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"Efficiency - Equity - Clarity"

Rail Transit In America

A Comprehensive Evaluation of Benefits

Report Summary

25 October 2004

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Produced with support from the
American Public Transportation Association

Abstract
This report evaluates rail transit benefits based on a comprehensive analysis of transportation system performance in major U.S. cities. It finds that cities with large, well-established rail systems have significantly higher per capita transit ridership, lower average per capita vehicle ownership and annual mileage, less traffic congestion, lower traffic death rates, lower consumer expenditures on transportation, and higher transit service cost recovery than otherwise comparable cities with less or no rail transit service. This indicates that rail transit systems provide economic, social and environmental benefits, and these benefits tend to increase as a system expands and matures. This report discusses best practices for evaluating transit benefits. It examines criticisms of rail transit investments, finding that many are based on inaccurate analysis.

Previously titled *Comprehensive Evaluation of Rail Transit Benefits.*

Introduction

During the last century most North American cities became increasingly automobile oriented (for this analysis "automobile" refers to any personal motor vehicle, including cars, light trucks, vans, SUVs and even motorcycles). Now, the majority of personal travel is by automobile, the majority of transportation resources (money and land) are devoted to automobiles and their facilities, and many communities have dispersed land use patterns that depend on automobile travel for access. The resulting growth in vehicle traffic creates various problems, including congestion, high road and parking facility costs, costs to consumers of owning and operating automobiles, traffic accidents, inadequate mobility for non-drivers, and various environmental impacts.

In recent years many experts and citizens have advocated diversifying our transport systems by increasing support for alternatives modes such as walking, cycling and public transit. To accomplish this many cities are making significant investments in public transit, including busways, light rail and heavy rail systems. There is considerable debate over the merits of these investments. Critics argue they are inappropriate and wasteful.

This study evaluates rail transit benefits based on a comprehensive analysis of transportation system performance in U.S. cities. It uses best available evaluation methods, based on guidance from leading experts and organizations. This analysis takes into account a variety of performance factors, including the amount and type of travel that occurs, congestion costs, road and parking facility costs, consumer costs, accident rates, transit system efficiency and cost recovery, and various other impacts.

This study compares rail and bus transit, identifies the conditions in which each is most appropriate, and discusses the role that each mode can play in an efficient transportation system. It also describes various ways of improving transit service performance in order to increase benefits.

This study evaluates various criticisms of rail transit, including claims that it provides minimal congestion and emission reduction benefits, that it is not cost effective, and that money is better spent on roads, bus service or subsidized cars. It also examines various factors that could offset rail transit benefits, including the possibility that transit oriented development is harmful to consumers, that new rail systems cannot achieve significant benefits, that apparent benefits of rail actually reflect other factors such as city size, and that bus transit can provide equal benefits at less cost.

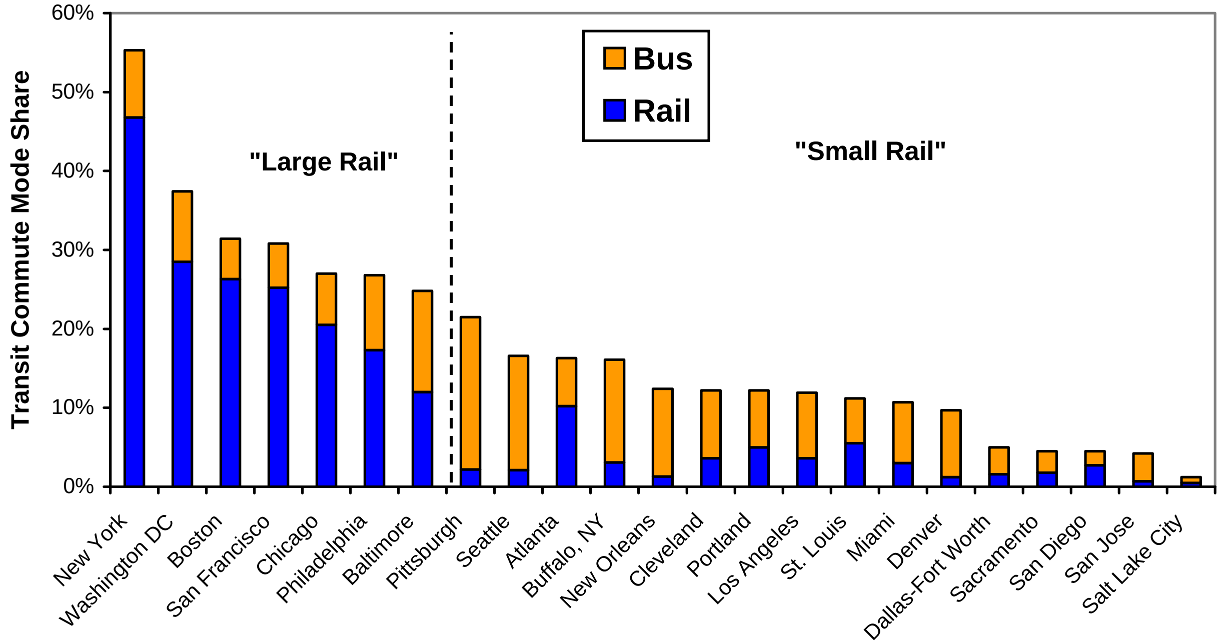
The Analysis

About two dozen U.S. cities have some sort of rail transit service, but most are small and so cannot be expected to significantly effect regional transportation system performance, although they may have significant impacts on a particularly corridor or within a particular area. For this study, U.S. cities are divided into three categories:

- *Large Rail* – Rail transit is a major component of the transportation system.
- *Small Rail* – Rail transit is a minor component of the transportation system.
- *Bus Only* – City has no rail transit system.

Seven cities are classified as "Large Rail," meaning that transit represents more than 20% of total commutes, and more than half of transit passenger-miles are by rail, as illustrated in Figure 1.

Figure 1 **Transit Commute Mode Share**



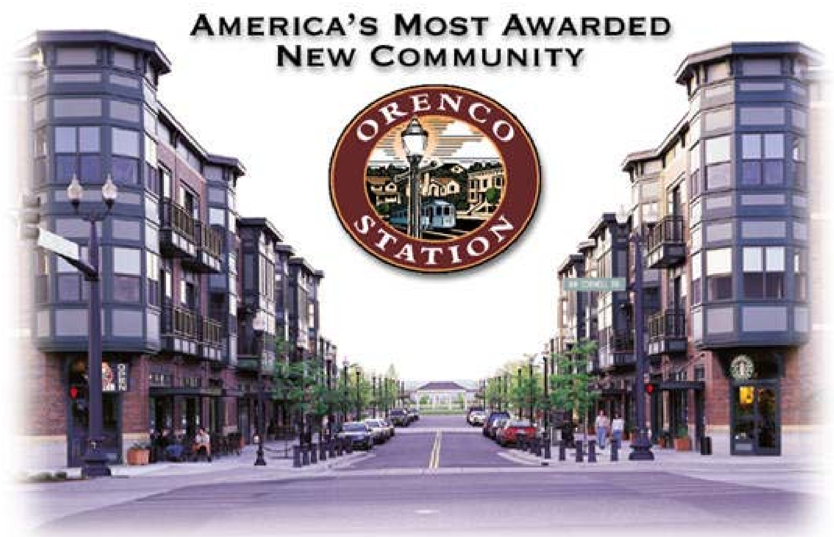
This figure shows the portion of commutes by rail and bus transit. Only a few cities have rail systems large enough to significantly impact regional transportation system performance.

The next section of this report evaluates these different categories in terms of various transportation system performance indicators.

Transit Ridership and Automobile Travel Reductions

A key issue in evaluating transit is the degree to which it attracts riders and substitutes for automobile travel, and therefore reduces traffic problems such as congestion, parking costs and accidents. Rail tends to provide higher quality service than bus transit. Rail is usually more comfortable, faster (particularly if grade separated, so trains are not delayed by congestion) and better integrated into the urban landscape. As a result, rail transit usually attracts more riders within a given area, particularly *discretionary riders* (travelers who could drive but choose to ride transit, also called *choice riders*), and so is more effective than bus transit at reducing automobile trips.

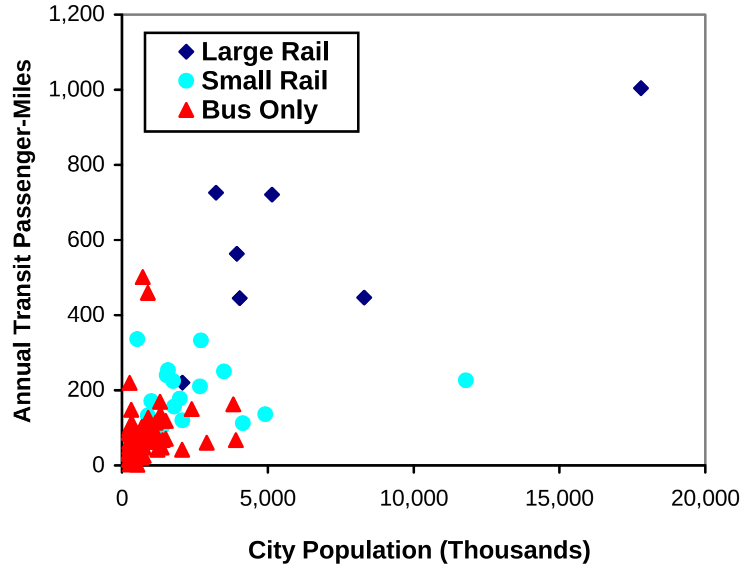
Rail transit tends to leverage additional automobile travel reductions by providing a catalyst for more accessible land use patterns and reduced per capita vehicle ownership. This reflects the impacts of *Transit Oriented Development* (also called *New Urbanism* and *Smart Growth*), which consists of compact, walkable, mixed-use centers. If you live near a rail transit station your neighborhood probably has a variety of shops and services nearby, and pedestrian-friendly streets, so you are more likely to walk for errands such as picking up a video or taking children to school, and your household may own fewer cars than it in a more automobile-dependent location.



Orenco Station in Portland, Oregon is an example of Transit Oriented Development, a medium-density, mixed use, walkable neighborhood located near a rail transit station. Residents tend to own fewer cars and drive less than they would in more automobile-oriented communities.

In other words, rail transit reduces automobile travel in two different ways: directly, when a rail passenger-mile substitutes for an automobile vehicle-mile, and indirectly when it creates more accessible land use and reduces automobile ownership in an area. Although indirect effects are difficult to measure, this and other studies suggest that they are often larger than direct effects. Research indicates that each rail transit passenger-mile represents a reduction of 3 to 6 automobile vehicle-miles.

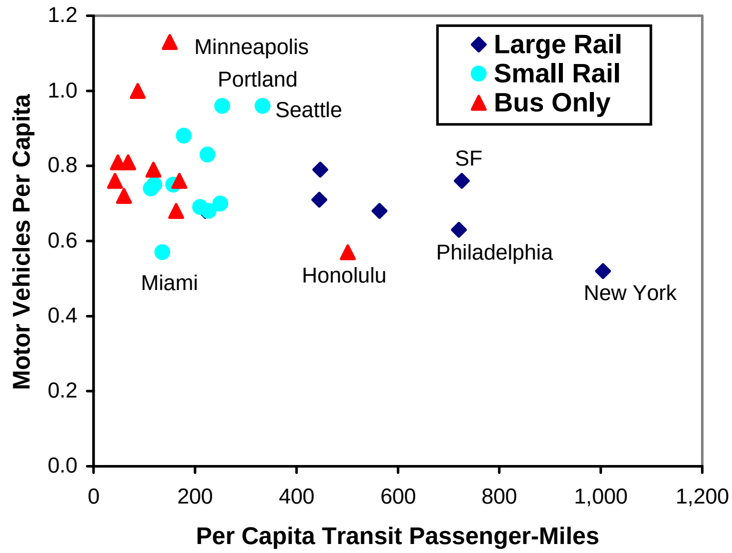
Figure 2 **Per Capita Transit Travel**



This figure shows the relationship between city size and per capita transit ridership. Transit ridership tends to increase with city size. Large Rail cities tend to be located toward the upper-left corner of the graph, indicating higher than average ridership for their population size.

This analysis finds that per-capita transit ridership is far higher in rail transit cities, as illustrated in Figures 2. Annual per capita transit passenger-miles average 589 in Large Rail cities (520 excluding New York), 176 passenger-miles in Small Rail cities, and 118 passenger-miles in Bus Only cities. Although this partly reflects the tendency of transit ridership to increase with city size, cities with rail systems tend to occupy the upper-left area of the graph in Figure 2, indicating high ridership for their population. Large Rail cities have 34.8% transit mode share (30.7% excluding New York), as opposed to 11.0% for Small Rail and 4.5% for Bus Only cities. Transit mode share tends to be even higher for peak-period travel on rail transit corridors and destinations, such as downtowns.

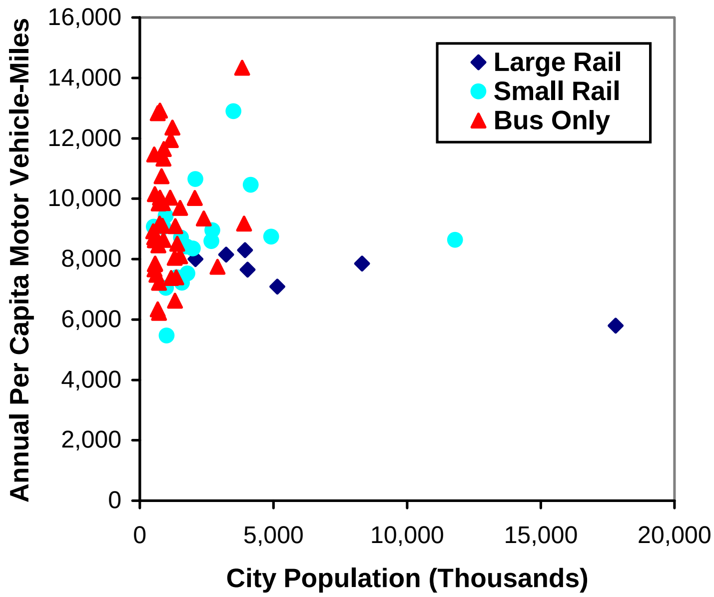
Figure 3 **Per Capita Vehicle Ownership**



Per-capita vehicle ownership tends to decline with increased per-capita transit ridership, and is lower, on average, in Large Rail cities.

Figure 3 shows how per capita vehicle ownership declines with rail transit. In Large Rail cities residents own 0.68 vehicles per capita (0.71 excluding New York), as opposed to 0.77 in Small Rail cities, and 0.80 in Bus Only cities. This reduction in vehicle ownership provides consumer cost savings and helps leverage additional reductions in automobile travel beyond just the passenger-miles shifted from driving to transit, as discussed elsewhere in this report.

Figure 4 **Average Per Capita Annual Vehicle Mileage**



Residents of Large Rail cities tend to drive significantly less than residents of other cities.

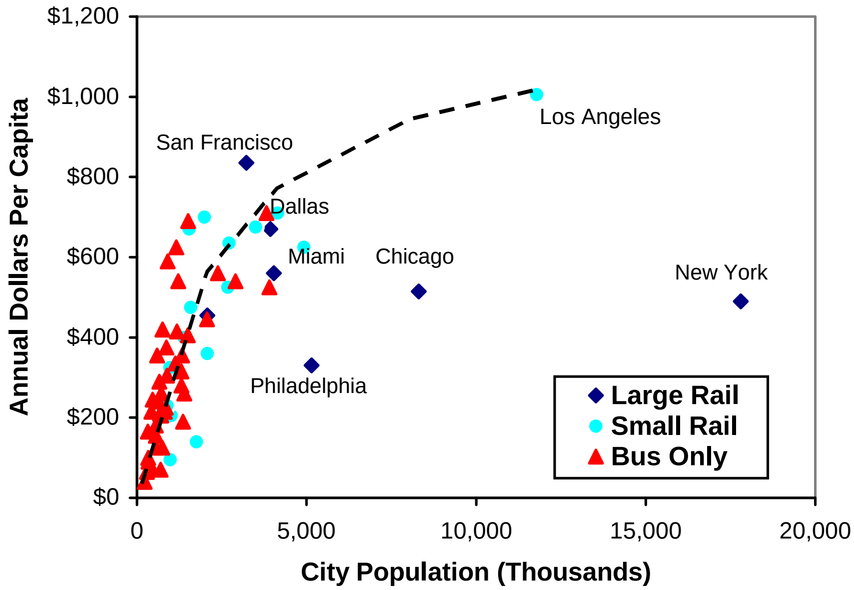
Figure 4 shows average annual per capita vehicle mileage for various cities. Residents of Large Rail cities drive an average of 7,548 vehicle-miles (7,840 excluding New York), residents of Small Rail cities average 8,679 vehicle-miles, and residents of Bus Only cities average 9,506 annual vehicle-miles. Large Rail city residents drive 12% less per year than residents of Small Rail cities, and 20% less than residents of Bus Only cities. This indicates the leverage effect of rail. Residents of Large Rail cities average 470 more transit passenger-miles than Bus Only cities, and drive 1,958 fewer vehicle-miles, a 4:1 ratio. This ratio increases to 5:1 when the analysis is limited to cities with more than 2 million population, indicating that city size by itself does not explain these differences.

Congestion Impacts

Special care is needed to accurately evaluate transit congestion reduction impacts. Traffic congestion tends to increase with city size because there are more vehicles within a given area. Rail transit systems are generally developed as cities grow large enough to experience significant congestion problems, so cities with rail transit tend to have worse congestion than those without, but it is wrong to suggest that rail transit *causes* congestion, or that congestion problems would be as bad if rail transit did not exist.

The Texas Transportation Institute's annual *Urban Mobility Study* is the most commonly-used reference for comparing congestion costs between U.S. cities. It provides seven congestion indicators. Some of these indicators are more appropriate than others for evaluating transit impacts. *Per-capita Congestion Cost* is a better indicator of transit congestion reduction benefits, since it accounts for time savings that result from shifts to alternative modes and more accessible land use patterns. Measured in this way, Large Rail cities have substantially less congestion than other comparable size cities, as illustrated in Figure 5. For cities with Small Rail or Bus Only transit systems, traffic congestion increases substantially with city size, but cities with Large Rail transit systems do not follow this pattern.

Figure 5 **Congestion Costs**

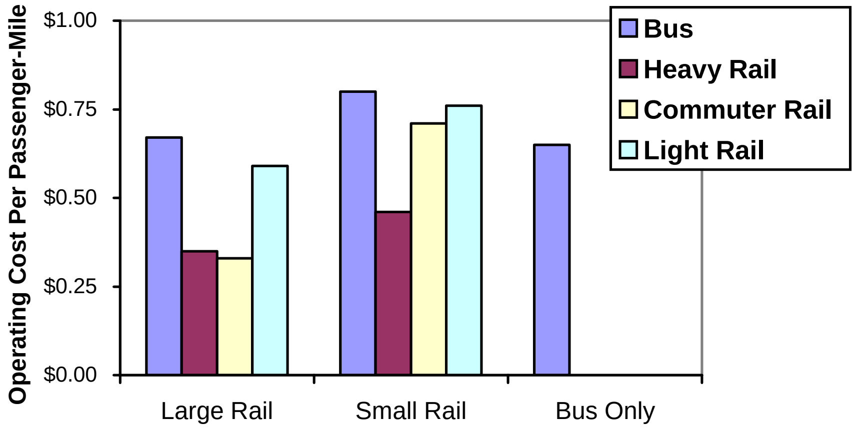


In Bus Only and Small Rail cities, traffic congestion costs tends to increase with city size, as indicated by the dashed curve. But Large Rail cities do not follow this pattern. They have substantially lower congestion costs than comparable size cities. As a result, New York and Chicago have about half the per capita congestion delay as Los Angeles.

Cost Effectiveness

Operating costs per transit passenger-mile are generally lower in Large Rail cities than in Small Rail cities, and heavy and commuter rail costs are lower than light rail and bus costs, as illustrated in Figure 6.

Figure 6 **Average Operating Cost By Mode and City Category**



Transit operating costs tend to be lower in Large Rail cities than Small Rail cities. Bus Only cities have slightly lower bus operating costs, probably due to lower wages and less congestion.

Rail transit systems also tend to have greater cost recovery, that is, a larger portion of operating costs are paid by fares. Transit cost recovery (including both rail and bus services) averages 38% for Large Rail systems (36% excluding New York), 24% for Small Rail systems, and 21% for Bus Only systems.

Road and Parking Cost Savings

To the degree that transit substitutes for automobile travel, it reduces road and parking facility costs. Table 1 illustrates an estimate of these costs and savings from rail.

Table 1 **Estimated Road and Destination Parking Cost Savings**

	Large Rail	**Small Rail**	**Totals**
Transit Passenger-Miles (millions)	32,107	8,957	
Portion of Transit Passenger-Miles by Rail	80%	31%	
Portion of transit trips that substitute for a car trip.	60%	50%	
Avoided Roadway Costs (cents per veh.-mile)	$0.50	$0.25	
Total Roadway Cost Savings (millions)	*$7,697*	*$349*	*$8,046*
Avoided Parking Costs (cents per vehicle-mile)	$0.40	$0.30	
Total Parking Cost Savings (millions)	*$6,158*	*$419*	*$6,577*
Total Road and Parking Savings (millions)	**$13,855**	**$768**	**$14,623**

This table shows estimated road and parking cost savings from automobile travel shifted to transit.

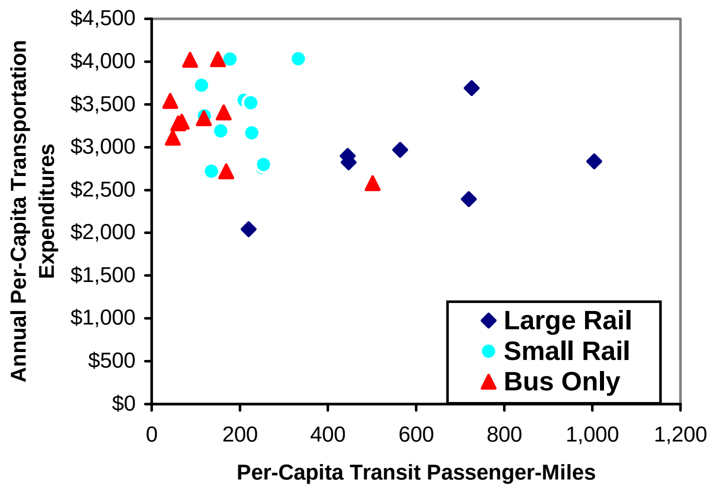
These estimates are conservative because they do not account for the additional savings from the automobile trip reductions leveraged by rail transit, due to reductions in vehicle ownership and improved accessibility due to transit oriented development. Residents in such communities walk rather than drive for more local errands, providing additional road and parking cost savings for those trips.

In addition, reduced vehicle ownership provides residential parking cost savings. Rail transit city residents would need to park 6.1 million more vehicles if they owned automobiles at the same rate as Bus Only city residents. At $800 per space, residential parking cost savings for these vehicles total $4.8 billion. Total road and parking cost savings from rail therefore total more than $20 billion dollars annually, substantially more than total rail transit subsidies.

Consumer Financial Impacts

Large Rail city residents spend an average of $2,808 on vehicles and transit, compared with $3,350 in Small Rail cities, and $3,332 in Bus Only cities, as illustrated in Figure 7. Large Rail city residents save $22.6 billion in total compared with what consumers spend on transportation in Bus Only cities.

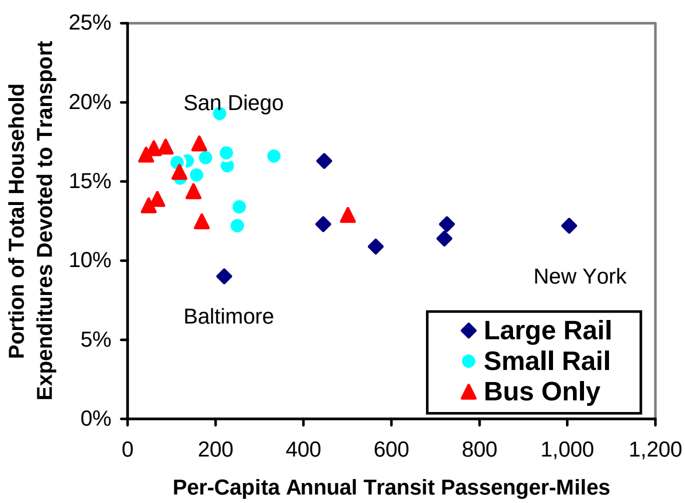
Figure 7 **Transportation Expenditures** (BLS, 2003)



Per-capita transportation expenditures tend to decline with increased transit ridership.

Figure 8 compares transportation as a percentage of household expenditures, which takes into account the higher wages in large cites. Large Rail city residents devote just 12.0% of their income to transportation (this does not change if New York is excluded), compared with 15.8% in Small Rail cities, and 14.9% in Bus Only cities.

Figure 8 **Percent Transportation Expenditures**

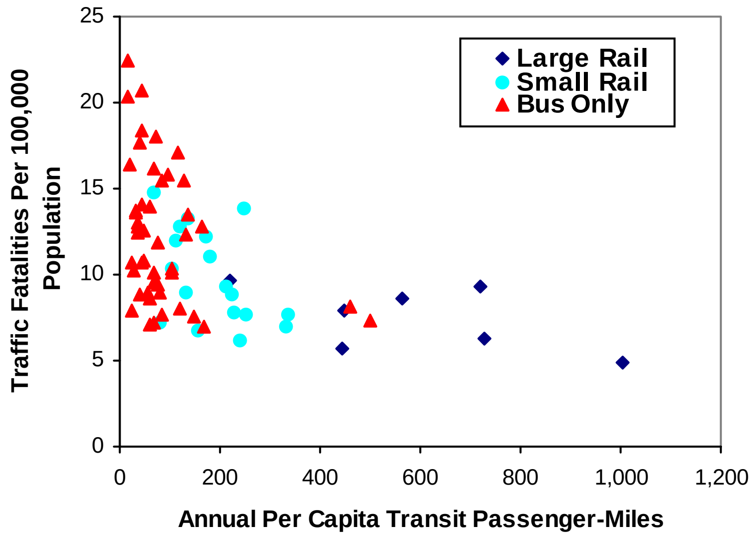


The portion of total household expenditures devoted to transportation (automobiles and transit) is lower, on average, in Large Rail cities.

Safety Impacts

Rail transit cities have significantly lower per capita traffic death rates, as illustrated in Figure 9. Large Rail cities average 7.5 traffic fatalities per 100,000 population (7.9 excluding New York), Small Rail cities average 9.9, and Bus Only cities average 11.7, a 40% higher rate. If Large Rail cities had the same fatality rate as Bus Only cities there would be 251 more annual traffic deaths, plus increased disabilities, injuries and property damages. This represents $5.6 billion in annual savings, based on USDOT recommended values for valuing crash reduction benefits.

Figure 9 **Traffic Deaths**



Per capita traffic fatalities (including automobile occupants, transit occupants and pedestrians) tends to decline with increased transit ridership. Rail cities tend to have lower traffic fatalities.

Energy and Emission Reductions

Rail transit can provide substantial energy conservation and emission reduction benefits. Rail travel consumes about a fifth of the energy per passenger-mile as automobile travel, due to its high mechanical efficiency and load factors. Electric powered rail produce minimal air and noise emissions. Rail provides even greater energy and emission reduction benefits when it leverages additional reductions in vehicle travel.

Conclusions

There is an important and interesting debate over the value of rail transit compared with other transportation options. To accurately assess rail transit benefits it is necessary to use a comprehensive analysis framework. This study applies the best current practices for evaluating rail transit benefits.

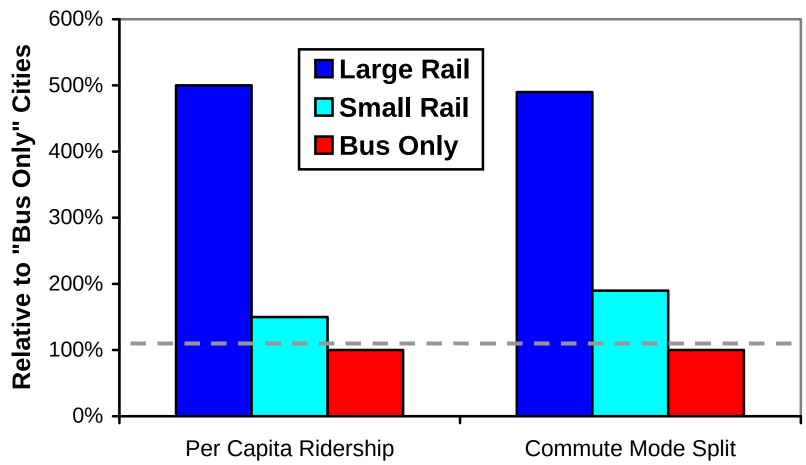
Table 2 **Transportation Performance Comparison**

	Definition	Large Rail	Small Rail	Bus Only
Ridership	Annual Passenger-Miles Per Capita	589	176	118
Commute Mode Split	Portion of Commute Trips By Transit	13.4%	5.2%	2.7%
Vehicle Mileage	Per Capita Average Vehicle-Mileage	7,548	8,679	9,506
Vehicle Ownership	Average Vehicles Per Capita	0.68	0.77	0.80
Traffic Safety	Traffic Deaths Per 100,000 Population	7.5	10.0	11.7
Congestion	Per Capita Annual Hours of Congestion Delay	28	24	20
Transport Expenditures	Avg. Annual Consumer Expenditures on Transport	$2,808	$3,350	$3,255
Portion of Income	Average Portion of Income Devoted to Transportation	12.0%	15.8%	14.9%
Operating Costs	Transit Operating Costs Per Passenger-Mile	$0.42	$0.63	$0.63
Transit Cost Recovery	Portion of Transit System Costs Covered By Fares	38%	23%	24%

This table summarizes the results of this study.

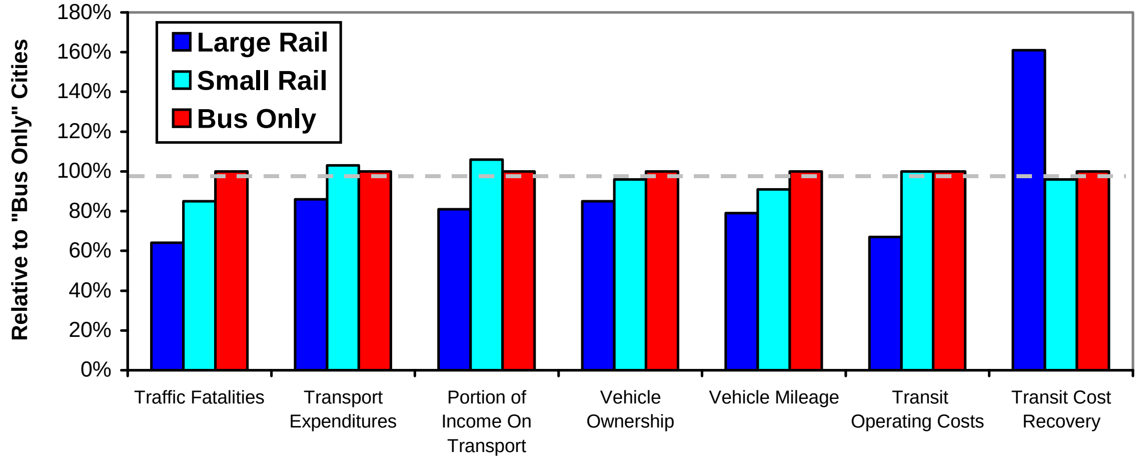
For this study, U.S. cities were divided into *Large Rail* (rail serves a significant portion of local travel), *Small Rail* (rail serves a minor portion of local travel), and *Bus Only* (city has no rail transit system). This analysis indicates that Large Rail cities have significantly superior transport system performance, as summarized in Table 2 and illustrated in figures 10 and 11.

Figure 10 **Transit Ridership and Commute Mode Split Comparison**



This graph shows the far higher rates of transit ridership and transit commute mode split in "Large Rail" cities. The dashed line at 100% indicates "Bus Only" city values.

Figure 11 **Transportation Performance Comparison**



This graph compares different categories of cities by various performance indicators. The dashed line at 100% indicates "Bus Only" city values.

Compared with Bus Only cities, Large Rail cities have:

- 400% higher per capita transit ridership (589 versus 118 annual passenger-miles).
- 887% higher the transit commute mode split (13.4% versus 2.7%).
- 36% lower per capita traffic fatalities (7.5 versus 11.7 deaths per 100,000 residents).
- 14% lower per capita consumer transportation expenditures ($448 average annual savings), despite residents' higher incomes.
- 19% smaller portion of household budgets devoted to transport (12.0% versus 14.9%).
- 21% lower per capita motor vehicle mileage (1,958 fewer annual miles).
- 33% lower transit operating costs per passenger-mile (42¢ versus 63¢).
- 58% higher transit service cost recovery (38% versus 24%).

Many of these benefits result from rail's ability to create more accessible land use patterns and more diverse transport systems, which reduce per capita vehicle ownership and mileage. These additional benefits should be considered when evaluating rail transit.

Rail transit does have a cost. Rail transit requires about $12.5 billion annually in public subsidy, which averages about $90 additional dollars annually per rail transit city resident compared with Bus Only cities. These extra costs are offset several times over by economic benefits, including $19.4 billion in congestion costs savings, $8.0 billion in roadway cost savings, $12.1 billion in parking cost savings, $22.6 billion in consumer cost saving, and $5.6 billion in reduced crash damages.

From a household's perspective, rail transit provides a positive return on investment. Direct transportation cost savings average about $450 annually per capita. Rail transit tends to increase regional employment, business activity and productivity. It can contribute to urban redevelopment. Property values increase near rail stations. Quality transit improves mobility for non-drivers, reduces chauffeuring responsibilities for drivers, improves community livability and improves public health.

When critics conclude that rail transit is ineffective and wasteful, the failure is often in their analysis. Either from ignorance or intention, critics fail to use best practices for transit evaluation. Their statistical analysis tends to be flawed and biased. They ignore many benefits of rail transit, and understate the full costs of travel by other modes under the same conditions. They use inaccurate information. These errors and omissions violate basic evaluation principles and significantly distort results. Critics claim that rail transit support is limited to "Pork Lovers, Auto Haters, and Nostalgia Buffs." This is untrue. There are many reasons to favor rail development, and community support tends to increase after rail systems are established, indicating that users consider them successful.

This study indicates that rail transit is particularly important in large, growing cities. Large cities with well established rail systems are clearly advantaged in terms of congestion costs, consumer costs and traffic crash rates compared with cities that lack such systems. Cities with newer and smaller systems have not yet achieved the full impacts, but, if these rail systems continue to develop, their benefits should increase for decades, and so are a valuable legacy for the future.

Critics raise some valid issues. In particular, rail transit service has high fixed costs, and many benefits depend on reducing car travel, so it is important to attract riders, particularly travelers how would otherwise drive. This requires quality services that responds to user preferences, and is implemented with support strategies such as rider incentives and transit oriented development. Rail systems experience significant network effects, that is, the more complete the system, and the more support it receives, the more useful it is, the more ridership it attracts, and the more it helps achieve transportation and land use planning objectives. For this reason, the best way to address most criticisms is to expand rail system and increase ridership support.

This study compares bus and rail transit and discusses their appropriate applications. This is not a debate over which is best overall, since each has an important role to play in the nation's transportation system. It is up to individual communities to determine the combination of transit options that best meets its needs. This study does not suggest that rail service should be provided everywhere. However, on major corridors where road and parking facility are costly to construct and transit demand is high, rail transit can be the most cost effective and overall beneficial way to improve urban transportation.

References

This summarizes the full report, "Rail Transit in America: Comprehensive Evaluation of Benefits" (www.vtpi.org/railben.pdf). Data and analysis used in this report is from the "Transit Performance Spreadsheet," (www.vtpi.org/transit.xls).