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Infrastructure and Social Welfare in Metropolitan America

- Infrastructure investment may indirectly affect firm productivity and household welfare through its impact on the *location* of economic activity.

- State infrastructure policies currently favor decentralization—the opening of new territory to development and the movement of firms and households from dense urban environments to the surrounding suburbs.

- Recent research, however, suggests that the clustering of producers and consumers in a given geographic area is economically and socially beneficial.

- In light of this research, institutional reforms that would change the management and direction of public infrastructure investment may be in order. Agencies authorized to choose and finance investments that promote regional well-being would most likely target more investment to central cities and less to the surrounding suburbs.

Public infrastructure is an important part of a well-functioning urban economy. Such infrastructure—defined here as publicly owned and maintained physical capital—has historically played a central role in allowing cities to grow by mitigating or reducing problems such as congested roadways, potholes, water-main breaks, and overcrowded schools. Yet while the benefit of some public works can hardly be disputed, a key policy issue is whether *additions* to our stock of public infrastructure provide overall benefits that exceed their costs.[1] That is to say, is the amount of infrastructure we have sufficient, or would we benefit from an increase? Another important question is, do our institutional structures promote efficient infrastructure investment decisions?

As these questions suggest, the status of urban public infrastructure is an important topic. Education and highway facilities are being stretched to their limits in fast-growing cities and suburbs, while concerns are being raised about the level and physical condition of public works in slower growing, older central cities.[2]

No doubt, public investment is an important function of government, and it is particularly crucial at the state and local level. In 1999, states and localities invested more than $210 billion in equipment, software, and structures (Table 1). By combining this amount with the nearly $43 billion in nondefense investments made by the federal government, we see that new gross public investment in 1999 exceeded a quarter-trillion dollars, or 2.7 percent of GDP. Moreover, the

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stock of publicly owned nondefense capital in 1999 exceeded $4.5 trillion, or nearly 50 percent of GDP.[3]

Although complete data on the geographic distribution of this spending are not available, it is certain that a large share of these national totals, particularly the state and local portions, is going to public investment in and around America's metropolitan areas. More than 200 million people reside in these areas, and the public investments made there affect the lives of a large and growing share of the U.S. population.[4]

Accordingly, the question of whether we should increase the amount of infrastructure available has received much attention from economists. This article puts that research into a broad perspective, attempts to draw policy conclusions from what is known, and suggests some directions for further research.

Infrastructure investments can affect social welfare in two ways (see Appendix A). One way is by adding to economic growth. The relationship between infrastructure and economic growth has been the subject of intensive economic research over the past decade. The second way in which infrastructure investments can affect social welfare is by potentially improving the quality of life of those living in the invested area. For example, public parks, water systems, and other facilities can improve social welfare without having any effect on residents' incomes. This article also examines this second channel, which has received less attention in the research, in part because the value of quality-of-life improvements is difficult to measure.

Infrastructure investments may also indirectly affect social welfare in ways that have not been fully considered in public policy or research, such as location behavior, that is, where activities occur. For example, public works attract activities, such as the building of office parks near airports or housing developments near local roads. Furthermore, location behavior affects both economic growth and the quality of life.

Social Value of Public Investments: Direct Effects on Firms and Households

Investments in public infrastructure may influence society's general level of well-being in several different ways. In this section, we address what we refer to as infrastructure's direct effects.

Infrastructure's Value to Firms

The relationship between public investments and aggregate economic growth has been the subject of the bulk of recent infrastructure research by economists (Table 2 summarizes some of the findings). A storm of research in this area was touched off by a controversial study published by Aschauer (1989). Aschauer used *national* data for the postwar period to estimate the relationship between the nation's stock of public capital and aggregate income, or GNP. His results suggested that the marginal productivity of public capital—the addition to total income that could be expected from additions to the public capital stock—was enormous. Aschauer's most widely cited conclusion was that a 1 percent increase in the nation's infrastructure stock would raise aggregate output by 0.39 percent. This conclusion suggested that infrastructure was roughly twice as productive (at the margin) as private capital, and that the nation's public capital deficit was very serious. Aschauer went on to argue that a significant share of the

Table 1
Nondefense Public Capital, 1999
Millions of dollars

	Gross Investment	Net Stock
Total	254,475	4,512,982
Federal	43,609	518,727
Equipment and software	32,738	105,496
Structures	10,871	413,231
State and local	210,866	3,994,255
Equipment and software	53,366	198,738
Structures	157,500	3,795,517
Buildings	71,380	1,582,955
Educational	38,762	789,027
Other buildings	32,618	793,928
Highways and streets	54,766	1,300,053
Conservation and development	2,360	69,710
Sewer systems	10,344	322,166
Water supply	7,796	212,826
Other structures	10,854	307,807
Memo:		
Total (percentage of GDP)	2.7	48.50
Federal	0.47	5.58
State and local	2.27	42.95
GDP		$9.3 trillion

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

national productivity growth slowdown that began in the early 1970s was because of declining rates of public investment.

Aschauer's study was immediately controversial. Because national time-series data tend to rise and fall together, skeptical researchers immediately focused on the statistical properties of his model (Hulten and Schwab 1991). Subsequently, the use of widely accepted statistical techniques eliminated the statistical significance of the time-series relationship between national infrastructure and economic growth (Aaron 1990). Criticism of the national approach quickly led to research that examined the effects of variation in public capital availability *within* the nation at the state or city level.

Like Aschauer, Munnell (1990) and Eberts (1986) estimated aggregate production functions, but used data for states and metropolitan areas, respectively. A 10 percent increase in private capital is usually assumed to raise output by about 1.5 to 2.0 percent. Munnell estimated that a 10 percent increase in public capital would raise private output by about 1.5 percent. This estimate was both economically and statistically significant and fueled further interest in the possibility of large unexploited returns to public investment. More recent refinements to the aggregate production approach have focused even more thoroughly on the model's statistical properties. In Holtz-Eakin (1994) and Garcia-Mila, McGuire, and Porter (1996), correction of the estimates for unobserved state-level characteristics reduces the output elasticity of public sector capital to zero. This suggests that the findings of Munnell resulted from correlations between infrastructure and unmeasured state traits. Another important study that used an analogous methodology found that although infrastructure had significantly positive effects on productivity, the price of new investment may ultimately exceed its benefits (Morrison and Schwartz 1996).[5]

Although there is some lingering controversy in the literature over whether infrastructure is, at the margin, productive at all in the aggregate, there seems to be general agreement that raising taxes to fund large additions to a particular state's stock of public works would not have very large positive effects on aggregate income in that state. This generally held view is important because it suggests that arguments for substantial increases in investment in state infrastructure must be based on something other than productivity improvements, such as infrastructure's value to household consumption.

TABLE 2
Selected Previous Estimates of the Value of Public Capital

Author	Data	Method	Estimated Output Elasticity	Use of Controls	Comments
Eberts (1986)	Standard metropolitan statistical areas over time	APF	0.04	No	Manufacturing only
Aschauer (1989)	National over time	APF	0.3 - 0.4	NA	Time-series data
Munnell (1990)	States over time	APF	0.15	No	
Holtz-Eakin (1994)	States over time	APF	~0	Yes	
Holtz-Eakin and Schwartz (1995)	States over time	APF	~0	Yes	Negligible interstate spillovers
Garcia-Mila, McGuire, and Porter (1996)	States over time	APF	~0	Yes	
Morrison and Schwartz (1996)	States over time	ACF	0.11	Yes	Aggregate cost function
Boarnet (1998)	California counties over time	APF		Yes	Negative intrastate spillovers
Rudd (2000)[a]	Standard metropolitan statistical areas over time	Compensating variations	0.03 - 0.1	NA	Cross-sectional data
Haughwout (forthcoming)[a]	Central cities over time	Compensating variations	0.0 - 0.03	Yes	Large household consumption effects

Note: APF is aggregate production function; ACF is aggregate cost function.

[a] The dependent variables in the compensating variations studies are local land and labor prices.

Infrastructure's Value to Households

The value of infrastructure as a contributor to quality of life has received little attention, in part because the value of unpriced goods is difficult to measure. However, the quality-of-life benefits of public investments are nonetheless likely to be very important because households are heavy users of infrastructure systems. Indeed, some public works are specifically designed to benefit households alone, and the justification for their construction does not point to their value in generating economic growth. One example is the construction of public parks and recreation facilities. This very significant line item in the nation's public capital budget seems clearly intended to provide direct benefits to households, with

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little regard for its effects on productivity.[6] Furthermore, the quality-of-life benefits of public works are not necessarily limited to this class of investments. Even elements of "core infrastructure," such as transportation and sewer and water systems, provide large direct benefits to households.

These quality-of-life benefits for households are excluded from productivity studies that currently dominate the literature. Consider the effects of a new road from your home to your place of work that cuts your one-way commuting time from one hour to thirty minutes. Will you arrive early at work each day, or sleep somewhat later? The treatment of public works in the productivity literature implies that employees will choose to arrive early at work, increasing their output. But at least some workers will likely claim at least a portion of the time for themselves, by eating breakfast with their families or reading the paper longer each morning. This potential for increased leisure will not be accurately measured in standard studies of income or productivity, but is a benefit nonetheless, as it improves the well-being of the individuals whose homes are affected by the new road. Accounting for the consumption value of public works is thus an important, but difficult, task.

Infrastructure investments may also *reduce* the availability of some quality-of-life benefits for household consumption. The classic example here is the often-argued case that investments in highway infrastructure induce more driving,

which increases auto emissions and congestion, degrading the environment and consuming workers' valuable leisure time (see, for example, Downs [1994, p. 8]). Since air pollution and time lost to congestion are unpriced negative factors that are not traded in markets, any increase in them will not be directly reflected in incomes, but will reduce welfare.[7]

Few studies have tried to measure the consumption benefits of public investments on a large scale, but some evidence is available. Haughwout (forthcoming) uses a spatial equilibrium model to estimate the aggregate value that households put on public investments in central cities. In this model, households demand lower land prices and higher wages as compensation for living in locations with insufficient infrastructure. Using this method, Haughwout estimates that the present value to households of a $4.64 billion increase in central-city infrastructure is about $1.8 billion, far higher than the comparable benefit to firms. This estimate implies, however, that the aggregate benefit of such an investment is less than its cost, even when both household and firm benefits are included.[8]

The problems inherent in measuring the quality-of-life benefits of public works have led to an overemphasis on relatively easy-to-observe productivity effects. Whether these effects are large or not is only one part of the answer to the nation's public investment question. By themselves, findings that policies designed to raise taxes for public works do not significantly influence worker productivity cannot be taken as sufficient evidence that these policies have insignificant effects on social welfare. Until one presents convincing evidence of infrastructure's effects on household welfare derived from sources other than household income, the direct social welfare effects of infrastructure investments must be considered an open question.

SOCIAL VALUE OF PUBLIC INVESTMENTS: INDUCED LOCATION EFFECTS

There are many less direct ways in which infrastructure can affect economic growth and quality-of-life benefits. In this section, we focus on one of the most important ways and one that is central to policymaking in metropolitan areas: the relationship between infrastructure investments and the location of activities. The argument proceeds as follows: after reviewing evidence on the relationship between infrastructure and the geography of economic activity, we find that infrastructure does affect location behavior by changing the distribution of firms and households within metropolitan

areas. Next, we outline the theoretical and practical conditions under which the location behavior of individual firms and households affects aggregate social welfare. In the presence of spatial externalities (such as traffic congestion or shared local public goods), the location choices of individual firms and households will have implications for society as a whole. We conclude that infrastructure investment that encourages decentralization may serve to undermine growth in productivity and social welfare.

Infrastructure and Intrametropolitan Location Patterns

The idea that public investments, especially in transportation systems, alter the intrametropolitan geography of economic activity is supported by both the majority of urban theory (Fujita 1989) and a substantial historical record (Jackson 1985; Tarr 1984). However, location has not been central to the most recent empirical work on infrastructure. Implicit in state infrastructure productivity studies is the notion that states with

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more public capital might grow faster than those with less. Yet few of these studies have taken seriously the possibility that marginal additions to infrastructure stock have their most important effects on *intrastate* patterns of activity.

Nonetheless, evidence from studies using a variety of methodologies indicates that although the *aggregate* (statewide) economic impact of new public works is small, infrastructure's local effects are much more significant. Here we attempt to draw new inferences from the numerous existing productivity studies and combine them with historical and contemporary evidence on the relationship between public works and the location of economic activity. Viewed from a geographic perspective, the seemingly conflicting results that emerge from studies that use different methodologies tell a

consistent story. Moreover, the message that emerges is surprising: infrastructure is a productive and valuable good, but additions to its stock of public capital can actually reduce economic growth and social welfare, even before one considers the tax cost of new investments.

Most studies of the role of infrastructure in state-level economic growth agree that marginal increases in state public investment levels do not have large effects on aggregate output. The traditional interpretation of these results is that infrastructure's "productivity" is low or negligible. However, there is growing evidence for an alternative explanation—that infrastructure investment is a costly method of rearranging the economic geography of our metropolitan areas, with uncertain effects on productivity and welfare.

How Might Infrastructure Affect Location Behavior?

Public works will have important effects on location decisions if their benefits differ from one place to another. In the simplest framework, the benefits of a public good are the same irrespective of location. The usual example is national defense—a nuclear arsenal deters foreign attack everywhere in the nation. Most public works are fixed in place, however, and thus differ from this polar case—they provide the greatest benefits to those in a position to utilize them. This is the idea behind looking at the relationship between infrastructure and economic growth at the state level. However, the benefits from new public investments are unlikely to be uniform throughout a typical state because states are simply too large. Instead, infrastructure investments confer benefits on one part of a state relative to other parts, potentially influencing intrastate location patterns.

One of the principal reasons for building urban infrastructure is that it reduces some of the negative effects of urban life, allowing cities to grow and increase the productivity and consumption advantages they offer. In theory, public roads provide fast, cheap intrametropolitan transportation, public systems draw water to cities from places where it is abundant, and wastewater treatment plants and public landfills help dispose of city waste. In theoretical models, improvements to transportation and other local public goods increase land values in newly served areas, leading to higher density in those locations (Fujita 1989; Anas, Arnott, and Small 1998). A clear example from U.S. history was the development of urban trolley systems, which allowed workers to live farther from their workplaces, thereby expanding the size of the urbanized area (Jackson 1985; Margo and Atack 1998).

How Does Infrastructure Affect Modern Metropolitan Location Patterns?

Recent studies of the effects of public capital on intra-metropolitan patterns of economic activity indicate that the place-specific effects of new public investments are substantial. These studies share the common assumptions that firms and households are mobile and that there is a free market for land. In these circumstances, the value of different locations will be reflected in local land and labor prices, and the marginal value of infrastructure investment may be calculated by comparing land values near where the investment took place before and after its completion.

Substantial academic and anecdotal evidence exists to support this intuition. Studies have found that land prices and infrastructure investments are positively related at the

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intrametropolitan scale (Voith 1993; McDonald and Osuji 1995; Haughwout 1997, 1999a). Evidence that intrastate patterns of activity are significantly influenced by infrastructure development is available at the county level for California (Boarnet 1998) and for the nation as a whole (Haughwout 1999b). Using a less formal approach, Garreau (1991) points out that the new agglomerations that he calls "edge cities" often arise near highway interchanges on the fringes of metropolitan areas. If the development of public capital stock has positive effects on some parts of state economies, one could question how it can have negligible effects on states in toto, as found in recent state-level productivity studies.

The answer is that the dominant effects of public investment must be on the location, not the level, of economic activity within states. For example, a given improvement in a state's highway system serves to move activity from its current location to newly accessible places elsewhere within that state. This conclusion is consistent with the notion that marginal increases in the nation's stock of public capital provide localities that receive new public works with an advantage compared with those places that get fewer public investment

dollars. If correct, this description of infrastructure's benefits is very important because it implies that academic researchers have been looking in the wrong place in trying to understand infrastructure's effect on social welfare. It also means that, if location patterns affect productivity and household welfare, then infrastructure's effects on location patterns may be the most important way in which infrastructure influences well-being. As we explain below, recent evidence on the relationship between the location of activities and social welfare indicates that location patterns matter.

Location and Social Welfare

The idea that equilibrium location patterns in a market economy might have implications for social welfare depends on the existence of spatial externalities. If a household's or firm's choice of location has no effect on the well-being of others, then the land market will simply reflect the relative value of different locations and no relocation would improve a household's or firm's own welfare or society's welfare (Fujita 1989). However, the very existence of central business districts and cities implies that spatial externalities could be important and thus the location of activities may have effects on welfare.[9]

Businesses

A focus on the relationship between the location patterns of individual businesses and their productivity is an important theme in much of the recent literature on urban growth and development (Quigley [1998] and Anas, Arnott, and Small [1998] offer reviews of parts of this literature). Most of this research argues that the proximity of producers yields productivity benefits to these firms. The arguments in favor of these so-called agglomeration economies proceed on several fronts. First, geographically concentrated producers are believed to benefit from shared inputs. If, for example, an employee unexpectedly quits, a firm can find a replacement more easily if it is near other firms in a dense labor market. This proximity will reduce inefficient "down time" and will allow maximum use of the firm's private capital plant. Likewise, geographically clustered firms can share the cost and use of inputs such as those provided by producer service firms, which can operate at efficient scale when there are many potential consumers. Large concentrations of producers and consumers further allow for the sustainable production of a wider variety of goods and services than is available in smaller markets. A wider *variety* of available inputs allows producers to target

their input purchases more precisely, promoting efficiency. A final major source of agglomeration benefits to producers is information spillovers. The idea that general and specialized information about products, processes, and markets circulates most freely in environments conducive to frequent formal and informal contact is not new (Marshall 1890; Jacobs 1969), but it has become increasingly important in recent discussions of the sources of economic growth (Lucas 1988; Ciccone and Hall 1996; Glaeser 1998).

Households

For households, an analogous set of arguments in favor of concentration applies. Households may benefit from the sharing of consumption goods that are best constructed on a large scale, such as public parks and stadiums. Households may value the insurance against unemployment that having multiple employers nearby offers, and they may benefit from the variety of private consumption goods that are sustainable in large agglomerations. Finally, household location may provide external effects analogous to the informational spillovers hypothesized to exist among firms.

Recent sociological and economic research indicates that segregation of poor minorities has significant social costs (Wilson 1987, 1996; Cutler and Glaeser 1997; Benabou 1996). When poor residents of urban areas are concentrated in particular neighborhoods removed from the middle class, those residents suffer from the lack of information about jobs, stable neighborhood associations, and access to high-quality public and private services (Wilson 1996). For poor children, segregation results in low-quality schools, relatively few working role models, and less absorption of mainstream social attitudes (Wilson 1987; Case and Katz 1991). Segregation thus makes it more difficult to escape poverty, contributing to higher social costs in both the short and long run.

Implications

These interactions among individuals and firms are reciprocal and not directly priced in markets. Individual firms both benefit from and contribute to the information that exists in dense agglomerations: although firms recognize the benefits they receive, their location decisions will ignore their benefits to others. Middle-class households' participation in local PTAs provides benefits to their own children, which they value, and to those of other parents, which they may not value. The reciprocal nature of these interactions means that individual

location choices have effects outside the private benefit-cost calculus, and that the free market underprovides agglomeration. This opens up the possibility that atomistic location decisions will lead to socially inefficient patterns of business and residential locations.[10]

Infrastructure's Indirect Effect on Social Welfare

Even when public capital has value to both firms and households, its effect on social welfare will be ambiguous when location is also important. For example, county employment density is an important locational attribute of state economies: roughly speaking, states with jobs concentrated in a few counties appear to grow faster than those states in which employment is more dispersed (Ciccone and Hall 1996). The social welfare effect of infrastructure investment will partially depend on whether the investment encourages or discourages county employment density. The evidence reviewed above

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suggests that current state infrastructure policies serve to reduce density, which in turn implies that infrastructure's effect on location offsets at least part of its value to individual firms and households.

The intuition is that new state public works serve primarily to open up new territory for urban development. Because public works are valuable and are disproportionately placed in relatively undeveloped areas (Voith 1998b; Haughwout 1999b), public investments provide individual firms and households with incentives to move from more dense to less dense environments. In making this decision, individual firms and households ignore their contribution to socially beneficial density and diversity. The result is too much decentralization from society's perspective. Thus, the irony of the effect of infrastructure investment is that it can reduce aggregate productivity and welfare, but only if it is productive for individual firms and valued by individual households. If infrastructure were ineffective in attracting firms to new locations, it would not be able to reduce agglomeration economies and slow productivity growth. A similar argument

applies to households—infrastructure investment will induce them to relocate in socially damaging ways only if it is valuable to them individually.

Of course, decentralization, perhaps even excessive decentralization, can occur for reasons totally unrelated to public finance, including greater demands for space and income growth.[11] Infrastructure plays the role of accommodating these individual desires. If public works were free goods, there would be somewhat less reason for concern, since decentralization could arguably be the natural result of a market process.

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Nonetheless, because individual firms and households consider only their private costs and benefits of decentralizing and ignore the negative effects on others, the private market is likely to produce too little density. Thus, social welfare might still be improved with careful bargaining over the level and location of infrastructure, even if public works were free.

However, public works are not free. Most infrastructure research using the aggregate production and cost function approaches has downplayed the cost of infrastructure investment and focused primarily on its benefits. If it can be established that improvements in the stock of public capital have little or no effect on the economy, regardless of their cost, then there is little reason to be overly concerned with how these investments are financed. We argue, however, that the distribution of the (financial and nonfinancial) costs of infrastructure investment is crucial to understanding the incentives for decentralization that they create.[12]

Selecting and Financing Urban Infrastructure Projects

The benefit principle of local public finance states that efficiency requires those who benefit from a particular public expenditure to pay for it. The finding that marginal increases in infrastructure stocks are associated with land-value benefits in places that receive new public works implies that efficiency may be realized if public investment decisions are made by a local institution armed with a land tax. Governments that tax land may apply a simple rule of thumb when evaluating proposed public works: raise taxes to make investments that will raise the price of land after accounting for both the cost of taxes and the benefits of the new investment (Brueckner 1979; Brueckner and Wingler 1984). As a first approximation, municipal governments seem to fit this description, and there is modest evidence that local government decisions are approximately efficient by this "local property value maximization" standard. But the existence of benefit and cost spillovers means that locally driven infrastructure policymaking is likely to lead to inefficiencies.

First, local governments in the United States tax *property*, not land. The taxation on property covers both capital and land. This raises a host of complex issues about who pays the property tax.[13] Because capital taxes reduce the national return on capital and are paid by owners of capital everywhere, part of the financial cost of local spending on public works is exported to owners of capital who live outside the jurisdiction that levies the tax. When part of the financial cost of investment can be exported through the tax system, local governments will rationally choose levels of spending in excess of the socially optimal amount.

The second major concern is that urban infrastructure investments appear to generate substantial benefits and costs that spill over municipal boundaries (Haughwout 1997, 1999a). If infrastructure investments induce relocations, then the decision of whether to make investments must be based on consideration of both the pluses and minuses. Ideally, the policymaking institution must be large enough to internalize all the relevant externalities. In urban areas, this would seem to suggest a regional authority, with a mandate to finance and make those investments that improve overall regional well-being. Such a body would not make investments that simply relocate activity from one place to another, unless the spatial reorganization somehow were to offer net benefits. Given the evidence on spatial externalities described above, relocations that increase density might meet this criterion.

However, there are no regional infrastructure investment authorities with the power to raise taxes to fund investment and allocate it according to regional benefit-cost principles. The closest approximations are metropolitan planning organizations (MPOs), which are empowered under federal law to plan and prioritize regional transportation investments. Among the criteria that MPOs are mandated to consider is metropolitan land use, which theoretically allows them to evaluate the effects of new investments on agglomeration economies and neighborhood externalities.

However, MPOs are imperfect instruments for planning infrastructure investments rationally. The institutional structure of these bodies typically makes them unrepresentative of the metropolitan area's population. (See Lewis [1998] and Appendix B for information on MPOs in the Second District.) In general, political jurisdictions within the planning area are equally represented, in spite of the fact that they have unequal numbers of residents. For example, the rule in the New York–northern New Jersey area is one county, one vote, although New York City, Jersey City, and Newark each have an additional vote. However, tremendous disparities remain: tiny Putnam County (population 95,000) has the same formal influence as Nassau County (population 1.3 million).

In addition, MPOs do not choose how much money to invest, only the distribution of funds over potential improvements (Boarnet and Haughwout 2000). Finally, the authority of these bodies is limited to transportation projects funded by state and federal governments, meaning that other kinds of public investment decisions, including locally funded road projects, may be made in a fragmented manner,

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uncoordinated with transportation. Of course, it is valuable to match the geographic scale of the decision-making body with the area affected by its policies. The geographic area affected by transportation investments may be quite different from the area affected by sewer investments or public parks, suggesting that authorities with different service areas should make these different decisions. Yet the complementarities between transportation and other capital services suggest that the coordination of their planning would offer efficiency gains.

Finally, funding for local public works involves substantial intervention by higher levels of government, particularly at the state level. State decision makers might seem to have an appropriately broad perspective that allows them to evaluate benefits and costs that appear anywhere in the state, but in practice direct state infrastructure investments, especially for highways, appear to undermine rather than support dense urban environments (Haughwout 1999a, 1999b; Voith 1998). A better understanding of state infrastructure decision making

is crucial to rationalizing the nation's urban infrastructure investment policies. For the time being, what is clear is that the prominent state role adds to the net local benefits of investment by reducing the cost.

Localities in many states depend primarily on property tax revenues to finance the local cost of public services. New jobs, and especially the commercial and industrial tax base that they bring with them, are attractive ways for localities to finance new services or reduce tax rates on resident homeowners (Danielson and Wolpert 1992). The benefits of new development thus give towns strong incentives to build new public works funded in large part by nonresidents. Those with the most to gain are the rapidly growing areas that tend to be most heavily represented on regional transportation planning boards, and they presumably use their disproportionate influence to bring in money for new roads. These localized benefits are financed by the rest of the population, through higher taxes and, perhaps, lower productivity growth as our cities are undermined.

Conclusion

Some responsibility for making infrastructure investment decisions rests with state governments as well as with local and regional authorities. Financing, meanwhile, is a complex combination of state and local taxes and user charges. A typical municipality, which will realize much of the benefit of a new investment but pay only a portion of the cost, has significant incentives to overinvest. Regional authorities, which could theoretically constrain the worst of these impulses, generally have limited power and overrepresent underdeveloped, sparsely populated areas. Given what we know about the effects of infrastructure and the importance of fostering dense urban environments, the reform of strategies for investing in urban infrastructure could significantly enhance social welfare. Accordingly, researchers might consider refining their estimates of the spatial scale at which agglomeration benefits operate. They might also relate these estimates more directly to different types of infrastructure investments. At the same time, research into the determinants of investment policies, particularly at the state level, seems warranted.

Our current state of knowledge supports a few tentative directions in which policy reform might go. The crucial elements in a reform package would be the creation of institutions capable of balancing the full costs and benefits of new investments and the allocation of direct state investments in such a way as to maximize their contribution to aggregate

welfare. Often this will mean relatively more public investment in central cities and probably less in their surrounding suburbs. The difficulty lies in finding politically feasible changes to infrastructure policymaking strategies that will represent real improvements to the current system.

To date, attempts to eliminate state support for infrastructure investments outside of specifically designated areas have been controversial and have met with mixed success. Maryland's "Smart Growth" initiative has been highly touted, but it has been in place for only three years (Gurwitt 1999). In New Jersey, the state plan has led to conflict between state and local governments, as the latter continue to face increasing development pressures, giving them incentives to shift the financial and nonfinancial costs of infrastructure development onto nonresidents (Hamill 1992).

Local efforts to establish regional authorities with the power to make and finance a broad array of infrastructure investments have also met with mixed success. In a recent case, voters in Jefferson County, Alabama (which includes Birmingham and a portion of its suburbs), twice rejected proposals to increase sales taxes to fund a regional infrastructure agency that would have emphasized funding to the central city (Sweeney 1999). However, in Atlanta, where sprawl and pollution problems are among the worst in the nation, the state has created a powerful regional agency to manage and finance infrastructure investments (Ehrenhalt 1999). Calls for increased regional cooperation on infrastructure and land use have recently been heard in even the staunchly small-government-oriented areas of San Diego and Dallas (Murphy 2001; Michaels et al. 2001).

All told, the record is mixed, and in most metropolitan areas public investment decisions continue to be made on a case-by-case, locality-by-locality basis. Perhaps the most encouraging development is the apparent recognition among suburban voters that new infrastructure investments, particularly roads, do not seem to solve the problems associated with uncontrolled suburban growth (Egan 1998). Purchases of open space and regulation of new development are currently the most common responses to this problem. Nevertheless, it is a small step from this recognition to the conclusion that larger shares of infrastructure investment should be directed to maintaining and improving existing facilities, which are disproportionately found in densely developed central cities. Indeed, politicians, including former Vice President Gore (Egan 1998), and the popular press (*Philadelphia Inquirer* 1999) have begun to argue that the way to minimize the cost of growth is to direct growth into areas that have seen declines and that offer existing, albeit aging, infrastructure capacity.

Of course, it is likely no accident that the crucial suburban support for managing the location of growth and developing city infrastructure systems has occurred during a period of extraordinary prosperity. When traffic is among the issues that voters most often cite as important, it seems a safe bet that times are fairly good. In Seattle, growth management has seen support ebb and flow with the region's economic fortunes (Egan 1996). In Birmingham, whites living below the poverty line were the group most strongly opposed to the creation of a regional authority; wealthier suburbanites and African-Americans voted for it (Sweeney 1999). In San Diego and Dallas, the central city is making the case for regional institutions; it is unclear what the suburban reaction will be.

Just as the effects of today's investment decisions will be felt for decades to come, marginal adjustments to annual investment policies will provide little relief in the short run. Durable improvements in the nation's urban infrastructure policymaking require that new institutions with substantial staying power be created. Such institutions—to be maximally efficient—would accurately represent the region's population, have responsibility for planning and financing regional infrastructure investments, and work within an explicit mandate to evaluate the land-use changes that result from new investments. However, this ideal system will be difficult to achieve.

Perhaps the most important steps one could take in the short run are to encourage regional transportation planners to consider regionwide land-use effects and to support an open exchange of views among the affected parties. A good first step would be to create forums in which the regional implications of infrastructure investments could be discussed by all interested parties, equally represented.

Appendix A: A Mathematical Approach

The argument is shown mathematically by examining a social welfare function. This function provides an ordinal ranking of society's preferences over different outcomes:

$$(A1) \qquad W = \{WY(G), Z(G)\} .$$

Society is made up of individuals; businesses do not play a role in the social welfare function except in that they provide incomes and otherwise affect the well-being of individuals. The idea in equation A1, then, is that social welfare (W) is determined in part by total income (Y), which allows consumption of private goods that are traded in markets, and in part by other factors that are not reflected in incomes (Z). The social value of increases in public investment (G) is determined by their effect on these components of social welfare. The effect of infrastructure on social welfare is given as:

$$(A2) \qquad \frac{dW}{dG} = \frac{\partial W}{\partial Y}\frac{dW}{dG} + \frac{\partial W}{\partial Z}\frac{dZ}{dG} .$$

The components of infrastructure's value are represented by the terms on the right side of equation A2.

Infrastructure's contribution to income (which is also its net value as a factor of production) is given as $\frac{dY}{dG}$, and $\frac{\partial W}{\partial Y}$ translates income changes into changes in social welfare. If infrastructure has a positive effect on firms, then workers and owners of private capital will see income increase as public capital increases, meaning that $\frac{dY}{dG} > 0$. The social value of

infrastructure as a contributor to the availability of unpriced consumption goods is $\frac{dZ}{dG}$.

If infrastructure has significant effects on the location of economic activity (L), then equation A1 must be rewritten as:

$$(A3) \qquad W = W\{Y(G, L(G)), Z(G, L(G))\} .$$

Now, the effect of infrastructure growth on social welfare is given as:

$$(A4) \qquad \frac{dW}{dG} = \frac{\partial W}{\partial Y}\left(\frac{\partial Y}{\partial G} + \frac{\partial Y}{\partial L}\frac{dL}{dG}\right) + \frac{\partial W}{\partial Z}\left(\frac{\partial Z}{\partial G} + \frac{\partial Z}{\partial L}\frac{dL}{dG}\right)$$

or

$$(A5) \qquad \frac{dW}{dG} = \frac{\partial W}{\partial Y}\frac{\partial Y}{\partial G} + \frac{\partial W}{\partial Z}\frac{\partial Z}{\partial G} + \frac{\partial W}{\partial Y}\frac{\partial Y}{\partial L} + \frac{\partial W}{\partial Z}\frac{\partial Z}{\partial L}\frac{dL}{dG} .$$

On the right side of equation A5, the first two terms are positive if infrastructure is valuable to households and firms, and the signs of the last term will depend on the effect of infrastructure on location patterns. For simplicity, let us take L as a measure of the density. If density is a good from society's viewpoint (that is, if $\frac{\partial Y}{\partial L}$ and $\frac{\partial Z}{\partial L}$ are positive, as suggested in the literature), the social welfare effect of infrastructure investment will depend on whether it encourages or discourages density (that is, whether $\frac{dL}{dG} > 0$). The evidence reviewed suggests that current state infrastructure policies serve to reduce density ($\frac{dL}{dG} < 0$), suggesting that infrastructure's effect on location may at least partially offset its direct value to individual producers and households.

In the Second Federal Reserve District, metropolitan planning organizations (MPOs) exist for all urbanized areas. Three groups in the New York City region share transportation planning authority. The New York Metropolitan Transportation Council (NYMTC) serves the city and the suburban counties of Rockland, Nassau, Suffolk, Putnam, and Westchester. The thirteen-county northern New Jersey region is served by the North Jersey Transportation Planning Authority (NJTPA). The South Western Regional Planning Agency (SWRPA) covers the eight municipalities of lower Fairfield County, Connecticut. The structure of the New York region's MPOs is fairly typical of those in other parts of the country.

NYMTC's voting members are the five suburban county executives, the New York City Planning Commission chairperson, the New York City Department of Transportation commissioner, the New York State Department of Transportation commissioner, and the Metropolitan Transportation Authority chairperson. The NJTPA Board of Trustees consists of one elected official from each of the fifteen subregions—the thirteen counties and two major cities, Newark and Jersey City. The Board also includes a governor's representative, the commissioner of the New Jersey Department of Transportation (NJDOT), the executive directors of New Jersey Transit and the Port Authority of New York and New Jersey, and a citizens' representative appointed by the governor. Only the Connecticut MPO's makeup is explicitly linked to population. Each of the eight Connecticut municipalities is represented by two members of SWRPA, with a town receiving an additional member for each 50,000 residents.

The structure of the NYMTC leads to radical differences in representation, with Putnam County's 95,000 residents having the same official influence as Nassau's 1.3 million. Although they have two representatives on the MPO, New York City residents are still underrepresented by this "votes per capita" measure. With 7.4 million residents, the city has one delegate per 3.7 million residents, a ratio far lower than any other ratio in the region. In New Jersey, the 857,000 residents of Bergen County have one vote on their MPO, as do the

125,000 residents of Hunterdon County. Because the mostly densely settled counties are generally those that are relatively close to New York City, for most of the area's residents their representation on the MPO depends on how far from New York City they live. In general, the rule is the farther away the county, the more representation its residents have in regional transportation planning. Suffolk County, New York, and Ocean County, New Jersey, both have relatively low per capita representation and are exceptions to this general rule.

The Structure of Representation of Two Second District MPOs

County or City	MPO	Distance from New York City (Miles)	MPO Votes per Million Residents
New York City	NYMTC	0.0	0.3
Hudson	NJTPA	6.1	1.8
Jersey City	NJTPA	6.5	4.3
Bergen	NJTPA	13.8	1.2
Essex	NJTPA	14.4	1.3
Newark	NJTPA	11.1	3.8
Union	NJTPA	19.3	2.0
Nassau	NYMTC	20.3	0.8
Passaic	NJTPA	24.7	2.1
Rockland	NYMTC	26.1	3.5
Westchester	NYMTC	28.6	1.1
Morris	NJTPA	30.7	2.2
Middlesex	NJTPA	32.6	1.4
Monmouth	NJTPA	35.0	1.6
Somerset	NJTPA	36.7	3.5
Sussex	NJTPA	45.3	6.9
Putnam	NYMTC	46.9	10.5
Hunterdon	NJTPA	51.5	8.0
Warren	NJTPA	53.7	10.0
Ocean	NJTPA	64.0	2.0
Suffolk	NYMTC	68.5	0.7

Notes: NYMTC is New York Metropolitan Transportation Council; NJTPA is North Jersey Transportation Planning Authority. Jersey City and Newark each have an additional representative on the NJTPA Board of Trustees.

1. Simply maintaining the current public stock costs tens of billions of dollars per year. Increasing the available infrastructure stock would require even more funding.

2. In 1999, for example, more than 50 percent of all cities considered infrastructure needs a top concern, while 68 percent reported increasing their infrastructure spending during fiscal year 2000. See Pagano and Shock (1999, 2000) for details.

3. Nearly 90 percent of the nation's nondefense public capital is owned by state and local governments.

4. In 1998, more than 80 percent of the U.S. population lived in metropolitan areas. See U.S. Census Bureau, Statistical Abstract 2000, Table 33, for details.

5. Readers interested in the infrastructure productivity literature should consult the complete reviews found in Gramlich (1994) and Eberts and McMillen (1999). For explicit and implicit critiques of the dominant aggregate approaches, see Haughwout (1998, forthcoming) and Rudd (2000).

6. State and local governments alone spent nearly $5.7 billion on parks and recreation capital in fiscal year 1997. We make the qualification here because secondary arguments in favor of park construction may mention that happy, healthy workers will be more productive, but we take these as comparatively unimportant justifications for these expenditures.

7. The fact that the value of time lost to congestion can be estimated does not mean that it is truly priced or that congestion reduces national income. Instead, these estimates reflect the value of leisure that drivers forgo because of congestion. Many land-use models predict that reductions in transportation costs will lead to increased residential decentralization (Anas, Arnott, and Small 1998), but whether these changes in residential patterns have in fact increased the length of commutes is more controversial. Gordon and Richardson (1994) argue that residential decentralization has not been accompanied by longer commutes, since employment locations have tended to decentralize as well.

8. The household present-value estimate of 39 cents per dollar of net investment $(1.8/4.64 = 0.39)$ is not directly comparable to the Aschauer (1989) elasticity estimate of 0.39, which is an annual figure. Aschauer's result implies that public capital was dramatically undersupplied in the nation; the results in Haughwout (forthcoming) suggest an oversupply of public capital in large, older central cities.

9. A classic example of a positive spatial externality is the relationship between an apiary and an apple orchard. Both benefit from proximity to the other: the apple blossoms improve the quality of the honey the bees produce and the bees, in turn, help pollinate the apple trees. But if the beekeeper has an opportunity to move his hives to another location, he would consider only the net benefit to his honey business and would ignore any cost his move would have on the apple grower. Recent empirical evidence confirms the existence of very significant spatial externalities like these in both production and household welfare.

10. For individuals' unpriced consumption, relative proximity appears to provide the largest benefits and segregated neighborhoods seem to experience negative consequences. Unfortunately, less is known about the scale at which the relationship between density and welfare's productivity component operates. This question is important: without its answer, we cannot be certain whether a firm's move from the central city to an inner-ring suburb is a cause for concern. Identifying this scale is an important component of the research agenda outlined in our conclusion.

11. See Anas, Arnott, and Small (1998) for a comprehensive review.

12. Boarnet and Haughwout (2000) discuss the latter point with regard to highways; here the focus is on public investment more generally.

13. Hamilton (1975) argues that with optimal zoning, local property taxation is equivalent to a local benefit tax, but more recent work, summarized by Mieszkowski and Zodrow (1989), argues that the local property tax is partly a benefit tax and partly a tax on capital. In addition, some local governments use other taxes, whose statutory incidence varies (Haughwout et al. 2000).

REFERENCES

Aaron, Henry. 1990. Discussion of "Why Is Infrastructure Important?" In Alicia Munnell, ed., Is There a Shortfall in Public Capital Investment? Federal Reserve Bank of Boston Conference Series no. 34: 51-63.

Anas, Alex, Richard Arnott, and Kenneth Small. 1998. "Urban Spatial Structure." Journal of Economic Literature 36, no. 3: 1426-64.

Aschauer, David. 1989. "Is Public Expenditure Productive?" Journal of Monetary Economics 23, no. 2 (March): 177-200.

Benabou, Roland. 1996. "Workings of a City: Location, Education, and Production." Quarterly Journal of Economics 108, no. 3: 619-52.

Boarnet, Marlon. 1998. "Spillovers and the Locational Effect of Public Infrastructure." Journal of Regional Science 38, no. 3: 381-400.

Boarnet, Marlon, and Andrew Haughwout. 2000. "Do Highways Matter? Evidence and Implications of Highways' Influence on Metropolitan Development." Unpublished paper, Brookings Institution.

Brooks, Nancy, and Anita Summers. 1997. "Does the Economic Health of America's Largest Cities Affect the Economic Health of Their Suburbs?" Wharton Real Estate Center Working Paper no. 263.

Brueckner, Jan K. 1979. "Property Values, Local Public Expenditure and Economic Efficiency." Journal of Public Economics 11, no. 2 (April): 223-45.

Brueckner, Jan K., and Thomas L. Wingler. 1984. "Public Intermediate Inputs, Property Values, and Allocative Efficiency." Economics Letters 14 (April): 245-50.

Business Week. 1997. "The Ties that Lead to Prosperity." December 15.

Case, Anne, and Lawrence Katz. 1991. "The Company You Keep: The Effect of Family and Neighborhood on Disadvantaged Youth." NBER Working Paper no. 3705.

Ciccone, Antonio, and Robert Hall. 1996. "Productivity and the Density of Economic Activity." American Economic Review 86, no. 1: 54-70.

Cisneros, Henry. 1996. "Regionalism: The New Geography of Opportunity." U.S. Department of Housing and Urban Development Cityscape (December): 35-54.

Cutler, David, and Edward Glaeser. 1997. "Are Ghettoes Good or Bad?" Quarterly Journal of Economics 112, no. 3: 827-73.

Danielson, Michael, and Julian Wolpert. 1992. "Rapid Metropolitan Growth and Community Disparities." Growth and Change 23, no. 4: 494-515.

Downs, Anthony. 1994. New Visions for Metropolitan America. Washington, D.C.: Brookings Institution.

Eberts, Randall. 1986. "Estimating the Contribution of Public Capital Stock to Metropolitan Manufacturing Production." Federal Reserve Bank of Cleveland Working Paper no. 8610.

Eberts, Randall, and Daniel McMillen. 1999. "Agglomeration Economies and Public Infrastructure." In Paul Cheshire and Edwin Mills, eds., Handbook of Regional and Urban Economics. Vol. 3. New York: North-Holland.

Egan, Thomas. 1996. "Urban Sprawl Strains Western States." New York Times, December 29.

———. 1998. "Dreams of Fields: The New Politics of Urban Sprawl." New York Times, November 14.

Ehrenhalt, Alan. 1999. "The Czar of Gridlock." Governing, May.

Fujita, Masahisa. 1989. Urban Economics. New York: Oxford.

Garcia-Mila, Teresa, Therese McGuire, and Robert Porter. 1996. "The Effect of Public Capital in State-Level Production Functions Reconsidered." Review of Economics and Statistics 78, no. 1: 177-80.

Garreau, Joel. 1991. Edge City: Life on the New Frontier. New York: Doubleday.

Gillette, Clayton. 2001. "Regionalization and Interlocal Bargains." New York University Law Review 76, no. 1 (April): 190-271.

Glaeser, Edward. 1998. "Are Cities Dying?" Journal of Economic Perspectives 12, no. 2: 139-60.

References (Continued)

Gordon, Peter, and Harry Richardson. 1994. "Congestion Trends in Metropolitan Areas." In Curbing Gridlock. Washington, D.C.: National Academy Press.

Gramlich, Edward. 1994. "Infrastructure Investment: A Review Essay." Journal of Economic Literature 32, no. 3: 1176-96.

Gurwitt, Rob. 1999. "The State versus Sprawl." Governing, January.

Hamill, Sam M., Jr. 1992. "Beyond the NJ State Plan." <http://www.njfuture.org/HTMLSrc/beyond.html> (August 2001).

Hamilton, Bruce. 1975. "Zoning and Property Taxation in a System of Local Governments." Urban Studies 12, no. 2: 205-11.

Haughwout, Andrew. 1997. "Central City Infrastructure Investment and Suburban House Values." Regional Science and Urban Economics 27, no. 2: 199-216.

———. 1998a. "Aggregate Production Functions, Interregional Equilibrium, and the Measurement of Infrastructure Productivity." Journal of Urban Economics 44, no. 2: 216-27.

———. 1998b. "Local Capital Spending in U.S. Metropolitan Areas." Public Works Management and Policy 3, no. 1: 73-91.

———. 1999a. "Regional Fiscal Cooperation in Metropolitan Areas: An Exploration." Journal of Policy Analysis and Management 18, no. 4 (fall): 579-600.

———. 1999b. "State Infrastructure and the Geography of Employment." Growth and Change 30 (fall): 549-66.

———. Forthcoming. "Public Infrastructure Investments, Productivity and Welfare in Fixed Geographic Areas." Journal of Public Economics.

Haughwout, Andrew, Robert Inman, Steven Craig, and Thomas Luce. 2000. "Local Revenue Hills: A General Equilibrium Specification with Evidence for Four Cities." NBER Working Paper no. 7603.

Holtz-Eakin, Douglas. 1994. "Public Sector Capital and the Productivity Puzzle." Review of Economics and Statistics 76, no. 1 (February): 12-21.

Holtz-Eakin, Douglas, and Amy-Ellen Schwartz. 1995. "Spatial Productivity Spillovers from Public Infrastructure: Evidence from State Highways." International Tax and Public Finance 2, no. 3 (November): 459-68.

Hulten, Charles, and Robert Schwab. 1991. "Is There Too Little Public Capital?" Paper presented at the conference "Infrastructure Needs and Policy Options for the 1990s." Washington, D.C.: American Enterprise Institute.

Jackson, Kenneth. 1985. Crabgrass Frontier: The Suburbanization of the United States. New York: Oxford.

Jacobs, Jane. 1969. The Economy of Cities. New York: Vintage.

Lewis, Paul. 1998. "Regionalism and Representation: Measuring and Assessing Representation in Metropolitan Planning Organizations." Urban Affairs Review 33, no. 6: 839-53.

Lucas, Robert. 1988. "On the Mechanics of Economic Development." Journal of Monetary Economics 22, no. 1 (July): 3-42.

Margo, Robert, and Jeremy Atack. 1998. "Location, Location, Location! The Price Gradient for Vacant Urban Land: New York 1835-1900." Journal of Real Estate Finance and Economics 16, no. 2 (March): 151-72.

Marshall, Alfred. 1890. Principles of Economics. London: Macmillan.

McDonald, John, and Clifford Osuji. 1995. "The Effect of Anticipated Transportation Improvement on Residential Land Values." Regional Science and Urban Economics 25, no. 3: 261-78.

Michaels, Dave, Selwyn Crawford, and Louise Applebome. 2001. "Kirk Praises Call for Regional Plan: Leaders React to Report's Vision for City." Dallas Morning News, March 5.

Mieszkowski, Peter, and George Zodrow. 1989. "Taxation and the Tiebout Model." Journal of Economic Literature 27, no. 3: 1098-1146.

Morrison, Catherine, and Amy-Ellen Schwartz. 1996. "State Infrastructure and Productive Performance." American Economic Review 86, no. 5: 1095-1111.

Munnell, Alicia. 1990. "How Does Infrastructure Affect Regional Economic Performance?" In Alicia Munnell, ed., Is There a Shortfall in Public Capital Investment? Federal Reserve Bank of Boston Conference Series no. 34: 69-103.

Murphy, Dick. 2001. "A Vision for San Diego in the Year 2020: A City Worthy of Our Affection." State of the City Address, January 8.

Pagano, Michael, and David Shock. 1999. "City Fiscal Conditions in 1999." Washington, D.C.: National League of Cities.

———. 2000. "City Fiscal Conditions in 2000." Washington, D.C.: National League of Cities.

Philadelphia Inquirer. 1999. "Gains and Losses: City and Suburb Are Feeling the Shift of People in the Region. Together They Can Stem the Tide." Editorial, July 2.

Putnam, Robert. 1993. "The Prosperous Community." The American Prospect 4, no. 13: 35-42.

Quigley, John. 1998. "Urban Diversity and Economic Growth." Journal of Economic Perspectives 12, no. 2: 127-38.

Rudd, Jeremy B. 2000. "Assessing the Productivity of Public Capital with a Locational Equilibrium Model." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series no. 2000-23.

Shoup, Carl. 1989. "Rules for Distributing a Free Government Service among Areas of a City." National Tax Journal 42, no. 2: 103-21.

Sweeney, Donald. 1999. "Looking Back to the Future: An Analysis of the Metropolitan Agenda for Birmingham, Alabama." Unpublished paper, Princeton University.

Tarr, Joel A. 1984. "The Evolution of the Urban Infrastructure in the Nineteenth and Twentieth Centuries." In Royce Hanson, ed., Perspectives on Urban Infrastructure, 4-60. Washington, D.C.: National Academy Press.

Voith, Richard. 1993. "Changing Capitalization of CBD-Oriented Transportation Systems." Journal of Urban Economics 33, no. 3: 361-76.

———. 1998a. "Do Suburbs Need Cities?" Journal of Regional Science 38, no. 3: 445-64.

———. 1998b. "Transportation Investments in the Philadelphia Metropolitan Area: Who Benefits? Who Pays? And What Are the Consequences?" Federal Reserve Bank of Philadelphia Working Paper no. 98-7.

Wilson, William. 1987. The Truly Disadvantaged: The Inner City, the Underclass, and Public Policy. Chicago: University of Chicago Press.

———. 1996. When Work Disappears: The World of the New Urban Poor. New York: Knopf.