THE CONTRIBUTION OF TRANSPORTATION TO RURAL ECONOMIC DEVELOPMENT

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INTRODUCTION
Physical infrastructure investment, particularly transportation innovations, set the cornerstone for socio-economic change in the United States. The construction of navigable water routes, then railways, and later roads, highways, and the Interstate system nurtured a perception of a causal role between transportation and economic growth. Increased access, it was commonly theorized, would stimulate growth in manufacturing and commercial activity. Disciples of central place, classical location, or, later, "growth pole" theory maintained that industry would seek locational advantages revealed by transport savings. (Losch 1938).

Early efforts by Zipf (1949) and others (Niedercorn and Bechhdolt, Jr., 1969) to derive a regional law of gravity for development initiated a genre of research on transportation and economic development potential.

Different modes of transportation have had profound effects on the pace of development in rural America. Early settlements were dependent on water transportation and cities developed along the lakes and waterways that connected remote places with the oceans.

Railroads served as a catalyst for transforming the U.S. from an agrarian society to an industrial power during the mid 19th century. Rostow (1964) argued that railroads stimulated the growth of the iron, steel and other backward linked industries. And railways provided access to large eastern markets that midwestern farms needed to reap profits from large scale production. Although the role of railroads as a "leading sector" in the economy has been debated by academics (see Fishlow, 1965 and Fogel, 1964 for example), through the early part of the 20th century, the railroad was the primary transportation mode that brought people and capital to rural America and carried farm goods to population centers.

Since World War II, auto and truck flows over highways—especially the Interstate Highway System—have been viewed as the primary link between rural America and the population centers of metropolitan cities. While intermediate sized cities seem to be interested in improving air service, especially by becoming a "hub" center, many rural places see access to a four lane highway in their county or town as the key to development. Since most of rural America is now dominated by manufacturing (see Henry et al. 1986), rural development proponents suggest that good highway transportation is the missing link to development of their area. Rural development practitioners argue that rural areas have cheap land, low cost labor, and less congestion than urban complexes. New firms would be attracted to rural areas if only a new four lane highway was built to connect the isolated rural area to the interstate system. Maybe.

The effects of highways can be distributional (shifts in the incidence of economic activity among locations) and/or developmental (changes in the total level of economic activity). The objective of this paper is to establish what is known about the role of highways in regional economies. As the above account suggests, infrastructure has historically been closely associated with the process of economic growth and development. Relevant questions for policymakers are, "does infrastructure still stimulate economic development and if it does, do highways contribute to rural economic development or are alternative types of
infrastructure more important?" and "what kinds of impacts do highways have on the location (distribution) of economic activity?" The impact of a particular highway investment will be largely distributional when, for example, the public expenditure involved would have been made in another location, or on another type of project or service if the project in question had not been chosen. Distributional impacts include the multiplier effects of investments. Multiplier impacts are of roughly similar magnitudes no matter what project or location is chosen.

Developmental impacts are more fundamental changes in the structure of the economy, in the economic base, and the size and composition of the economic multiplier. A wise investment in infrastructure can increase the productivity of private capital, human capital, and other public infrastructure (better roads and bridges will make fire, rescue, police, and public education services more efficient for example). Development stems from the change in efficiency of consumption, as well as production, due to lower unit costs and/or higher valued services.

In practice, developmental effects are much more difficult to measure than distributional effects. As we will see, we know far less about the process which generates these developmental effects than we do about the distributional process.

DO NEW HIGHWAYS REDISTRIBUTE ECONOMIC GROWTH?

Input-output models are the quintessential economic impact assessment tool. There are numerous examples of the use of I-O in the prediction of the economic consequences of highway investment (Liew and Liew, 1980, 1984; Stevens et al., 1982; Madden, 1985). All studies based on the input-output approach will inevitably find positive impacts from highway development because this follows logically from the assumptions upon which the analysis is conducted. The magnitude of the benefits depends solely on the magnitude of the cost savings. This approach, then, is not an appropriate mechanism for asking the questions, "Do highways lead to economic development?" or even, "How much economic development do highways generate?" This measure does, however, give an indication of the distributional effects of highway investments assuming the magnitude of cost savings and change in expenditures can be measured accurately.

A number of authors (Dievert; Gruver; Harris; Kanemoto; Mohring and Williamson; Lakshmanan) have directly measured the magnitude of benefits generated by highways for nearby producers and consumers. Since only the effects on existing enterprises and households can be measured using this approach, it can only be used to estimate the distributional and short run effects and not the longer run developmental impacts.

Willingness to pay for infrastructure (Dievert) is similar to the direct benefit measurement approach. In this approach measures of producers’ willingness to pay for improved highway service is considered the gross benefit of the project. Costs of providing the infrastructure are then subtracted to get net benefits.

A number of statistical analyses have been conducted which have attempted to make direct ex post measurements of the effects of highways and other types of infrastructure on economic activity. In general, these studies do not discriminate between distributive and developmental impacts.

Early statistical analyses (generally simple regression, rank correlation or descriptive, i.e., survey data) attempted to estimate economic growth primarily as related to changes in population and land use based on proximity to highways. Twark (1967) discovered, for example, that daily traffic on a cross-route, on the Interstate highway, and some population measure were positively correlated with new development at interchanges. Likewise, economic development at the interchange was inversely related to distance from the nearest urban center.

As the Interstate highway system neared completion and post construction data became available, evidence of growth became less evident. The Appalachian Regional Development Act of 1965 generated a series of investments in physical infrastructure in the
region. And, regional analysts evaluated the impacts of these investments.

Munro (1969) and Straszheim (1972), for example, criticized the Appalachian (ARC) highway investment program for its lack of investigative detail in the planning phase. They surmised that it was an efficiency-criterion program rather than redistributive as was intended. Admittedly, highway construction might have interregional effects, but even so, Munro questioned, were the existing highways so inefficient as to justify highway investment as a development strategy? Straszheim added that ARC highway expenditures would be more likely to encourage outmigration. Additionally, Hale and Walters (1974) determined that greater benefits in transportation and employment would be felt in the periphery or secondary growth centers of Appalachia and regional outmigration would be the end result. Hansen (1966) decried the policy for its neglect of opportunity cost and labor mobility issues.

Similarly, Kuehn and West (1971) in their analysis of the Ozarks Economic Development Region, concluded that highways are only "pemissive causes of regional development insofar as they primarily affect regional supply conditions." In fact, highways, they contended, probably serve to encourage initial growth in employment and income which induce additional highway construction. Rank correlation coefficients indicated that they were not crucial factors in economic development in the Ozark Region.

Cribbins et al. (1966) finding insignificant regression coefficients for highway associated land value changes, simply deduced: The major effects of [Interstate highway] construction will be gradual and intermixed with the effects of other factors controlling an area's economic development. If the economy of an area is basically sound and is growing, then it will continue to grow; if it is basically depressed, then it will remain depressed.

Geographic specific questions include whether highway investment produces booming interchange communities in nonurban locales or rejuvenates entire lagging rural regions. The exact approaches and findings remain varied, however. Additionally much of the Interstate highway system is located in rural or nonurban areas not served previously by major highways. Such a major highway construction project has carried with it expectations for major impacts on socioeconomic variables of communities with these Interstate "corridors." This would be true particularly for communities with interchanges linking interstate highways with local transportation networks (Eyerly et al., 1975). An analytical consensus, however, is lacking in that research on highway investment produces no guarantee of promoting positive changes even in such geographic specific contexts.

Miller (1979) observes that no empirical evidence indicates that nonmetropolitan counties with Interstates experience persistent expansion of job opportunities. Instead, he finds that these counties experienced growth in the late 1960s which diminished after the completion of the Interstate system in the 1970s.

Additionally, Humphrey and Sell (1975), find that impact of highways is secondary to other correlates of nonmetropolitan growth. Multiple regression analyses to determine a relationship between characteristics of nonmetropolitan communities and the average annual rate of demographic growth produce no statistically significant relationship between distance to controlled access highway interchange and nonmetropolitan growth between 1940 and 1950. However, between 1950 and 1960, and from 1960 to 1970, minor civil divisions with close proximity to interchanges did exhibit significantly higher growth rates than places farther away.

Lichter and Fuguit (1986) found effects of highways on net out-migration to be most pronounced in less remote areas and that they promote movement change in tourist-related service employment. They find little evidence that highways influence demographic changes through expanded manufacturing employment and immigration.
Briggs (1980, 1981, 1983) examines factors involved in demographic and economic change in nonmetropolitan areas of the US from 1950 to 1975. He compares with and without interstate counties for changes in net migration and employment and identifies types of industries affected by limited access highways using path analysis. Results indicate existence of a weak relationship only. Manufacturing and wholesaling have minor roles with correlation coefficients of .04 and .02 between 1960 and 1970 and .005 and -.02 between 1970 and 1975 and .005 and -.02 between 1970 and 1975. "Tourist services, however, are the industry most closely associated with interstate with correlation coefficients of .07 and .03, respectively." Using a series of multiple regression models, (regressing net migration on variables within each of these categories Briggs analyzes the importance of transportation by way of looking at nontransportation factors. Even if controlling for metro area adjacency, and urban population concentration, Interstate do not, according to Briggs' results, ensure growth for an individual county. In fact, nontransportation factors are better able to explain spatial development patterns of development than are Interstates. These include urbanization, industrial base, social base, government activities, and environmental amenities. These, however, produce consistently small correlation coefficients and beta weights as well. He concludes that manufacturing may benefit from highways but may not necessarily have to locate near them whereas tourism requires physical proximity to highways.

More recently, Stephenides and Eagle (1986) investigate interaction between employment and transportation using cross-sectional analysis of 30 Minnesota nonmetro counties over a 25 year period. Mixed results are derived from causality tests in that highway expenditures affect manufacturing and retail employment and employment then affects highway expenditures. But for counties located more than 25 miles from large cities (>30,000) causality is not evident. In the short run, employment increases post highway improvement. But by the 10th year, it returns to initial base drained by improved access to metro areas. This is especially true for those counties within 25 miles of a large city.

Contrary to this conclusion, however, are the findings of Burress and Clifford (1989) who contend that Interstate highways encourage private sector growth but with a several year lag. There are however, no significant short-run multiplier effects. Non-local government activities such as higher education and transfer payments may have more immediate multiplier effects on local economy. Specifically they examine the roles of higher education, interstates, and transfer payments in affecting growth in income population and employment in Kansas counties between 1969 and 1985. Thus they look at direct multiplier effect of government activity and indirect effect of government services in expanding the private sector.

Moon (1987) studies nonurban interchange "villages" and finds a pattern of cyclical development in their evolution. His investigation suggest that these "interchange villages" act as central places within their regions. Typically these "new" towns function as tourism service centers, island communities of other urban areas, or focal points of regions.

Eyerly et al. (1975) examines the interchange growth hypothesis via use of conventional indices (income, housing, population, employment) and new indices ("assessed market value of real property"). Regressing county level changes in per capita income on these variables indicates a positive relationship with nonurban interchanges.

Barkley et al. (1988) examine the interaction between rural transportation with high technology economic development. Attempts are made to determine its relative importance as a locational factor. They argue that transportation factors have been ignored due to assumptions that high tech industries are predominantly labor- and amenity— oriented (i.e., the early assumptions with transportation and industrial location were based on increased access to raw material and market centers). They find social organization of a local economy and local institutional arrangements are perhaps more important than highways in developing a climate conducive to attracting high technology firms.
Nijkamp (1986) explains in detail what others imply in attempts to arrive at some theoretical understanding of recent research findings. Nijkamp analyzes production and potentiality factors to identify disparities among regions with approximately equal private stock. He concludes that both network and urban infrastructure provide a significant explanation for regional development asserting that it is the stage of total socioeconomic development in an area or region that determines the effects of infrastructure investment.

Wilson et al. (1985) entertain similar logic in explaining weak relationships between regional economic growth to "saturation and shift." That is, the highway system becomes saturated with increase in mileage and developmental effects become progressively diluted. New highways at some point act only as people movers. Wilson maintains that the phase of highway development is an important factor, i.e., in the first phase it encourages regional development whereas in the third phase it induces personal mobility. Notably, Baerwald (1982) cites historical factors and the timing of development as an important factor in development process. And, Eyler reminds us that early studies were predictive in nature in this respect as the research was conducted while highways were under construction or immediately thereafter.

DO HIGHWAYS HAVE LONG-RUN DEVELOPMENTAL EFFECTS?

While it is never clear if economic impacts are totally distributional (the location of economic activity), or if they include some net economic benefits (the efficiency of economic activity), some approaches and statistical analyses tend to more directly address the latter. In order to qualify as a net economic approach, a study must be capable of measuring the future locations of firms and households and of measuring the effects of infrastructure on the profitability of all present and future firms and households, including those which are advantaged and disadvantaged by the infrastructure.

One approach which tends to get at some of the efficiency effects of highway investments is to use programming models to simulate the effects of a highway investment (Lord, 1972). The models are based on assumed average practice or best practice relationships for each of the users, or types of user, expected to use the infrastructure service. Computable General Equilibrium (CGE) Models have also been used to measure the impacts of infrastructure investments (Shoven and Whalley).

Harris developed a model of spatial production in which output in each sector is a function of location rent, the value of land, demand, supply, input supply, and gross equipment purchases. Migration (by age and race) is also estimated as a function of wage rates, changes in employment, and labor supply. The estimated equations are then used with an input-output model to predict other variables such as total output, employment and income. The model in some instances predicts negative impacts of transportation investment. This occurs when (1) transportation cost reductions lead industries to be attracted, by other factors, to alternative locations, and (2) as rural consumers are able to travel greater distances to purchase retail goods in neighboring areas.

A relatively popular approach to the estimation of infrastructure impacts is to directly measure the relationship between industrial and/or household location decisions and the level of infrastructure. This approach does consider some longer-term issues, but it considers the efficiency and profit issues at best implicitly as a factor in the location choice.

Kuehn, Bruschler, and Shonkwiler found that adequate transportation, educational, water, sewer, and sanitation facilities attracted firms. Carlino and Mills used a somewhat more sophisticated approach to measure the determinants of population and employment growth at the county level. A simultaneous equations model was estimated for 3,000 counties using two-stage-least-squares. Their study indicated that an interstate highway increased population density and manufacturing employment. Dorf and Emerson estimated the relationship between transportation and plant location and found that access to interstate highway or water transpor-
tation affected larger firms but had little effect on small to medium sized firms. Kriesel found that access to interstate highway increased the probability of attracting manufacturing firms with 10 or more employees. Finally, Hastings and Goode, in their NorthEast Economic Development System (NEEDS) included a number of infrastructure variables including access to rail service, airlines, interstate and primary highways, size of hospital, proportion of homes with water, sewer, and telephone. Each of these had an influence on some of the manufacturing industries included in the study.

Aschauer (1990) provides a simple economic framework for estimating the direction of causality from highway investment to economic growth at the state level. And, he finds that over the 1960 to 1985 period, added road capacity (miles of highway per square mile in the state) leads to added growth in per capita income. Moreover, increased rural road capacity tends to have a larger impact on growth rates than urban roads. At a more micro level, Fox and Murray (1990) use a TOBIT model of firm location in Tennessee counties. They find that the presence of in-county interstate highways leads to higher entry rates into those counties for most size of firm categories—but they do not directly test for the direction of causality between highways and firm location.

Carlino and Mills (1985) built a regional model of employment and population change at the county level. Their two equation model emphasizes a series of initial conditions at the county level as the forces that cause differential employment change between counties. Using cross sectional analyses of employment change over the 1970 to 1980 period, they were able to isolate the influence of county level attributes in 1970 to the subsequent employment change.

In a case study of South Carolina four lane highway investments since 1960, a set of initial social and economic conditions were estimated for regions that are overlays of County Census Divisions and Zip code boundaries. Cross sectional analysis of change over a ten year period—from 1980 to 1989—was analyzed. Statistical tests suggested a positive association of new infrastructure investment (four lane highways) and change in regional economic activity (Henry et al., 1991).

The South Carolina study suggests that increased investment in highways and water/sewer utilities in a region will increase the rate of return to private investment in the region by increasing the level of infrastructure services to producers. These increased levels of services may serve as an unpaid public inputs to the private production function or they may increase the productivity of existing private resources or both (see Eberts, 1990, for example). The "infrastructure induced" increase in rate of return in a region relative to the fixed cost of capital will attract private capital investment in the region. This increase in capital investment will cause output and employment to grow in the region. And, these decisions to invest are subject to variation across regions of South Carolina in response to other initial conditions and the strength of long term forces that may favor one region over another.

The social and economic forces that cause some regions to grow while others lag over a given time period are diverse. Thus, attempts to isolate the contribution of new highways to growth should control for these other forces. For example, agglomeration forces in regional development suggest that areas that already have a high density of employment are good candidates for future growth for two reasons. First, existing firms may simply decide to expand employment at current locations rather than seek out new and untested areas. The more firms in the area at the beginning of the period, the greater is the likelihood of "locally-grown" sources of new employment. Second, outside investors may view regions with more firms and employees as successful places to begin new plants. Availability of trained workers and amenities desired by operators of new plants may be perceived as being in greater supply in areas with a higher density of similar firms.

Neoclassical economics argues that unfettered economic forces will move labor and capital to regions where each resource yields the highest rate of return (Borts and Stein, 1963). Accordingly, lagging regions will tend to grow faster than high income areas and catch-up to the
high income areas over time (Nardinelli et al., 1989).

Another perspective on the effects that initial socioeconomic conditions play in regional development is from Hansen (1965). He argued that physical infrastructure investment (such as highways and water/sewer) would have the highest payoffs in "intermediate" regions not characterized by severe congestion or by long term stagnation. Hansen's intuition has held up under empirical testing by others as noted in Eberts, 1990. It is hard to argue that any South Carolina regions are severely congested. Instead they tend to fall into a series of intermediate regions and some persistent lagging regions.

The most direct approach for estimating the benefits of spatially fixed infrastructure, public services, and amenities is that of hedonic land prices. This approach asserts that the benefits of changes in spatially fixed amenities, services and infrastructure are capitalized into the value of land and can, therefore, be estimated by measuring the contribution of these variables to differences in land values.

The validity of the approach has been the topic of considerable conceptual and empirical debate. The validity of the approach depends on whether all benefits are capitalized into land values (locational rent) or if some are left as quasi-rent (profits). The critical factors are, whether there are enough buyers in the land market to ensure ideal prices, whether consumers are relatively homogeneous, and whether the general equilibrium effects lead to significant changes in prices and wages. Arnott concludes, on the basis of conceptual arguments, that only part of benefits of such spatial investments as transportation will be capitalized into land values and that this approach will underestimate the benefits. Arnott argues that if the economy is not sufficiently open, new residents and firms will not bid up the land prices sufficiently to capitalize all benefits. Secondly, if similar improvements occur widely, then the demand will again be insufficient to fully capitalize benefits. Finally, Arnott argues that if the land buyers are not identical, then some changes in consumer (and presumably producer) surplus will occur which are not reflected in the marginal valuation of land. This latter point is a rather inconsequential point when reasonably small changes take place. The first two conditions essentially require that the market operate reasonably well:

Kanemoto (1988) develops a rigorous general equilibrium treatment of the issue. He assumes a competitive market and considers the ex ante measurement of benefits and costs using hedonic land prices. He concludes that:

1. hedonic prices will in general over estimate benefits;

2. hedonic price estimates of benefits will be accurate if prices and wages do not change because of the investment or if production and utility functions do not permit substitutability among commodities;

3. the hedonic price approach does include the consumer's surplus;

4. heterogeneity in consumers tends to reinforce the paper's conclusions;

5. hedonic pricing is preferable to direct measures of infrastructure price because the latter ignores consumer's surplus;

6. benefits received by producers are measured equally well by hedonic prices if long-run, free entry competition is assumed;

7. the results are unchanged if we assume that labor supply is endogenous, that is if workers determine the number of hours they work based on wages, and prices; and

8. the results are unchanged if wage rates are dependent on infrastructure, if land is demanded by both consumers and producers since any wage rate differences due to infrastructure and amenities will be reflected in the bid price for commercial and industrial land;

9. "the hedonic measure can be used as an upper bound estimate... If mobility is imperfect, capitalization tends to be less than perfect, which creates a counteracting tendency for under
estimation and the net result is uncertain (p. 989)."

McHone reports on an empirical test of a theory developed by Fishel and later by Fox (1978). This theory relates location rent, local tax rates, and industrial development. McHone empirically estimates a simultaneous model in which tax payments per employee and manufacturing employees per capita are price and quantity variables respectively in supply and demand functions for industrial locations. The price of land is a significant variable in the demand function. The study indicates that manufacturing firms pay for some locational value through taxes and capitalize the rest into land values. This is consistent with the conceptual predictions of Kanemoto and suggests that total benefits should be increased by the change in tax revenues collected to the infrastructure investment.

A study by Wade et al. employed the hedonic land value approach to measure the impacts of a highway corridor project in Virginia. Land value equations were estimated from a sample of real estate transactions for the State of Virginia over a five year period. A geographic information system was used to generate highly geographic specific measures of infrastructure, traffic, public services, and business activity. The estimated coefficients were then applied to a large study area in Southwestern Virginia which included all areas where land values could be influenced in either a positive or negative direction by the construction of a new highway. The results of the analysis indicate that highway investments have relatively large positive net benefits. The benefits vary considerably and are highly location specific. The results suggest that in general benefits associated with a new highway may be higher in rural communities than in large cities since extensions to the road network in the city will not improve access as much at the margin. Furthermore, benefits are largest immediately adjacent to the highway and are lower (and often negative) as distance from the highway increases.

CONCLUSIONS

The case study in South Carolina and other recent evidence—like Aschauer’s results—support a conclusion of a positive association between highways and economic growth. However each study is somewhat flawed. Aschauer’s results seem plausible at the state level, but they are not adequate for small region analysis. And, while Fox and Murray have a sound empirical base for testing at the county level, they do not provide a direct test of the direction of causality. The South Carolina case study does not rule out the redistribution of economic activity. This would occur if new firms along new highways simply substitute for firms that shut down as the new highways divert business from their previous location.

Rephann (1991) evaluates the pros and cons of alternative methods of testing for the growth effects of new highways. He finds that most analysts conclude that new highways may—under selected conditions—promote local economic development. It is almost traditional to conclude that new highways are a "necessary but not sufficient condition" for regional growth. These conclusions beg the question: What are the "other conditions" that will allow the new highways to work their economic magic in rural America?

To find an answer from deductive techniques requires a structural model of regional and rural growth that specifies the linkages between highways and economic change. However there is no general agreement on the structure of regional—much less rural—growth processes. Thus, the models of Carlino and Mills, Aschauer and others are somewhat ad hoc—making structural parameter estimation fuzzy at best.

The lack of consensus on regional growth processes stems, in part, from a lack of good regional data that allow for testing of hypotheses from alternative growth models. The data problem is particularly acute when it comes to regional trade activities. And since for small open economies, trade is a large component of total activity, the lack of trade data at the regional level is more of a problem than it is in modelling national economies.
Accordingly, analysts fall back on "expert judgement" from case studies, quasi-experimental techniques, or ad hoc regional development models in attempts to identify the "other conditions needed" to make new highways an effective rural development tool. Still, there are many ways to improve our understanding of the efficacy of transportation improvements in promoting regional growth.

First, for long run growth analysis, rural analysts need to pursue the aggregate production function framework suggested in Eberts and Aschauer. Do public highway transport improvements serve as an unpaid input in the aggregate productions function of regions, a substitute or complement to existing or new private inputs, or as a shifter of the entire function.

Second, research can test for interactions between new transportation investments and other regional conditions or to determine if they wield an independent influence.

Third, Geographic Information Systems (GIS) may be useful in improving both the spatial variables created for model tests and in defining the impact regions of interest. Unfortunately, GIS systems are expensive and do not help if important data are not available to be used with these systems. Still, the potential is great to use GIS to avoid the use of arbitrary county boundaries as regions and to undertake tests of the effects of space on econometric estimators.

Fourth, the recognition that rural areas are diverse with respect to their economic bases and natural resource endowments suggests the need to develop growth frameworks that reflect this diversity.

Finally, major new highways that link an isolated area to regional growth centers may have substantial "backwash" effects that speed rural decline. Urban/rural trade and commuter links are likely to be strongly tied into real transportation improvements. Unfortunately, the lack of spatial data will continue to impede our ability to estimate the extent of these linkages.

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