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Transit and Regional Economic Growth: A Review of the Literature

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Transit and Regional Economic Growth: A Review of the Literature

William S. Huang

Introduction

Public transit can affect the location and intensity of development within a metropolitan region.[1] This ability to steer growth, however, does not necessarily imply improved economic performance for the region as a whole. The construction or expansion of a transit system may cause the redistribution of development within the metropolitan area, without any net increase in regional growth.

This paper summarizes empirical research related to the issue of whether public transit improves regional economic performance. Because so few studies specifically analyze this aspect of transit investment, selected works on the economic growth effects of highways are also discussed. An important body of literature is not covered here. Many studies examine land use changes near transit facilities. In general, however, while those studies provide valuable information on transit's ability to organize and shape urban growth, they do not systematically evaluate whether the observed development represents a net addition to the metropolitan region.[2] They will not be discussed here

Part I of the paper briefly covers alternative theories linking public transit to regional economic growth. Parts II and III present studies from two separate lines of empirical research that have converged on the issue. In Part II, aggregate models of the productivity effects of public infrastructure are discussed. Although such analyses were originally used to measure national competitiveness, efforts to test and refine theory have produced empirical studies of the effects of specific types of infrastructure investment on metropolitan economic performance. Part III presents selected project evaluation studies, focusing on analyses that have attempted to move beyond the traditional focus on localized impacts to measure the regional benefits of public transit. Studies of the economic growth effects of highways are also briefly discussed in Part III.

In Part IV, studies of the determinants of business location are reviewed. Since that literature is so large, only a few of the studies are covered here, and the discussion will focus on their findings about transportation facilities. Finally, Part V presents selected studies on the regional economic effects of transit infrastructure expenditures as they ripple through the local economy.

I. The Mechanisms by which Public Transit Could Cause Regional Economic Growth

According to Rephann (1993: 440), new transportation facilities can have two different effects on development: (1) redistributive effects whereby development that would have occurred anyway is relocated to take advantage of the new facility; and (2) "[g]enerative effects [that] arise from utilizing previously unused local resources or using resources more efficiently." Transportation infrastructure can cause net economic growth in a metropolitan region only if it lowers the production costs of firms so that activities from outside the region are attracted there or local enterprises enjoy a competitive advantage over businesses in other areas. Eberts (1990, 1991) identifies three ways in which this can occur. First, public infrastructure may make the metropolitan area more attractive to households. This could affect regional growth, because "infrastructure may reduce labor costs by providing an attractive environment within which households are willing to accept lower wages in order to locate" (Eberts, 1991: 88).

Second, infrastructure may function as a direct input into firms' production processes (Eberts, 1991: 88-90). If so, the effect of constructing additional infrastructure can be analyzed as if it were a private input; but it is an "unpaid" input, since firms generally are not charged for their use of public infrastructure on a per-unit basis (Eberts, 1991: 88). Publicly constructed transportation facilities usually fall into this category. Firms rely on highways, for example, for the delivery of other production inputs and for the distribution of their output. In general, however, they do not pay marginal cost-based rates for their use of the network. If an excellent metropolitan transportation system gives firms in the area a competitive advantage, other firms will be attracted to the region until either: (1) the network is overused and no longer a source of real economic profits (Eberts, 1991: 89); or (2) other metropolitan areas improve their local transportation networks to equal the first city's system.

According to Eberts (1991: 89), it is critical to know whether public infrastructure that functions as an unpaid input is a substitute or a complement to private inputs. If it is a substitute, then major infrastructure expenditures may crowd out private investment. This does not necessarily mean that those public expenditures are unwarranted. The classical justification for public infrastructure is that a public system can realize economies of scale and avoid free-rider problems. Those advantages may remain. Nevertheless, if infrastructure enhancements cause an overall decrease in private investment and employment, they might undermine other public policy goals.

If public infrastructure is a complementary input, then additions may induce higher levels of private investment. A complementary relationship, however, also implies that the ability to use infrastructure investment to spur regional economic growth may be severely limited. Even extremely large public infrastructure investments may have no discernible effect on productivity, unless additional private investment is made.

Third, public infrastructure may function as a pure public good. In this case, it is appropriate to model the effect of infrastructure as an enhancement to the productivity of other inputs. Since such infrastructure is non-rival and non-excludable, "an increase in the level of public inputs results in increased output for all firms through neutral increases in the efficiency with which the private inputs are used" (Eberts, 1990: 21).

Based on these theoretical explanations, what metropolitan economic growth effects can be expected from a public transit system? In general, transit systems move passengers, not goods. Therefore, unlike roadway improvements, the service they provide does not affect the production costs of firms directly.[3] Under general equilibrium theory, however, the construction of a transit system could decrease labor costs by increasing the size of the labor pool competing for jobs — particularly in the central city (Sullivan, 1990 230-33). In addition to this wage-reducing effect on the supply of labor, if public transit makes the metropolitan environment more attractive, then workers may be willing to accept lower wages, so long as they can remain in the area. It is important to note that both of these effects are mediated through the behavior of workers. The extent to which the transportation cost savings or the environmental amenity desires of workers are reflected in wages will depend on the elasticity of the supply of labor. In the extreme case, where the regional supply of labor is relatively inelastic, there may be little or no effect on the labor cost of firms

Transit may also have an indirect effect on firms' transportation costs, if it decreases highway congestion by reducing the number of private automobile trips. The magnitude of this effect, of course, would be mediated by the market. If transit is costly, automobile users might not be induced to change their mode. Moreover, if there are high levels of latent demand for road space, congestion would not be substantially reduced by diverting some current drivers to transit.

II. Aggregate Models

Since the 1950s, international development theorists have explored possible connections between public infrastructure and economic growth. Hirschman (1958: 94-95), for example, argued that "social overhead capital" may have its largest effects on economic growth in already booming, urbanized regions where private investment levels are high. Hansen (1965: 5-6) defined two distinct types of public infrastructure (social overhead capital and economic overhead capital) and three broad categories of regions (congested regions characterized by high concentrations of population, economic activity, and public infrastructure; intermediate regions ripe for additional development; and lagging regions unattractive to firms). He argued (at 11-12) that economic infrastructure investment would be most productive in the intermediate regions, and that it should be concentrated there. Leven, Legler, and Shapiro (1970: 67-68) modeled an interdependent system in which public and private investment decisions reinforce one another and produce economic development.

Among domestic policymakers, interest in the relationship between infrastructure and economic growth was sparked in the 1980s, when Aschauer (1989) published empirical work linking recent declines in U.S. productivity growth to falling national investment in public infrastructure. Aschauer uses aggregate time-series data to study the relationship between private output and the stock of nonmilitary public capital.[4] He models output per unit of private capital as a function of: (1) a constant, (2) time, (3) labor per unit of private capital, (4) public capital per unit of private capital, and (5) the level of capacity utilization in manufacturing (a variable used to control for the cyclical nature of productivity). Based on this specification, he finds that the elasticity of (output per unit of private capital) with respect to (public capital per unit of private capital) is 0.39. According to Aschauer, most of this effect is attributable to "core infrastructure": highways and streets; water and sewer facilities; and gas, electric, and transit facilities. Munnell's (1990a) analysis of national output supports Aschauer's findings. She models private nonfarm business output per hour as a constant returns-to-scale function of: (1) a constant representing level of technology, (2) an index of private capital services per hour of labor, (3) nonmilitary public capital stock per hour of labor, and (4) the level of capacity utilization in manufacturing. She finds that the elasticity of output per hour with respect to public capital is between 0.31 and 0.37 — a range remarkably close to Aschauer's 0.39.

Aschauer's and Munnell's results have been widely challenged. First, most economists agree that they are implausible. Aschauer's conclusion implies that the economic returns on public infrastructure projects would be many times greater than the typical rate of return for a private capital investment.[5] This result, however, is inconsistent with the findings of project benefit-cost analyses. Although project assessments suggest that there may be extremely high real rates of return for a few carefully selected public projects, others have low economic returns (Congressional Budget Office [1991: 35-41]; see also Federal Highway Administration [1992: 14-15], an excellent literature review of empirical studies on the connections between public infrastructure and national productivity). Moreover, even for the projects justified by high benefit-cost ratios, it is not clear that the economic benefits could produce productivity increases of the magnitude reported by Aschauer and Munnell.

Most important, the correlation between public infrastructure expenditures and productivity may be spurious. That public infrastructure spending and output per worker have both declined during the past 20 years does not mean that there is a causal relationship between the two. Indeed, the actual causal relationship may be exactly the reverse — rising productivity may generate increased public investment (see, for example, Federal Highway Administration [at 6]). Winston and Bosworth (1992: 276 n.6) summarize the key obstacle to resolving the causation issue:

> The statistical studies encounter a fairly simple problem. The rate of increase in total factor productivity slowed sharply after 1973. The inclusion in the statistical analysis of any variable, such as the public capital stock, with a similar one-time break in its growth rate around 1973 will yield a highly significant statistical coefficient. Unless one can observe multiple episodes of sharp variation in the growth of productivity or public capital, it is difficult to use the correlation to infer a causal relationship.

Subsequent studies have attempted to find such multiple, comparable episodes by disaggregating national statistics both geographically and by type of infrastructure. In general, these state- and metropolitan-level analyses have produced much smaller estimates of public infrastructure's productivity effects. Munnell (1990b: 16), for example, followed her study of national infrastructure expenditures and productivity with an analysis of subnational trends. Although she again finds that public capital has a significant positive effect on output, the magnitude of that effect is substantially smaller than the estimates from her study of national-level data. In her unconstrained regression model of state-level data, the elasticity of output with respect to public capital is 0.15; when she introduces a constant returns-to-scale constraint, the coefficient on state and local public capital stock falls to 0.08. Both of these figures are substantially below the 0.31 to 0.37 range she estimated using national data. Munnell notes that the coefficients in her unconstrained equation survive the implausibility test:

> The coefficient of public capital is also sensible in that it implies a reasonable marginal productivity for public capital and equality between the productivity of public and private capital. That is, the elasticity of private sector output with respect to public capital is roughly half that with respect to private capital, and the state and local public capital stock is approximately one-half the size of the private capital stock.

Munnell (1990b: 17) also disaggregates public capital into three components: highways and streets, water and sewer systems, and other. The coefficient she estimates for highway and street infrastructure is 0.06. Garcia-Milà and McGuire find a similar elasticity for highway capital in their 1992 study. They model highway capital and education expenditures, by state, in a Cobb-Douglas production function with gross state product as the dependent variable. They estimate (at 235) that the elasticity of gross state product with respect to highway capital is 0.04.

A few of the aggregate studies have analyzed metropolitan-level data. Eberts (1986) models the relationship between public capital stock and manufacturing output in 38 metropolitan areas for the period from 1958 through 1978. He uses value-added as the dependent variable, hours of production and nonproduction workers as the labor input, and private manufacturing capital stock as the measure of private capital. Eberts concludes that public capital stock makes a positive, statistically significant contribution to manufacturing output, but that its elasticity — 0.03 — is small relative to the elasticities associated with other inputs. Deno (1988), in contrast, finds a very high elasticity. He uses a normalized translog profit function to model the relationship between public capital and manufacturing production decisions in 36 metropolitan areas from 1970 to 1978. This specification differs from the production functions discussed above. According to the Federal Highway Administration (1992: 12):

> [E]conomists have suggested that cost or profit functions may be more appropriate than production functions for analyzing the relationship between public capital and productivity. The production function method is criticized in this case because private and public capital variables may be related through their input prices (interest rate on capital), which contradicts the notion that all input variables should be exogenous . . . rather than endogenous . . .

Based on his analysis, Deno concludes (at 407) that the elasticity of output supply with respect to highway capital is 0.31. The size of this estimate suggests that highway investment might be a valuable tool for promoting regional economic growth.

In 1991, Duffy-Deno and Eberts collaborated in a study of pooled data from 28 SMSAs. Their paper seeks to isolate the effects of public capital expenditures from the effects of public capital stocks. According to Duffy-Deno and Eberts (at 337), public investment affects personal income because construction activities result in increased wages and employment. Public capital stocks, in contrast, function as production inputs and as household consumption goods. They find that public capital stock has a significant effect on per capita personal income within the metropolitan area.

The subnational studies have also been challenged. Hulten and Schwab (1991: 133), for example, scrutinize the sources of regional economic growth, and they conclude that since there is so little variation in productivity growth between regions, inter-state comparisons are ultimately unilluminating:

> The rough equality of regional productivity growth leaves little room for any variable, including public capital, to serve as a key determinant of regional differences in [multifactor productivity], simply put, there are very few differences to explain. Our results [suggest] that regional differences in public capital growth do not seem to be a major determinant of productivity differentials across regions. The conceptually richer model we have offered in this paper suggests that public infrastructure does not generate significant Meade externalities.

Evans and Karras (1994) model panel data from 1970-1986 for the 48 continental United States, using several alternative functional forms. They conclude that while government educational services appear to be productive, there is no evidence that other types of government investment are productive. Holtz-Eakin (1994: 19) concludes that when productions functions are corrected to control for unobserved, state-specific characteristics, the data reveal no role for public-sector capital at the margin:

> Findings of a statistically and economically significant, positive elasticity for public sector capital are an artifact of restrictions placed on the error structure. When using more appropriate techniques, the most plausible estimate of this elasticity is zero.

The results of the subnational studies must be interpreted cautiously: the absolute inter-regional redistribution of wealth effected by public expenditures must be isolated from the growth-inducing effects of an input mix that includes more infrastructure. This complexity has been largely ignored by aggregate economic studies, which are rooted in the macroeconomics tradition, not benefit-cost analysis. Only one of the sub-national studies — Duffy-Deno's and Eberts' 1991 analysis of the relationship between metropolitan income, public capital investments, and public capital stocks — considers the possibility that part of the productivity gains associated with public infrastructure may be explained by the immediate infusion of externally collected dollars into the metropolitan economy.

To date, none of the aggregate studies of productivity and infrastructure investment have attempted to isolate the effects of transit investment. The basic metropolitan models discussed above, however, probably could be easily adapted to test the relationship between various productivity measures and transit infrastructure. Given the conflicts within this literature, however, such an analysis could not be expected to provide conclusive evidence of transit's effects on regional economic growth.

III. Project Evaluations Addressing Regional Economic Effects

Most empirical studies of specific transit projects do not try to determine whether regional economic performance is improved by the public transportation system. Even Beimborn et al. (1993:

113-25), who present a general framework for measuring the benefits of transit, limit their consideration of employment impacts to the direct and indirect effects of construction expenditures.[6]

A review of the transit project evaluation literature identified only two studies that have confronted this question head-on: (1) the 1979 study of *The Economic and Financial Impacts of BART*, and (2) a 1991 study of the metropolitan economic effects of shutting down SEPTA.[7] The two analyses reach very different conclusions. The BART impact study finds that the rapid transit system had no significant effect on regional economic growth. In contrast, the SEPTA team estimates that shutting down metropolitan Philadelphia's transit system would have a very substantial negative effect on business sales, personal income, employment, and population within the region.

The BART Impact Study

The BART Impact Study, conducted in the 1970s, was a comprehensive assessment of the San Francisco Bay Area's then relatively new rapid transit system. One component of the study sought to determine whether BART had improved the economic performance of the metropolitan area. According to Grefe and McDonald (1979: 5), the authors of that portion of the study, such an effect could occur only if BART gave a competitive advantage to industries within the region:

> If BART service has had an impact on regional economic development, it would be manifested in an impact on the competitive advantage of industry within this region. The accessibility of employment to residents in the region, or conversely, the access of business to a larger work force through transit, might improve the competitive position of the region in attracting new business.

Grefe and McDonald use three techniques to detect potential competitive advantages related to BART service: (1) an evaluation of the inter-zone travel time effects of BART, to isolate any accessibility advantages provided by the system; (2) a shift/share analysis to identify industries with unusually high post-BART growth rates in the counties served by the system; and (3) key informant and directed interviews to identify any causal links between BART and economic development.

Their accessibility study reveals (at 67) that on average, BART offered a 19 percent improvement in travel time to major employment centers. This effect was not distributed uniformly across all socioeconomic groups: high-income households experienced higher than average improvements, while poor households experienced improvements well below the 19 percent average (at 67-68).

Despite these large accessibility effects, neither the shift/share analysis nor the key informant interviews revealed any significant BART-generated competitive advantage for business (at 73-78). Virtually all of the businesses interviewed were affected by BART in some way, but the magnitude of that effect was judged to be minimal. According to Grefe and McDonald (at 77), the interview responses overwhelmingly support the following conclusions:

- There was *no* locational advantage for the BART service area compared to other areas in the San Francisco Bay region, or other regions, because of the existence of BART. There were no instances where BART service could be cited as a significant or causal reason for a locational decision from outside the Bay Area.

- There were *no* instances cited where BART provided a significant efficiency of operation for an existing business. BART usage is a convenience in many instances, but no case was identified in which the availability of BART service would have a measurable effect on productivity or operating profits.
- There was *no* indication that BART in any way affected demand for the products of the San Francisco Bay Area's export-base industries — including the tourism industry.

Although land developers believed that BART enhanced the region's image (Grefe and McDonald, 78), informants from the tourism, health services, legal, banking, and manufacturing sectors identified only very minor business advantages from BART service. Grefe and McDonald confirm the result in four case studies selected on the basis of the employment analysis and the interviews (at 78-81).

Although Grefe and McDonald conclude that BART did not increase regional economic growth, there is a basic tension in their results. They document substantial potential consumer benefits from BART – i.e., significant reductions in commute-time. Those benefits, however, were not reflected in any competitive advantage for business or increase in economic activity — a result inconsistent with traditional economic theory. A possible explanation for this discrepancy is that their research design is not well-tailored to detect BART's effects on regional economic growth. If those effects were indirect, dissipated by intermediate markets, and spread widely over the entire economy, it is possible that none of the key informants interviewed would have recognized BART's contribution.

The SEPTA Study

In *The Economic Impacts of SEPTA on the Regional and State Economy*, the Urban Institute and Cambridge Systematics, Inc. (1991), use a dramatically different technique to tackle the same basic question. does transit affect metropolitan economic growth? In contrast to Grefe and McDonald, the authors of the SEPTA study do not attempt direct measurement of transit's effects on regional economic activity. Instead, they perform a two-stage analysis. First, the travel-related benefits of SEPTA service are measured. Second, a regional input-output model is used to estimate the effect of those benefits on regional economic growth. This approach is consistent with major theories of urban economics, and it avoids some measurement problems. Its accuracy, however, depends on models that may not perform well in this context.

Measuring the Travel-Related Benefits of Transit

According to Beimborn et al. (1993: 67-76), the travel-related benefits of transit should be measured by calculating the change in consumer surplus produced by the system. While this approach is preferred from the perspective of economic theory, it is extremely difficult to implement. To measure the effect of any given facility, it is necessary to sum the change in consumer surplus over all possible modes, origins, and destinations. (Beimborn et al., at 73). In the United States, where the existing network offers a large number of origin, destination, mode, and route choices to consumers, this is a formidable and probably impossible task.

The problem is compounded because: (1) the "cost" of different transportation alternatives is a combination of dollar charges, travel time, and inconvenience; and (2) most of the transportation system is not priced at marginal cost. The first complication can be addressed by travel disutility models that combine time, inconvenience, and dollar charges into a single metric. This solution, however, is not perfect: although standard weights have been developed for converting time and inconvenience into dollars (see, e.g., Beimborn et al., at 69), some consumers may have substantially different reservation prices. If standard weights are used to evaluate their behavior, their travel decisions will appear irrational (Beimborn et al., at 77-78). Therefore, while generalized cost models make analysis more tractable, they are also a potential source of considerable inaccuracy.

The second problem — the general lack of marginal-cost pricing in transportation — poses a more fundamental challenge. Most transportation facilities in the United States are not financed by per-unit user-fees, based on the cost of constructing and maintaining the facility. Moreover, transportation often has substantial externalities. Verhoef (1994), for example, emphasizes the importance of considering the environmental costs associated with road transport. Congestion costs must also be addressed. Finally, there may be positive externalities from the use of a transportation facility, although Verhoef argues (at 276-77) that virtually all of the benefits of road transport are fully internalized

The lack of explicit marginal cost prices makes it extremely difficult to estimate the effect of a new facility on net consumer surplus. Moreover, even if the net consumer surplus could be measured accurately, it is unclear how meaningful or useful that information would be for policymakers. While it might be valuable for construction decisions at the margin, it would not reveal whether the proposed facility would be economically justified if market distortions were eliminated.

Perhaps because of these problems, none of the project evaluations reviewed tries to estimate travel-related benefits by measuring net consumer surplus. The SEPTA study relies on a computation of time savings — a method transplanted from the larger literature on the economic benefits of highways. According to Beimborn et al. (at 77), when used to compare public transit with private automobiles, the time savings method tends to underestimate the benefits of transit, because mode choice is not taken at face value:

> A conventional time savings calculation underestimates the benefits of the service change because it simply penalizes travelers who switch to transit. These travelers appear to be making an irrational decision in choosing a mode with a higher disutility.

The SEPTA study, however, completely avoids comparisons of the disutility associated with competing transit and automobile modes. Instead, the travel benefits of transit are estimated by eliminating the transit system, re-allocating some or all of the displaced trips to the highway network, and projecting the effect of those additional trips on highway travel-times, vehicle operating costs, and accidents.[8] According to the researchers (at 3-7), the direct user impacts of eliminating SEPTA services would be: (1) "increased travel by car, at greater personal cost for former SEPTA users"; and (2) "more traffic congestion, bringing longer travel times and greater out-of-pocket operating costs for existing car and truck users."

The SEPTA study estimates that if transit were unavailable, 96 percent of current transit work-commute trips and 65 percent of the non-work transit trips would be made by some other mode — primarily private automobiles (at 4-7). Assuming that current SEPTA users would switch to automobiles with the same occupancy rate as cars currently crossing Philadelphia's CBD screenlines, the peak accumulation of vehicles in the CBD would be about 85,000 additional vehicles on an average workday (at 4-7).

The SEPTA team assembles data, multipliers, and travel-time cost estimates from a variety of sources in order to calculate the effect of these extra trips on regional economic activity. Motor vehicle operating costs and travel times, for example, are estimated using a highway user cost simulation model based on the Transportation Research Board's *Highway Capacity Manual*, tables from New York's Highway User Cost Accounting Micro-Computer Package, and historical and projected volume-to-capacity ratios from a Delaware Valley Region transportation plan. They use the Federal Highway Administration's Highway Economic Requirements System Model to place a dollar value on the accident-rate and travel-time changes. (The Urban Institute and Cambridge Systematics, Inc., at 3-8 to 3-9).

The SEPTA team estimates (at 4-9) that the travel cost impacts of shutting down SEPTA would be over $1.9 billion per year in 1990 dollars. Because this figure is based on a partial equilibrium analysis, it should be interpreted cautiously. The SEPTA team's congestion projections are based on transferring a percentage of current transit riders to the road network. This, however, probably represents the maximum possible congestion effect — not the level that would actually be observed. If congestion is severe, for example, an unusually high percentage of former transit users might choose to travel by some mode other than driving alone. Employers might aggressively expand the use of flex-time and van pooling to reduce peak hour congestion. As the SEPTA researchers correctly note (at 5-9), land use changes might also be produced by changes in the transportation system:

> One type of potential change which would take place if SEPTA were curtailed or eliminated is the relocation of job locations within the metropolitan area. This study did not explicitly model how activities remaining within the metropolitan area would relocate in response to higher transportation costs and greater congestion.

Most importantly, current users of the road network might change their travel behavior if congestion rises dramatically. Although transportation models can accurately predict the effects of minor, incremental changes to the highway system, they have been less reliable when projecting the effects of major network changes. It may be inappropriate to use them in this context.

Measuring the Regional Economic Development Effects of Transit

Once the effects of shutting down SEPTA had been translated into highway user costs, the researchers could draw on recent models developed to predict the effects of highways on regional economic development. Specifically, the SEPTA team models the regional economic impacts of eliminating SEPTA as the product of seven factors (at 3-10):

- Increased "cost of doing business" in the region, resulting from the longer time cost and out-of-pocket cost of business delivery, shipping and "on-the-clock" individual business travel on congested roads
- Reduced business access to labor markets
- Increased "cost of living" in the region, resulting from the greater out-of-pocket cost of personal travel on congested roads, and additional cost of car ownership and usage by some former SEPTA users
- Loss of jobs for SEPTA employees
- Decreased "attractiveness" or quality of life, resulting from the greater travel times of personal travel on congested roads, and reduced options for non-car travel
- Shifts in personal spending patterns, with increased purchases of cars, petroleum products, insurance, parking, and repair services in place of transit fares and other expenditures
- Reduced attraction of visitors

They use the Regional Economic Models, Inc., (REMI) economic forecasting and simulation model — an input-output base — to evaluate the regional effects of the proposed service level changes. According to the SEPTA Study (at 3-12 to 3-13),

> The REMI Forecasting and Simulation Model includes all of the inter-industry interactions among 49 private sectors in the economy. It also includes the trading flows by industry between the Philadelphia metro area and the rest of the state of Pennsylvania.
>
> In addition to containing a complete inter-industry and trade flow structure, the model also includes key aspects of the economy that are regarded as important for policy evaluation. These include the effect on the location of industry, in the present and future, of changes in the relative cost of doing business. This relative cost of doing business is built up for each industry based on tax costs, fuel costs, wage costs, and costs of all the intermediate inputs in the area. The model allows for substitution among capital, labor and fuel, based on shifts in relative cost in these factor inputs. It has a wage determination response for each of 94 occupations based on shifts in relative demand for labor in each occupational category. These wage changes, by occupation, affect costs for each industry. The model includes a migration response to employment conditions in the area.
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> The modeling and analysis process is dynamic: transportation cost impacts and overall economic impacts for each scenario are modelled year-by-year. The transportation model estimates transportation related costs for each year. These are used in the economic model to estimate changes in economic activity over the year. The change in economic activity is then input to the transportation model for the next year, and this analysis process is carried on through the year 2020 in order to estimate long-term changes.

Based on the REMI model, the researchers conclude (at 5-23) that by the year 2020, a complete shutdown of SEPTA would produce the following negative economic effects for the Philadelphia metropolitan area: a loss of $14.9 billion in business sales (in 1990 current dollars); a decrease in personal income of $9.6 billion (in 1990 current dollars); the loss of 170,600 jobs; and a population decrease of 313,200.

Modeling the Regional Economic Impact of Highways

Because so few studies have systematically analyzed the regional economic growth effects of transit, a brief review of the larger literature on the economic effects of highways is worthwhile. Several recent papers summarize current approaches to highway economic impact evaluation (Drew, 1990; Forkenbrock and Foster, 1990; Washington, Pinnoi, and Stokes, 1990). Together, they identify five basic methodologies: (1) aggregate models/econometric base models; (2) input-output analyses; (3) econometric and quasi-experimental studies; (4) other regional economic models that include transportation variables, such as spatial general equilibrium analysis, production models, and regional econometric models; and (5) system dynamics modeling. Most empirical studies fall into one of the first three categories.

The first category — which includes aggregate production function and profit function models — was discussed in Part II, above. Those studies have generated a wide range of estimates of road infrastructure effects.

The second category consists of input-output analyses that trace the effects of travel cost reductions as they ripple through the regional economy. While still relatively rare in public transit studies, they are common in the highway impact literature. Before it was used in the SEPTA study, the REMI input-output model was a well-established highway impact model. (See, e.g., Seskin [1990], who describes three highway projects evaluated using various versions of the REMI model.) Several other input-output models have been developed for highway impact studies (Forkenbrock and Foster, 1990: 309 [using the IMPLAN model to estimate the effects of transportation cost reductions from a proposed 500-mile highway corridor connecting St. Louis, Missouri, and St. Paul, Minnesota]; Allen et al., 1988 [using the TRIM input-output model to estimate the effects of various proposed transportation investments in Ontario]; and Politano and Roadifer, 1989 [estimating the effects of proposed highway construction in the Dallas/Ft. Worth area with the Regional Economic Impact Model for Highway Systems]. See also Sullivan, 1992 (who uses judgments of transportation cost and travel time elasticities to predict the effect of facility improvements on industries in the coastal areas of the Pacific Northwest); and Butler et al., 1984 (using an input-output model to estimate the national effects of decreased highway expenditures). Although there are differences between these models — particularly with regard to their level of industry disaggregation and the extent to which they allow elasticities and prices to change over time — their basic structure is quite similar. Moreover, that structure ensures they will find some regional economic benefits from any transportation facilities that improve travel times or reduce travel costs.

Other studies have used regression analysis or other econometric modeling techniques in an effort to isolate the effects of highway investment on regional economic development. Wilson, Graham, and Aboul-Ela (1985), for example, model the relationship between per capita income and highway investment in New Brunswick during 1957-1980. They conclude that highways do not always produce economic growth. Their results suggest that in the earliest stages of its development, the highway network is not capable of encouraging regional growth. Highways will cause economic growth in the intermediate development phase, but as the network becomes saturated, "[i]nvestment in the highway network no longer encourages economic development, but serves to increase the mobility of the residents" (at 14).

Thompson, Weller, and Terrie (1993) use multiple regression analysis to explore the relationship between growth in per capita income and various measures of road system expansion in Florida between 1980 and 1990. They find that, in general, growth of total per capita income does not appear to be a function of highway investment levels. (See also Lombard, Sinha, and Brown, 1992, who use cross-sectional multiple regression analysis to study the relationship between highway infrastructure and economic development in Indiana between 1980 and 1988.)

Eagle and Stephanedes (1987) run Granger-causality tests and structural plots to test whether highway construction expenditures during the 1960s and 1970s caused county employment to increase in Minnesota. They conclude that highway expenditures Granger-cause long-term employment growth in the regional center, but do not Granger-cause long-term employment increases in other areas of the state. Washington, Pinnoi, and Stokes (at 57), however, criticize the study:

> The present model based on the time-series analysis has several weaknesses. First, the structural equation may have the problem of simultaneity because of the interrelationship nature of the two variables. Next, the highway expenditure variable is not the only variable explaining the behavior of employment. Finally, employment is only one of many representatives of economic development. Total output, earnings and tax bases may be tested for causality as well.

Eagle's and Stephanedes's county-level focus also masks the redistribution of economic growth within metropolitan areas. They conclude that highways cause employment growth in regional centers, but they also find that in next-to-urban counties, an increase in highway expenditures is associated with declining employment (at 61). They then note (at 61-62) that this finding suggests at least part of the urban growth they document may be redistributed from next-to-urban counties. Because they do not analyze the metropolitan region as a whole, their study does not explore this phenomenon in detail.

Two recent studies have used quasi-experimental methods to isolate the effects of highway investment on regional economic growth. Andersen et al. (1993) use matched pairs to study the economic effects of highway bypasses in Texas. They find that a bypass generally produces a small, but statistically significant, decrease to business volumes. Rephann and Isserman (1994) use longitudinal data and matched pairs to examine the effect of highways constructed between 1963 and 1975. They conclude (at 746) that "[n]ew freeways can be a useful part of a growth center strategy to reinforce the competitive characteristics of small cities. ... [y]et, the largest economic changes [caused by new highways] will be on the urban fringe of larger cities."

In general, the results of the econometric and quasi-experimental studies have been more equivocal than those of the input-output models. There seems to be a strong consensus that highway construction will not necessarily generate net economic growth. Indeed, the recent NCHRP report, *A Primer on Transportation and Economic Development* (Lewis, 1991: 18 citation omitted), expressly cautions that most highway projects will not produce new economic development:

> While studies often report [a] large number of jobs either directly or indirectly associated with transportation facilities, more in-depth investigations find that virtually all employment associated with expansions of the transportation system in mature economies would be absorbed elsewhere in the labor market if the investment were not to take place. Only where a regional economy displays long-term structural unemployment can regional net gains in employment and income stem from transportation policies and projects. Even then, the gains are typically small.

The potential to extend these econometric and quasi-experimental research methods to the analysis of public transit is probably limited. Public transit — particularly rail transit — is generally restricted to the largest and oldest U.S. cities. Studies that rely on regression analyses and/or matched pairs would face formidable problems, because cities with extensive transit systems probably are not comparable to cities that do not have them.

IV. Transportation Facilities and Industrial Location Decisions

Research on the determinants of industrial location has identified transportation infrastructure as an important site attribute that can attract new plants. The studies can be divided into two basic categories. (1) surveys that ask decisionmakers to identify or rank the factors most important to their location decisions; and (2) econometric models that isolate the effects of various site characteristics on actual location decisions.

Survey Research

Most of the survey research studies present a list of site characteristics and ask respondents to rate their importance. Summarizing the literature in 1965, McMillan (1965: 239-40) noted that:

> With some minor variation, the results appear inevitably to be the same. Markets tend to rank first or second. If the industries surveyed are resource oriented, raw materials will rank first and markets second. Market oriented industries will tend to rank markets first, labor second, and raw materials third. Transportation, whether it is reported in terms of "central location to market" or "transportation facilities" will customarily rank third or fourth.

According to McMillan (at 240), however, most of the studies improperly fail to distinguish between factors that are basic prerequisites and those that are determinants of specific location decisions. Plant siting is a two-stage process. In the first stage, a geographic region is selected that provides the basic prerequisites — for example, access to raw materials, markets, and labor. After a region has been selected, decisionmakers conduct a second-level search to identify particular sites. McMillan reports the results of a 1964 McGraw-Hill survey of 2,000 *Business Week* subscribers that focused on the second stage. Seventy-six percent of the respondents to that survey identified good truck transportation as an important consideration in selecting a specific area or site for their plant — the broadest consensus for any single item. Twenty-nine percent identified public transportation as an important consideration — a relatively high figure, although it ranked low compared to other factors (McMillan, 242).

In 1976, *Fortune* magazine surveyed the 1,000 largest industrial corporations in the United States, asking them to rank each of 26 factors as to their importance in locating their next mainland plant (*Fortune*, 1977). Although "Efficient transportation facilities for materials and products" ranked very high in their survey (tying with "Productivity of workers" for first and second of 26), "Efficient transportation facilities for people" was near the bottom of their list (20th/21st out of 26) (*Fortune*, 5). "Efficient transportation facilities for people," however, ranked near the top of the list of criteria for siting corporate headquarters; and the survey results identified it as a factor that would be more important in the future than it had been in the previous five years (*Fortune*, 17). The *Fortune* survey did not inquire separately about the value of public transportation systems. However, among the respondents who expressed reservations about central city sites, 15 percent volunteered that good public transportation would make their company more interested in a central city location (*Fortune*, 19). Sixteen percent cited "Efficient transportation for products and materials," and 7 percent identified "Ample parking, less traffic congestion," as factors that would make a central city location more attractive.

Kieschnick (1981) conducted a survey of firms that had made investments in 1979 in states offering automatic tax incentives for new development. Although the main purpose of his survey was to isolate the importance of tax incentives to location decisions, Kieschnick also asked respondents to rate a variety of other factors, including the quality of the transportation network. For new firms, 24.4 percent identified the transportation network as a deciding positive factor; 34.4 percent identified it as a moderate positive factor; 32.2 percent thought that it was an insignificant factor; and 5.6 percent responded that it was a moderate negative factor. Among expanding firms making interstate location choices, 14.3 percent identified the transportation network as a deciding positive factor; 42.9 percent identified it as a moderate positive factor; and 42.9 percent thought that it was insignificant (Kieschnick, 1981: 70-71).

Schmenner (1982) reports the results of a survey that examined the plant location decisions of 60 *Fortune* 500 companies during the 1970s. He used a three-tier structured telephone interview questionnaire in which managers who participated in the location decision process were asked to identify: (1) absolute requirements that constrained their region/state choice; (2) absolute constraints on final site selection; and (3) site factors that were desirable, if available (Schmenner, 149). Transportation factors did not rank particularly high in the region/state choice; but both rail service and location on an expressway were among the most frequently cited constraints in selecting a specific site. Although transportation factors did not also dominate the "desirable, if available" responses, this may be because so many respondents had already identified them as absolute requirements. Local transportation networks and public transit do not appear to have been mentioned by survey respondents (Schmenner, 150-51).

In 1984, *Industry Week* surveyed 1,000 executives about their site-selection criteria. Fifty-four percent said that land transportation was "vitally important" to site-selection decisions (Goldstein, 1985). Public transportation was not identified as a separate item in Goldstein's 1985 report on the survey.

In 1987, Blair and Premus reviewed the empirical literature since 1970. Like McMillan two decades earlier, they find that labor force, transportation, and markets ranked high in the surveys (Blair and Premus, 1987: 80). See also Tosh et al., 1988. They note, however, three important trends: (1) "[these] traditional economic factors of location are becoming, as a group, quantitatively less significant," while business climate and quality of life factors have gained importance; (2) "the primary impact of technical change has been to reduce the significance of 'proximity to raw materials' and to increase 'proximity to markets' as a locational factor"; and (3) "in recent years, state and local taxes have had an important effect on business location, particularly within metropolitan areas where business property taxes can vary substantially among jurisdictions" (Blair and Premus, 1987: 80).

These changes do not mean that transportation facilities have become irrelevant to the siting process Although proximity to raw materials has become less important, proximity to markets has become more important. Moreover, the adequacy of the transportation network may be an important quality of life or labor force availability factor. In his survey of high-tech businesses in Orange County, for example, Galbraith (1985) separates transportation into two components: good transportation for people and good transportation for materials/products. Of his respondents, 40.4 percent identified good transportation for people as an important or very important factor influencing their location decisions. In contrast, only 22 percent thought good transportation for materials/products was important or very important. (See also Rex, 1993, who notes that traffic congestion is a major quality of life factor.)

Calzonetti and Walker (1991) report the results of a nationwide survey of new manufacturing plants that started operations between 1978 and 1988. Although transportation infrastructure does not appear on the list of factors important in the regional site selection process (at 234), highways were the third most important factor in the local search, after proximity to markets and the availability of non-union labor (at 236). For single-plant establishments, access to highways ranked even higher (at 236-37). Finally, a 1994 survey of corporate executives polled through the National Association of Corporate Real Estate Executives found that transportation facilities are important in the initial site screening process,[9] ranking only behind "Real Estate Costs" and "Labor Force Issues" in importance (MacKay, 1994).

Public transit appears as a siting criterion in only two of the general industry surveys reviewed — McGraw-Hill's 1964 plant location survey (McMillan, 1965) and *Fortune Magazine*'s 1976 poll (*Fortune*, 1977). In theory, however, the factor may be embedded in general quality of life measures, transportation network rankings, and/or labor market ratings. Anecdotal evidence from Rochester, New York;

Atlanta, Georgia; and San Antonio, Texas, suggests that transit has lured specific facilities to particular sites in new states or urban areas (American Public Transit Association, 1983: 4).

At least two of the rail transit evaluation studies have used surveys in an effort to isolate the effects of transit on business location decisions. As discussed above, the 1979 study of the economic impacts of BART included 85 interviews with San Francisco Bay Area business and industry leaders to determine whether BART had altered the structure of the region's economy (Grefe and McDonald, 76) The study concludes that BART did not have any significant effect.

The San Diego Association of Governments (1984) finds that the San Diego Trolley was a minor positive factor in siting decisions — at least among those who chose to locate near stations. The SDAG interviewed the developers and leasing agents for 10 projects constructed near Trolley stations between 1980 to 1984. Based on those interviews, the SDAG (1984: 44) concludes:

> First, the extensive residential, commercial and office development in the vicinity of the Trolley stations and the responses of developers and leasing agents indicate that the Trolley does not have a negative impact on new construction.
>
> Second, the existence of the Trolley is seen as an advantage in locational choice for land uses, particularly in the areas outside Centre City San Diego. It is not, however, a major locational determinant.

The SDAG also conducted a survey of commercial establishments located close to Trolley stations. Although about 20 percent of the respondents stated that the Trolley was an important factor in their business remaining at its current location, over 60 percent felt that the Trolley had no effect, positive or negative, on their business volume (SDAG, 1984: 45).

As a group, the business survey studies indicate that transportation facilities are still important to industrial location decisions. The studies, however, do not reveal whether sites with adequate transportation facilities are scarce. Moreover, the geographic scale of the studies is either too large (multi-state regions) or too small (specific sites) to make them directly useful for determining if additional infrastructure would enable any given metropolitan area to attract new businesses. None of the studies finds that public transit is a critical factor in location decisions.

Econometric Studies

In contrast to the survey research studies that ask decisionmakers to state their preferences, econometric analyses isolate the importance of transportation facilities by analyzing firm behavior.[10] Many of the econometric models of industrial location do not consider transportation infrastructure at all (see, for example, Carlton, 1983). Of those that do, most find that transportation facilities are a significant, but not determinative, factor. Dorf and Emerson (1978: 119), for example, conclude that within rural areas in the Western North-Central region of the United States, access to the interstate highway system is not a critical factor for average size plants, although it is important to large manufacturing facilities. Fox and Murray (1990: 425) study 95 Tennessee counties between 1980 and 1986, and they identify the presence of an in-county interstate highway as an important attribute associated with higher entry rates for most firm size categories. They note, however, that the relationship may be spurious:

> these results raise an important and unresolved issue: does the interstate system (or other highways) create new activity, accommodate existing activity between major trade and population centers, or serve to redistribute activity across sites?

V. The Effects of Transportation Infrastructure Expenditures

The expenditures associated with constructing, operating, and maintaining major transportation facilities may substantially increase regional economic activity. In general, input-output analysis is used to track such infrastructure expenditures as they ripple through the local economy. Strathman's (1983) study of the effects of transit construction expenditures on the Portland metropolitan economy is typical. He uses a 24-sector input-output model and finds that gross local outlays of $236 million will generate a total of $385 million in direct, indirect, and induced metropolitan production. Most other input-output studies show similar, substantial regional economic benefits. (See, for example, Paaswell, Berechman, et al. [1987: 67], who use economic base analysis to estimate that local outlays of 297 million will generate over 1 billion in income over the six-year construction period).

Beimborn et al., however, emphasize (at 114) the need to establish a clear baseline for any input-output analysis of transit expenditures:

> When considering the actual employment benefits of transit, it is important to compare transit employment with employment in other sectors. Does transit create more jobs than would occur if the funds were left untaxed in the economy? Does transit provide a significant amount of job creation different from highway construction or other capital-intensive projects? Are the created jobs low wage or high wage? What types of jobs are needed immediately to stimulate the local economy? Before one can properly determine the impacts of transit upon employment, all of these questions must be accurately answered with the proper analytical methods.

While traditional input-output studies are useful, their results must be interpreted cautiously. The total increased production figures (the $385 million figure from Strathman's 1983 study, for example) reflect marginal economic growth only if all of the expenditures are funded from an external source. If funds must be raised locally to finance the infrastructure, it will be diverted from other — possibly more productive — local enterprises. That lost production will offset some or all of the construction expenditure benefits [11]

A few studies have explored the effects of diverting local funds into transit construction. Watterson (1985), for example, models three transit alternatives for metropolitan Seattle. Watterson varies the assumed level of local funding in each scenario, based on a judgment of the level of federal subsidy that can be expected for each type of proposal. According to Watterson (at 8), although the results are tentative,

> The usual capital cost multiplier analysis and its total economic impacts was [sic] shown to be extremely sensitive to the local share funding assumption, whatever that might be. Negative regional economic impacts of transit investment are entirely possible. The best economic impact may be gained from putting money in consumers' pockets, not in public investment.

Strathman and Dueker (1987) tackle the issue even more directly, examining the regional economic impacts of raising $1 million in local transit operating expenses from seven alternative sources in the Portland metropolitan region: personal income tax, property tax, retail sales tax, gasoline sales tax, downtown parking fees, payroll tax, and a transit fare increase. Even after accounting for the effects of increased transit agency expenditures, all of the local financing scenarios generated net negative effects for the region — "from a net reduction of $87,000 associated with the gasoline tax to a loss of $426,000 following a fare increase" (Strathman and Dueker, at 44-45). Strathman and Dueker note (at 46), however, that these figures do not take into account the redistribution effects or externality benefits that may result from increased transit ridership — they consider only the effects of changed spending patterns.

CONCLUSION

Despite frequent claims that the construction of transit systems will produce regional economic growth, this literature review has identified only two empirical studies — separated by over 10 years — that have attempted to measure those effects systematically. The two studies reach opposite conclusions. One found no significant effects on economic growth; the other reported large, long-term effects on business sales, population, employment, and metropolitan income.

This disagreement may be explained, in part, by methodological differences. The 1979 BART impact study attempts to isolate the effects of transit through key informant interviews and shift-share analysis. Regional growth, however, is a complex process involving many related factors, so it is difficult to identify the effect of any single variable. Moreover, theory suggests that transit's effects on firm costs are, at best, indirect. Given these problems, perhaps it is unsurprising that the study concludes BART had no significant impact on metropolitan economic growth.

The SEPTA study, in contrast, focuses on the directly measurable effects of transit — decreases in travel time and congestion — and it uses a model that necessarily translates those effects into increased economic growth. So long as transit provides any travel-related benefits, the study's design virtually ensures that some positive effect on economic growth will be found.

Additional studies of transit systems might help reconcile this basic conflict. It is worth noting, however, that new empirical work may not resolve basic philosophical differences, and that the same bifurcation appears in the more developed highway impact literature: the input-output analyses tend to find economic growth effects, while the results of econometric and quasi-experimental studies are more ambiguous.

Notes

[1]See, e.g., the studies cited in Huang (1994).

[2]The studies of the Washington, D.C., Metrorail system fall into this category (Metropolitan Washington Council of Governments [1983], Dunphy [1982]).

[3]Public transit may reduce the costs of business by facilitating face-to-face meetings and speeding business-related intra-metropolitan travel. This contribution, however, is probably small. (Grefe and McDonald [1979: 72]). Surveys administered for the BART Impact Study, for example, revealed little use of BART for business purposes. Moreover, "extensive interviewing failed to confirm that business use of BART has increased business efficiency." (Grefe and McDonald, 83).

[4]Aschauer includes the following facilities in nonmilitary public capital: highways and streets, educational buildings; hospital buildings, sewer and water facilities; conservation and development facilities; gas, electric, and transit facilities; and other miscellaneous but nonmilitary structures and equipment.

[5]Schultze (1990: 63 n.31) notes that:

> According to Aschauer's regression, a 1 percent increase in the stock of public infrastructure raised the level of output – everything else held constant – by 0.39 percent during the period from 1949 to 1985. By virtually all estimates that increase was larger than the gain in output from a 1 percent increase in the stock of private business capital. Yet the stock of business capital (in 1987) was 3.3 times the size of the stock of public capital.

[6]Mahdi (1982) demonstrates a method for measuring the transportation benefits of transit. Mahdi uses a 490 sector input-output model to simulate the effects of transit improvements that reduce the costs of local travel by 10 percent. Mahdi models the economies of Atlanta, Boston, San Francisco, and Washington, D C., and concludes that transit improvements would have the smallest effect in Washington, D.C. (because government services are a major part of the metropolitan area's economy and are not affected by reduced transportation costs) Although Mahdi uses the same basic technique as the SEPTA study discussed below, the simulations are based on hypothetical changes in local transportation costs No effort is made to determine whether or how much transit improvements would actually change local travel costs Therefore, Mahdi's study will not be discussed in detail here

[7]Large-scale studies of rail transit impacts have also been undertaken for Atlanta's MARTA system and the Washington, D.C., Metro. Neither of those studies, however, addresses the issue of regional economic effects as comprehensively as the BART or SEPTA studies. Both the MARTA and Metrorail research efforts document some land use changes near transit stations. Neither, however, confirms the existence of regional economic development benefits from transit.

Most of the studies of smaller systems expressly discount the possibility that transit will attract new development. The *Milwaukee Northwest Corridor Rapid Transit Study* (RERC]1986: 22-23, emphasis added]), for example, assumes strongly that no new development would be generated by the construction of a light rail line:

> There is one generality that applies to the relationship between transit lines and real estate development. transit lines can focus existing development potential but they do not create new development. The experience of both heavy and light rail developments in other cities shows that in areas of economic growth a portion of the new development will focus around transit stations, and that in areas that are economically stagnant little or no development occurs.
>
> ***
>
> Overall, the transit system may enable the City of Milwaukee to capture a slightly larger share of the region's development activity by encouraging businesses to remain in downtown office space rather than moving to the suburbs and by causing some households to remain in the city or move to transit-served neighborhoods rather than out of the city. *The transit system will not, however, stimulate any new economic activity within the region.* Whatever development occurs near transit stations will be development that would have occurred in the region anyway — though it might have occurred later and in another location, perhaps outside the City of Milwaukee.

[8]Lomax and Memmott (1989: 20) use the same technique in their report, *The Cost and Benefits of Urban Public Transit in Texas*, noting that

> One of the biggest benefits transit systems provide is to take motorists and vehicles off the road and put them as passengers in higher occupancy buses. This reduces the congestion, fuel consumption, and accidents for all motorists This is particularly true in urban areas with significant congestion during peak periods

Lomax and Memmott assume (at 20) that all passengers currently using the transit systems would make their trips by private automobiles if transit did not exist. They acknowledge that this is a liberal assumption — it is likely that some of the trips would not be made at all in the absence transit. It is probably partially offset, however, by a conservative assumption. because they do not have detailed data on the time when transit trips were made, Lomax and Memmott spread them over the entire day

Using the Highway Performance Monitoring System (HPMS) developed by the Federal Highway Administration, Lomax and Memmott calculate the effect of the additional automobile trips on (1) fuel consumption, (2) travel time; (3) vehicle operating costs, and (4) accidents The HPMS Analysis Package translates each of these effects into dollar values.

Based on their analysis, Lomax and Memmott conclude that the six largest transit systems in Texas — in Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio — would generate total motorist benefits of approximately $483.6 million in 1992.

[9]As defined for the survey, in the initial screen, "the project's broad site selection parameters (e g., geographic region, transportation infrastructure, etc) are applied to the universe of potential locations to produce a list of three to five top candidates."

[10]These studies differ from the econometric and quasi-experimental highway impact studies discussed in Part III, in that they focus on location decisions — not net employment change or other general measures of economic performance

[11]Lomax and Memmott address this problem in their analysis of urban public transit benefits in Texas, by basing their input-output calculations only on money received from federal subsidies (at 25). This approach, however, does not allow for the possibility that any locally collected funds would have different regional economic effects if spent by private firms and consumers instead of the public sector.

References

Allen, B L., D. W. Butterfield, A. Kazakov, M. L. Kliman, A. A. Kubursi, and J. D. Welland. 1988. "Measuring Economic Stimulation from Capital Investment in Transportation," *Transportation Research Record* 1197: 49.

American Public Transit Association. 1983. *The Economic Benefits of Public Transit.* Washington, D.C.: American Public Transit Association (May).

Andersen, S. Johann, Hani S. Mahmassani, Reijo Helaakoski, Mark A. Euritt, C. Michael Walton, and Robert Harrison. 1993. "Economic Impact of Highway Bypasses," *Transportation Research Record* 1395: 144.

Aschauer, David 1989. "Is Public Expenditure Productive?" *Journal of Monetary Economics* 23(2): 177.

Beimborn, Edward, and Alan Horowitz, with Julie Schuetz and Gong Zejun. 1993. *Measurement of Transit Benefits. Final Report.* Milwaukee, WI: The Center for Urban Transportation Studies, The University of Wisconsin -Milwaukee (June).

Blair, John P., and Robert Premus. 1987. "Major Factors in Industrial Location: A Review," *Economic Development Quarterly* 1(1): 72.

Butler, Stewart E., Walter E. Gazda, Richard J. Horn, Rene T. Smith, Hilmy Ismail, and Arthur L Webster. 1984. "Highway Investment and the National Economy," *Transportation Research Record* 984: 42.

Calzonetti, F. J , and Robert T. Walker. 1991. "Factors Affecting Industrial Location Decisions: A Survey Approach," in *Industrial Location and Public Policy*, Henry W. Herzog, Jr., and Alan M. Schlottmann, eds., Knoxville, TN: The University of Tennessee Press.

Carlton, Dennis W. 1983. "The Location and Employment Choices of New Firms· An Econometric Model with Discrete and Continuous Endogenous Variables," *The Review of Economics and Statistics* 65(3): 440

Congressional Budget Office. 1991. *How Federal Spending for Infrastructure and Other Public Investments Affects the Economy.* Washington, D.C.· Congressional Budget Office (July).

Deno, Kevin T. 1988. "The Effect of Public Capital on U.S. Manufacturing Activity: 1970 to 1978," *Southern Economic Journal* 55(2): 400.

Dorf, Ronald J., and M. Jarvin Emerson. 1978. "Determinants of Manufacturing Plant Location for Nonmetropolitan Communities in the West North Central Region of the U.S.," *Journal of Regional Science* 18(1): 109.

Drew, Donald R. 1990. "Overview of Methodology," *Transportation Research Record* 1274: 281.

Duffy-Deno, Kevin T., and Randall W. Eberts. 1991. "Public Infrastructure and Regional Economic Development: A Simultaneous Equations Approach," *Journal of Urban Economics* 30: 329.

Dunphy, Robert T., and Department of Community and Economic Resources, Metropolitan Washington Council of Governments. 1982. *Trends Before Metrorail: A Metrorail Before-and-After Study Report.* Interim Report. Washington, D.C.: U.S GPO (July).

Eagle, David, and Yorgos J. Stephanedes. 1987. "Dynamic Highway Impacts on Economic Development," *Transportation Research Record* 1116: 56.

Eberts, Randall W. 1986. *Estimating the Contribution of Urban Public Infrastructure to Regional Growth* Working Paper, Federal Reserve Bank of Cleveland, No. 8610. Cleveland, OH: Federal Reserve Bank of Cleveland.

_____. 1990. "Public Infrastructure and Regional Economic Development," *Economic Review* 26(1): 15.

_____. 1991. "Some Empirical Evidence on the Linkage Between Public Infrastructure and Local Economic Development," in *Industrial Location and Public Policy*, Henry W. Herzog, Jr , and Alan M. Schlottmann, eds., Knoxville, TN: The University of Tennessee Press.

Evans, Paul, and Georgios Karras. 1994. "Are Government Activities Productive? Evidence from a Panel of U.S. States," *The Review of Economics and Statistics* 76(1): 1.

Federal Highway Administration. 1992. *Assessing the Relationship Between Transportation Infrastructure and Productivity*. Searching for Solutions, A Policy Discussion Series No 4. Summary of Current Research: Part of a Highways and Economic Productivity Agenda. Washington, D.C.. U.S. Department of Transportation (Aug.).

Forkenbrock, David J., and Norman S. J. Foster. 1990. "Economic Benefits of a Corridor Highway Investment," *Transportation Research A* 24A(4): 303.

Fortune, Inc. 1977. *Facility Location Decisions: A Fortune Market Research Survey*. New York City, NY: *Fortune*, Inc.

Fox, William F., and Matthew N. Murray. 1990 "Local Public Policies and Interregional Business Development," *Southern Economic Journal* 57(2): 413.

Galbraith, Craig S. 1985. "High-Technology Location and Development: The Case of Orange County," *California Management Review* 28(1): 98

Garcia-Milà, Teresa, and Therese J. McGuire. 1992. "The Contribution of Publicly Provided Inputs to States' Economies," *Regional Science and Urban Economics*, 22: 229.

Goldstein, Mark L. 1985. "Choosing the Right Site," *Industry Week* 225(2): 57 (Apr. 15).

Grefe, Richard, and Angus N. McDonald. 1979. *The Economic and Financial Impacts of BART: Final Report*. Springfield, VA: NTIS (Apr.).

Hansen, Niles M. 1965. "Unbalanced Growth and Regional Development," *Western Economic Journal* 4(1): 3.

Hirschman, Albert O. 1958. *The Strategy of Economic Development*. New Haven, CT: Yale University Press.

Holtz-Eakin, Douglas. 1994 "Public-Sector Capital and the Productivity Puzzle," *The Review of Economics and Statistics* 76(1): 12.

Huang, William. 1994. *The Effects of Transportation Infrastructure on Nearby Property Values: A Review of the Literature*. Working Paper No. 620. Berkeley, CA: University of California at Berkeley, Institute of Urban and Regional Development (Aug).

Hulten, Charles R., and Robert M. Schwab. 1991. "Public Capital Formation and the Growth of Regional Manufacturing Industries." Part I, Proceedings of a Conference on the Tax-Exempt Bond Market, *National Tax Journal* 44(4, Part 1): 121.

Kieschnick, Michael. 1981. *Taxes and Growth: Business Incentives and Economic Development*, Studies in Development Policy, v. 11. Washington, D.C.: Council of State Planning Agencies.

Leven, Charles, John Legler, and Perry Shapiro. 1970. *An Analytical Framework for Regional Development Policy*. Cambridge, MA: M.I.T. Press.

Lewis, David L. 1991. *A Primer on Transportation and Economic Development*, National Cooperative Highway Research Program Report No. 342. Washington, D.C.: Transportation Research Board, National Research Council.

Lomax, Timothy J., and Jeffery L. Memmott. 1989. *The Costs and Benefits of Urban Public Transit in Texas*, Texas Transportation Institute Report No. 2003-1F. College Station, TX: Texas Transportation Institute (Nov.).

Lombard, Paul C., Kumares C. Sinha, and Deborah J. Brown. 1992. "Investigation of the Relationship Between Highway Infrastructure and Economic Development in Indiana," *Transportation Research Record* 1359: 76.

MacKay, John W. 1994. "The Evolving Importance of Incentives," *Economic Development Review* 12(4): 4.

McMillan, T. E., Jr. 1965. "Why Manufacturers Choose Plant Locations vs. Determinants of Plant Locations," *Land Economics* 41: 239.

Mahdi, Syed I. 1987. *Estimating the Construction Phase Impacts of Urban Mass Transit Projects*. Springfield, VA: NTIS (Feb.).

Metropolitan Washington Council of Governments. 1983. *Metrorail Station Area Planning: A Metrorail Before-and-After Study Report*. Washington, D.C.: U.S. GPO (Aug.).

Munnell, Alicia H. 1990a. "Why Has Productivity Growth Declined? Productivity and Public Investment," *New England Economic Review* Jan./Feb.. 3.

Munnell, Alicia H., with the assistance of Leah M. Cook. 1990b. "How Does Public Infrastructure Affect Regional Economic Performance?" *New England Economic Review* Sep./Oct.: 11.

Paaswell, R.E., J. Berechman, *et al.* 1981. *An Analysis of Rapid Transit Investments: The Buffalo Experience*. Washington, D.C.: U.S. GPO (July).

Politano, Arturo L., and Carol J. Roadifer. 1989. "Regional Economic Impact Model for Highway Systems (REIMHS)," *Transportation Research Record* 1229: 43.

RERC. 1986. *Development Potential Analysis: Milwaukee Northwest Corridor Rapid Transit Study*, attached to Southeastern Wisconsin Regional Planning Commission. *Milwaukee Northwest Corridor Rapid Transit Study. Report No. 9. Land Development and Redevelopment Assessment Procedures*. Waukesha, WI: Southeastern Wisconsin Regional Planning Commission (Jan.).

Rephann, Terance J. 1993. "Highway Investment and Regional Economic Development: Decision Methods and Empirical Foundations," *Urban Studies* 30(2): 437.

Rephann, Terance, and Andrew Isserman. 1994. "New Highways as Economic Development Tools: An Evaluation Using Quasi-Experimental Matching Methods," *Regional Science and Urban Economics* 24: 723.

Rex, Tom R. 1993. "Quality of Life is Important Factor in Site Selection," *Arizona Business* 40(8): 1 (Aug.).

San Diego Association of Governments. 1984. *San Diego Trolley: The First Three Years - Summary Report*. Washington, D.C.: Urban Mass Transportation Administration (Nov.).

Schmenner, Roger W. 1982. *Making Business Location Decisions*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Schultze, Charles L. 1990. "The Federal Budget and the Nation's Economic Health," in *Setting National Priorities: Policy for the Nineties*, Henry J. Aaron, ed., Washington, D.C.: The Brookings Institution.

Seskin, Samuel N. 1990. "Comprehensive Framework for Highway Economic Impact Assessment: Methods and Results," *Transportation Research Record* 1274. 24.

Strathman, James G. 1983. *Effects of Banfield Transitway Expenditures on the Portland Metropolitan Economy*. Portland, OR: Center for Urban Studies, Portland State University (Sep.).

Strathman, James G., and Kenneth J. Dueker. 1987. "Regional Economic Impacts of Local Transit Financing Alternatives: Input-Output Results for Portland," *Transportation Research Record* 1116: 40.

Sullivan, Arthur M. 1990. *Urban Economics*. Homewood, IL: Irwin.

Sullivan, Edward C. 1992. "Transportation and Economic Development of Coastal Areas in the Pacific Northwest," *Transportation Research Record* 1359: 117.

Thompson, Gregory L., Bob Weller, and E. Walter Terrie. 1993. "New Perspectives on Highway Investment and Economic Growth," *Transportation Research Record* 1395: 81.

Tosh, Dennis S., Troy A. Festervand, and James R. Lumpkin. 1988. "Industrial Site Selection Criteria: Are Economic Developers, Manufacturers and Industrial Real Estate Brokers Operating on the Same Wave Length?" *Economic Development Review* 6(3): 62.

The Urban Institute and Cambridge Systematics, Inc. 1991. *The Economic Impacts of SEPTA on the Regional and State Economy: Final Report*. Washington, D.C.: U.S. Department of Transportation.

Verhoef, Erik. 1994. "External Effects and Social Costs of Road Transport, *Transportation Research A* 28A(4): 273.

Washington, Earl J., Nat Pinnoi, and Robert W. Stokes 1990. *State Highway Investment and Economic Development: State-of-the-Art Review*, Texas Transportation Institute Report No. 1228-1. College Station, TX Texas Transportation Institute (Oct.)

Watterson, W. T. 1985. "Estimating Economic and Development Impacts of Transit Investments," *Transportation Research Record* 1046. 1.

Wilson, F.R , G. M. Graham, and Mohamed Aboul-Ela. 1985. "Highway Investment as a Regional Development Policy Tool," *Transportation Research Record* 1046: 10.

Winston, Clifford, and Barry Bosworth. 1992. "Public Infrastructure," in *Setting Domestic Priorities: What Can Government Do?*, Henry J. Aaron and Charles L. Schultze, eds., Washington, D.C.: The Brookings Institution.