Public Transit: Realizing Its Potential

*Richard Voith**

Most major metropolitan areas provide subsidized mass transit. The primary rationale for government support is that public transportation has benefits that extend beyond those enjoyed by the riders. Because of these added benefits, the value of public transportation to society exceeds the amount that riders alone are willing to pay for the service.

Proponents of subsidies for public transportation cite several potential benefits to society at large. Increased transit use reduces the number of people using highways, thereby alleviating congestion and the need for additional, expensive highway construction. Diverting commuters from autos to transit also reduces auto emissions and thus improves air quality. Transit service also allows dense concentrations of economic activity, which many economists believe increases overall productivity. Proponents also note that public transit can benefit specific groups; for example, it may provide access to employment for low income people.

Subsidized public transportation is not without its critics, however. Opponents of government transit subsidies suggest that the benefits to society at large are too small to justify a subsidy. After all, according to the 1990 cen-

*Dick Voith is an economic adviser in the Research Department of the Philadelphia Fed.

sus, only 5.3 percent of all workers commute by public transit, down from 6.4 percent in 1980. Continued decentralization of population and employment may further erode transit's market share in the future. Opponents argue that low ridership precludes transit from having large social benefits. They also claim that transit agencies use their subsidies inefficiently, resulting in high costs relative to the public benefits.[1] Finally, opponents note that transit services targeted to disadvantaged groups constitute "in kind" transfer payments and suggest that cash or voucher programs are more efficient means of improving the welfare of the targeted group.

While there may be disagreement about the value of transit subsidies to help specific groups, transit proponents and opponents alike would agree that public transit's benefits to society at large are directly related to the number of people choosing to ride. For example, transit's contribution to reducing congestion and pollution depends on how many people prefer to ride transit instead of driving.[2] Similarly, public transit's contribution to productivity growth will be small unless the service is sufficiently attractive to encourage private investment in dense economic developments.

Since transit's benefits to society at large are linked to use, the social value of a given level of subsidy depends on how well transit can compete in the transportation marketplace. This issue of transit's market potential is more complicated than it might appear for two reasons. First, public transit's ability to compete varies from one market to another.[3] Second, current ridership may not be a good indicator of potential because transit providers may be pursuing objectives other than attracting the largest number of riders. Despite these complications, policymakers need to evaluate transit's market potential to determine the proper level of subsidy and to monitor the efficiency of transit providers. Transit providers need to understand the dynamics of the market to attract as many riders as possible with the level of subsidies granted.

WHAT DETERMINES TRANSIT'S MARKET SHARE

The potential of public transit depends on the underlying demand in each market and the cost of supplying transit to that market. In markets where the demand for transit is very low or the cost of supplying it is very high, transit's potential is low.

The underlying supply and demand for transit can be difficult to observe for a couple of reasons. First, for any mass transit system, whether buses, trains, or airlines, the cost of carrying each person depends on the number of other people making the same trip. Thus, supply and demand are not independent of one

[1]For example, Jose Gomez-Ibanez argues that transit operators invest in excessively expensive rail transit systems whose benefits do not justify their costs. See "The Federal Role in Urban Transportation" in John Quigley and Daniel Rubinfeld, eds., *American Domestic Priorities*, University of California Press (1985). In the popular press Frederic Rose (*Wall Street Journal*, June 29, 1993) has argued that increasing transit subsidies has had little success in increasing transit's national market share.

[2]All public transportation trips may not be of equal social value. For example, a transit trip during rush hour may reduce congestion more than a trip at midday. Still, the assumption that the social benefits are linked to overall transit use is a good one because the patterns of transit use are not easily categorized. A person choosing to use transit during rush hour might have driven instead if he had not had the opportunity to make a return transit trip midday. Thus, the social value of the midday trip may be greater than first appears.

[3]Despite transit's small national market share, transit plays a very important role in the central cities of many large U.S. metropolitan areas. New York, Washington, D.C., San Francisco, Boston, Chicago, and Philadelphia all have transit market shares above 25 percent. Although transit's market share is large in many central cities, it is small in the suburbs.

another. Second, as with any subsidized service, the price the rider pays and the quality of a particular transit route depend on how much subsidy it receives. The differences in ridership observed across routes may reflect different subsidy levels as well as different underlying supply and demand conditions. To evaluate the competitiveness of public transit, it is crucial to have a precise understanding of transit supply and demand and how they interact with public subsidies to determine ridership.

Demand for Transit Services. Individuals choose how to get from one place to another based on the relative price, quality, and convenience of the alternatives such as the automobile or the bus. To understand transit demand, we need to know how changes in these factors affect people's choices between riding transit or driving cars. Of course, demand for public transit may differ across individuals because they have different preferences and incomes.[4]

Travel, whether for work or leisure, involves more than simply moving from point to point, and people may have strong preferences for how they do so. For example, some people may like the perception of control associated with car travel; others may prefer to be able to read on the train. These idiosyncratic differences explain why two people facing the decision of taking a car or a train may not make the same choice.

More systematic differences in individuals' transit demands arise from income differences. People with higher incomes tend to value their time more highly and therefore are more likely to choose a faster mode of travel.[5] In addition, higher income people can afford to choose more comfortable and convenient transportation. Luxury cars with many amenities are often the chosen means of travel for people with higher incomes. On the other hand, bus transportation is frequently characterized as an "inferior good," that is, people choose to ride the bus less as their income increases.[6]

Regardless of preference or income, the relative price of transportation is always an important factor in an individual's demand for public transportation. As with most other products or services, a consumer's demand for transit falls as the price increases. Similarly, as the price of automobile travel rises, transit demand increases.

For any particular trip, the additional or marginal cost of that trip is the relevant consideration. Even though the total private costs of automobile travel tend to be higher than those of transit, the marginal cost of a trip by car is very low. The greatest private costs of auto travel are the fixed costs associated with purchasing, maintaining, and insuring an automobile.[7] Thus, once a person has made the decision to own a car, the out- of-pocket financial

[4]Because people have diverse tastes, economists describe transit demand in terms of the probability that an individual will choose public transit rather than a car. Formally, the theory of transportation mode choice is based on the random utility model pioneered by Daniel McFadden, "Conditional Logit Analysis of Qualitative Choice Behavior," in Paul Zarembka, ed., *Frontiers in Econometrics* (Academic Press, 1973), pp. 105-42.

[5]See Kenneth Small, *Urban Transportation Economics* (Harwood Academic Publishers, 1992), pp. 43-44, for a review of the literature examining the link between income and the value of time in transportation mode choice.

[6]Curiously, in Paris the bus is not considered an inferior good, at least when compared with the famous Paris Metro. According to officials of the RAPT, the agency that operates the transit system in Paris, wealthier people choose to ride the bus system rather than the Metro. The Paris bus system, which provides services that are largely duplicated by the Metro in central Paris, is also higher priced than the Metro.

[7]For 1991, the total private cost of auto travel is estimated to be 43.6 cents per mile, of which 9.8 cents are for the out-of-pocket variable costs. Source: American Automobile Manufacturers Association of the U.S., *Motor Vehicle Facts and Figures*. The average fare per mile of transit is 15.3 cents. Source: Computed from Tables 20 and 38, *1993 Transit Fact Book*, American Public Transit Association.

expense of a trip includes only the relatively small cost of gas and perhaps tolls and parking. On the other hand, a consumer's out-of pocket expense for transit is usually relatively high and frequently higher than the marginal costs of car travel.[8]

The relative quality of transit and travel by car is, in some ways, even more important than the relative price. Because the scope of transit service is not universal, transit is simply not available for some trips, while for others the need to transfer several times may make the journey by transit absurdly time-consuming. The automobile, on the other hand, has the advantage of being available at any time for any destination. On the basis of availability alone, the car is the mode of choice for many trips. For those trips with a transit alternative, the quality of the transit service—the speed, frequency, and comfort—will surely affect a person's choice. (See *Demand Comparison: SEPTA vs. PATCO.*) If transit is too slow, resulting in high travel-time costs; too infrequent, resulting in limited choices of travel time; or too crowded, resulting in an unpleasant trip, there is little likelihood that people will choose transit. On the other hand, if congestion erodes the quality of car travel, travelers will choose transit more frequently.[9]

Taken together, individual choices determine a community's travel demand in general and its demand for public transit services in particular. A community's demand for transit depends on the number of people in the community and the fraction of those people choosing transit. However, even within a relatively small neighborhood, the attractiveness of transit service will vary. The convenience and even the cost of a transit trip will depend, for example, on the amount of time a person has to spend walking or driving to use the service. Communities that are densely populated are likely to have more commuters living close to transit services and, therefore, have higher transit use. Similarly, communities whose residents tend to have destinations served by the transit route will have high demand. The layout of a community and the destinations of its residents are crucial for the transit provider because they have implications for the cost of supplying competitive transit service.

Supply of Transit Services. There are two ways to think about the supply of transit services. Public transportation providers can be thought of as simply providing a number of vehicle-miles of bus or train operation or, more generally, a number of passenger-trips on buses or trains. Whether we focus on vehicle-miles or on passenger-trips depends on the question to be addressed.

Vehicle-miles of bus operation are "intermediate products" because they have no direct value in themselves; rather they become valuable only when people choose to ride the bus. Focusing on intermediate products is most useful when we are examining the purely technical efficiency of operating and maintaining buses and trains, since the costs of producing intermediate products are completely independent of people's choices about riding public

[8]Transit agencies sometimes offer monthly, weekly, or daily passes, so that the consumer's marginal costs of each trip are zero, at least in the very short run.

[9]The high fixed cost and low marginal cost of auto travel have implications for the quality of highway travel. Since the marginal cost of car travel is very low, the use of cars (among car owners) is limited primarily by highway capacity. As the capacity of the highway system is reached, the travel time increases rapidly, eroding the time advantage of auto travel. See William S. Vickrey, "Congestion Theory and Transport Investment," *American Economic Review: Papers and Proceedings*, 1969, pp. 251-60, for an early discussion of highway pricing and congestion. The total costs of highway congestion for 50 large metropolitan areas were estimated to be about $39.2 billion in 1989. (James W. Hanks and Timothy J. Lomax, *1989 Roadway Congestion Estimates and Trends*. Texas Transportation Institute, 1991.)

Demand Comparison: SEPTA vs. PATCO

The effects of price and service on ridership can be seen in a comparison of two separate, very unequal rail systems providing commuter service to the central business district of Philadelphia. SEPTA (Southeastern Pennsylvania Transportation Authority) and PATCO (Port Authority Transit Corporation) provide service to demographically similar suburban neighborhoods, but there the similarity ends.[a]

As shown in the figure, PATCO's fare is less than half of SEPTA's. PATCO runs almost five times as many rush-hour trains on its single 14-mile line as SEPTA runs on its average commuter line. PATCO also runs much more frequent off-peak service. The net effect of the lower-price, higher-quality service is that PATCO carries over 10 times more people per mile of railroad than SEPTA does.[b] Thus, for very similar suburban markets and the same destination, ridership levels are dramatically different. The level of current SEPTA ridership doesn't necessarily reflect transit's potential.

[a]Communities served by SEPTA tend to have somewhat higher incomes than communities served by PATCO.
[b]PATCO ridership is higher, in part, because motorists in New Jersey must cross a toll bridge to enter Philadelphia.
[c]The PATCO fare is for a trip from Philadelphia to the end of the line. The SEPTA fare is a peak fare for zone two.

transportation. The cost of running a bus for 10 miles, which includes fuel and maintenance costs plus wages for the operator, is roughly the same whether four or 40 passengers are on board. Statistical studies of the transit industry also suggest that the cost per mile of running a bus or train is independent of the scale of operation.[10] In other words a transit authority could provide 10 or 100 bus vehicle-miles for roughly the same cost per mile.

Passenger-trips, on the other hand, are the "final products" of public transportation. Unlike the cost of an intermediate product, the cost of the final product depends, in part, on the number of people choosing to ride. The cost of a passenger-trip would vary tremendously depending on whether the cost of operating a bus were spread over four or 40 people. Moreover, statistical studies suggest that, unlike with intermediate products, producing the final product entails economies of scale. More frequent service enhances the competitiveness of public transportation, and economies of scale arise when increased service expands ridership faster than costs. That is, the cost per person riding transit falls as service levels increase. (See *Supply Comparison: SEPTA vs. PATCO.*)

The cost to supply identical quality service

[10]See Small (1992) for a review of the literature on the cost structure of public transit providers.

may differ widely from one community to another. At one extreme, consider a very low density suburban community whose residents work at dispersed employment locations throughout the region. This pattern of land use reduces the number of potential transit customers because of the great distance between residents and because of the low probability that residents along any route will have the same destination. Simply to cover the destinations of a high proportion of the community, the transit authority would have to operate many routes, each serving only a small number of people. To have frequent service would require running small buses at substantially less than capacity most of the time. The costs per person of supplying service to this community would be extremely high.

Next, consider a low density suburban community that has a relatively high proportion of people who work in one area, say, the central business district. In this second community, the cost of supplying high quality transit service will be lower than that in the first community. Concentration of destinations means that many people can be served by a single transit route, allowing transit vehicles to operate near full capacity with frequent service. Frequent service, in turn, attracts a larger share of the market. If the market is large enough, and if transit captures a large enough market share, higher capacity vehicles, such as larger buses or trains, can lower per-trip costs even further.

Transit is most competitive in communities that have high residential densities, common destinations, and high costs of auto travel. This type of market is most commonly found in older cities in which employment is concentrated in a central business district. In such markets, passenger volumes are large enough to justify high capacity, high efficiency technologies operating at high frequencies over a wide network of routes.

Like all markets, the market for public transportation is not static. The cost of supplying transit services changes over time as communities change. Incentives in the transportation system affect the way communities evolve. These incentives guide long-term choices such as residential and business location and private investment in automobiles. For example, if public transportation is attractive, people and firms will locate in areas where they can take advantage of transit services. Households will make less of an investment in private transportation by not purchasing a second or third car. In the long run, high quality transit service attracts people who have destinations served by transit and who own fewer cars.[11] On the other hand, public transit that is priced too high or is of poor quality will play little or no role in long-term decision-making. Little sorting by destination and car ownership will occur, which increases the cost of providing transit service in the long run.

Subsidies and Transit Ridership. In addition to the underlying supply and demand conditions, transit ridership depends on the level of public subsidies. On a per-rider basis, transit subsidies can be viewed as the price society is willing to pay to induce a person to ride public transit. For example, if transit authorities are willing to provide a high enough subsidy, they can increase ridership in low demand, high cost markets. Similarly, very low per-passenger subsidies may depress ridership well below potential in high demand, low cost markets. Since per-passenger subsidies are seldom equal across markets served by a transit authority, actual ridership may not

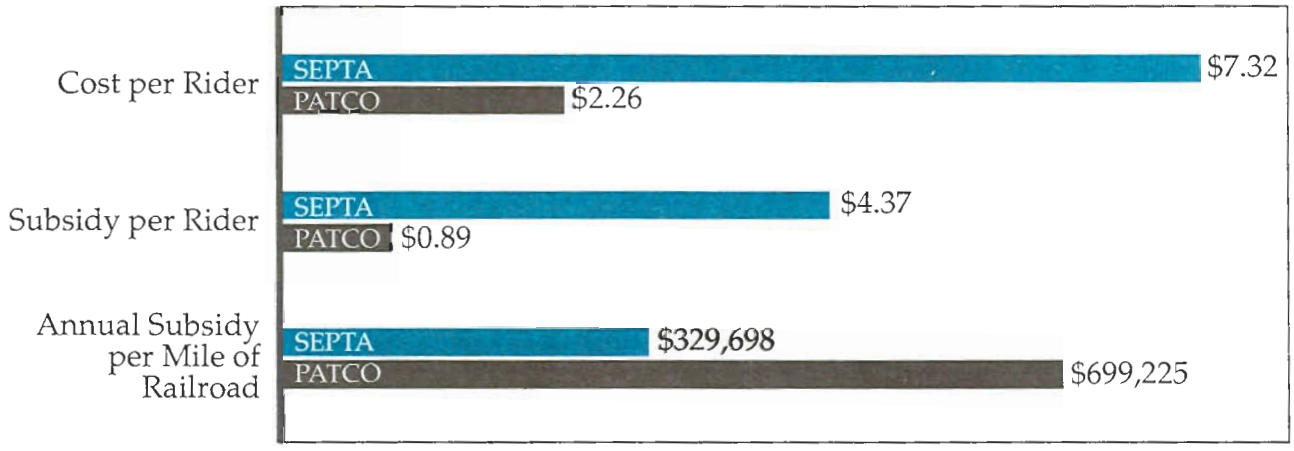
[11] In "Transportation, Sorting and House Values," Richard Voith examines the effects of transportation on residential location and finds that high quality public transportation induces people with similar destinations to live in the same neighborhoods. In addition, households living in areas with good transit service tend to own fewer cars than households of similar income living in other areas. (*AREUEA*, 1991, Vol. 19, pp. 117-37)

Supply Comparison: SEPTA vs. PATCO

PATCO succeeds in carrying many more passengers per mile of railroad than does SEPTA's Regional Rail system, but at what cost? As shown in the figure, PATCO's costs, on a per-passenger-trip basis, are one-third of SEPTA's costs. Part of the difference is simply that PATCO's cost of running trains is lower than that of SEPTA, but by far the major reason for the low costs per passenger is the extremely high ridership. Because PATCO's costs per rider are low, subsidies per-passenger-trip are only $0.89 on PATCO, much lower than the per-rider subsidy of $4.37 on SEPTA.

Why would SEPTA management opt for low quality service if it requires higher per passenger subsidies? The answer is that total subsidies per mile of railroad available to SEPTA are less than those for PATCO. Communities along the SEPTA lines receive less than half as much in total transit subsidies as communities along the PATCO line. PATCO's higher subsidies, which allow for higher quality service, have extremely high returns; they generate ridership that is higher by a factor of 10. PATCO's infrastructure is used much more intensively than is SEPTA's.

This does not necessarily imply that policymakers have chosen an unreasonably low level of subsidy for SEPTA. In theory, policymakers should choose a level of subsidy such that the social benefits of attracting an additional rider are just equal to the marginal subsidy costs. If the marginal benefit of an additional transit trip declines rapidly as the number of trips increases, then SEPTA's high subsidy per trip, low ridership regime is appropriate from a social perspective. However, some of the largest social benefits of a transit trip, such as reduction of congestion and pollution, are unlikely to fall rapidly as transit use increases. SEPTA's subsidy level may also be appropriate if the cost of attracting additional riders is very high. However, economies of scale would suggest that the marginal cost of attracting riders is not increasing, and thus the costs per additional rider are probably lower than the current average subsidy per rider.[a]



[a]SEPTA's marginal subsidy cost of attracting an additional rider might be somewhat higher than PATCO's because New Jersey motorists must cross a toll bridge to enter Philadelphia and because communities served by SEPTA have higher incomes. In addition, there may be substantial infrastructure costs in converting the SEPTA commuter rail system to make it capable of operating at significantly higher frequencies.

accurately reflect the fundamental supply and demand conditions.[12]

Diverting scarce resources from markets where the price of gaining an additional rider is low to markets where a high subsidy is required to attract riders necessarily lowers the overall ridership on a transit system. Given a fixed subsidy, maximizing ridership requires that the change in ridership resulting from an increase in subsidy must be equal across markets. In other words, the price that the transit authority pays to attract an additional rider must be the same on all its routes. Otherwise ridership could be increased by shifting subsidies from a market with high costs for an additional rider to a market with low costs for an additional rider. (See *Intrasuburban and Reverse Commuting.*)

REALIZING TRANSIT'S POTENTIAL

An array of national, state, and local policies—including investment in infrastructure, user fees and subsidies, and regulation of land use—shapes the environment in which consumers choose between cars and transit. Changes in these policies could affect transit's future potential. But given the current policy environment, there are three keys to achieving the greatest benefits from transit: a measurable objective, appropriate incentives, and a long-run strategy.

A Measurable Objective. Although publicly subsidized transit authorities face a daunting array of competing demands, not all of them can or should be met. A measurable objective is needed to help transit providers focus resources in areas of high potential and to help policymakers evaluate the performance of transit management. Because most of public transportation's social benefits are linked to high use, management's overriding objective should be to attract the greatest number of riders.

Appropriate Incentives. Another key to realizing transit's potential is providing incentives to management to attract the greatest number of riders. These incentives are a better tool than the common practice of budgetary restraint for ensuring the efficient use of public funds. Because costs per rider tend to fall as transit service increases, excessively tight budgets may result in higher, not lower, costs per rider. If, for example, insufficient subsidies limit transit frequencies to uncompetitive levels, ridership will fall, increasing subsidy per passenger even though total subsidies are lower. On the other hand, if management fails to use its public subsidies to attract the most riders, the full social benefits of transit subsidies will not be achieved. With management incentives tied to ridership objectives, policymakers could more confidently choose the level of public subsidies justified by transit's potential social benefits without being concerned that transit providers are using public funds inefficiently.

Long-Run Strategy. Because markets evolve over time, transit authorities need a long-run strategy to attract riders. Good transit policies can support development that favors public transit; however, poor policies can undermine the very markets for which public transit is most cost effective. A successful strategy will support markets in which transit has a potential competitive advantage and avoid subsidizing locations in which providing transit services is inherently expensive.

The objective of attracting the greatest number of riders using incentives and a long-run strategy may appear simple, but it involves choices that favor some markets over others. Generating consensus about where public transit authorities should focus resources tests the ability of regional leaders to make hard choices for the common good of the region.

[12]On the SEPTA city transit system in 1992, the subsidy per rider varied dramatically from route to route. SEPTA's best route was profitable, with the Authority earning $.08 for each rider carried, while trips on the worst route received a subsidy of $15.88.

Intrasuburban and Reverse Commuting

The rapid increase in suburban employment and intrasuburban commuting has prompted new requests for public transit service in suburban areas. Public transit is often suggested as a means of linking lower income city residents with suburban jobs or as a means of reducing suburban congestion. While these are laudable objectives, public transit is frequently not the answer to the problem. In many suburban markets, the costs to supply transit services are high because destinations are widely dispersed and demand is low, in large part because there is extensive free parking.

A comparison of SEPTA city service with special "reverse commute" services provides a good illustration of the difficulty that transit faces when competing in suburban markets. The figure compares the performance measures for a "typical" SEPTA transit route in the city of Philadelphia with special "reverse commute" routes designed to deliver city people to suburban work sites. Ridership per vehicle hour—the number of people who board a bus or train in an hour—is about 52 on a city route versus only nine on the reverse commute routes. The low ridership on the reverse commute routes results in an extremely high cost per rider of $6.52, compared with a figure of $1.47 on a city transit route. Finally, the subsidy per rider is $3.51 on the reverse commute routes versus $0.63 on the city transit routes. In other words nearly six people could be carried on the city transit routes for the subsidy provided for a single person on the reverse commute route. The subsidies for SEPTA's reverse commute routes are generally borne by companies whose employees use the services, but the numbers illustrate the amount of public subsidies that would be necessary if the costs were not paid by private employers.

While there are almost certainly some large and growing suburban markets where public transit can be competitive, that is not the case in many other markets. Attempts to serve these markets will likely fail. Furthermore, diverting resources to these markets may undermine those in which transit is a viable alternative. For example, companies that expect the public transit agency to subsidize their employees' commutes, regardless of where the companies locate, will have one less incentive to locate near a transit hub. Ultimately, there will be more congestion and less accessibility to employment for residents in older, densely populated areas because transit will become less and less viable over time.