the trips made would have been unaffected when the trip travel time increased by 15 minutes or less for all trip purposes. Another 20 to 40 percent of trips made would have changed in that the respondent would have arrived earlier or later at a destination and made no change in the departure time to compensate for the

travel time change. About 10 to 15 percent of the trips would have been rescheduled to compensate or take advantage of the travel time change. Timesavings of 5 minutes would have generated extra stops for about 3 percent of the trips, which would have increased to 5 percent when a 15-minute timesavings occurred. The authors concluded that current travel forecasting probably results in an under prediction of 3 to 5 percent in the number of trips induced by major new highway capacity projects, and a key impact of new highway capacity is temporal shifts in demand.

**32.** Dunphy, R. T. (1998). Widening the Roads: Data Gaps and Philosophical Problems, *Transportation Research Circular No. 481: Highway Capacity Expansion and Induced Travel: Evidence and Implications*: pp. 16-32. Washington, DC: Transportation Research Board, National Research Council, National Academy of Science.

*Keywords: Highway improvements, highway capacity, highway congestion, Houston, TTI index, VMT*

Dunphy addressed whether large highway capacity additions relate to traffic congestion and how improvements in the highway system can be made in response to growth in population, the economy, and travel. One of the few means for analyzing the long-term impacts of traffic congestion has been to analyze current conditions across regions with different degrees of mobility. He advocated a regional rather than a corridor analysis because many travelers often use portions of the highway network far from their usual commute and shopping trips.

The Texas Transportation Institute (TTI) Roadway Congestion index has been used as a consistent measure of regional congestion since 1990. An analysis of this index of congestion and Vehicle Miles Traveled (VMT) on an average day indicated that areas with more congestion also had more driving. However, that relationship may not hold for other regions. The New York urbanized area has experienced some of the highest congestion levels in the U.S. but has had the lowest levels of driving (about 14 miles daily). This may be because New York has had the most extensive transit system, some of the highest densities, and the largest numbers of households without cars. The TTI index indicates that the highest level of congestion is that of Los Angeles, which has been only the ninth in daily driving (22 miles daily). The highest VMT region has been Atlanta (35 miles daily), which has ranked ninth in congestion. Such figures have indicated that region congestion is not well linked with levels of driving, at least for 1990. Comparing different regions has shown some of the potential long-range equilibrium effects of highway supply, congestion, and levels of driving. Many of the differences have been caused by demographics, local patterns of land use, and the speed and congestion of the transportation system. The question for individual regions is the extent to which transportation improvements increase travel or whether failing to make improvements will cause people to reduce their travel.

The massive improvements ($1 billion) resulting from the 1982 Houston Regional Mobility Plan (RMP) is a case study that has addressed this question. The RMP

improvements reduced congestion as indicated by freeway speeds, which increased during the evening peak period 28 percent, and by the number of severely congested arterial streets, which fell from 74 percent in 1985 to 29 percent in 1992. Similarly, bus ridership doubled over the decade and the number of transit commuters increased by 69 percent. Regionally, VMT grew by 38 percent, about double the growth in regional population. Thus, the relationship between capacity and driving is complex. This is due in part to demographics, which includes not only overall population growth, but also the disproportionate increases in the prime driving cohorts. It is also due to increased dependency on the private auto and the declining use of transit and auto occupancy as well as the growth in trip distances as a result of the continuing spread of urban areas.

One of the problems in clearly examining the question is the simplistic analysis of single facility in a fixed time horizon without considering regional growth. In addition, the needs of new development are not included. Most new development has been located at the periphery of metropolitan areas and good planning needs to evaluate the areas suitable for new development and prepare transportation plans in advance to serve those growth areas. Dunphy concluded that the many cases now of substantial highway improvements and creation of whole systems offer unique research opportunities to the transportation profession to address the critical gaps in understanding the relationship between congestion and capacity.

**33.** Economic Research Service. (1997). Migration Contributes to Nonmetropolitan Per Capita Income Growth. *Rural Conditions and Trends, 8*(2)*:* pp. 40-45. Washington, DC: Economic Research Service, United States Department of Agriculture.

*Keywords: Rural population, migration, economic growth*

Recent migration into and out of nonmetropolitan counties increased non-metropolitan per capita income, especially in rapidly growing, high-amenity places. Incomes of nonmetropolitan inmigrants exceeded incomes of outmigrants in all types of nonmetropolitan counties except those dependent on mining. Between 1992 and 1995, the average per capita income was $11,176 for inmigrants but only $10,579 for outmigrants. Migration increased per capita income in roughly half of all non-metropolitan counties. Nonmetropolitan areas currently have had higher levels of inmigration from metropolitan areas and lower outmigration to metropolitan areas than in the previous decade (1980s). This movement to and from metropolitan areas, along with county-to-county migration within nonmetropolitan regions, has sustained a national redistribution of population that has caused some areas to grow rapidly while others have declined.

Inmigration to the nonmetropolitan West has been substantially higher than outmigration so that the annual regional population has gained 1.4 percent from net migration. Migrants raised per capita income in northwest Montana by more than $50 in all counties except Granite and Lincoln Counties. The authors attributed this nonmetropolitan growth to the parallel pull of natural amenities and economic

opportunities associated with amenity-based economies. The uneven distribution of the inmigration per capita income gain per county has appeared to be due more to the natural amenities that counties have had to offer than from the job opportunities offered by their economies.

**34.** Economic Research Service. (1997). Nonmetro Population Growth Rebound of the 1990's Continues, But at a Slower Recent Rate. *Rural Conditions and Trends, (8)*2: pp. 46-52. Washington, DC: Economic Research Service, United States Department of Agriculture.

*Keywords: Nonmetropolitan population growth*

Nonmetropolitan population grew by about 6 percent between 1990 and 1996 with 60 percent of this increase resulting from the net inmigration of people from metropolitan areas and abroad. The rate of increase was only 1 percent lower than that in metropolitan America but more than twice the population increase that occurred in nonmetropolitan regions during the entire 1980s.

In the nonmetropolitan West, the regional population increased 12 percent during all of the 1980s but rose 13.6 percent between 1990 and 1996. This is in contrast to the West's metropolitan population growth, which rose 24.1 percent during the 1980s but increased only 10.4 percent between 1990 and 1996.

Migration from metropolitan areas accounted for 50 percent of the total nonmetropolitan population increase across the country. Another 10 percent resulted from direct foreign immigration. All economic types of nonmetropolitan counties have shared in the rebound of population growth in the 1990s; these include counties dependent on manufacturing, farming, mining, government work, services, and trade. However, these counties have not done so equally. Nonmetropolitan counties with economies focused on services and trade have had the most rapid average growth (8.4 percent). Many of these counties have attracted retirees and/or recreational destinations. Retirement-destination counties grew by 16.3 percent, the highest growth rate of any identified type of counties. In such counties, nearly 90 percent of the population increase has stemmed from net immigration. Counties with high levels of recreational activity increased by 11.2 percent. Farming- and mining-dependent counties had the lowest rates of overall population increase— 4.0 and 2.8 percent respectively. Nevertheless, even these two county types have generally participated in the larger demographic trend by having less loss than in the 1980s or some growth where there was earlier decline. Areas with above-average population increase were very common in the Mountain West. Declines were most pronounced in the Great Plains, Corn Belt, and Mississippi Delta, but even these counties suffered less decline than in the 1980s.

Also in sharp contrast to the population pattern of the 1980s has been the shift in age structure in nonmetropolitan counties. Fully a third of all these counties have been estimated to have had declining older populations since 1990— more than three times as many as in the 1980s. This trend has stemmed heavily from the past depletion of cohorts

now reaching 65, i.e., the rural young people who moved away to the cities in the 1940s or who stayed but gave up farming in the 1950s. Thus, the burden of elderly dependency has already started to lessen in many rural areas, both absolutely and proportionately. This has been in advance of the more widespread trend now in place in which people reaching 65 are currently survivors of the small birth cohorts of the Great Depression era.

**35.** Enders, W. T., Poston, P. M., and Briggs, R. (1974). *Access to Essential Services in the Rural Urban Environment: A Selected Interdisciplinary Bibliography.* Monticello, IL: Council of Planning Librarians. 53 pp.

*Keywords: Rural services, transportation needs, elderly, medical accessibility.*

The authors listed (no annotations) the literature from the 1960s and the 1970s on the accessibility of essential services to rural residents. They noted that the literature has not empirically or theoretically distinguished the concepts of need versus demand. Most studies have examined access to services providing physical and mental health. Such services have been difficult for rural residents to access because of distance. Studies focusing upon assessing and augmenting the role of transportation in improving accessibility to essential services for rural residents, especially the elderly, were included.

**36.** Everly, R. W., Twark, R. D., and Downing, R. H. (1987). *Interstate Highway System: Reshaping the Non-Urban Areas of Pennsylvania.* College Park, PA: Environmental Resources Research Institute, Pennsylvania State University. 23 pp.

*Keywords: Express highways, rural roads, Interstate Highway System, economic changes, Pennsylvania*

One of the studies of spatial effects reviewed by Brown (1999), Everly, Twark and Downing described the economic changes that occurred in the 1970s in nonmetropolitan Pennsylvania communities adjacent to interstate highways. They found that changes in per capita income at the county level were positively related to the presence of interchanges. The authors concluded that the economies of many nonurban communities along interstates experienced large increases in residential, commercial, and industrial growth.

**37.** Falk, E. L. (1968). Measurement of Community Values: The Spokane Experiment. *Highway Research Record,* No. 229: pp. 53-64.

*Keywords: Community values, model, planning, Washington*

Falk reviewed citizens advisory committees and noted that better communication between citizens and planners has been necessary. The author presented a pilot study that included nine important factors of public involvement and the means of applying them. The ultimate goal was to select the most acceptable alternative of three hypothetical road solutions in Spokane, WA. The author's method required assuming that how much

citizens preferred one factor over another was directly related to the importance of that factor. Using this equality of averages assumptions, Falk assigned a value without a common scaling system and combined these values with measures of the relative importance of the factors involved. The result was an evaluation table that provided a total weighted score for each alternative solution. No validation of the model was presented.

**38.** Federal Highway Administration. (1972). *Social and Economic Effects of Highways*. Superintendent of Documents No. TD 2.2:H 53/6/972. Washington, DC: Socio-economic Studies Division, Office of Program and Policy Planning, Federal Highway Administration, United States Department of Transportation. 104 pp.

*Keywords: Impact studies, highway accessibility, highway proximity, community impacts*

This report summarized a wide variety of impact studies that varied by the type of facility studied, the geographic area covered, and the economic and social indicators measured. Controlled-access highways predominated although some studies dealt with highways permitting free access, bypass routes, circumferential highways, radial highways, frontage roads, and parkways. Highway features included interchanges, median barriers, and bridges. The geographical areas varied from a single town or highway corridor to a metropolitan or state area. Methodology varied from before-and-after comparisons, cross-case comparisons, trend analysis for an affected area, attitude sampling, single case studies, and economic input-output models. At the time of the report (1972), relatively few studies were being made of single towns bypassed by highways and instead, studies covered larger areas or several locations. More attention was also being paid to economic and environmental impacts of highways. Findings presented in the report are drawn from individual studies rather than from across studies.

General findings that the authors reported were: a) new highways accelerated economic changes already underway; b) interchange areas gained in economic activity through more intensive land use; c) beltways integrated the highway system of an urban area and produced a more complex land development pattern; d) local tax roll losses due to right-of-way acquisitions were offset by new or intensified existing development; e) environmental impacts were more positive when highways were developed jointly with residential, recreational, or commercial facilities; and f) right-of-way values shifted in a ratio of four gains to one loss in property values.

Specific economic effects included: a) stimulating economic change by opening new areas for development and improving labor force mobility; b) increasing industrial and commercial property values more than residential values; c) attracting firms through advertising; d) helping stimulate economic growth in underdeveloped areas (when other factors were present); e) enlarging market areas and decreasing distribution costs for commercial firms; f) affecting local businesses adversely when improvements facilitated travel to firms with lower prices; g) facilitating storage and inventory costs for industrial firms, and h) increasing farmer market mobility and facilitating part-time farm resident

employment.

Specific residential impacts included: a) generally benefiting residential properties; b) improving accessibility and therefore attracting residential development (although not necessarily in the immediate vicinity of the freeway); c) slowing urban residential development along radial freeways when freeway capacity was reached; d) dislocating poor, old, or non-white residents through right-of-way acquisitions, and creating serious economic problems for them; and e) improving living accommodations to displaced residents, but at an increased cost to them.

Other community effects of highways included: a) minimally impacting people if highways were well landscaped and located outside or on the border of neighborhoods and school districts; b) facilitating school consolidation; c) making police and fire service more efficient but posing access problems in terms of fires and access; and d) benefiting institutions like churches when members' residences were widely dispersed.

**39.** Federal Highway Administration. (1974). *Social and Economic Effects of Highways*. Superintendent of Documents No. TD 2.2:H 53/6/974. Washington: Socio-economic Studies Division, Office of Program and Policy Planning, Federal Highway Administration, United States Department of Transportation. 190 pp.

*Keywords: Impact studies, highway accessibility, highway proximity, community impacts*

The 1974 report is the basis for (and almost exactly the same as) the 1976 report. See the abstract for the 1976 report.

**40.** Federal Highway Administration. (1976). *Social and Economic Effects of Highways*. HS-018 985. Washington, DC: Socio-Economic Division, Office of Program and Policy Planning, Federal Highway Administration, United States Department of Transportation. 250 pp.

*Keywords: Impact studies, highway accessibility, highway proximity, community impacts*

This report synthesized the highway impact studies of the previous 15 years (1960 to 1975) and included abstracts of studies completed during the last five of those years (1970 to 1975). Tentative conclusions about proximity and accessibility effects of highway were identified in the report. Residents and businesses displaced by highway right-of-way were generally relocated satisfactorily. Residents in close proximity to highways often endured noise, air pollution or safety problems, and those disadvantages were reflected in lower property values. Highway accessibility often created positive benefits, including increased residential property values. The impacts of highways varied by the land use involved. Generally, industrial or commercial uses benefited, residences suffered by highway proximity, and services like schools, churches, and hospitals usually benefited from accessibility. The majority of studies summarized in the report analyzed

urban areas. The chapter on community impacts summarized citizen concerns about neighborhoods and city streets. These included noise, pollution, safety, and other related impacts.

**41.** Finsterbusch, K., and Barker, M. (1977). *Social Impact Assessment Manual for Highways*. FHWA-MD-R-77-11. College Park, MD: Department of Sociology, University of Maryland. 154 pp.

*Keywords: Highway planning, citizen participation, social impact assessment (SIA), social impact assessment forms, U.S. Census, longitudinal assessment of highway development*

This social impact assessment (SIA) manual instructs highway planners on how to conduct a social impact assessment. This manual includes a workbook providing nine worksheets that include interview forms and questionnaires. The report presented a map analysis oriented to social factors and recommended special procedures for projects that warrant "extra effort" analysis. Generally, these were for new highways in urbanized areas, controversial highways, and highways that significantly alter the character or economy of a community, e.g., the bypass of a rural town.

The authors recommended that for "extra effort" SIAs, planners insured extensive community social profiles, intensive field visits and informant interviews, community workshops to draft more socially desirable options, formulas based on census and land use data to indicate areas that needed to be avoided, a post card survey of those potentially relocating, mini-surveys, an inventory of interested groups, and a content analysis of public comment hearings. The worksheet "Community Social Profile Based on Census Areas Traversed by the Highway Corridor" could be very useful for using census secondary data to track population growth in the corridor before and after development or construction. Similarly, Interview Form 1: Informant Interview Guide on the Character of the Community" would be a useful draft interview form for assessing community perceptions of population growth as a result of highway development or construction.

**42.** Forkenbrock, D. J. (1990). Putting Transportation and Economic Development into Perspective. *Transportation Research Record*, No. 1274: pp. 3-11. Washington, D.C.: Transportation Research Board.

*Keywords: Economic development, highway development, transportation infrastructure*

One of the "other" studies reviewed by Brown (1999), Forkenbrock discussed the relationship between transportation and economic development. He noted that government policies can promote economic development by helping an area increase the returns from the resources they use through increasing the flow of benefits relative to costs. Transportation services have generated benefits by serving as an economic development tool in transporting goods and services. However, these benefits must be offset by reductions in transportation costs. The author addressed the factors that should

be considered in this ratio, namely, the scale of the impact area (since one activity can move from one location to another) and social objectives (such as assisting a remote but needy area).

After examining several paradigms of development, Forkenbrock concluded that good transportation is not enough to ensure that economic development will occur. Investing in facilities whose benefits exceed their costs is critical to making an area attractive for development, and failing to invest in such facilities will retard growth. However, the long-term benefits are more uncertain, especially when the cost-benefit efficiency ration competes with other social objectives. If investment is made in inefficient facilities, a subsidy from other, more efficient facilities or from taxpayers will be required to offset the difference. The result is higher user fees or higher taxes than otherwise would be the case, which can hinder economic development. The implications of these tradeoffs are discussed, and a series of "decision screens" to provide a practical basis for applying the findings are presented.

**43.** Forkenbrock, D. J., and Foster, N. S. J. (1996). Highways and Business Location Decisions. *Economic Development Quarterly, 10*(3): pp. 239-248.

*Keywords: Business Location Decisions, high capacity highways, maintenance vs. new highway impacts*

One of the industrial location studies reviewed by Brown (1999), Forkenbrock and Foster addressed the degree to which investments in high capacity highways were likely to influence business location decisions. Through case studies, the authors concluded that access to highways had become a less important factor in location decisions than in the past. State-level highway investment policies that emphasized proper maintenance and relatively minor improvements were likely to be more cost-effective strategies for economic development than expensive highway construction projects.

**44.** Forkenbrock, D. J., and Plazak, D. J. (1986). Economic Development and State-Level Transportation Policy. *Transportation Quarterly, 40*(2): pp. 143-158.

*Keywords: Highway departments, public opinion, economic development, transportation policy*

One of the "other" studies reviewed by Brown (1999), Forekenbrock and Plazak examined the role of state departments of transportation in facilitating economic development. They surveyed all 50 state departments of transportation about a) their economic development objectives in programming, b) economic development funds and bonding, c) industrial park road program, and d) quick response capabilities. (Note: Montana had none of these four features). Of these, 36 states were explicitly taking economic development into account in their highway programming activities. Almost half the states (22) had special funding or bonding authority for economic development. Eleven states programs focused on making industrial parks more accessible, and eight

states included the capability for a quick response to funding requests for development-related highway projects. Examples of the latter were expedited environmental review procedures in Minnesota to readily available capital in Florida and Iowa.

The authors discussed a series of policy issues with reference to how a state could increase the competitive advantage of its communities by funding certain types of highway improvements. Specific reference was made to Iowa's Revitalize Iowa's Sound Economy (RISE) program, one of the more ambitious programs. Iowa has been experiencing the conditions that inhibit economic development including an aging and deteriorating highway system, inadequate user tax receipts, and a stressed economy. To improve the climate for economic diversification and expansion, the Iowa General Assembly established RISE in its 1985 session. The $30 million program has involved two general types of projects: one facilitates negotiations with private sector investors and the other improves local communities' potential to attract economic development.

**45.** Forkenbrock, D. J., and Schweitzer, L. (1999). Environmental Justice in Transportation Planning. *Journal of the American Planning Association, 65*(1): pp. 96-112.

*Keywords: Environmental justice, public policy, public health, GIS, Iowa, infrastructure investment, minority impacts, low income impacts, regional economic development*

Over recent decades, huge investments in transportation infrastructure have increased the efficient movement of people and goods. However, it has become increasingly clear that expanded transportation infrastructure has not benefited everyone equally. For some populations, usually low-income or minority populations, unacceptable noise or air pollution levels have made residential areas worse. The authors presented a geographic information systems (GIS) case study of Waterloo, Iowa that measured how air quality or noise production of a transportation system could disproportionately affect minority or low-income populations. The approach used in the case study applied GIS with U.S. census data and results from emission and dispersion models of vehicle-generated pollutants as well as noise propagation models. To determine whether disproportionate effects would occur, pollution and noise contours were overlaid on data representing race and income levels. By using both population characteristics and the products of computer-based models in a map format, the authors demonstrated how it is possible to determine whether air quality or noise effects would adversely and disproportionately affect minority or low-income populations.

**46.** Fox, W. F., and Murray, M. N. (1990). Local Public Policies and Interregional Business Development. *Southern Economic Journal, 57*(2): pp. 413-427.

*Keywords: Regional economic development, economic shift, business location*

One of the industrial location studies by Brown (1999), Fox and Murray conducted a comprehensive examination of the effects of different local public policies

on the business location process in Tennessee. They used a pooled, time series, cross-sectional database on firm entries in all 95 Tennessee counties from 1980 to 1986. Data on the number of entering firms were drawn from state employment files. The authors determined that the presence of an interstate highway within a county was an important location attribute that lead to higher entry rates for most firms, regardless of size. Less clear was whether interstate highways created new economic activity or simply redistributed existing activity across different sites. Firm siting decisions appeared to be sensitive to variations in local public policies because policies alter the perception of profitability and quality of life attainable at a given location. The most robust results related to long-term policies, such as the presence of interstate highways and rail highways, and educational policy, as evidence by years of educational attainment.

**47.** Fuguitt, G. V. (1971). The Place Left Behind: Population Trends and Policy for Rural America. *Rural Sociology, 36* (December): pp. 449-470.

*Keywords: Rural population growth, United States*

Fuguitt analyzed population changes in incorporated places in nonmetropolitan areas of the United States between 1950 and 1970. Although size of place distributions changed little during this period, the percentage of places growing over each decade ranged greatly by size and location groupings. Smaller, more remote places were less likely to grow. However, an emerging decentralization trend around larger nonmetropolitan centers appeared. Regions showed marked differences in patterns. In the West, places located near metropolitan areas increased the most in size.

**48.** Gauthier, H. L. (1970). Geography, Transportation, and Regional Development. *Economic Geography, 46*(October): pp. 6112-6119.

*Keywords: Regional development*

Gauthier addressed the relationship between capital investment in transportation and regional economic development. He presented an overview of the historical arguments concerning the relationship, particularly in spatial terms, but did not provide any empirical evidence as part of his argument.

**49.** Ghelfi, L. M., and Parker, T. S. (1997). A County-Level Measure of Urban Influence. *Rural Development Perspectives, 11*(2): pp. 32-41. Washington, DC: Economic Research Service, United States Department of Agriculture.

*Keywords: Urban influence, rural population growth*

An area's geographic context has a significant effect on its development. Broad economic opportunities adhere to a place because of its size and access to larger economies. Larger economies include centers of information, communication, trade and finance. Access to these centers provides the means through which the smaller economy connects to national and international marketplace.

To distinguish geographic differences in economic opportunities, the authors developed a set of county-level urban influence categories. The urban influence codes measured the importance of adjacency to the large and small metropolitan areas and the importance of the size of the largest city within a nonmetropolitan county. The categories grouped metropolitan and nonmetropolitan counties based on population and commuting data from the 1990 census. Various social and economic characteristics of counties distinguished the urban influence groups and their changes in growth patterns between the 1980s and the early 1990s.

Population growth increased more in the metropolitan areas during the 1980s. Nonmetropolitan counties adjacent to other large metropolitan areas were the fastest growing nonmetropolitan groups. These grew even faster between 1990 and 1995 than the large metropolitan areas themselves. Small metropolitan areas have since grown faster than the large metropolitan area and faster than their adjacent nonmetropolitan counties (but only slightly).

**50.** Glasgow, N. and Blakely, R.M. (2000). Older Nonmetropolitan Residents' Evaluations of Their Transportation Arrangements. *Journal of Applied Gerontology, 19* (1): pp. 95-97.

*Keywords: Elderly, rural residents, transportation, New York*

The authors examined how older, nonmetropolitan residents of upstate New York arranged their transportation during different stages of their lives. Through focus groups, the authors found that the young-old (ages 65 to 74) rural residents typically drove themselves to most of their activities. The old (those age 75 and older) depended on a broader range of transportation because they had stopped driving.

**51.** Goodwin, P. B. (1996). Empirical Evidence on Induced Traffic: A Review and Synthesis. *Transportation, 23*(1): pp. 35-54.

*Keywords: Traffic estimation, traffic flow, traffic congestion, United Kingdom*

Goodwin first summarized the studies that have indicated that providing extra road capacity has produced a greater volume of traffic. Although the amount of extra traffic has depended on the context, size, and location of road projects, Goodwin suggested that an average road improvement induces an additional 10 percent of base traffic in the short term and 20 percent in the long term. This finding was based on both urban and rural roads in the United Kingdom and was drawn from comparisons of forecasted versus observed (counted) traffic growth on improved roads. Moreover, induced traffic was particularly obvious on the alternative routes that road improvements are intended to relieve.

**52.** Green, M. B., and Meyer, S. P. (1997). An Overview of Commuting in Canada with Specific Emphasis on Rural Commuting and Employment. *Journal of Rural Studies, 13*(2): pp. 163-175.

*Keywords: Commuting flows, commuting patterns, rural employment, Canada, British Columbia, commuting distance, industry type impacts*

Understanding commuting flows and patterns between rural and urban communities is important for understanding changes in employment opportunities. Rural areas lacking job opportunities are likely to have many residents commuting to other areas, especially urban areas. Conversely, rural areas experiencing economic growth may have more residents commuting internally to surrounding areas, both rural and urban. The researchers used tabulations from the 1991 Canadian census to examine directional commuting flows for all areas of Canada. Specifically, they examined the employment, demographic, and regional variations within the rural-urban commuting flows at the spatial scale of the census subdivision. These rural-urban commuting flows constituted six types of varying distances: a) urban-rural, b) rural-urban, c) rural-rural, d) urban-urban, e) intra-urban, and f) intra-rural.

Of the six patterns, short-distance commuters comprised 57.6 percent of the total. Of these short-distance commuters, intra-urban commuters comprised over 40 percent of total commuters and intra-rural commuters constituted another 15.5 percent of the total. Of the remaining 42.4 percent considered long-distance commuters, 35 percent commuted to an urban-based job (rural to urban and urban to urban) and only 7.5 percent commuted to a rural-based job (rural to rural and urban to rural). Overall, the influence of rural settings on the commuting patterns of Canadians was disproportionately less important than the work-related attraction of urban centers. Only 23 percent of Canadians worked in rural areas and only 7.5 percent actually commuted to a rural-based place of work. Significant differences were found when the Canadian population was categorized by commuting type, industry, and region. In general, intra-rural commuting (flows very short in distance) is the most common pattern for rural-based workers, especially for work in the two most rural-based industries (agriculture and fishing/trapping). Commuting to rural areas has been most important in the Maritime provinces, the territories, and British Columbia and least important in the prairie provinces that are dominated by large cities. Canadians in their 30s and 40s have been the most likely to commute longer distances and men have been slightly more mobile than women.

**53.** Greenwood, M.J., Hunt, G.L. and McDowell, M. (1986). Migration and Employment Change: Empirical Evidence on the Spatial and Temporal Dimensions of the Linkage. *Journal of Regional Science, 26*(2): pp. 223-234.

*Keywords: Migration, employment, national economy, United States*

The authors used a unique set of data to examine the magnitude of the linkages between employment changes and net employment migration. The data were derived

from a 1 percent sample of all persons employed in Social Security-covered jobs during each year from 1958 to 1975. These data are known as the One-Percent Social Security Continuous Work History Sample (CWHS), which had only recently become available on an annual basis at the time of the authors' study. The spatial unit they used was the Bureau of Economic Analysis (BEA) economic area. The coterminous U.S. is divided into 171 such areas with each area delineating a labor market. They described a simple simultaneous system by which they obtained estimates for the 171 areas for 17 consecutive years.

Greenwood and colleagues found that in an average year, two extra jobs attracted about one additional net migrant, and one additional net migrant had a direct effect on area employment of about 1.4 jobs. These relationships differed over the 17-year cycle. The migrant-attractive power of higher annual earnings in a destination area rose during economic upswings and fell during downswings. As a result, during national economic expansion, migrants had a less direct impact on area employment than during economic recessions. In other words, on average, area migrants had a smaller impact in inducing additional job creation during expansionary periods.

**54.** Hansen, M. (1995). Do New Highways Generate Traffic? *Access: Research at the University of California Transportation Center*, No. 7: pp. 16-22.

*Keywords: Traffic estimation, trip generation, express highways, induced growth*

Advocates and opponents of new highway construction have debated the question as to whether new highway capacity affects travel behavior and hence traffic volumes for years. Established planning procedures have assumed that most extra traffic on enlarged roads has been reassigned from other parts of the network. There have also been claims that sizable numbers of new trips and net increases in vehicle miles of travel (VMT) occur. Thus, advocates have perceived a fixed number of vehicles operating in improved traffic conditions while opponents have predicted more vehicles in conditions not much better or even worse than before.

In California, the ratio of VMT to lane-miles has been larger than ever and is increasing. But it remains unclear whether increased road supply has caused that increased travel. It is impossible to determine whether induced traffic represents a net increase in regional VMT or whether it is merely redistributed from other parts of the region. Cross-sectional studies cannot deal with this problem of causality. Regional transportation models have also routinely been used to assess the effect of road supply on traffic, but these studies have usually focused on site-specific situations instead of generalizable relationships. In addition, many of their modeling assumptions have been limited in reflecting the complexity of real travel decisions and even real road capacity.

To address these problems, Hansen and colleagues studied road supply and traffic with time series data for a set (panel) of metropolitan areas. They used annual data from 30 urban counties in California from 1973 to 1990 and analyzed the data at both the county and the metropolitan levels. Their analysis focused on state highway VMT

(California systematically counts traffic on state highways) and the relationship of VMT to the supply of state highways as measured in lane-miles. With panel data, Hansen claimed they could absorb many regional variables into a single region-specific correction factor, and time-specific variables that affect traffic in all regions, such as the OPEC oil embargo, could be captured in a time-specific factor. Thus, they could control for region-specific and time-specific variables by using fixed effects and their results depended on the correlation between year-to-year variations in traffic and in year-to-year variation in lane miles. Because highway projects require years, road supply cannot respond to VMT on an annual basis. Therefore, if lane-miles and VMT grow faster over a short span of years, growth is probably not the result of road supply responding to traffic. Finally, because added lane-miles affects VMT gradually as travelers adjust their behavior, regional VMT in a given year was related to regional lane-mileage in several previous years as a distributed lag.

Hansen and colleagues found that adding lane-miles did induce substantial new traffic. At the county level, they found that a 1.0 percent increase in lane-miles induced an immediate 0.2 percent increase in traffic and a 0.6 percent increase within two years after the lane-miles were added. At the metropolitan level, the immediate effect was also about 0.2 percent but 0.9 percent increase four years later. They also estimated the contributions to VMT growth from various sources during three periods (1977 to 1980, 1980 to 1985, and 1985 to 1990). For each period, they calculated the average VMT increase for 14 metropolitan areas. They then attributed VMT growth to population, per capita income, highway lane-miles, and other factors (including declining real prices in gasoline, declining transit subsidies, and other trends affecting VMT in all regions). The most consistent source of VMT growth has been population growth. Lane-mile growth has become progressively less important as fewer lane-miles have been added to the system and per capita income has become more important, reflecting the effect of income on car ownership.

**55.** Hansen, M. (1998). The Traffic Inducement Effect: Its Meaning and Measurement, *Transportation Research Circular No. 481: Highway Capacity Expansion and Induced Travel: Evidence and Implications*: pp. 7-15. Washington, DC: Transportation Research Board, National Research Council, National Academy of Science. 46 pp.

*Keywords: Traffic estimation, induced traffic, highway capacity, express highways, travel behavior, demand elasticity, California*

Advocates of road improvements have viewed highway projects as accommodations to exogenous demand. Opponents, on the other hand, have argued that such accommodations inevitably cause more traffic in an endless cycle of road building. Hansen has claimed that this problem of mutual causality results from an economic interpretation and the fact that roads are subject to congestion effects. Elastic demand results in greater benefit if improvement of a congested system leads to an uncongested system at a new equilibrium. The negative view of induced traffic has been related to how the adjustments represented by movements along the demand curve from a

normative standpoint have been viewed. Increased demand has been associated with urban sprawl, increased fuel consumption, more emissions, and other ills. In contrast, adjustments associated with increased rail use, more focused developments, or curtailed automobile use, have been viewed more favorably. The debate over the impact of road investments on traffic levels has sometimes been characterized as one over whether roads do or do not generate traffic. However, the actual debate has not been over whether the induced traffic effect exists but its magnitude.

Hansen offers a metric measurement procedure to calculate the capacity elasticities of traffic for different points in time after the road supply changes. These elasticities are not physical constants but variables that depend on the characteristics of the region, its baseline transportation network, and the road supply change. Nevertheless, the elasticities have a central tendency, which in principle can be estimated by modeling different regions and supply changes considered representative of the populations of interest.

Following this discussion of elasticities, Hansen summarized two studies in which the capacity elasticities of traffic were estimated. Using panel data, he reduced the problem of mutual causality and presented evidence that adding road capacity generated traffic. The effect was stronger at the aggregate network level than at the individual highway segment level. Most of the response occurred within five years of the capacity expansion. He noted that the findings were subject to several caveats. They applied to urban highways for California between the 1970s and 1980s, were based on pooled data, and relied on evidence from quasi-experiments.

**56.** Harris, C. (1990). New Developments and Extensions of the Multiregional, Multi-Industry Forecasting Model. *Journal of Regional Science, 20*(2): pp. 159-171.

*Keywords: Forecasting, industry location, rural growth*

One of the industrial location studies of Brown (1999), Harris used the Multiregional, Multi-Industry (MRMI) Forecasting Model to assess how major industrial location decisions are made. He described a set of industry location equations that explained changes in output by region for 1970 to 1974 with independent variables representing components of profits. Employment growth and income growth were positively related to highway access, but the relationship was much weaker for non-metropolitan areas. Distance to a metropolitan or larger urban area was a much greater determinant of non-metropolitan growth than the presence of highways.

**57.** Hart, T. (1993). Transport Investment and Disadvantaged Regions: UK and European Policies Since the 1950s. *Urban Studies, 30*(2): pp. 17-36.

*Keywords: Transportation investment, policy, industrial regions, United Kingdom*

Hart outlined transportation investment policies for older industrial regions with higher unemployment. He examined the motivation behind such policies and compared

them with transport policies for other regions. His study involved surveying policies for transport investment in relation to lower-growth regions before and after 1974. His comparison showed growing politically and economic competition between problem industrial regions and other regions of disadvantage or growth potential. His principal conclusions were that transport policies should not be dominated by a focus on infrastructure investment. Neither inter-regional nor intra-regional transport investment will promote sustained growth in disadvantaged regions if other favorable conditions are lacking. He also claimed a skewing of transport investment towards disadvantaged regions may improve their relative position if they are well integrated with other policies to promote change in the distribution between regions of population and productivity. He predicted additional private sector finance, rail investment, and direct road pricing within future policies within the United Kingdom for transport, regional development, and environmental improvement.

**58.** Hartgen, D. T., and Kim, J. Y. (1998). Commercial Development at Rural and Small-Town Interstate Exits. *Transportation Research Record*, No. 1649: pp. 95-104. Washington, D.C.: Transportation Research Board.

*Keywords: Interstate highways, commercial development, highway access, United States*

The authors studied five commercial types of development (gas stations, convenience stores, fast food restaurants, sit-down restaurants, and motels) at 63 rural and small-town interstate exists. Geographic information system analysis determined network access and local trade area characteristics. Each development type was then classified and model estimates were compared with actual development. The relationships between interstate exits and development types are complex.

**59.** Haughwout, A. F. (1999). State Infrastructure and the Geography of Employment. *Growth and Change, 30* (Fall): pp. 549-566.

*Keywords: Highway infrastructure, public infrastructure, economic growth, redistributed growth, intrastate economic shift*

Much of the research on state public capital investment has ignored the influence of such investment on the intra-state pattern of economic activity. Because public capital investment may alter the relative attractiveness of places within states, it may redistribute economic growth rather than create it. If growth in state public capital does not provide uniform benefits to all locations in a given state, then it may impact the intra-state distribution of activities. Intra-state moves have been important since the 1980s and early 1990s when between 80 and 90 percent of residential relocations occurred within the same state each year.

Drawing data from a variety of sources including Regional Economic Information System (REIS) files, Haughwout employed regression models to analyze employment rates and infrastructure growth from 1974 to 1992 within the 48 contiguous states. Infrastructure growth included highway infrastructure using separate state highway

investments from 1943 forward.

To address the ambiguity of whether infrastructure investment causes growth or vice versa, Haughwout controlled for time by relating the growth in infrastructure for 1974 to 1983 to subsequent employment growth from 1983 to 1992. He found that state highway development was associated with substantially lower employment growth in dense, urbanized counties and concluded that state infrastructure growth served to redistribute growth from dense to less dense metropolitan area counties. Such redistributional effects are consistent with Boarnet's (1995) findings that stocks of highway capital affected the distribution of economic growth across California counties with increases in counties not proximate to the investing counties.

**60.** Heanue, K. (1998). Highway Capacity and Induced Travel: Issues, Evidence, and Implications, *Transportation Research Circular No. 481: Highway Capacity Expansion and Induced Travel: Evidence and Implications*: pp. 33-45. Washington, DC: Transportation Research Board, National Research Council, National Academy of Science.

*Keywords: Highway capacity, induced travel, Milwaukee*

Heanue defined induced travel as any increase in daily travel (measured as passenger or vehicle miles of travel) resulting from a change in the transportation system. To account for induced travel, the network and geographic context of urban travel changes needs to be considered. In most cases, a modest system change has little or no effect on the absolute number of highway trips made and/or the length of existing trips. However, if the travel measurements (counts) are limited to the main lanes of the freeway where a route shift from the outer to inner lanes may happen, a modest change might be seen to generate induced travel where in reality, little or no net additional travel actually occurs. Thus, the narrower the geographic or network scope of the measurement, the larger the chance of error in counting induced vehicular travel. Another error can occur when the redistribution of traffic in time is not considered. Travel previously done in the off-peak periods may shift to peak periods because of the added peak period capacity now available, but again, without an increase in total daily traffic. This was shown in the panel study of the Zeeburger Tunnel in the Netherlands.

Over fifty years of research suggests that a number of highly interrelated decisions impact travel including whether to travel to satisfy the activity need (trip generation), when to travel, where to go to satisfy the activity need (trip distribution), and how to travel. These decisions have in turn been influenced by the characteristics of the trip maker (e.g., income, age, etc.), the nature of the activity (e.g., work vs. shopping), and the characteristics of the transportation system (including costs and reliability). Travel decisions have been made by the universe of travelers in response to the need to perform activities in locations. Three types of factors have driven the increase in total person travel and vehicle miles traveled (VMT) in the U.S. and elsewhere. These have been demographic factors, land use factors, and stable or declining transportation costs.

In examining these exogenous factors for a "typical" American city (Milwaukee), Heanue found that regardless of the travel vs. supply elasticity analysis chosen (Cohen 1995, Goodwin 1996, or Hansen 1995), most VMT growth was directly related to factors other than changes in the highway system. Highway capacity expansion interacted with far more important variables in determining highway travel. These included population, household and employment growth, personal income, auto ownership increases, regional economic growth and fuel price changes.

Heanue claimed survey evidence has indicated that transportation is not playing as important a role in land use decisions as in prior years. The key to understanding the causal relationship between urban travel and highway capacity is to avoid attributing travel growth "induced" by changes in other causal factors (e.g., changes in the total number of trip makers) and other exogenous factors (such as gasoline prices). Good studies require traveler, system, and travel data collected continuously over a relatively long period of time for comparable populations split into two groups, those benefiting from highway supply additions and a control group for which supply did not change.

**61.** Highway Research Board. (1969). *Transportation and Community Values: Report of a Conference Held at Warrenton, Virginia, March 2-5, 1969.* HD 1664. Washington, DC: Highway Research Board, National Research Council, National Academy of Sciences.

*Keywords: Transportation, transportation planning, community values, public participation, urban transportation systems*

This report presented the transcripts of presented papers and discussions at a Highway Research Board conference on highway planning and community values. The conference focused on urban values and urban transportation issues. The generalizations obtained from the conference were several. One was that conference participants agreed that the physical, administrative and planning barriers that once separated transportation planning from the rest of the city were gone. Coordinated improvements were not just the responsibility of transportation officials but of urban specialists and public administrators as well. Second, transportation improvements were included in the entire urban crisis of the time and were augmented by urban problems such as housing, inadequate finances, and minority tensions. Third, more two-way flow of information between officials and the public was necessary.

**62.** Hills, P. J. (1996). What is Induced Traffic? *Transportation, 23*(1): pp. 5-16.

*Keywords: Traffic estimation, traffic congestion, United Kingdom*

Road improvements raise the level and alter the pattern of accessibility over the total area served by a road system. Vehicle users will respond to increased accessibility in various ways, most of which can lead to more than rather than less travel on the system. This induced traffic can be countered by the fact that as congestion spreads on the network, some travel is deterred or suppressed.

Hills defined induced traffic and related its various components to the range of responses by travelers based on the 1994 Standing Advisory Committee on Trunk Road Assessment (SACTRA) report. The set of decisions that travelers made described the mathematical procedure within the transportation model. These included: whether or not to travel at all (trip generation), which destination was best (trip distribution), when was the best time to travel (trip scheduling), which was the best mode of transport to use (modal choice), what was the best route to take (traffic assignment), whether to travel alone or with others (vehicle occupancy), and how often to repeat the journey within a given period (trip frequency). The separate choices could interact so that real life complexity made it difficult to develop reliable and accurate models of travel demand.

Using a fixed matrix of person-trips per day, the SACTRA model found several behavioral responses to the opening of a new road without any new trips being induced. These included: some drivers choosing to divert from old roads in the network to the new (change in route), more people choosing to travel in the peak period (change in timing), some people choosing to go by car rather than by bus, train, or bike (mode switch), and some existing car passengers deciding instead to use their own cars (decrease in vehicle occupancy). In general, the phenomenon of "fewer trips but further" is usually associated with increasing scale and agglomeration of land-use activity, e.g., large retail superstores, regional hospitals, etc. Overall, induced traffic due to extra miles run by vehicles diverting to new roads may not be significant in the case of bypasses to small towns or the widening or upgrading of existing trunk roads, but could well be significant where new routes are concerned.

Hills concluded that the distinctions between "induced" and "generated" traffic are important because of the following implications. One, even within the unrealistic confines of the fixed trip-matrix assumption, induced traffic nevertheless arises due to drivers choosing to travel further to use a new road in order to save travel time. Two, attempts to measure induced/suppressed traffic that rely solely on before and after counts of traffic volumes or throughputs based upon flow estimates cannot hope to capture the complexities of behavioral response to a change in accessibility. Three, the full value in terms of consumers' surplus gain accorded to induced traffic associated with existing trips is not appropriate for that arising from induced trips, for which "the rule of half" should apply. Fourth, the overall economic benefit of the road investment rises until congestion begins to set in on the network, which eventually erodes the benefits to all the traffic using it.

**63.** Hirschi, T. A., and Summers, G. F. (1982). Cash Transfers and the Export Base of Small Communities. *Rural Sociology, 47*(2): pp. 295-316.

*Keywords: Interstate highway access, population change, nonmetropolitan communities, cash transfers, planning, economic development*

One of the studies of industries reviewed by Brown (1999), Hirshi and Summers presented an export-based model of local employment growth for the 1960s and 1970s

where the export sectors were agriculture, manufacturing, inter-governmental transfer payments, and cash transfer payments to individuals. The latter was an important variable because retirees and other recipients of case transfers have been free to locate in communities of their choice. They tested their model with a sample of U.S. counties using income and employment data from secondary sources. The authors found that cash transfers had a strong, positive effect on local, nonbasic employment growth. Interstate highways (as measured by the number of interstate highway exits within a county) did not stimulate employment in nonmetropolitan, nonbasic industries. The model was discussed in the context of the "population turnaround" of nonmetropolitan communities, the growth of social welfare payments, and the economic significance of cash transfers to local communities. The authors concluded that although cash transfer payments to individuals did not reflect export production, they did reflect export circulation and were therefore important in planning for economic development.

**64.** Hoover, J. (1994). Post-Intermodal Surface Transportation Efficiency Act Public Involvement. *Transportation Research Record*, No. 1463: pp. 48-52. Washington, D.C.: Transportation Research Board.

*Keywords: Planning, public participation, ISTEA, United States*

The Intermodal Surface Transportation Efficiency Act (ISTEA) called for increased citizen participation in transportation planning and programming. Hoover reviewed a survey of all 50 states and information provided by the survey, a review of post-ISTEA literature, and FHWA documents about over 100 metropolitan transportation planning organizations (MPOs). She found that many states and MPOs responded to the ISTEA requirements in a "fairly perfunctory" manner. With notable exceptions, there was not yet "widespread enthusiastic" support for public involvement at either state or MPO levels. She recommended that planners experiment on a trial-and-error basis and not feel constrained by lack of funds but seek other sources of assistance including citizen volunteers, private foundations, and flexible funding programs. Because each community is different and every planning process varies, a single "best practice" public involvement process is not possible. However, universal guidelines include involving citizens from the very beginning, carefully planning methods of participation, including a broad mix of strategies that build on existing mechanisms as much as possible, assigning meaningful roles to citizens, focusing technical attention on issues of substantial public interest, and maintaining objectivity, fairness, and responsiveness.

**65.** Horn, J. W. (1960). *The Impact of Industrial Development on Traffic Generation in Rural Areas of North Carolina*. Raleigh, NC: Engineering Research Department, North Carolina State College. 143 pp.

*Keywords: Traffic estimation, rural development, household driving behavior, North Carolina, family characteristics*

Increasing industrial employment of rural residents in North Carolina added new traffic to rural secondary roads prior to 1960. Routes that once carried primarily farm-to-

market traffic were now carrying a large number of industrial work trips. Horn analyzed the factors that affected traffic generation from the rural home by conducting a statewide interview survey of 5,294 households. Study results indicated that family vocation and race were related to family travel. The part-time farm vocational group was the most active in averaging 4.3 trips (32.8 miles) per day. Families who worked only in business or industry were second with 3.5 trips (28.2 miles) per day. White families averaged 3.6 trips (25.6 miles) per day and non-white families averaged only 1.5 trips (9.5 miles) per days. The average length of trip for the entire study was 7.1 miles and the total average number was 3.1 trips and 22.1 miles per dwelling unit per day. Medical trips were the longest type of trip (14 miles) and shopping trips were the shortest (3.4 miles). Work trips (10 miles) accounted for 27.3 percent and shopping claimed 22.2 percent of the total trips made. There appeared to be little variation in average travel values across the state. Over 92 percent of the part-time farm families owned motor vehicles as compared to only 68.6 percent of full-time farming families. In all, approximately 78 percent of all families interviewed owned motor vehicles and each household had an average of 1.45 drivers. Of the 55 percent of the households who had family members who worked in business or industry, about two-thirds of these drove to work and 26 percent rode as passengers with someone else driving.

**66.** Horwood, E. M., Zellner, C. A., and Ludwig, R. L. (1965). *Community Consequences of Highway Improvement.* Highway Research Board NCHRP Report, No. 18: pp. 1-37. Washington, DC: Highway Research Board of the Division of Engineering and Industrial Research, National Research Council, National Academy of Science.

*Keywords: Highway bypasses, express highways, freeways, nonuser benefits, regional economic shifts*

This study was initiated in response to the increased attention on nonuser benefits of new highway construction so as to develop guidelines for highway agencies to follow in considering the community consequences of highway improvements. The authors reviewed economic impact studies based on the function or purpose of the freeway facility involved. Most of these related to bypasses, particularly in small communities. They reported averages and ranges of the values for the various parameters in relation to the size of the town bypassed. Findings indicated that no generalization could be made that bypasses aided local business in the bypassed community other than in reducing congestion or increasing pedestrian amenity. Bypasses did, however, affect communities differentially by changing the nature of trade area boundaries and by altering the relationship of one town to another. Thus, a bypass could negatively affect economic activity in one community but enhance it in another.

In addition, the authors reviewed the results and methodology of six urban circumferential studies on the effects of urban radial freeways on property values and apparent land use. These studies indicated that land values rose by proximity to a freeway in an urban radial corridor. Other studies that focused on the limited or partially limited access highway forming a radial route for commuters in relatively large urban

areas were reviewed, but generalized findings were not apparent.

A survey of ten state highway departments was also reported. The survey attempted to address the utility of the various studies conducted and the gaps in knowledge. Identified gaps related to uncertainty over methodological approaches to highway impact analysis and clearer understanding of the impacts themselves, e.g., the effects of highways on urban renewal, route adoption on right-of-way costs, land-use impacts from congestion at interchanges, and the relationship of highway development to regional economic development.

**67.** Huddleston, J. R., and Pangotra, P. P. (1990). Regional and Local Economic Impacts of Transportation Investments. *Transportation Quarterly, 44*(4): pp. 579-594.

*Keywords: Transportation, capital investments*

One of the "other" studies reviewed by Brown (1999), Huddleston and Pangotra presented an "impact assessment" framework for the regional economic analysis of transportation investments. They described a model of the variables affecting a regional economy and the types of stimuli that transportation provides for regional economies. The model included a broad array of local economic variables that may be affected by transportation investments. In summarizing the potential economic impacts that may result due to transportation investments, they noted that their survey of transportation impact studies and other literature had shown that only a few of the indicated variables were commonly used in economic impact assessment. However, they argued that it was neither necessary nor sufficient to measure or project all the variables. The choice of variables should be determined by the key economic relationships that are influenced by the introduction of the transportation investment. For any ex-post facto analysis, these variables should be incorporated in the research design and data collection methods. In an ex-ante analysis, those variables thought to be affected by the initial stimulus should be estimated and then changes in other variables should be estimated and derived. Research design guidelines are discussed. No empirical data supporting the use of the models are presented.

**68.** Humphrey, C. R., and Sell, R. R. (1975). The Impact of Controlled Access Highways on Population Growth in Pennsylvania Non-Metropolitan Communities 1940-1970. *Rural Sociology, 40*(3): pp. 332-343.

*Keywords: Nonmetropolitan population growth, controlled access highways, Pennsylvania, census/longitudinal analysis of growth*

The authors examined the impact of controlled access highways on population growth between 1940 and 1970 in all 1,815 minor civil divisions (MCDs or townships and boroughs) of nonmetropolitan Pennsylvania. This study involved a longitudinal analysis over three census periods to observe the demographic growth of nonmetropolitan places before and after controlled access highways were opened as well as impacts of

these highways from decade to decade. Using census data, the authors examined a number of variables including miles to the nearest controlled access highway interchange, distance to the nearest metropolitan community, average annual rate of growth, and population size. They found that places with highways grew faster than places without controlled access roads. The exception was those MCDs that experienced access to a controlled road during the 1940s, an era when communities were first intersected by the original Pennsylvania Turnpike. Places where highways were eventually constructed were growing faster than places without them even before the highways were opened. Nonmetropolitan places that had controlled access highways open in the 1950s had grown 1.64 percent per year during the previous decade (the 1940s) while communities without controlled access roads had grown by only .24 percent during the same period. This pattern also held for places that had highways open in the 1960s. Thus, although places with highways were growing faster, they had been doing so before highway construction.

The authors concluded that for Pennsylvania, high-speed roads augmented the population growth of less densely settled areas within 25 miles (about a one-hour drive) of a metropolitan center. These communities had the potential for "spillover" from those centers. As controlled access highways were constructed in or near them, access to the metropolitan areas improved. Thus, it was likely that low population density and a nearby controlled access highway together produced nonmetropolitan growth for these areas. The authors claimed future studies will need to address the redistribution process more specifically, particularly by collecting primary (versus secondary) data on the kinds of jobs that become available in nonmetropolitan areas, the reasons why employers are moving into those places, and the significance of controlled access highways and non-economic amenities in their decisions to move into those locations.

**69.** Kilkenney, M. (1998). Transport Costs, the New Economic Geography, and Rural Development. *Growth and Change, 29*(3): pp. 259-271.

*Keywords: Transport expenses, rural economic development, externalities, rural quality of life, rural wages*

The distances between urban population centers and rural areas are surmounted only at some cost, including transport cost. The author addressed whether these transport cost changes encourage firms and people to spread out (disperse) or to concentrate even more. She noted that high transportation costs are just one of a variety of dispersive factors including high land rents, immobile factors, and rural amenities. Concentrating factors include positive spatial spillovers and market access. Concentrative factors may be reduced and dispersion increased with the synergy of positive feedback of "people follow jobs and jobs follow people." Her economic model drew on the new economic geography models driven by demand-side assumptions, e.g., the more firms there are, the more varieties, the higher the utility, the more people want to live in the location, etc. Her simulations showed that a higher real/lower nominal rural wage could compensate for the lack of concentration in rural areas. Generally, a higher rural wage could be obtained in four ways: higher nominal rural wages, lower rural prices, subsidies, or more

positive rural externalities, that is, improved quality of rural life.

**70.** Koch, J. A., Moavenzadeh, F., and Chew, K. S. (1979). A Methodology for Evaluation of Rural Roads in the Context of Development. In T. R. Board (Ed.), Low-Volume Roads: Second International Conference. *Transportation Research Record*, No. 702: pp. 31-38. Washington, D.C.: Transportation Research Board.

*Keywords: Rural roads, development*

The authors presented an evaluation framework to account for the various socioeconomic objectives of rural transportation projects. They described utility assessment techniques to develop decision makers' preferences and to scale projects contributions to the criteria. These scaled measures of the criteria for each project were then incorporated into a single value structure as a basis for project ranking and decision-making. Weights could be assigned to the criteria or an ordinal ranking of them. This appraisal framework could be helpful in the project selection stage where a decision maker faces many potential projects and needs some means for evaluating each project's relative worth. Testing of the framework still needed to be done in the field.

**71.** Kuehn, J., and West, J. (1971). Highways and Regional Development. *Growth and Change, 2*(July): pp. 23-28.

*Keywords: Highway development, regional development, Ozarks*

Kuehn and West reviewed conflicting views about the impact of highways on regional economic development and examined the relationships between highway and economic development in the Ozarks region. The argument, they noted, has been particularly heated in the Appalachian region of persistent poverty. For example, some have suggested that the low income in the region is not due to the lack of accessibility but rather to the mix of industry, general neglect of education, poor use of natural resources, an unskilled labor force, a shortage of capital, the resistance to migration, and traditional values.

To clarify the relationship of highway and economic development in this region, the authors conducted a study of the Ozarks Economic Development Region. Secondary data consisting of highway types by years and 1959 income were analyzed. The authors found that highways did not appear to be crucial factors in explaining Ozark income variations. Highway types exhibited little or no correlation with employment rates or the percentage of the civilian labor force working outside the county of residence. The only highway type even moderately correlated with full-time employment (measured by the percentage of workers who worked 48 to 52 weeks) was local roads. Local roads and the access network were most strongly correlated with total manufacturing employment. However, highways did not appear to be a significant factor in explaining county differences in manufacturing employment. Highways were somewhat more strongly correlated with service employment. The authors conclude that highways have not been a critical factor in economic development within the Ozark Region.

**72.** Kusmin, L. D., Redman, J. M., and Sears, D. W. (1996). *Factors Associated with Rural Economic Growth: Lessons from the 1980's.* ERS-TB-1850. Washington, DC: Economic Research Service, United States Department of Agriculture.

*Keywords: Rural counties, economic growth, commuting zones, highway access*

One of the aggregate economic studies reviewed by Brown (1999), Kusmin, Redman and Sears identify characteristics of rural areas conducive to economic growth for the period 1979 to 1989. Using multiple regression analysis, they explained growth in total real earnings by place of work for nonmetropolitan U.S. counties. They found access to interstate highway interchanges contributed to earnings growth in rural areas although the relationship was not among the most important factors. Each interchange brought approximately 0.42 percent additional income growth during the period. The results may imply that highway access primarily affects the distribution of earnings growth within commuting zones. (A commuting zone is a cluster of contiguous counties grouped together on the basis of commuting patterns; thus a commuting zone may be viewed as being a regional labor market). In addition, an airport within 50 miles had a modest but significant positive effect on earnings growth in the 1980s. The presence of such an airport increased earnings growth by 2.77 to 4.18 percent. Other factors associated with improved county earnings were attractiveness to retirees, right-to-work laws, high levels of high school completion rates, public education expenditure. Factors associated with poor earnings growth included higher wage levels and concentrations of receiving transfer-payment. The mix of industries active in a county and the rate of earnings growth in nearby counties were also strongly associated with county earnings.

**73.** Lamb, R. F. (1983.). The Extent and Form of Exurban Sprawl. *Growth and Change, 14*(1): pp. 40-47.

*Keywords: Exurban sprawl, population growth, government incentives/disincentives, land use factors, U.S. Census*

One of the studies of spatial effects reviewed by Brown (1999), Lamb discussed the concept of sprawl as it related to exurban areas, or rural countryside situated on the edge of expanding urban areas. Land use planning for exurban areas typically has tried to control unorganized sprawl through various types of concentrated development because of the problems associated with sprawl, including traffic problems and how they affect local development. Using U.S. census population density data and regression models to construct a concentration index, the author provided a measure of the extent of exurban sprawl and indicated ways in which it can be more effectively controlled.

He concluded that the most promising exurban centers, those in the 2,500-to-9,999 population range, were able to absorb only about 13 percent of the total exurban population increase during the 1960s. In addition, the older, more densely populated centers of the Northeast and North Central regions and parts of the South are unlikely to absorb future exurban population increases without extensive revitalization efforts. No significant relationship was found between a place's distance to an urban area and the

success of exurban centers in absorbing population increases. Because of the rural renaissance of the 1970s, there has been the prospect of continuing growth not only within exurbia but also in traditionally rural areas. Lamb concluded that public dollars should not be spent on programs that encourage or subsidize sprawl. Rather, resources should be spent on villages or small cities to contain and control growth.

**74.** Lash, M. (1965). Community Conflict and Highway Planning: The Case of a Town That Didn't Want a Freeway. *Highway Research Record,* No. 69: pp. 1-17.

*Keywords: Public involvement, attitudes, freeways, value conflicts*

This case study reflected the types of community conflicts that have developed when a new freeway is proposed through an urban area. The case study described the events and the conflicts that developed over a period of 12 years between a state highway department and a local community over the choice of a freeway location through that city. The author presents the fundamental questions that arise with the location of every new highway in an urban area. Many of the conflicts were over basic differences in values that cannot be easily resolved. e.g., the number of homes that would be razed for the freeway was an intolerable price to pay to solve the traffic problem for some. Some officials also felt it their duty to protect the quiet atmosphere of the town against the dense land development pressures they believed would come with the construction of the freeway. These objectives were not compatible with those of state highway department officials who believed that the traffic congestion would plague the community until it was solved regardless of officials' willingness to tolerate it. The highway gave them an excellent opportunity to solve several transportation problems at once at little added cost. For those trying to see the situation objectively, the inadequate information available was frustrating. Without complete information and informed debate on the objectives, the conflict continued. The author suggested these needs inform approaches that can be used to encourage more constructive public debate.

**75.** Lee, D. B., Klein, L. A., and Camus, G. (1999). Induced Traffic and Induced Demand. *Transportation Research Record,* No. 1659: pp. 68-75. Washington, D.C.: Transportation Research Board.

*Keywords: Traffic estimation, traffic flow, induced demand, induced traffic*

Lee, Klein, and Camus addressed the research problems of appropriately conceptualizing "induced demand". In the case of traffic volumes, "induced demand" has been used to describe the phenomenon that highway improvements, especially capacity improvements, often result in more traffic choosing to use the road than would have been the case if the highway had not been improved. However, the authors argued that induced demand has not been specifically defined nor adequately operationalized for accurate modeling. They defined "induced" as referring to a movement along a travel demand curve as a result of changes in endogenous factors such as travel time and other user costs. The measurement of induced travel depends on the market for which the demand curve is defined. Induced travel defined at the facility level will include traffic

diverted from parallel routes. Induced travel at the regional level will include only trips that are new to the region. A useful distinction is one between short-run and long run demand. Movement along the short-run demand curve amounts to induced traffic, but movement along the long-run demand curve is a shift in the short-run demand or induced demand. They argued that selecting the relevant demand curve is then an analytic choice.

Using the FHWA's Highway Economic Requirements System (HERS) model, they evaluated highway improvement projects using benefit-cost analysis by incorporating the effects of short-run traffic volume on changes in generalized price, long-run land use, and other economic "feedback." They used this improved HERS model to prepare the 1997 "Conditions and Performance" report to Congress.

**76.** Lichter, D. T., and Fuguitt, G. V. (1980). Demographic Response to Transportation Innovation: The Case of the Interstate Highway. *Social Forces, 59*(2): pp. 492-512.

*Keywords: Interstate highway access, population change, nonmetropolitan communities, employment growth, net migration, employment characteristics, population characteristics, railroad comparison, U.S. Census, industry type (service) impacts*

One of the studies of industries reviewed by Brown (1999), Lichter and Fuguitt investigated the relationships between date of completion of an interstate highway and employment and population characteristics for all nonmetropolitan counties in the coterminous U.S. The authors noted that transportation improvements had spurred population growth in the U.S. since the nineteenth century with the expansion of the railroads. In addition to bringing population growth in previously remote areas, the railroads also created significant nodal growth at the intermittent points along their routes. In contrast to railroads, the expansion of the interstate highway system beginning in the mid-1950s has had a much less nonequivocal role in bringing population growth to remote areas. The authors claimed that the lack of clear evidence of a population growth-inducing effect by the interstate highway system has resulted from several factors including a) the regional or case study design of many studies, b) the failure to adequately link date of completion of a highway with subsequent growth for more than one period of time, c) the failure to adequately control other variables that affect the relationship between highway expansion and growth, and d) the failure to specify a system of relationships among economic growth, population change, and accessibility to a controlled access highway.

To surmount some of these limitations, Lichter and Fuguitt examined the relationship between the date of completion of an interstate highway and changes in nonmetropolitan county population and employment characteristics during three time periods: 1950 to 1960, 1960 to 1970, and 1970 to 1975. Data were obtained from the U.S. census and analyzed through path analytic procedures to decompose direct and indirect effects of interstate highways. Population growth was greatest in interstate highway counties, and counties located on interstate highways before 1960 had the largest average population at each of the four dates considered (1950, 1960, 1970, and

1975). It also appeared that interstate highways were constructed in counties that in prior periods had experienced higher than average rates of net migration. In contrast to noninterstate highway counties, interstate counties had higher net migration and employment growth as direct effects of highway completion. The employment effect has grown over time since the difference between being on an interstate highway, and being off, was greater for 1960 to 1970 than from 1950 to 1960. The authors found that the net migration change was greatest in interstate highway counties in less remote areas. They suggest that this direct effect resulted from the indirect effect of service employment growth.

**77.** Liew, C. K., and Liew, C. J. (1984). Measuring the Development Impact of a Transportation System: A Simplified Approach. *Regional Science and Urban Economics, 14* (2): pp. 75-198.

*Keywords: Transportation models, input-output analysis, regional economy, Alabama, economic growth*

One of the studies of industries by Brown (1999), Liew and Liew introduced a methodology for measuring possible economic development impacts arising from a proposed transportation system in Alabama. They used a Multi-Regional Variable Input-Output model to empirically estimate future local and regional industrial output, personal income, and employment effects for 31 industries over a 40-year period. The authors concluded that the proposed transportation project would reduce the cost of shipping commodities, which would stimulate the economy of the region and the rest of the state.

**78.** Litman, T. (1999). *Generated Traffic: Implications for Transport Planning.* Victoria, British Columbia, Canada: Victoria Transport Policy Institute. 20 pp.

*Keywords: Generated traffic, traffic congestion, road capacity, population growth*

This report is an extensive review of the economic and planning literature on generated traffic and transport planning. In addition to synthesizing the literature, the author analyzed several planning models using economic sensitivity analysis and generalized data from his review. His review of the literature indicated that traffic congestion tends to reach equilibrium at which point it constrains additional growth in peak-period trips. If road capacity increases, the number of peak-period trips also increases until equilibrium is reached. The additional travel between the point of road capacity increasing and traffic equilibrium is generated traffic, which consists of diverted traffic (trips shifted in time, route, and destination) and induced traffic (shifts from other modes than vehicles, longer trips, and new vehicle trips). Thus, generated traffic can significantly contribute to filling new road capacity. The effects of generated traffic can reduce predicted congestion reduction benefits of road capacity expansion, increase external costs due to changes in transportation choices and land use patterns, and provide relatively small user benefits because of vehicle trips that consumers forego. Thus, failing to consider generated traffic in transport planning tends to overstate the benefits of road capacity expansion and undervalues alternatives. Generated traffic can be

categorized as diverted travel, induced vehicle travel, and destination changes. In the short term, most generated traffic consists of trips diverted from other routes, times, and modes. Over the long term, an increasing portion consists of induced travel, a large part of which occurs on roads with no added capacity, e.g., a new highway may encourage households and businesses to locate in suburban and exurban areas. These indirect impacts are difficult to quantify but are potentially large. Generated traffic can also work in reverse as when an urban roadway capacity is reduced and previous vehicle traffic is diverted elsewhere.

The author summarized studies that have estimated the range of generated traffic. The more congested a road system is, the more traffic is generated by increased capacity due to high levels of latent demand. Typically, more than half of added urban road capacity is filled by additional vehicle trips that would not otherwise occur within five years of project completion. To accurately predict generated traffic, planners must use full feedback on diversion to other routes, times and modes and changes in trip length and frequency. Most planning models currently account for diverted traffic but do not account for the long term effects of induced vehicle travel, especially changes in trip frequency, as well as the effects transportation decisions have on land use. Full feedback models are necessary to accurately predict future traffic congestion and speeds as well as accurate costs and benefits of projects. Without full feedback, models tend to overestimate both future congestion reduction and the benefits of road capacity expansion.

In addition, incremental external costs of generated traffic need to be included in project planning. Incremental costs are the difference between the external costs of the generated travel and the external costs of alternative activities. These can include subsidized parking fees, accident damages, and environmental damages. Incremental external costs depend on road system conditions and the type of generated traffic. Costs can be reduced or increased depending on the degree to which traffic is concentrated within the network and the number and type of travel alternatives available. Diverted trips have minimal incremental costs, longer trips have moderate costs, and induced trips have the largest incremental costs. Incremental costs are difficult to quantify but significant. The incremental external costs of road capacity expansion tend to increase over time as the total amount of generated traffic grows and induced travel increases.

Generated traffic also represents benefits in the form of increased mobility. However, these benefits tend to be modest because generated traffic consists of marginal value trips or those trips people are most willing to forego. The benefits of increased mobility are often capitalized into land values. Comprehensive land use/transportation models such as TRASNUS and MEPLAN track transport benefits through their impacts on land values.

Litman tested his arguments by using sensitivity analysis on three cases employing different assumptions about road expansion costs and benefits. The first case used assumptions most favorable to the project, the second, values considered most likely, and the third, assumptions least favorable to the project. The first case resulted in

a positive cost/benefit ratio even when generated traffic was considered. The second case resulted in a positive cost/benefit ratio if generated traffic was ignored and a negative ratio if it was included. The analysis indicated how generated traffic could significantly impact project assessment. Ignoring generated traffic exaggerated the benefits of road capacity expansion by overestimating congestion reduction benefits and ignoring incremental external costs.

These claims were then evaluated from the perspective of counter arguments about the importance of generated traffic in highway planning. Such arguments hold that increased road capacity contributes little to overall growth in vehicle travel compared to other factors such as increased population, employment, and income. The researcher claimed that these arguments ignored critical issues such as the cost effectiveness of particular projects and whether users were willing to pay the full incremental costs their travel activities imposed. Thus, while highway projects are often justified for the sake of economic development, recent studies have indicated that highway capacity expansion may provide few net economic benefits. Other solutions to transportation problems may become relatively more attractive. Examples of these include congestion pricing, commute trip reduction programs, land use management to bridge common destinations, pedestrian and cycle improvements, and public transit.

**79.** Llewellyn, L. (1975). The Role of Social Impact Assessment in Highway Planning. *Environment and Behavior, 7*(3): pp. 285-306.

*Keywords: Citizen participation, social impact assessment, federal highways, FHWA, NBS- National Bureau of Standards*

In 1973, the Federal Highway Administration (FHWA) asked the National Bureau of Standards (NBS) to conduct a 26-month study of the social and environmental effects of highway location alternatives. The NBS conducted interviews with officials of nine state highway departments, one from each of the FHWA regions. The authors found that federal regulations had outpaced a state's capacity to predict accurately the social impacts of new and improved highways. Confusion over the term "social" had also precipitated a cautious approach in preparing environmental impact statements. The lack of concrete guidelines indicating the scope or amount of coverage that had to be given to the social effects of an individual highway project was a problem. The authors also found that despite implementation of some innovative citizen participation programs, an adversary relationship still often prevailed between the highway department and the public.

**80.** Mackie, P. J. (1996). Induced Traffic and Economic Appraisal. *Transportation, 23*(1): pp. 103-119.

*Keywords: Traffic flow, traffic estimation, congestion, induced traffic, UK economics*

A central assumption of economic appraisal of major UK roads has been that the volume and pattern of traffic in any given year is independent of the quality of service offered by the network, i.e., that demand is fixed or the fixed trip matrix (FTM)

assumption. The authors claimed that because of projected traffic growths, the FTM methods will become increasingly problematic. Thus, the crucial question for road investment policy is how well an FTM assumption approximates reality. More accurate forecasts through variable demand methods (VDM) at scheme level are required for consistent traffic as well as realistic economic and environmental assessments. VDM methods incorporate local phenomena more explicitly than regional FTM methods. Examples of VDM schemes were presented and the policy implications for assessing road improvements in terms of induced traffic and economic and environmental performance were addressed.

**81.** Marshall Kaplan Gans and Kahn. (1972). *Social Characteristics of Neighborhoods as Indicators of the Effects of Highway Improvements*. Contract No. FH-11-7789. Washington, DC: Federal Highway Administration, United States Department of Transportation.

*Keywords: Express highways, neighborhood activity, highway improvement, California, Massachusetts,*

This report addressed the social effects of highways on patterns of neighborhood activity and pedestrian dependence. The authors developed a social feasibility model to use at early stages of corridor location decisions. The model relies on secondary data and is based on known social effects from four case study neighborhoods adjacent to two freeways in Worcester, MA and Oakland, CA. The neighborhoods included a range of income, racial, ethnic, mobility, and age characteristics. The activities identified included shopping, work, schools, churches, clubs, fire, police, and community services. Each pattern was measured for access, support, and user characteristics.

The comparative before and after freeway analysis in the four case studies indicated that the most significant variables determining the social effects of highways were dependence on pedestrian access, vitality of activities prior to the construction of the freeway, and the degree of physical impact on the neighborhood. Elements of highway physical impact in the case study neighborhoods included cutting off local streets and impeding access to an activity, dividing a set of related activities into two or more parts and thus weakening the whole, increasing traffic around on-off ramps and thus making access to certain facilities more dangerous, and building a large highway facility at a point where it isolates part of the neighborhood. Case study analysis indicated that highway social effects could be minimized if these alignment decisions take into account neighborhood activity patterns and the preservation of pedestrian access to neighborhood-based activities.

**82.** McGranahan, D. A. (1999). *Natural Amenities Drive Rural Population Change*. ERS-AER-781. Washington, DC: Economic Research Service, United States Department of Agriculture. 32 pp.

*Keywords: Natural amenities, population change, retirement, recreation.*

Since 1970, population change in rural counties has been strongly associated with their attractiveness as places to live. Attractiveness can be summarized in three types of amenities: mild climate, varied topography, and proximity to surface water such as lakes and coastlines. Rural county population change and the development of rural recreation and retirement-destination areas are all highly related to a single index of these three natural amenities. This relationship between population growth and natural amenities is much stronger than other location measures such as the rural-urban continuum code. Demographic data have indicated that natural amenities are more important to population growth in rural areas than proximity to urban areas and the size of the largest settlement within the county. This relationship is a result of indirect effects of desirability for retirement or recreation. Although employment growth is also highly related to areas with higher-ranking natural amenities, it varies much more across these counties than does population growth. This may be a result of the seasonality of recreational industries.

**83.** McHugh, R. J., and Wilkonson, J. T. (1988). A Random Effects Approach to Substate Growth Models: A comment on 'The Determinants of County Growth'. *Journal of Regional Science, 28*(2): pp. 271-273.

*Keywords: Limited access highways, economic impact*

One of the aggregate economic studies reviewed by Brown (1999), McHugh and Wilkonson provided an alternative estimation technique to that of Carlino and Mills (1987). They argued that a simple random effects model more clearly accounted for the determinants of county-level population and employment growth during the 1970s. Nevertheless, they agreed with Carlino and Mills that total employment, manufacturing employment, and population density were positively affected by the presence of limited access highways. They disagreed with Carlino and Mills in that their simple random effects model found the level of unionization was a significant determinant of employment growth and that local taxes had a larger effect on population density.

**84.** Michigan State University. (1961). *Economic and Social Effects of Highway Improvements; A Summary*. East Lansing, MI: Highway Traffic Safety Center, Michigan State University. 129 pp.

*Keywords: Highway improvements, land use, land values, retail business, settlement patterns, Michigan*

The authors identified an inventory of economic factors influenced by highway development and compiled a series of research studies that reported the relationships between various economic factors and highway development. In terms of the national

economy, highway development is itself an economic activity and thus affects economic trends. Highway improvement also increases the efficiency of transportation costs and affords access to lands. Improvement or extension of the access service tends to impact land use and land values. The studies in the report analyzed and determined the kind and extent of certain highway improvements on land uses, land values, retail trade, community growth, and settlement patterns over large areas of Michigan. The studies found that if highway improvements facilitate higher types of land use or make existing use more profitable, land values will generally increase depending on the phase of the improvement and the development stage of the affected area. The largest changes in land value occurred when large tracts of farmland were subdivided for residential or other more intensive use. There was relatively little change in the smaller, or already subdivided, parcels. Early industrial and commercial developments made the area less attractive for residential use.

Studies that investigated the impact of highway improvements on retail businesses found that these businesses depended on immediate proximity to major highway routes. Sales before and after through traffic was diverted to a relocated or by-pass highway were analyzed. Highway-oriented establishments such as gas stations and restaurants were negatively impacted, but retail business in most of the by-passed cities made relatively greater gains than in the state as a whole, i.e., if business gained, it increased more than the state average and if it declined, the decline was less. In general, the studies' findings indicated a pattern in which each city reaches out beyond its borders to form a web-like pattern that follows the alignments and inter-connections provided by the major highways. This pattern predicts the shape of the future pattern of settlement within Michigan. Locally, urban population will become more dispersed, but on a statewide basis, it will become more concentrated in the southern half of the Lower Peninsula, which is geographically dominated by the diffusion and dispersion of its cities.

**85.** Miller, G. H., Jr. (1995). Dynamics of the U.S. Interstate Migration System, 1975-1992. *Growth and Change, 26*(Winter): pp. 139-160.

*Keywords: Migration efficiency, population redistribution, economic change, interstate migration, population planning*

The interrelationships between patterns of interstate migration and how those patterns relate to national economic change and spatial patterns of economic activity were the focus of this research note. In particular, the author questioned whether the redistributive power or effectiveness of population migration responded to short-term economic change. Determining whether the redistributive power of migration is greater in periods of expansion or contraction could help planners in both the public and private sectors. Miller presented an extension of McHugh and Gober's (1992) study by using annual state-to-state migration flow data from Internal Revenue Service records to measure migration efficiency (rates) and changes in U.S. migration patterns. He found that after the economic upheavals associated with the boom (that crested in 1981 and 1982) and bust (1987 and 1988) of the energy industry, national migration reverted to the earlier and less dramatic levels of the mid-1970s. Miller concluded that although a new,

significant pattern of population redistribution emerged in the U.S. in the 1980s as reported by McHugh and Gober, it was transitory. His findings did not support McHugh and Gober's conclusion of an inverse relationship between migration effectiveness and economic expansions and contractions.

**86.** Nadiri, M. I., and Mamuneas, T. P. (1996). *Contribution of Highway Capital to Industry and National Productivity Growth.* GPO 0982-G-05. Washington, DC: Office of Policy Development, Federal Highway Administration, United States Department of Transportation. 128 pp.

*Keywords: Express highways, highway capital, national economic growth, industry type impacts*

This study assessed the economic contribution of highway capital on the U.S. economy. The authors estimated a model using industry data covering the entire U.S. economy and derived aggregate estimates of the effects of both demand and supply factors as well as highway capital on the movements of aggregate productivity growth at the national level. In doing so, they obtained the marginal benefits of highway capital stock in each industry and its contribution to industry productivity growth as well as the aggregate marginal benefit of highway capital to output and productivity growth for the economy as a whole.

Two measures of highway capital were used: total highway capital (including roads under federal, state, and local government jurisdiction) and the stock of upper level roads excluding local government investments in roads and streets. The latter included the federal highway system with the exception of expenditures on secondary rural roads and is referred to as the non-local highway system (NLS); this represented approximately 70 percent of total highway capital stock. To address the major economic impact objectives of the study, the authors developed an analytical framework and econometric model and collected primary data to estimate results. The primary data included a cross-sectional time series of prices and quantities of output and inputs for 35 industry sectors for the period 1950 to 1989. Collectively, these industries represented the U.S. economy and provided the basis for estimating the contributions of various factors to the growth of output and productivity.

The data included measures of gross output, material inputs, and private capital and labor. Demand and supply (cost) functions for each industry were estimated, and the determinants of productivity growth for each industry including the contribution of highway capital were identified. The marginal benefit of highway capital to each industry was also specifically measured. Two specific approaches were used to generate aggregate measures for the whole economy. The authors used an aggregated approach with a weighted sum of individual industry elasticities to obtain aggregate elasticity measures for the whole economy. In contrast, they also used an aggregate approach by fitting the model to aggregate data obtained by adding industry data. The results of the two approaches were compared and the total growth was decomposed into its various components. They also calculated the net social rate of return to highway capital and the

ratio of optimal to actual stock of total highway and NHS capital to examine whether there had been any over- or under-investment in highway capital or NHS capital over the postwar period reviewed. The rates of return to NHS capital were generally higher than those for total highway capital, and therefore the sum of marginal benefits from NHS capital was larger than that for total highway capital. Both exhibited similar patterns of return rates over time.

Specifically, the authors found that total highway capital and NHS capital contributed significantly to economic growth and productivity at both the industry and national economy levels. Their contribution varied across industries and over time. The elasticity of output at the aggregate level was stable and about 0.05, which was much smaller than comparable estimates previously reported in the literature. The authors found some evidence of a mild degree of increasing returns in most industries and at the national level. The marginal products of labor, capital, and intermediate inputs varied across industries and the output elasticity of labor was generally the largest. At both the industry and national levels, the elasticity of private capital dominates that of total highway capital or NHS capital almost fourfold, e.g., one dollar of private capital was worth four dollars of public capital. This result contrasted sharply with previous findings that indicated an additional dollar of public investment was substantially more productive than a corresponding dollar of private investment.

The authors also found that total highway capital and NHS capital had a significant effect on employment, private capital formation, and demand for materials inputs in all industries. At a given level of output, an increase in highway capital and NHS capital lead to a reduction in demand for all inputs in manufacturing while the pattern was mixed in non-manufacturing sectors. The main effect seemed to be to reduce the demand for private capital and labor in the majority of industries. In addition, the marginal benefits of total highway and NHS capital at the industry level were negative for all non-manufacturing industries. This suggests that for these industries, the existing stock of highway capital may be oversupplied.

In general, the authors found that the net social rate of return on total highway capital was high (about 35 percent in the 1950s and 1960s), but the social rate of return has declined considerably since and was only 10 percent in the 1980s. The same pattern held for NHS capital although the net social rates of return were higher. For both measures of highway capital, the social rates of return were lower than those previously reported in the literature. In the 1980s, the rates of return on total highway capital and private sector capital seemed to have converged and were basically equal to the long-term rate of interest. The authors concluded that the ratio of the optimum to actual highway capital (measured by total or NHS capital) was high at the beginning for the period until the 1960s and then declined as the construction of the interstate highway system was completed. By the end of the 1980s, they found no evidence of either under- or over-investment in highway capital. In all, the contribution of highway capital to total economic growth was positive in almost all industries (except some non-manufacturing sectors) because highway capital has been over-supplied. Thus, the contribution of highway capital to the trend in U.S. economic productivity growth is relatively small and

contributes little, if any, to short-term fluctuations in growth.

**87.** National Association of Development Organizations. (1998). *NADO Rural Transportation Survey Results*. 8 pp.

*Keywords: Rural transportation, planning, United States, National Association of Development Organizations (NADO)*

In July 1998, the National Association of Development Organizations (NADO) surveyed 250 regional development organizations that served small metropolitan and rural communities about their role in rural transportation planning and programming. Findings from the survey indicated that 23 of 39 states that responded to the survey had established a process the involved regional development organizations in the statewide transportation planning process for rural areas. Sixty-three percent of regional development organizations that were involved the state transportation planning processes were satisfied with the current process; 32 percent were not. The strengths of the state rural planning process were involving regional planners and local elected officials and thinking beyond roads and bridges to include intermodal projects. Challenges identified in the survey were lack of funding, differences between engineers and planners, public involvement, and adjusting to new partners and processes.

**88.** Palmquist, R. B. (1982). Impact of Highway Improvements on Property Values in Washington State. *Transportation Research Record,* No. 887: pp. 22-29. Washington, D.C.: Transportation Research Board.

*Keywords: Property values, highway improvements, Washington*

Palmquist examined the effects of major highways on the value of surrounding properties. Data were derived from 9,349 sales records and 383 interviews with owners of homes and businesses for five study areas in Washington. In each of the five areas, a quality-adjusted price index was constructed and then compared for the years during which a highway was opened and for a comparable area not affected by highway change. Improved highway access to residential areas resulted in property value increases of 15 to 17 percent greater than those comparable properties that lacked the access advantage. Even in areas where the highest noise level readings, highway accessible property appreciation offset the noise-induced depreciation. The author concluded that these findings indicated that improvements in accessibility and timesavings were reflected in residential property values. The extent to which this effect occurred, however, depended on the degree of the accessibility improvement, especially in regard to work trips. Where the improvement was substantial, property values increased by 12 percent or more. However, when few residents saved time in their commuting trips, property values appreciated little because of the highway. Thus, the accessibility improvement should be estimated when planning highway improvements.

**89.** Payne-Maxie Consultants. (1980). *The Land Use and Urban Development Impacts of Beltways: Executive Summary*. DOT-P-30-80-38. Washington, DC: Office of Community Planning and Development, Federal Highway Administration, United States Department of Transportation. 173 pp.

*Keywords: Urban policy, express highways, limited access highways, freeways, land use, United States*

Beltways are limited access highways partially or completely circling cities. During the construction of the Interstate Highway System in 1940s and 1950s, beltways were considered primarily bypass highways to carry through traffic around central cities. With post-war suburbanization of housing and employment, beltways became important links between suburbia and cities. They became increasingly important in affecting location and development decisions, but research by the 1960s had largely ignored their regional impact on land use and economic development. This study aimed to assess the impacts of beltways on land use and urban development. In addition to the Executive Summary summarized here, it includes the Guidebook, Case Studies, and a Final Report. The Guidebook proposes a specific assessment methodology and shows how beltways can be a positive element in community development. The remaining publications, the Case Studies and Final Report, describe the study in detail.

The study consisted of three parts: a) a survey of the relevant literature, b) a comparative statistical analysis of 54 metropolitan areas (27 with beltways and 27 without), and c) eight detailed case studies of beltway cities. The latter included interviews with 104 local informants. The comparative statistical analysis indicated that beltways did not necessarily improve a metropolitan area's competitive advantage but did contribute a small, positive effect to population growth during the 1960s (but not the 1970s).

In all, various attributes were found to influence a beltway's effects on the surrounding community. A complete loop beltway did not produce higher traffic volumes than a partial circumference highway, but location and interchange spacing significantly affected land use and urban development in the belt corridors and the metropolitan area at large. Closely spaced interchanges and frontage roads attracted more development to a beltway corridor than widely spaced interchanges because of increased accessibility. Without coordinated land use and transportation planning, a beltway increased traffic on intersecting local streets and radial highways in the corridor because of development patterns and accessibility. Highly accessible interchange areas offered valuable opportunities for commercial and industrial development. These development opportunities reinforced prevailing urbanization patterns and facilitated compact development. Beltways appeared to affect the timing, location, size, and initial success of regional shopping centers, but they were not critical in determining their success. Differences in housing patterns between beltway and non-beltway cities were not significant.

The study also found several attributes that beltways contributed to land use.

Most economic and land use effects of beltways represented transfers of activity from one area to another within the same metropolitan area. This affected the economic and fiscal health of individual jurisdictions, particularly in the absence of compensating measures such as tax revenue sharing or annexation. Planning policies proposed to manage corridor and interchange development did not receive much political support. Water and sewer service policies were rarely coordinated with beltway planning efforts. Finally, annexation and infrastructure financing policies had far greater impacts on suburban development than the presence of a beltway.

The general political and social effects of beltways included facilitating suburbanization of population and employment. In doing so, beltways in most cases did not benefit disadvantaged and low-income residents since the majority of these people lived in central cities. Suburban beltways drew activity out of central cities and thus negatively affect the tax base for the cities to deliver needed social services. Similarly, by attracting industrial development to outlying areas, beltways reduced job opportunities for inner city residents. Finally, beltways did not increase the rate of suburbanization.

**90.** Peters, Alan and MacDonald, H.J. (1994). The Worktrips of Rural Nonmetropolitan Women in Iowa. *Growth and Change, 25*(3): pp. 335-253.

*Keywords: Commuting behavior, rural women, worktrips, commuting decisions, transportation resources, Iowa*

Rural nonmetropolitan labor markets in the U.S. have experienced significant restructuring and have altered family economies and community work patterns. Rural women began to heavily participate in the labor force in the 1980s. Since, the level of their participation has reached approximately the same level as urban women. The authors conducted a study of the worktrips of rural women in several nonmetropolitan counties in eastern Iowa. They found that the most important variables in affecting women's commuting decisions were job incentives, job structure, and transportation resources.

**91.** Planning Environment International. (1975). *A Study of Social, Economic and Environmental (SEE) Impacts and Land Use Planning Related to Urban Highway Tunnel Location: An Annotated Bibliography*. McLean, VA: Environmental Design and Control Division, Voorhees (Alan M.) and Associates Inc. and JRB Associates Inc. Unpaged.

*Keywords: Freeways, tunnels, social impacts*

The authors prepared this bibliography as part of a social, economic, and environmental impact assessment related to urban highway tunnel location. The bibliography focused on the unique impact of tunnels in urban areas. Eight key references were drawn from this bibliography for inclusion in this review of the literature.

**92.** Rephann, T. J., and Isserman, A. M. (1994). New Highways as Economic Development Tools: An Evaluation Using Quasi-Experimental Matching Methods. *Regional Science and Urban Economics, 24*(6): pp. 723-751.

*Keywords: Spatial analysis, interstate highways, population growth, economic growth*

One of the studies of spatial effects reviewed by Brown (1999), Rephann and Isserman examined the effectiveness of highway investment as an economic development tool. The argument they addressed was whether highways were a "necessary" or a "sufficient" condition for economic development. They used a quasi-experimental matching method to examine the effects of interstate highways on counties that obtained interstate highway links (or were in close proximity to these newly linked counties) during the period 1963 to 1975. Such counties were matched with "twin" counties that had not experienced such links.

Findings indicated that highway construction affected overall county economic and population growth, but it did not induce a local boom period characterized by broader sectoral effects. In general, economic growth of counties with interstate highways was greatest for those close to large cities or those that had experienced some degree of prior urbanization (such as a city with more than 25,000 residents). "Interstate counties" that were isolated or rural experienced few positive benefits. The authors concluded that the distinctive spatial elements make interstate highway investment different from most other public investment. One, highway investment affects many types of regions and it is not concentrated at a single point in improving economic welfare, i.e., highways must necessarily cross low-density regions with limited economic development potential. Two, new highways affect market boundaries, commuter sheds, and residential choices. Their principal effects are to foster changes in residential location and the location and viability of private and public services. Thus, interstate highways centralize and disperse effects far more than other forms of public infrastructure, including local roads.

**93.** Richardson, B. C., and Kostyniuk, L. P. (1998). Method for Including Societal Issues in Transportation Decisions. *Transportation Research Record*, No. 1626: pp. 140-148. Washington, D.C.: Transportation Research Board.

*Keywords: Transportation Planning, citizen participation, decision-making models, Michigan*

The authors presented a multiorganizational decision analysis (MODA) process to include social and institutional issues in transportation decision. The MODA model is a modification of decision risk analysis methods and considers the diversity of decision makers in transportation improvement decisions. MODA structures a set of interactions among a decision-making team, an analysis team, and facilitators. The steps include a shared vision statement, framing of the problem, generation of alternatives, analysis of alternatives, and a decision. Consensus by decision makers is required at each step of the process. The authors tested their MODA model on the decision of whether a hypothetical community that represented communities in southeastern Michigan should upgrade its

paratransit service to include intelligent transportation technology. The authors presented the use of the model and its validation with the decision makers involved in the hypothetical decision.

**94.** Sanchez, T. W., Dueker, K. J., and Rufolo, A. (1987). Geographic Information Systems Methodology for Assessing Growth Effects of Highway Improvements. *Transportation Research Record,* No. 1660: pp. 76-83. Washington, D.C.: Transportation Research Board.

*Keywords: Highway corridors, zoning, land use, spatial analysis, Oregon*

Previous studies have indicated that investments in road infrastructure are sufficiently large in most urban areas that marginal investments appear to have little impact on the rate of local economic growth but the impact of road improvements on land development is not well understood. The land use impact of road improvements in a rapidly growing area is more likely to accommodate a level of development that otherwise would not have been feasible. The goal of this study was to identify the relationship between capacity-increasing highway improvements and changes in land use intensity over time.

The authors presented a methodology to assess the induced land use effects of state highway improvements on urban development patterns and applied it to the case study city of Hillsboro, Oregon, a suburban community in the Portland metropolitan area that had experienced extensive population growth and urban development between 1970 and 1990. They used temporal land use characteristics and spatial measures (digitized aerial photographs) as predictors of urban development activities resulting from highway accessibility improvements. They then applied a logit regression analysis to test the significance of these variables in predicting the locations of urban development over time. Their analysis provided quantifiable indicators that described the urban development trends associated with Hillsboro.

Findings indicated that all other factors constant, development activity was most likely to occur at approximately 1.67 km from the nearest highway project. Thus, state highway projects appeared to be providing accessibility through the highway system and enabling regional development. The urban status of surrounding properties and the zoning classification had significant effects on whether a particular location was developed for urban purposes. Land was more likely to be developed if surrounding properties were developed, and land zoned for single-family residential and commercial land uses was more likely to be developed compared with land zoned as industrial or rural. These results suggested that rural and agricultural designations had generally inhibited development, whereas growth accommodating commercial and residential zones was associated with changes in urban land uses. Another possible interpretation is that the land was zoned in anticipation of the future type of development. Of most significance in the analysis was that urban development in Hillsboro had not clustered along the state highway project corridors. The analysis did not account for intra-urban transportation network improvements for the period. Non-highway improvements may

improve circulation and congestion but not have the growth-inducing impacts of major highway capacity increases. In the case of Hillsboro, the highway projects have not led to direct and immediate land development activities.

**95.** Schimpler, C. C., and Grecco, W. L. (1968). The Community- Systems Evaluation: An Approach Based on Community Structure and Values. *Highway Research Record,* No. 238: pp.123-152. Washington, D.C.: Highway Research Board.

*Keywords: Transportation system, community development model, Kentucky*

The authors present a procedure to evaluate alternative transportation system design concepts based on community development criteria. The model was applied to three alternative system design concepts for transportation in the Louisville, KY metropolitan area. However, no validation of the model was presented.

**96.** Shaffer, M. T. (1967). Attitudes, Community Values, and Highway Planning. *Highway Research Record,* No. 187: pp. 55-61. Washington, D.C.: Highway Research Board.

*Keywords: Attitude measurement, community values, model*

Although community values have been recognized as important considerations in highway planning, there has been little agreement about the nature of values or how to measure them. Most frequently used is the attitude survey but in practice, opinions are often measured instead of attitudes. Shaffer claimed that attitudes are more basic, complex, and stable than opinions; they relate to abstract concepts such as time, convenience, aesthetics, and education. As an attitude is a learned predisposition to behave in a consistent manner in a given situation, attitude assessment is a more reliable basis for prediction. The author presented several projective techniques for measuring attitudes. From these, she claimed, values could be determined. No validation of the projective techniques or the value derivatives was presented.

**97.** Skorpa, L., Dodge, R., Walton, C. M., and Huddleston, J. (1974). *Transportation Impact Studies: A Review with Emphasis on Rural Areas.* Austin, TX: Council for Advanced Transportation Studies, University of Texas. 134 pp.

*Keywords: Highway planning, United States, social impacts, economic impacts, methodology*

This study aimed to define and evaluate the methodologies used to measure transportation-related impacts in rural areas. Most of the studies reviewed were conducted between 1960 and 1970. Because most studies concentrated on the impacts of highway improvement, especially the interstate system, limited-access highways received the most attention. A few studies had examined arterials without access-control, farm roads, new airports, and rail and bus service. Most of the literature has focused on the

effects at interchange areas, by-pass routes, and rural highways. Impacts that were measured included land use, land value, business activity, industrial and manufacturing growth, and community social characteristics and attitudes. Most studies had concentrated on land value, land use, and business activity. Of these, most concluded that the results of highway improvement were favorable to rural communities. By-pass studies generally showed that declines in land value and business activity declines were either temporary or were offset by later growth that was usually attributed to the highway's influence.

The methodology used to evaluate transportation impacts usually involved one or more of a) before-and-after measurements, b) survey control areas, c) case studies, d) multiple regression analyses and statistical controls, e) projected land use/value estimations, and f) natural road comparisons. In the studies employing before-and-after methodology, most defined the before period as a 2 to 5 year time span prior to the improvement and the after period as a 2 to 5 year period after the facility had been completed. Any differences in the measurements, e.g., land values, were then attributed to the transportation improvement. The disadvantages to this method are that the trends prior to and knowledge of the improvement are ignored and the impact of the improvement is not controlled for other factors.

The survey control method attempts to isolate the impact of the improvement by comparing the results in the area being studied with those from a similar (control) area that has not experienced a change in transportation. The difference is attributed to the transportation improvement. The problem with this method is in the lack of total similarity between the study and control areas and the lack of control of other factors that might account for any differences.

The case study approach obtains detailed information about specific impacts in one area, but the findings are not easily applicable to other areas. Multiple regression analysis has been used in cases where appropriate "control" areas could not be found. Independent variables may be statistically controlled to isolate the impact of the improvement.

The projected land use/land value estimation and neutral road comparison method are approaches that try to compensate for the limitations of some of the other methods. The projection method assumes that the facility is not built and projects that land use/value with the one that actually occurred. The neutral road comparison approach predicts changes in business activity and compares alternative highway locations to a hypothetical "neutral" road. Both methods tend to forecasting error.

To compensate for error, the authors recommended that the a) the study period be long enough to include all the important changes in both the community and the transportation system, b) the study continue over time to reveal the general trends in community development both before and after transportation system changes, c) the geographic limits of the study area incorporate the entire community, d) the study include all physical, social, and economic impacts of importance, and e) the study include all the

transportation modes of serving the community to determine which are of the greatest importance for community development.

**98.** Smith, T. (1994). The Impact of Highway Infrastructure on Economic Performance. *Public Roads, 57*(4): pp. 8-14.

*Keywords: Highway infrastructure investment, economic growth, FHWA, economic development*

The recognized link between transportation and economic development continues to justify significant public expenditures in transportation systems at the local, state, and federal levels. Still, many of the "intuitive" relationships have not been analytically established. It is difficult to quantitatively link such investments to national or regional growth, economic development, or industry or national productivity and competitiveness. Since 1989, the Federal Highway Administration (FHWA) has made the linkage between investment in highways and bridges and economic performance and growth a priority research area. Smith explained the FHWA research agenda and summarized research from this program.

Although studies funded by the program have shown mixed results, they emphasize the difficulty of answering the question of how highway infrastructure is related to economic performance. In all, the research program has pursued three unique dimensions to address several questions about the linkage between highways and the economy. The first has been a macroeconomic approach that investigates national and state-level linkages between infrastructure capital stock or investment and economic growth and productivity. The second has been a microeconomic industry analysis that explores the connection between individual industries or firms and transportation infrastructure. The third, highway system assessment, has examined service, network, and system characteristics to determine whether a causal relationship exists. Conclusive results have not currently been reached. Smith describes the broad range of the project and the integration that the three dimensions might achieve in the future.

**99.** Stephanedes, Y. J., and Eagle, D. M. (1983). Work Location Estimation for Small Urban and Rural Areas. *Transportation Research Record*, No. 931: pp. 83-90. Washington, D.C.: Transportation Research Board.

*Keywords: Work location choice, rural development, Minnesota, length of employment*

The authors proposed a model of a set of economic and transportation level-of-service variables to improve economic development in rural areas. Transportation and socioeconomic data from four rural Minnesota towns were used to test and validate the model. The model predicted job search destination choices correctly to 77 percent. Travel conditions for the period of expected employment were found to influence location choice, but expected length of employment was the strongest determinant of choice.

**100.** Stephanedes, Y. J., and Eagle, D. M. (1986). Highway Expenditures and Non-Metropolitan Employment. *Journal of Advanced Transportation, 20*(1): pp. 43-61.

*Keywords: Highway investment, rural employment*

One of the studies of industries reviewed by Brown (1999), Stephanedes and Eagle used data on state highway expenditures and employment in different economic sectors from 30 Minnesota non-metropolitan counties over a 25-year period (1967 to 1982). Using causality tests and time-series analyses, they found that highway expenditures affected manufacturing and retail employment. Employment in turn influenced highway expenditures. Highway-induced economic stimulation was strongest in areas with some degree of prior urbanization. Highway expenditures also appeared to respond quickly to increased needs caused by retail improvements.

The authors concluded that although state highway expenditures influenced both manufacturing and retail county employment, short-term effects differed from long-term impacts. Although employment increased in the first two to three years following highway improvements, it then dropped and by the tenth year, returned to its initial base. This draining effect was particularly pronounced in counties within 25 miles of a large city so the retail employment drain may have been due to better access to metropolitan areas. Interactions between transportation and the service sector need to be investigated, and large highway construction projects should be distinguished from other projects and evaluated separately.

**101.** Thiel, F. I. (1962). Social Effects of Modern Highway Transportation. *Highway Research Board Bulletin* No. 327: pp. 1-20. Washington, D.C.: Highway Research Board.

*Keywords: Indicators, highway improvements*

Thiel noted that any effects of highway changes may have multiple causes and that the cause and effect of social trends interact so that it is generally difficult to distinguish between them. At the time of this paper, there was little use of quantitative terms to describe the social effects of highways. In the absence of such obtainable data, Thiel advocated for the use of careful observation and analysis of certain trends that appear to be strongly influenced by highway transportation, e.g., land use, population mobility, school consolidation, and other factors. He also noted the importance of local residents' attitudes toward a nearby highway facility as an important indicator of the social impact that the highway and its various stages of development may have on the local community.

Studies had already indicated that the tendency for residents near, but not abutting a highway facility had a more positive attitude of the facility than residents whose property abutted the highway. Highways tended to reduce residential housing blight by providing barriers between housing and industrial areas. Studies of residents dislocated

because of highway development indicated that such residents often improved their living conditions either by upgrading houses that were moved to new lots or by purchasing better quality homes. Improved highways brought additional employment opportunities by expanding commuting distance and reducing time and travel costs. Services such as education and postal delivery also benefited from improved highways because of reduced travel time, e.g., shorter school bus routes, fewer absentees, doctors seeing more patients, and more mobile police officers. The degree to which community interaction and voluntary organization membership was positively or negatively affected was more mixed.

**102.** Thiel, F. I. (1965). Seminar on Sociological Effects of Highway Transportation. *Highway Research Record,* No. 75: pp. 62-102. Washington, D.C.: Highway Research Board.

*Keywords: Displaced residents, living conditions, public participation*

Thiel's very short (1 page) introduction to the seminar noted the questions of the 1960s concerning displaced people relocated from highway right-of-way acquisition. He stressed the need to gather information about the sociological effects of highway and the need to measure and quantify them in order to plan highway projects successfully.

**103.** Toft, G. S., and Mahmassani, H. S. (1984). Transportation and High Technology Economic Development. *Transportation Research Record,* No. 984: pp. 22-29. Washington, D.C.: Transportation Research Board.

*Keywords: High technology firms, journey to work, arterials, aesthetics, industry type impacts, business location decisions, Texas, North Carolina, New Mexico*

This was an industrial location study also reviewed by Brown (1999). High technology industries have different spatial and production characteristics from the traditional manufacturing sector. Communication, exchange of information, and close proximity to "young" markets, including special transportation requirements, have been essential factors in the location choices of high technology firms. In a 1982 national survey of high technology firms that was conducted by the Joint Economic Committee of the U.S. Congress, 58.4 percent of respondents ranked transportation as significant or very significant in their location choices. Within regions, "good transportation for people" was ranked as significant or very significant by 76.1 percent of respondents. In addition to air freight needs (particularly international air cargo), high technology firms have gravitated to access arterials that provide tolerable congestion levels, access to semi rural, campus like industrial land, proximity to suburbs and exurbs, and collectively, a desirable, aesthetic setting for firms seeking highly visible locations. This is especially true for medium-sized urban areas such as Austin, Texas; Raleigh, North Carolina; and Albuquerque, New Mexico.

In general, proximity to highways is a relatively important factor in high-technology firms' decisions to locate because highways are a means of attracting high-

quality employees and can reduce their commuting time. The researchers concluded that at least four factors have been critical in the location choices of high technology firms in relation to their transportation needs. These are a) the journey to work of the predominately professional white-collar work force; b) business air travel for scientific, technical, and business purposes; c) high air freight volume due to the high value, low bulk, time-sensitive, and fragile nature of shipments; and d) clean, campus like, semi-rural, highly visible sites in the vicinity of major arterials, Interstates, and airports.

**104.** Tolbert, C. M., and Sizer, M. (1996). *U.S. Commuting Zones and Labor Market Areas: A 1990 Update*. ERS-AGES-9614. Washington, DC: Economic Research Service, United States Department of Agriculture. 145 pp.

*Keywords: Commuting, labor market, labor mobility, United States, U.S. Census*

Tolbert and Sizer identified U.S. commuting zones and labor market areas based on journey-to-work data from the 1990 census (and replicated a previous study of U.S. 1980 data). County to county flows of commuters were analyzed through cluster analysis and the commuting zones were identified from those groups of counties with strong commuting ties. For 1990, 741 commuting zones were determined for all U.S. counties and county equivalents. These zones could be treated as spatial measures and were aggregated into 394 labor market areas that met the Bureau of the Census' criterion of a 100,000-population minimum. The commuting zones and labor market areas were also classified according to the population of the largest place within them. This study exhibited multilevel modeling and provided current units of analysis for understanding commuting behavior.

**105.** United States Bureau of Public Roads. (1964). *Highways and Economic and Social Changes*. Washington, DC: United States Bureau of Public Roads. 221 pp.

*Keywords: Roads, benefit-cost analysis, economic growth, social change, highways*

This early work presented the results of more than 100 economic impact studies on highways and socioeconomic impacts. Because only a limited number of these studies were printed, the report provided a historical review of the research prior to 1961. Two major variables, population mobility and economic production, were identified in the report. Mobility was used as an indicator of demand for highway access. By 1960, 20 percent of the population moved from one home to another in any one year, and one-third of those individuals moved to a different county. A greater proportion of these changes occurred in the South, Mountain, and Pacific States. Additional figures for the growing use of mobile homes and automobile ownership supported the report's mobility description. Similarly, regional variation in economic production reflected the country's changes since the 1930s. Of the 1958 personal income total of $356 billion, more than 40 percent was accounted for by five states ( New York, California, Illinois, Pennsylvania, and Ohio in that order). By contrast, three states accounted for $1 billion or less in personal income (Vermont, Wyoming, and Nevada). The five Rocky Mountain States accounted for only a little more than 2 percent of the nation's income at the time. Within

this variation, per capita income fluctuated greatly. In the Far West and Mideast, per capita income was almost one-fifth above the national average but in the Southeast, it was only one-third. These regional income patterns had remained relatively stable since 1929 despite shifts in real national output.

The first studies on the effects of highways on population and economic growth were made in the 1930s and the 1940s. More studies were stimulated in the 1950s by state highway departments' concerns with right-of-way acquisition, highway hearings, route location, highway cost allocation, highway design, public relations, and other parts of the highway program. Of the some 100 studies reviewed by the report, two were conducted in Montana: the Montana Rural Study (Benefits from Highway Development, User and Non-User in 1956 and the Tourist Travel and Expenditure study in 1958). The 1956 study analyzed the allocation of benefits of rural highway development between highway users and other beneficiaries for various types of the highway system. The 1958 study presented statistics on Montana tourists including numbers, occupations, origin and destination, duration of trips, trip budgets, trip influence and other factors. Universities conducted most studies at the time, e.g., the 1956 study was done by MSU Bozeman and the 1958 study by MSU (now UM) Missoula.

In general, the 100 studies used before-and-after methodology with a control area to isolate the impact of the highway improvement. At the time of the report, few studies were available on the effects of the freeway interstate system since it was so new. Most studies focused on highways like the Boston Circumferential Highway, Connecticut Turnpike, Atlanta Expressway, the Edens Expressway (Chicago), California freeway, Lexington Bypass, Dallas Expressway and others. Bypass studies and primary highways of conventional design were emphasized. Impacts varied from changes in land values, land use, public utilities, public services, and other community-level variables. The report noted that it was extremely difficult to isolate the net benefits to a local community from highway improvement given the regional impact of highways. Similarly, it was not possible to predict that a particular type of highway improvement would inevitably lead to a particular set of consequences.

**106.** Unsworth, D. J. (1994). Redefining Public Involvement. *Transportation Research Record*, No. 1463: pp. 45-47. Washington, D.C.: Transportation Research Board.

*Keywords: Transportation planning, citizen participation, Montana*

Public involvement requirements were expanded by the Intermodal Surface Transportation Efficiency Act from project development to short- and long-term planning. Requirements include information meetings, scoping meetings, and hearings. However, even these did not prevent controversies from arising late in the project development process, e.g., expanding US 93 just south of Glacier National Park to five lanes. Such controversies have lead the Montana Department of Transportation (MDT) to develop a new process to minimize controversies that stop projects and erode public trust. The goals for that process have included providing useful, timely information to the public through the project, proactively seeking public comment and involvement in

project development, facilitating open discussion of controversial issues, and responding to comments and suggestions so that useful ideas are incorporated into projects. These goals, as well as the procedures and advice for meeting them, were incorporated in a simple MDT handbook. The handbook outlines four levels of involvement that relate to the level of complexity and interest in a given project. Results in applying the new procedures were then applied to planning the US 93 Somers to Whitefish reconstruction project.

**107.** Urban Land Institute. (1996). *Transportation and Growth: Myth and Fact.* 15 pp.

*Keywords: Population growth, transportation problems, development, transportation problems*

Although this is not a research report, per se, this Urban Land Institute publication reviewed some of the evidence on transportation problems in urban areas. The report addressed various "myths" or claims about transportation problems and then refuted the claim using data from various studies. The claims and counterclaims are summarized here. One is that today's traffic problems are not caused by a failure to plan adequately but by a failure to carry out plans. No evidence was presented as to why plans were not carried out, but various studies were cited as to the degree to which plans were not implemented.

The second claim is that stopping development will stop traffic growth is also disputed. Even with no new development, traffic would increase because of the population's growing mobility. This is the redistribution counterclaim, i.e., that transportation improvements do not bring new population growth to an area but instead redistribute population from one area to another. The report indicated that the growing dependency on the automobile and less use of transit and carpooling has been the reason for this increased mobility.

Three, it is less true that growth in a community primarily serves newcomers than the belief that development in growing areas is needed to serve existing residents. The evidence for this claim comes from census figures showing over one-half of new home buyers have bought homes in the same county as their previous homes.

Four, urban transportation's major challenge is to improve commuting to downtown jobs when in fact, in most growing areas commutes have been made entirely within the suburbs for shopping, personal business trips, and off-hours traffic.

Five, suburbanites will not ride buses when in fact suburbanites will ride buses when the service is reasonably fast and convenient. Evidence is cited that ridership has gained in cities with transit systems.

Six, new rail transit systems are needed to reduce traffic congestion when there is no evidence that rail transit reduces congestion. In fact, growing congestion has made transit more effective by reducing the attractiveness of driving.

Seven, highways can no longer be built in urban areas when new roads can and are being built in urban areas through the United States.

The eighth claim is that new roads should not be built because they will only fill up with traffic. In fact, new roads that fill up with traffic indicate the need for them. Their use has made it possible to improve service to current travelers and reduce congestion elsewhere. The report cited the most extensive evidence from the U.S. interstate highway system on which both the vehicle miles traveled and the actual mileage experienced have decreased since the early 1990s despite an increase in traffic. It has been estimated that peak-hour congestion primarily is a problem in the 33 largest urban areas. These urban areas also accounted for 53 percent of travel on major U.S. roads and sustained two-thirds of the congestion in the early 1990s.

Nine, people must change their attitudes so they depend less on the automobile. In fact people cannot depend less on the automobile without economic incentives and alternatives to serve their travel needs.

Finally, arguments that new capital investments should not be made because they will be outmoded by new technology is unfeasible; transportation options for the near future will be much like those available today— and cheaper.

**108.** von Reichert, C. (2000). The Changing Face of Montana: Population Shifts in Our State. *Great Falls Business Journal, 1*(4): pp. 13-15.

*Keywords: Migration, population growth, Montana*

The author analyzed census data for the state and its counties for the periods 1980 to 1990 and for 1990 to 1999. She found that during the 1980s, the population of the U.S. had grown by 9.8 percent, but Montana had grown by only 1.6 percent. More importantly, between 1985 and 1990, the population of the state even declined by over 22,000 (from 822,305 to 799,065). By the early 1990s, however, a rapid population boom occurred in Montana and other Rocky Mountain states so that in mid-1999, Montana's population had risen to 882,779 (a 10.5 percent increase from 1990). Within the state, the population shifts have been even more uneven. By 1998, only seven counties in Montana (Yellowstone, Missoula, Flathead, Lewis and Clark, Gallatin, Ravalli, and Lake) had 69 percent of Montana's population gain between 1990 and 1998. By 1998, 35 counties in the state had populations under 10,000, but only 14.9 percent of Montanans lived in them. Much of the population redistribution results from differences in migration (as shown in Figure 1 in the *Summary*).

During the 1980s and Montana's slow 1.6 percent population gain, the population grew naturally by 8.3 percent while the net migration rate was negative (-6.7 percent). During this period, all but nine counties of Montana lost population through migration as more people moved out of the state. The highest negative migration rates were in the eastern counties. Only a few counties, including the later growth leaders of Ravalli,

Flathead, and Gallatin, were already experiencing migration gains in the 1980s. However, the migration rates for these counties were minor compared to a decade later.

Between 1990 and 1998, net migration growth became very large for several counties including Ravalli (40 percent), Jefferson, Broadwater, and Stillwater (20 to 25 percent), Lake, Flathead, Gallatin, Carbon, and Sanders (15 to percent). These rates, the highest in the state, were highest in scenic amenity counties located near the larger metropolitan areas (Billings, Helena, and Missoula). During this period, Montana had a net-migration rate as a state of 6.3 percent. At the same time, half of Montana's counties experienced migration losses (see Figure 1). Most of these counties already had small populations and the exodus from these sparsely populated counties further depleted the population of the agricultural areas. Half or more of the outmigrants from these counties stayed within the state, but they often relocated to the more urban areas of Billings, Great Falls or Missoula. This trend further increased the east/west imbalance between counties with already large and growing versus small and shrinking populations.

**109.** von Reichert, C. (2000). Why Montanans Come Home: Understanding Return Migration Through Interviews at Reunions. *The Rocky Mountain West's Changing Landscape, 2*(3): pp. 2-9.

*Keywords: Return migration, population growth, Montana*

The author reviewed analyses of census data as well as reported results from her interviewees with attendees at Montana high school reunions across the state in 1999 to determine how much of the recent migration growth in Montana (see von Reichert 2000) involved return migrants to their home state. Previous census data indicates that on average, 20 percent of inmigrants to a state are returning migrants. The percentage for Montana, however, was only 15 percent. However "return migration" is characterized by a narrow definition (moving back to the state of birth). If the definition is broadened to say, returning to the state from which one graduated from high school, the proportion of return migrants is probably much higher. This was the case when the Montana Poll used a broader definition of return migration to "the state in which at least one household member had lived before." Data from the poll indicated that more than half of households moving to Montana in the 1990s were returning households. Thus, many of the "newcomers" perceived to be Californians or others were actually returning Montanans.

To discover why people were moving back to Montana, von Reichert conducted extensive (247) high school reunion interviews in the state. She found that of the non-migrants, most had a ranch, farm or business that had kept them at home. Of the people who left the state (124), career opportunities were mentioned often (70). Some left because there were no jobs in their field and others left for careers in the military services. Others (21) left to pursue an education and others (17) in search of different living environments. Only two moved for a more pleasant climate! Of the 124 ex-Montanans who were living out of state, 70 said they did not intend to return and 54 would have considered moving back. Many, both migrants and non-migrants, expressed

strong place attachment. For the migrants, the main obstacles to a return move were largely economic: jobs pay either too little or jobs in a particular field do not exist.

Of the 194 interviews von Reichert had with Montana graduates who had left the state, 70 had returned. She identified two distinct subgroups of these return migrants: those who returned shortly after leaving (within a year or less) and those who had returned after several years away. For the short-term returnees, respondents identified a strong out-of-state push factor, e.g., I went to Seattle and nearly went crazy with all the people. The long-term returnees identified the Montana-pull factor, i.e., wanting to return to Montana, but not because of discomfort in the other state. Many moved back because technology made it possible. Most frequently cited for returning to Montana by all the returnees was the child-friendly environment and proximity to family. Lifestyle and the natural environment were also important.

**110.** Voorhees Associates. (1965). Techniques for Determining Community Values. *Highway Research Record,* No. 102: pp. 11-18. Washington, D.C.: Highway Research Board.

*Keywords: Community values, assessment, planning*

The authors claimed that a weakness in most transportation studies has been that the study design fails to account for differences in community values. They noted that three methods were used to establish overall community values: focus groups, rating panels, and attitude surveys. In addition, community review and political review were used to resolve planning conflicts. They reviewed planning studies and found success varied considerably with the situation and with the particular goal. Special techniques were being developed to deal with social values, living patterns and community attitudes but the authors did not describe these techniques nor present any validation of them.

**111.** Wanmali, S., and Islam, Y. (1995). Rural Services, Rural Infrastructure and Regional Development in India. *The Geographical Journal, 161*(2): pp. 1-49.

*Keywords: Rural development, land settlement, central places, human services, India.*

This study analyzed the spatial distribution of rural services in selected regions of three states in India based on data collected over three decades. The researchers' analysis used Christaller's central place theory as a framework for understanding the demographic, functional, and spatial characteristics of settlement. Central place theory focuses on urban centers, their hexagonal marketing areas, and their transport networks. In their study, the researchers replaced rural centers for urban centers, service areas for hexagonal market areas, and movement patterns for transport networks.

They found that in all three study areas, a scale of service hierarchy from basic to complex, explained settlement hierarchy. Thus, for very basic services, regional residents did not travel very far. For more complex services, the distance traveled became substantial. The initial distance traveled to services was greater in less

economically developed study areas than in more economically developed study areas. Services tended to cluster in identifiable population size groups in the study area, e.g., a primary school, basic clinic, branch post office, regular bus stop, and a few other services tended to occur in settlements with a population of 250 to 950 in contrast to an area with a junior college, surgical center, scheduled bank, land mortgage bank and other complex services and a population of over 15,000. Since the availability of services was not uniform between settlements, residents had to travel for some services. The researchers identified those areas that tended to lack services or have a surplus and formed a service score ratio. The researchers found that older, more established areas exhibited higher service scores. Thus, population size is important, but it is not the only factor that determines service location and hence travel distances for regional residents. Residents of lower economic status tended to use transport network much less often than residents with higher economic status. All these factors interacted to determine household use of services within a region. The researchers concluded that the mere location of a new service in a service center does not necessarily mean that it will immediately start to serve surrounding communities. The location of a new service needs to be seen in its regional context.

**112.** Warner, A. E. (1958). *The Impact of Highways on Land Uses and Property Values: A Review of Current Studies*. East Lansing, MI: Highway Traffic Safety Center, Michigan State University. 31 pp.

*Keywords: Real property Prices, roads, land use, property values*

The author reviewed 14 different studies on economic and social impacts of highway developments. He found that most studies were highly descriptive and based too often on preconceptions. He recommended that studies develop a sound theory of value of real property that includes highway improvement as a contributing variable, develop research methods and designs that provide empirical evidence, and develop a working definition of value to quantitatively measure value.

**113.** Wolf, C. P. (1979). *Social Impact Assessment of Transportation Planning: A Preliminary Bibliography*. Monticello, VA: Vance Bibliographies. 35 pp.

*Keywords: Social impact assessment, highway development.*

In this unannotated bibliography, Wolf lists a series of studies from the 1960s and 1970s on the use of social impact assessment in transportation planning. He briefly notes that from his review of this literature, emphasis had formerly been placed on highway planning and mass transportation had been neglected. Similarly, noise and other health effects had not yet been considered nor had relocation and public participation.

**114.** Wong, B.S. (1999). Aren't City Centres Great? *The Economist, 352*(14 August): p. 23.

*Keywords: Urbanization, population growth, public transportation*

Wong claimed that every major city center in the United States expects its population to grow in the next decade of the 2000s. She cited studies by the Brookings Institute and the Fannie Mae Foundation that examined 26 cities and found every one expected its downtown population to grow by 2010. Houston expects its central-city population would quadruple, Chicago expects a growth of 32 percent and even Philadelphia, which had lost 600,000 people since 1950, expects to grow 13 percent. Where migration to the suburbs and adjacent rural areas had been the trend, people have begun moving back into the city to take advantage of city life. Retired persons and couples with grown children will be migrating to cities because they have no use for sprawling suburban homes and want to be closer to the arts, culture, and public transportation.

**115.** Zografos, K. G., and Stephanedes, Y. J. (1992). Impact of State Highway Investment on Employment Along Major Highway Corridors. *Transportation Research Record*, No. 1359: pp. 151-155. Washington, D.C.: Transportation Research Board.

*Keywords: Employment, highway investment, Minnesota, regional economic development*

Previous studies had shown that the magnitude and significance of highway investment on a regional economy might be affected by the nature of the economy and the spatial distribution of socioeconomic activity. The authors focused on how highway proximity influenced the impact of highway investment on the economic activity of 87 Minnesota counties. Their analysis was based on highway construction expenditures and county employment data. The results suggested that counties containing major highway corridors experienced a small increase in their total and manufacturing employment, but counties not containing major highways experienced a small reduction in their total employment.