Microeconomic Perspectives on US Transportation Infrastructure
Challenges and Directions for the 21st Century

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Abstract

This chapter describes two major contributions that microeconomic theory and modelling have made to understanding the future direction of infrastructure investment. The first is the trend towards implementing tolling to manage congestion. Pricing of this type ensures that facilities are used more efficiently by spreading out peak traffic. It also generates revenue for any needed expansions in capacity. The second contribution is in understanding how changes in transportation technology and costs may alter the structure of cities and with it the need for infrastructure provision either in the center or on the periphery. There are tantalizing questions concerning whether the advent of autonomous vehicles will lead to greater or lower urban density. Convincing arguments can be made either way. We seem to be at a crossroads in terms of the future structure of cities and the consequent needs for infrastructure provision and rehabilitation.

Introduction

This chapter considers how microeconomics can inform predictions of the nation's future transportation infrastructure needs. Microeconomics deals with the choices made by travelers and by infrastructure providers and operators. Specifically, microeconomists study questions concerning how prices and other user costs, such as travel time, affect demand and also how to structure incentives for providing infrastructure and keeping it in a state of good repair. Microeconomists also study the relationships between transportation networks and geographical decisions by individuals on where they live and where they work.

Microeconomics vs. Macroeconomics

This chapter deals with microeconomics. However, it should be acknowledged that macroeconomic rather than microeconomic trends dominate in the determination of the quantity and quality of infrastructure. The need for transportation infrastructure in the coming century, and the ability of the country to fund it, primarily depend on population growth and the economic success of the US. At the same time, the provision of transportation infrastructure may well be a prerequisite to achieving economic gains. Stated conversely, insufficient or poor-quality infrastructure can be a drag on the economy.

During the past 200 years, major infrastructure investments have repeatedly led to greater mobility, happiness and the ability to take full advantage of the continent's natural resources. These investments included the construction of the canals in the early 19th century, the building of the railroads somewhat later that century and the expansion of highway and aviation systems primarily in the second half of the 20th century. A big question is whether there any new technologies that might emerge between now and the year 2100 that have similar transformative effects?

Even in the short run, macroeconomics is very important. There will be periods when the economy is in recession, and there is a slowdown in traffic and a shortage of capital to expand infrastructure. In other periods, swift economic growth will result in increased traffic and congestion at chokepoints. We have witnessed both phenomena since the beginning of this century. Surging demand in the early 2000s led to a capacity crisis in all modes of transportation that figured in the deliberations of the National Surface Transportation and Revenue Study Commission (2007). In contrast, there was a period of excess capacity following the 2008 financial crisis.

Mega-trends in the location of economic activity affect infrastructure needs. The longstanding movement of population and economic activity from the Northeast to the South, Southwest and Northwest sections of the country will probably continue. Some cities will see explosive growth that outstrips the infrastructure that was originally designed for a much smaller city. Areas in the Northeast and Midwest could see stagnating or declining populations and economic activity. In some cases, the infrastructure put in place in the 1950s and 1960s will be underutilized, and maintenance may suffer as the tax base erodes.

International trade flows have affected and continue to affect infrastructure needs. Probably the greatest change in recent decades has been the offshoring of manufacturing to Mexico and Asia. This has led to a considerable increase in traffic at Mexican border crossings and at West Coast ports. The expansion of the Panama Canal in 2016 allowed larger trans-Pacific ships to access ports on the Gulf Coast and Eastern seaboard. Ultimately, the infrastructure necessary at

these facilities depends on national trade policy as well as the relative economic development of different parts of the world.

In contrast to the macroeconomic uncertainties, microeconomic considerations are more predictable. Microeconomists have generally reached a consensus about which models to use to predict behavior, and extensive historical data is available to validate the models. Economists feel much more certain in predicting the behavior of individual transportation users and infrastructure providers than they do in predicting long run trends in the economy. We now turn to these microeconomic predictions.

The Pricing of Highway Capacity

Perhaps the greatest contribution of transportation economists to the study of infrastructure provision has been pricing tools to control congestion. Pricing capacity has four main effects:

- congestion declines as there are incentives for some traffic to move to off-peak periods;
- the revenue can be used to fund the provision and expansion of "optimally-sized" facilities;
- a customer-supplier relationship is created between users and infrastructure providers that gives incentives to provide high levels of quality and reliability; and
- the potential for profit can attract new capital and suppliers to the market.

Managing Congestion

Economists have discussed pricing to deal with congestion for decades. Not surprisingly, the issue that motivated economists was, and still is, congestion on the highways. William Vickrey (1969) and Alan Walters (1961) first developed the concepts in the late 1950s. The major theoretical consideration is that drivers impose "externalities" on other drivers. When highways become congested, a driver who joins the traffic stream slows down other drivers around them and those who travel later. In deciding whether to make a trip, the driver is aware of the cost of their own travel time but does not take into account the negative effects on other drivers. Congestion prices aim to make drivers aware of the consequences of their actions.

When economists talk about congestion pricing they are referring to prices or tolls that vary with the level of traffic. Historically, some intercity highways in the Eastern US and many bridges and tunnels charged tolls. Most tolls did not vary by time of day and the level of traffic. These tolls may fund capacity provision, but they are not congestion prices.

Congestion pricing remained a theoretical concept until the 1970s. Subsequently, a perfect storm has occurred that has transformed these abstract ideas into a practical solution. The first part of the perfect storm was the worsening of congestion. The problems that Vickery and Walters were concerned about became more rather than less pressing.

Second, technology changed. Transponders have eliminated traditional tollbooths. Vehicles no longer have to stop and pay. Electronic pricing means that it is possible to charge complex tolls schedules that vary by time of day, day of the week, or the actual level of congestion. In former days, cash payment meant that toll schedules had to be kept simple.

Third, there has been a relative decline in the traditional method of paying for roads, which is to say the tax on gasoline. For decades, the gas tax had been an effective method of paying for highway infrastructure with a generally low cost of collection and limited tax evasion. The erosion of the real value of the federal gas tax due to inflation, and the introduction of more fuel-efficient and alternatively fueled vehicles, has led to the well documented undermining of the federal

Highway Trust Fund. Diversion of trust fund monies to transit and other uses has also been part of the story.

All three factors have combined to lead to an explosion of interest in directly pricing highways. This trend is likely to continue as users witness travel time benefits on highways where price regulates traffic flow, and as the federal gas tax becomes even more of a shadow of its former self.

Tolling facilitates making better use of the existing infrastructure. Manifestations of this improvement may include:

- allowing additional vehicles to buy into existing underutilized high-occupancy vehicle (HOV) lanes;
- shifting of some price sensitive traffic from the height of the peak to the shoulders of the peak, or to the off-peak;
- shifting other low-value traffic to alternative routes and modes; and
- dynamically managing traffic flows to avoid reaching the threshold at which very high volumes lead to flow breakdown.

For some tolled facilities, all lanes on a link are priced. Other facilities toll a subset of the lanes. Paid "express lanes" have prices set to keep traffic moving at a target speed, and the remaining lanes are unpriced "general purpose" lanes. It is possible to set prices such that users of both the paid and unpaid lanes benefit.

Funding New Capacity

The move from indirect gasoline taxes to direct tolling not only allows highway authorities to manage their existing infrastructure efficiently but also provides a mechanism for funding expansion. A famous theory developed by Herbert Mohring and Mitchell Harwitz (1962) and Robert Strotz (1965) showed that, with a number of caveats, congestion fees just cover the cost of expanding the facility to an "optimal" size. In effect, a congested facility generates funds to self-finance congestion relief. To an economist, an "optimally" sized facility is not necessarily a congestion-free facility, but rather one in which the marginal cost of capacity expansion is equated with the marginal travel time savings.

The self-financing principle should mean that for congestible tolled facilities, there is no need for additional external funding from other tax instruments. Conversely, monies from optimally tolled facilities should not be diverted for non-highway purposes.

Creating a Customer-Supplier Relationship

Tolling creates a direct consumer-to-producer relationship between drivers and highway agencies. The gas tax is an indirect pricing mechanism where there is limited market signaling and no market feedback for poor service. When drivers are paying directly, they expect an adequate and properly maintained product. Conversely, highway agencies can charge higher prices if drivers see that the tolls finance good maintenance and facility rehabilitation and expansion. Because reduced capacity leads to revenue shortfalls, agencies have incentives to expeditiously remove snow and make minor repairs and schedule rehabilitation activities to minimize traffic disruption. Contracts with construction firms would be structured to incentivize prompt completion.

In addition, as soon as traffic flow determines the revenue stream, highway authorities have incentives to seek out other ways to make best use of a space-constrained facility. These can include:

- eliminating one of the shoulders when two shoulders exist on each carriageway;
- permitting shoulder running at busy times of day; and
- narrowing existing lanes to create additional capacity at all times of day or just at certain times of day by using dynamic lane striping.

A significant advantage of the trend away from the gas tax and toward tolls is that highway agencies now have direct incentives to manage their assets and to make the best use of them.

The commercialization of highways may also lead to innovation and new designs. The most likely are separate truck-only facilities. In highly congested corridors, the trucking industry may be willing to pay for exclusive additional facilities that are designed for the dimensions, geometry and axle loads of large trucks. Conversely, other facilities may be built exclusively for light-duty vehicles featuring narrower lanes, steeper grades, thinner pavement and reduced vertical clearances.

Public-Private Partnerships

When some highway links are viewed as a commercial proposition, traditional methods of design, construction and management will change. The past few decades have seen the entry of commercial operators bidding for leases of existing facilities and providing new facilities. New public-private partnerships (P3s) have provided new highway capacity in Washington, D.C., Miami, Dallas, Denver and other places. In many cases, these private firms have had to use public-sector bonding for various tax and legal reasons, but they have introduced new private capital. As highways become more congested and tolling more commonplace, P3s are likely to become more common for both construction and operations (Poole, 2018).

However, a congested highway is a "scarce resource" and it is possible that private highway concessionaires could treat it as a "cash cow." They could charge excessive prices to earn super-normal profits that are not plowed back into maintaining and improving the highway. Of course, even public-sector highway agencies divert revenue to non-highway uses. Nevertheless, when private profit is involved there may need to be a resurrection of the type of government regulation that ceased to exist in other transportation modes in the 1970s. It is quite conceivable that a regulatory framework will need to be established to prevent private toll road operators charging excessive prices or underinvesting in quality.

The Pricing of Capacity in Other Intercity Modes

Airports and Airspace

As with highways, many airports and the surrounding airspace are severely congested. The Federal Aviation Administration's Next Generation Air Transportation System is designed to improve capacity in the skies by moving from ground-based control systems to satellite-based systems. These would potentially make better use of the available airspace and open up airspace not used by traditional control systems. There is continued controversy about the speed at which this project is being deployed. Critics point to procurement constraints within the government. Canada and

some other countries have moved their air traffic control systems from a government operation to quasi-governmental companies. There is a debate as to whether the US should do the same.

On the ground, there is a continued concern that demand outstrips the physical number of runways. Relatively few new airports and runways have been constructed in recent decades. Construction is constrained by physical and environmental concerns and not just a lack of finance. The economics of congested airport runways is similar to that of congested highways. Currently, landing fees are based on aircraft weight and typically do not vary by the degree of congestion. This has led to inefficient use of runways at commercial airports by general aviation (private) aircraft. In addition, there has been a trend for airlines to offer frequent service using smaller regional jets as opposed to less frequent service with larger aircraft. The current weight-based pricing system that does not reflect congestion does not give the correct incentives for an "optimal" aircraft size.

Economic theory suggests that at some hub airports where a single carrier dominates, the costs of congestion are "internalized" by the airline. Hence, the airline would have incentives to decide whether to bunch its connecting flights together or spread them out. But that would not be the case at airports such as Los Angeles, Seattle, Las Vegas, Chicago O'Hare, Boston Logan, Atlanta, New York LaGuardia, New York Kennedy, Washington National and Miami where there are multiple airlines competing.

There has been a discussion for decades as to whether congestion prices should be introduced to flatten out the peak and to spread out clusters of flights. Proposals to implement such pricing at Boston Logan in the 1980s and Newark in the 2000s never came to fruition. General aviation interests tend to be vociferous in their opposition, and airlines view such pricing as a "money grab." Economists would argue that the case for pricing airport runways has similar benefits to the pricing of highways. A more efficient use would be made of the existing capacity, and optimal runway prices would generate the funding for any needed expansions.

Inland Waterways

Barge traffic is a significant yet unheralded part of the nation's freight system. Much of the infrastructure debate has focused on the renovation and expansion of the 1930s-era locks on the upper Mississippi River. At 600 feet in length, these locks cause additional congestion as 1,200-foot barge tows have to be split into two to pass through them. As with highways, the funding system has not encouraged infrastructure investments. A tax on marine diesel fuel goes into a trust fund. However, this trust fund is not sufficient to pay for investments. Indeed, projects that do move forward are half funded from the trust fund and half from appropriated general tax revenues. Operational expenses come from general tax revenues. Consequently, users pay for only a small proportion of the reconstruction, maintenance and operational expenses of waterways. With the direct beneficiaries shouldering so little of the costs, it is no wonder there has been insufficient investment.

Major investments in the upper Mississippi River are only likely in two circumstances. The first is if agricultural interests have sufficient political influence to obtain a major investment program. The second is if the financing of the waterways—which currently dates from the Inland Waterways Revenue Act of 1978—is significantly changed. Revenue would need to be increased and perhaps the structure of pricing will have to change. Economists argue for congestion-based lockage fees. A consumer-producer relationship would be created between barge companies and the US Army Corps of Engineers. Incentives would thus be created to encourage reinvestment.

Deep-Sea Ports

As with inland waterways, there is a debate as to whether the Harbor Maintenance Tax (assessed on imports) is sufficient to pay for dredging and navigational aids, and which parties should bear the cost of these activities. Perhaps the biggest port constraint comes on the landside rather than the waterside. Intermodal traffic has to access the interstate rail and highway systems through surrounding neighborhoods. These neighborhoods have concerns about road congestion, trains blocking highway-rail grade crossings, noise and vehicle emissions. These are classic externalities and can lead to underinvestment as the port authorities bear the costs but some of the benefits accrue to the local community. Investments have already occurred to expand landside access and mitigate negative spillovers in Long Beach, Miami and Seattle. Similar joint ventures between federal and state governments, port operators and railroads may be necessary in the coming years.

Freight Railroads

In their recent book, Robert Gallamore and John Meyer (2014) titled their first chapter "The Enduring American Railroads." Railroads have been a large part of the American landscape for more than 150 years, and there is no reason to doubt that they will be part of the landscape for the next 150 years. For long-distance bulk freight, the railroads have a natural superiority, and North America is a land of great natural resources and immense distances.

Since the Staggers Act of 1980 liberalized economic regulation, railroads have done well financially and have renewed their infrastructure. Clearly, railroads internalize delays and lost traffic opportunities when infrastructure becomes congested. Consequently, they have strong incentives to reinvest. Nevertheless, congestion and chokepoints remain, most notably in Chicago where a "tragedy of the commons" has occurred. Because all of the major railroads meet in Chicago, the problems of interchange and coordination have led to considerable delays, and individual railroads underinvest because portions of the benefits accrue to other firms. The Chicago Region Environmental and Transportation Efficiency program has dealt with some of these issues, with the public purse paying for a portion of it.

Passenger Rail

There has been plenty of discussion concerning deteriorating railroad infrastructure in recent years. Much of the discussion has centered on bridges, tunnels and electrical systems along the Northeast Corridor between Boston and Washington, D.C. The root of these concerns is systemic funding problems of both the National Railroad Passenger Corporation (Amtrak) and commuter rail systems. It is tough to see a quick resolution to the funding needs in the Northeast. As long as Amtrak is funded from federal sources, there will be opposition from other parts of the country to spending money to resolve a regional problem. The only foreseeable break in this impasse would come if Amtrak ceased to be a national network and became separate regional entities. One would imagine that if funding for rail service in the Northeast became the responsibility of a consortium of states along the Eastern seaboard, they might form a consensus concerning significant investment.

Discussion of the Northeast Corridor naturally leads to consideration of investment in high-speed passenger rail services. It is clear that truly high-speed passenger trains (of 125 miles per hour and above) and freight trains cannot easily coexist on the same tracks. Despite considerable

enthusiasm for the types of services seen in Europe and Asia, high-speed passenger rail appears to be no further forward than it was 10 years ago. It is unclear whether the California scheme currently in the early stages of construction will end up being attractive to users, and whether a privately promoted scheme in Texas will come to fruition. A recent privately funded service on the east coast of Florida operates at speeds that are more conventional.

Urban Transportation

The principles discussed in the previous section are equally applicable to urban transportation. The problems of highway congestion tend to be much more severe on commuting routes into our major cities than they are on intercity highways. Riding transit at peak hours tends to be a crowded and unpleasant experience. However, the defining influence on urban transportation infrastructure is the future structure of cities. More accurately, there is a "chicken and egg" relationship. The structure of cities determines transportation infrastructure needs, yet the building of infrastructure can help shape the cities of tomorrow.

The Drivers of Urban Change

To draw some theoretical inferences on the intersection of urban and transportation economics, we start by considering a rather-abbreviated history of urban form in the US. To do so we use the terminology introduced in a 1977 book by J. Michael Thomson.

Prior to the 1880s people lived close to their work. Manufacturing, commerce and residences clustered around an urban core. Thomson describes these cities as a "low cost" city archetype where walking dominates. By the 1890s, new streetcars and commuter railroads allowed workers to live at lower densities and commute to the factories, shops and offices that were still located in the center of town. Thomson calls this type of radial city the "strong center" archetype.

The coming of the automobile age after 1945 challenged this city structure. Affluence led many people to purchase single-family homes on the edge of existing cities. Manufacturing businesses moved from inner city locations close to rail yards to suburban locations close to interstate highways. "Weak center" cities have lost much of their downtown employment to suburban centers. The result has been urban sprawl and increasing congestion in the suburban "edge cities." Cities of this type continue to have a downtown with sufficient activity to warrant a transit system to supplement urban freeways. However, in the off-peak, the road system can cope with the traffic, so there is limited off-peak transit demand. This leads to costly peak only transit systems with poor financial performance. Mayors of weak center cities are typically preoccupied with ensuring that their downtowns do not get any weaker.

Most cities that emerged in the auto age are of the "full motorization" archetype. These cities do not have a dominant downtown, but instead have multiple sub-centers. The low density living and working means there is often only a token transit service. A number of former weak-centered cities have turned into the full motorization archetype. These range from smaller places like Memphis to the large ones such as St. Louis and Detroit where flourishing downtowns of 100 years ago, supported by large streetcar systems, have virtually disappeared.

Two major microeconomic effects underlie the 150-year evolution of the American city. The first is declining transportation costs. As new infrastructure was built radiating out from city centers, out-of-pocket expenses and travel times fell. This made cheaper land on the periphery of cities more attractive for both employment and residential purposes. Companies and individuals

who valued, and still value, the benefits of low density living and working opted to move to the periphery.

The second is declining "agglomeration economies." It is no longer as essential for businesses to locate in physical proximity to each other to transact commerce. Even within individual companies, there is a declining need to situate the front office, the back office, the manufacturing facility and the warehouse on the same site. Functions that do not have to be located downtown could be relocated to the suburbs. The movement toward intercity trucking meant that manufacturing and warehousing no longer needed to be located around historic downtown railroad yards. Modern railroad intermodal facilities followed industry to the suburbs.

What is likely to happen to these underlying economic drivers in the next 80 years? It is clear that electronic commerce reduces agglomeration economies. Therefore, while some tasks will continue to require face-to-face contact, the rise of video conferencing and the like will further undermine the economic necessity for a downtown.

A continuation of the declining costs of transportation evident in the 1950s through 1970s is perhaps more questionable. The congestion-free roads of 1950s suburbia are history. Nowadays living in suburban areas and commuting to downtown is frustrating and time consuming whether commuting is by automobile or by public transit. As congestion has grown worse, basic urban economics models of the "monocentric city" (a single central business district surrounded by rings of housing) suggest that people will move their residences back from the suburbs into locations that are more central. The urban gentrification of decaying inner-city areas witnessed since the 1980s is consistent with this theoretical model.

Of course, congestion on the roads connecting the suburbs to downtown could also lead to further decentralization. If households continue to desire low-density living, and there are declining agglomeration economies, then even more firms would relocate activities to the suburbs and exurbs to attract employees. The city would then trend toward the full motorization archetype.

How these trends play out is partly beyond the transportation sphere. For gentrification to continue, the quality of public education has to improve to make the city appealing for families. There is no doubt that inner-city density leads to urban amenities such as dining and entertainment that are attractive to singles and empty nesters. To the extent that people are marrying later, and living longer, there would seem to be a growing segment of the population that has a desire for dense urban living. However, for families this is not true, and for companies looking for a workforce that is not solely in their 20s, it is not clear that downtown will continue to be a desirable place to locate.

Overall, there is a strong suggestion that the trends set in motion after World War II of increasing sprawl and weaker downtowns will continue, albeit that there will be a limited regeneration of some inner-city areas as singles and empty nesters move into neighborhoods with plenty of amenities. Blighted neighborhoods that had suffered from segregation, outward migration of industry and population and social strife in the 1960s could again become desired residential locations. However, what about the poorer people displaced from the gentrifying areas close to downtown? It is likely that displaced populations will move to older inner suburbs. These suburbs will then struggle to maintain their municipal infrastructure as their tax base declines.

Overall, there will be a need to both provide additional infrastructure on the periphery and to rebuild in the inner city. At the same time, there may be a run-down in the condition of the infrastructure in older inner suburbs.

Transportation Trends and Their Effect on Urban Infrastructure

Autonomous Vehicles

Some of the trends in future urban form may be determined within the transportation sphere. Perhaps the most intriguing is the introduction of semi- and fully-autonomous vehicles that free drivers of the aggravation of the driving task for at least part of the journey. It seems highly likely that these vehicles will come to fruition and may even dominate the highways by 2050. They might allow for a more efficient use of highway space and a reduction in travel times. More likely, depending on the technology and legal changes, people will regard travel time as less onerous as they can multi-task and engage in other activities while in their car. Transportation economists argue that when the disutility of driving falls, the quantity of driving ("vehicle miles traveled") will increase. What will this mean for urban form? The intuition from traditional urban economics models is that sprawl will increase, and there will be a further need for infrastructure investments at the edges of existing cities.

Some commentators suggest counterarguments that might result in higher urban densities. One argument is that vehicle automation will remove the biggest headache of urban driving which is finding parking. Imagine arriving at one's home or workplace, being dropped off at the door and then commanding the vehicle to go automatically to a distant parking lot. Living or working in a dense neighborhood will become a lot more attractive. Of course, all these unoccupied vehicles shuttling back and forth to and from remote parking lots may make downtown traffic congestion worse rather than better.

Another counterargument is that autonomous vehicles might change the nature of how people consume automobiles. Proponents of this counterargument argue that consumers will no longer own vehicles but rather rent shared vehicles by the hour or trip. This will change the perception of travel costs. With an owned vehicle, most of the costs such as the initial purchase and insurance are "fixed costs" and the marginal cost of a trip is just the cost of fuel. For rented vehicles, the fixed costs are spread out and recouped on every trip. Consequently, the marginal cost of a trip is higher in a rented vehicle, and urban economics models predict that people would live closer to the center of cities and density will increase. For such a counterargument to hold there would need to be a large change in preferences from owning assets to sharing them. The counterargument also presupposes the pricing scheme for shared cars. Pricing schemes with a high annual or monthly fixed payment and low per trip costs (called "two-part tariffs" by economists) are also likely, and these would perpetuate the existing incentives for trip making and residential location.

Parking

A surprising trend in the economics of transportation in recent times has occurred in the previously staid world of parking. Transportation economists have started to model the effects of changes in parking rates, and planners have debated how the quantity and pricing of parking affects land use and economic activity (Shroup, 2011). In the business world there has been entry into the market of firms offering innovative technology to provide drivers with information about vacant parking places, and even incumbent large firms who own and operate parking lots have experimented with innovative products and pricing.

Some of these changes have already affected infrastructure. These include:

- installing sensors under on-street parking spaces to detect occupancy;
- providing information on available on-street spaces to drivers to reduce "cruising" to find parking;
- providing information on availability and pricing of off-street lots;
- dynamic pricing of on-street parking to ensure that some spaces are always available; and
- using parking prices as a surrogate for a toll cordon around congested downtown areas.

The traditional uniformity of parking meter rates is already disappearing. Soon, prices will fluctuate to regulate demand and vary even within small geographic areas as people are given incentives to save money by parking one street away from their destination.

As soon as on-street parking becomes a commodity with a price that reflects its value, some infrastructure questions that have been dormant for decades re-emerge with a new urgency. What is the optimal mix of traffic lanes and parking lanes? Is displacing parking to provide bicycle lanes or bus lanes wise? What fees should be charged if parking is temporarily displaced for (non-highway related) construction?

Mass Transit Infrastructure

How the structure of cities evolves in the coming decades has implications for public transportation infrastructure. In terms of urban rail systems, there appear to be two conflicting trends. On one hand, we have seen an eroding of the financial base to support rail-transit infrastructure renewal and maintenance in cities such as New York City, San Francisco and Washington, D.C. On the other hand, many southern and western cities have constructed new light rail and streetcar systems.

Many transportation economists have been skeptical of the desirability of new rail capacity. Fares only cover a fraction of the operating costs and none of the capital costs. Government, including federal funds through the "new starts" program, has funded the construction. Some of the systems have had very disappointing ridership. John Kain (1997) in his study of Atlanta concluded that the citizens would have been better off if the expenditures used to construct and operate the 1970s-era rail system had been used for better bus services.

An alternative to rail systems known as Bus Rapid Transit (BRT) has many vocal proponents, but few systems have been built in North America. BRT covers a range of options, from exclusive lanes and signal priority for buses at one extreme to separate rights of way at the other. BRT has much lower capital and operating costs than rail-based alternatives. It is an alternative to some light rail lines, and even to some heavy rail lines in corridors with only moderate ridership. BRT is also an alternative to some existing heavily traveled bus routes, where it promises to deal with the big disadvantage of bus service, slow travel times due to congested regular traffic lanes and frequent stops. If BRT became more common, one could imagine that many city streets and intersections would need to be reconfigured to provide dedicated bus lanes for part or all of the day.

Buses and Taxis and the Effects on Urban Form

Public transit, both bus and rail, has been largely in the public sector since the 1950s and 1960s. There is well-documented evidence that costs rose rapidly, particularly in the 1970s. The US generally did not follow the post-1980s trend in Europe, Australia and South America of a greater private sector involvement. Full deregulation and competition are rare worldwide but competitive

contracting is common, whereby private companies compete in government tenders to provide service at the lowest net subsidy. In effect, the operation of services is decoupled from political decisions regarding which services to provide.

What would happen if certain states or cities decided to emulate London and Sydney and reintroduce the private sector into transit operation? If costs fell, would there be more and/or cheaper bus service for the same or fewer subsidy dollars? Presumably, more convenient urban bus services would make high-density living in cities more attractive. Convenient and inexpensive bus and taxi service makes it feasible to live in the city without the need to own a car.

While privatization of existing transit agencies does not seem likely in the near future, developments occurring in the taxi market might bring about a situation where competition emerges in the transit market. Ride-hailing companies such as Uber and Lyft have responded to a genuine market problem of poor taxi availability and expensive services. One could imagine that an attractive market for deployment of autonomous vehicles would be in taxi service. The cost of taxi service would fall even more and the overlap between a taxi, a shared automobile and a traditional rental car would become even more blurred.

The next frontier for ride-hailing companies is expanded shared rides (that is when more than one unrelated party with similar destinations share a vehicle). Both Uber and Lyft and some of their competitors already offer this service. The next step may be to deploy larger vehicles and require riders to walk a short distance to be picked up. One could imagine that these services could offer faster travel times than traditional transit buses at attractive prices. Minivan-sized vehicles used as shared taxis could match the (highly subsidized) bus fare. In these circumstances, the world would have come full circle with a reintroduction of the "jitney" that transit companies and local governments had legislated out of existence by the 1920s. Clearly, this would be detrimental for existing public transit companies and their employees and may act to undermine the case for light-rail construction. However, it would be a boon to riders.

The revolution in the taxi market (with more to come if driverless taxis become common) and future revolution in the transit market make city living more attractive. As a result, we may see more urban living with consequent changes in the needs for transportation infrastructure in the city and on the periphery.

Conclusion

Microeconomic theory and modeling have made two major contributions to understanding the future direction of infrastructure investment. The first is central to transportation economics and concerns the efficient pricing and use of infrastructure. Traditionally, transportation infrastructure has either not been priced, or is priced in a way that is not related to the true costs users impose on the infrastructure and other users. This applies equally to highways, airport runways and maritime facilities. Economists have long called for "congestion pricing," which considers the delays that one user imposes on all other users of a facility. The benefits of such pricing are twofold. The first is that some users, when faced with the true cost of using a facility, may decide to travel in the off-peak, by another mode, by a less-direct route, or not travel at all. Existing facilities will be used more efficiently. The second is that congestion prices generate the revenue for any needed expansions in capacity.

It would seem very likely that this style of pricing will become more common in the relatively near term, especially for limited-access highways. The decline in importance of the gas tax and the increased practicality of electronic tolling makes pricing very attractive for cash-

strapped infrastructure providers. Increased congestion, and the need to rehabilitate highway facilities constructed in the 1960s and 1970s, will probably be the events that trigger these changes. The decline in the importance of the Highway Trust Fund and a movement to direct pricing may actually spur infrastructure investment rather than reduce it. Moreover, it will create more of a producer-consumer commercial relationship between infrastructure providers and users that can only be beneficial.

The second contribution is in understanding how changes in transportation costs may alter the structure of cities and with it the need for infrastructure provision either in the center or on the periphery. In general, urban economics models provide some support for understanding the recent modest regeneration of inner-city neighborhoods. Rising congestion has made long commutes from the suburbs less attractive. Whether this heralds a complete reversal of the long-term trend to suburbanization and automobile-centric urban form is more debatable.

Are there any game changers on the horizon that may upset conventional wisdom on urban form? Perhaps the biggest game changers are outside the transportation sector and include improvements in school systems that attract families back into the city. Within the transportation arena, there is the tantalizing question of whether the advent of autonomous vehicles will lead to greater or lower urban density. Convincing arguments can be made either way. In addition, the revolution currently sweeping the taxi market may spread to reforms in urban transit, which might lead to easier and cheaper urban mobility. We seem to be at a crossroads in terms of the future structure of cities and the consequent needs for infrastructure provision and rehabilitation. It is going to be an interesting next few decades.

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