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Rail Transit In America

A Comprehensive Evaluation of Benefits

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Abstract

This study 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.

A condensed version of this report was published as, "Impacts of Rail Transit on the Performance of a Transportation System," *Transportation Research Record 1930*, Transportation Research Board (www.trb.org), 2005, pp. 23-29.

Contents

Executive Summary

This study investigates the impacts of rail transit on urban transportation system performance. For this study, U.S. cities and their urban regions were divided into three categories:

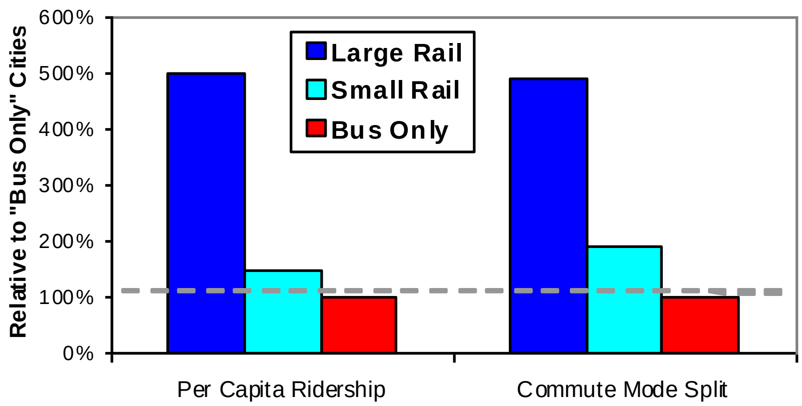
1. *Large Rail* – Rail transit is a major component of the transportation system.
2. *Small Rail* – Rail transit is a minor component of the transportation system.
3. *Bus Only* – City has no rail transit system.

When these groups are compared, Large Rail cities are found to have significantly better transport system performance. Compared with Bus Only cities, Large Rail cities have:

- 400% higher per capita transit ridership (589 versus 118 annual passenger-miles).
- 887% higher transit commute mode share (13.4% versus 2.7%).
- 36% lower per capita traffic fatalities (7.5 versus 11.7 annual deaths per 100,000 residents).
- 14% lower per capita consumer expenditures on transport ($448 average annual savings).
- 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%).
- Improved fitness and health (since most transit trips have walking or cycling links, so transit travelers are much more likely to achieve physical activity targets than motorists).
- More money circulating in local economies (since transit users spend significantly less on vehicles and fuel, and tend to spend the savings on other goods with more local input).

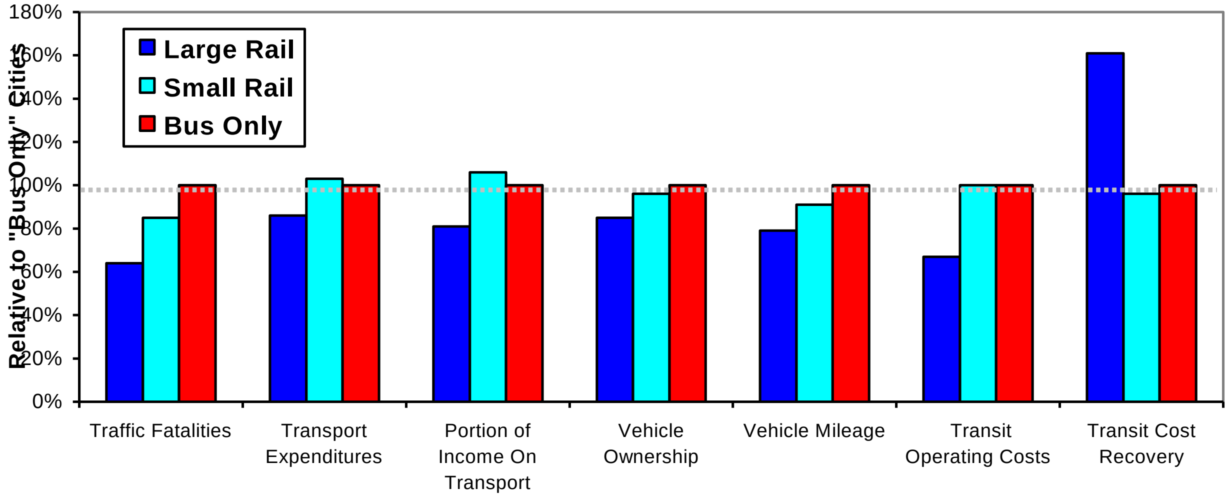
Figures ES-1 and ES-2 illustrate these benefits.

Figure ES-1 **Transit Ridership and Commute Mode Share Comparison**



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

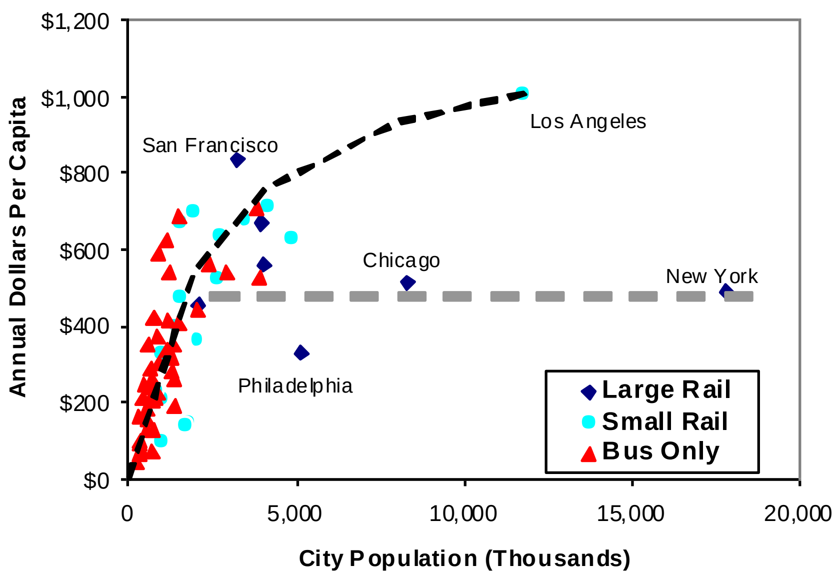
Figure ES-2 **Transportation Performance Comparison**



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

These benefits cannot be attributed entirely to rail transit. They partly reflect the larger average size of Large Rail cities. But taking size into account, cities with large, well-established rail transit systems still perform better in various ways than cities that lack rail systems. These benefits result from rail's ability to help create more accessible land use patterns and more diverse transport systems.

Figure ES-3 **Congestion Costs**



In 'Bus Only' and 'Small Rail' cities, congestion costs tend 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 of Los Angeles.

Although Large Rail cities have higher congestion costs, this occurs because congestion tends to increase with city size. Taking city size into account, rail transit turns out to significantly reduce per capita congestion costs, as indicated in Figure ES-3. Matched pair analysis indicates that Large Rail cities have about half the per capita congestion costs as other comparable size cities.

U.S. rail transit services require about $12.5 billion annual public subsidy (total capital and operating expenses minus fares), about an extra $90 per Large Rail city resident. However, economic benefits more than repay these subsidies: rail transit services are estimated to provide $19.4 billion in annual congestion cost savings, $8.0 billion in roadway cost savings, $12.1 billion in parking cost savings, $22.6 billion in consumer cost savings, and $50 billion in traffic accident cost savings. Rail transit also tends to provide economic development benefits, increasing business activity and tax revenues. It can be a catalyst for community redevelopment. Additional, potentially large benefits include improved mobility for non-drivers, increased community livability and improved public health.

This study critiques studies which imply that rail transit is ineffective. It finds that their analysis is often incomplete, inaccurate, and biased. It 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.

This study indicates that rail transit is particularly important in large, growing cities. Large cities that lack well-established rail systems are clearly disadvantaged compared with large cities that do in terms of congestion costs, consumer costs and accident risk. Rail transit can be a cost effective investment in growing cities, provided it is supported with appropriate transport and land use policies. Large cities with newer and smaller rail systems have not yet achieved the full potential benefits of rail transit, but, if their rail systems continue to develop with supportive public policies, their benefits should increase over time.

This analysis does not mean that every rail transit project is cost-effective, or that rail is always better than bus or highway improvements. It attempts to provide a fair and balanced evaluation of the advantages and disadvantages of each mode, and identify situations in which each is most appropriate. This study concludes that rail transit provides significant benefits, particularly if implemented with supportive transport and land use policies. In many situations, rail transit is the most cost effective way to improve urban transportation.

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 automobile-dependent land use patterns that provide poor access to non-drivers. 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. To accomplish this many cities[1] are investing in public transit improvements, including rail transit system expansion. 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 transport system performance in U.S. urban regions. It uses best available evaluation methods, based on guidance from leading experts and organizations (FTA 1998; Hale 2011; HLB 2002; Kenworthy and Laube 2000; Kittleson & Associates 2003; Litman 2004a; MKI 2003; Phillips, Karachepone and Landis 2001). This analysis takes into account various 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. The analysis and results are consistent with similar studies performed in other parts of the world (Kenworthy 2008).

This study compares rail and bus transit, identifies the conditions in which each is most appropriate, discusses the role each can play in an efficient transport system, and describes ways of improving transit service quality to increase benefits. Although ostensibly about rail transit, this study is really about high quality public transit that attracts a significant amount of *discretionary travel* (travel that would otherwise be by automobile) and provides a catalyst for transit oriented development (more compact, mixed, multi-modal development around transit stations), thereby leveraging reductions in residents' vehicle ownership and use. In theory, high quality bus transit could also have these leverage effects, although to date only rail systems have achieved this at a regional scale in North America.

This study also 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.

[1] The term *city* in this report generally refers to a major central city and its surrounding urban region.

The Analysis

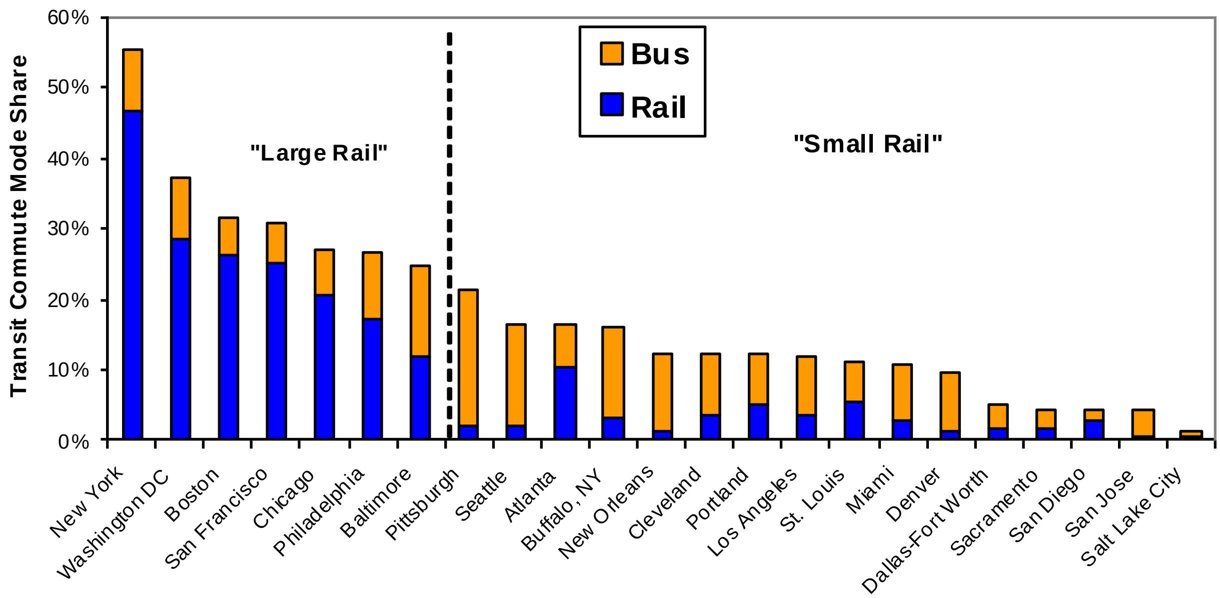
This section describes the evaluation methodologies. Analysis data are available in the "Transit Evaluation Spreadsheet" (www.vtpi.org/transit.xls). Beyond DC (www.beyonddc.com), provides maps of these cities. The " Millennium Cities Database" (Kenworthy and Laube 1999 and 2000) provides similar analysis of major cities throughout the world.

About two dozen U.S. cities have some sort of rail transit system, but most are small and so cannot be expected to significantly affect regional transportation performance, although they may have significant impacts on a particular corridor or district. For this study, U.S. cities and their metropolitan regions 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 more than 20% of central city commutes are by transit, and more than half of transit passenger-miles are by rail, as Figure 1 illustrates.

Figure 1 **Transit Commute Mode Share** (FTA 2001)



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

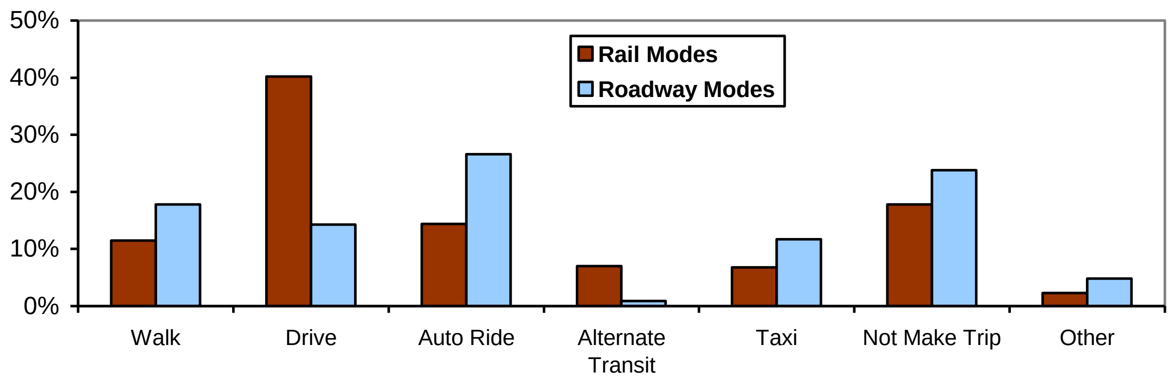
The next section evaluates the transportation system performance of these cities. Because Large Rail cities are relatively large, most comparisons include just the 50 largest cities to avoid skewing results with numerous small cities, and results are provided both including and excluding New York City, since New York is unique in the U.S.

Increased Transit Ridership and Reduced Vehicle Travel

An important factor in transit evaluation is the degree to which a particular policy or program increases transit ridership and reduces overall vehicle travel, thereby reducing traffic problems such as congestion, parking costs and accidents.

Rail transit tends to provide relatively high service quality; it is usually more comfortable, faster (particularly if grade separated), better integrated with other modes (walkable station areas, bike storage, park-and-ride facilities, and service to intercity bus stations and airports). Rail transit tends to leverage additional vehicle travel reductions by stimulating *Transit Oriented Development* (also called *New Urbanism* and *Smart Growth*), which consists of compact, mixed-use, multi-modal neighborhoods (TCRP 2004; Dittmar and Ohland 2004). Households in such areas tend to own fewer vehicles, drive less and use alternative modes more. As a result, rail transit usually attracts more riders within a given area, particularly *discretionary riders* (travelers who could drive, also called *choice riders*), and so tends to reduce per capita vehicle travel more than bus transit (Henry and Litman 2006; Lane 2008; CTS 2009a; Freemark 2010).

Figure 2 **Alternative Travel Option** (APTA 2007, Table 20)



If transit were unavailable, more than half of rail transit travelers would travel by automobile.

More than half of rail passengers would otherwise travel by automobile as a driver or passenger (either as a *rideshare passenger* in a vehicle that would make the trip anyway, or a special *chauffeured* trip that increases vehicle travel), a higher rate than bus transit.

Table 1 **Mode Shifts By New Transit Users** (Pratt 1999, Table 9-10)

Riders Attracted By Increased Bus Frequency		Riders Attracted By Increased Commuter Rail Frequency	
Prior Mode	Percentage	Prior Mode	Percentage
Own Car	18-67%	Own Car	64%
Carpool	11-29%	Carpool	17%
Train	0-11%	Bus	19%
Taxi	0-7%		
Walking	0-11%		

Rail improvements attract more travelers who would otherwise drive than bus improvements.

Table 2 **Demand Characteristics By Transit Mode** (CTS 2009a)

Transit Service	Definition	Type of Rider	How Transit is Accessed	Trip Characteristics
Light-Rail Transit	Hiawatha Line from downtown Minneapolis to its southern suburbs	Mostly (62%) choice	Balanced between bus, walking, and park and ride	Home locations spread throughout the region; the average rider lives more than three miles from the line.
Express Bus	Connects suburbs and downtowns	Primarily choice (84%)	About half park-and-ride (48%)	Home locations clustered at the line origin
Express Bus	Express routes with coach buses	Almost exclusively choice (96%)	Mostly park and ride (62%)	Home locations clustered at the line origin
Local Bus	Serves urban and suburban areas with frequent stops	Mostly captive (52%)	Nearly all bus or walk (90%)	Home locations scattered along route; most riders live within a mile of the bus line

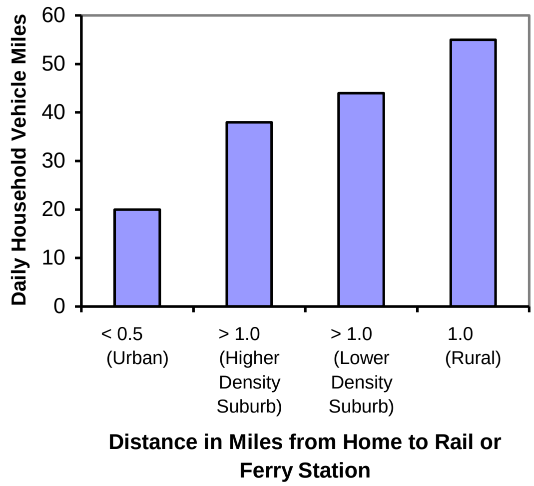
Rail transit tends to attract more "choice" riders (discretionary transit users who could drive).

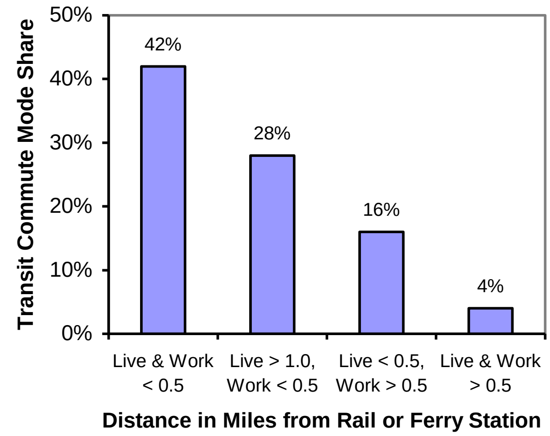
Several studies indicate that TOD can significantly reduce per capita automobile travel (Pushkarev and Zupan 1977; Cervero, et al. 2004; Evans and Pratt 2007; Gard 2007; Xie 2012). Residents, employees and customers in such areas tend to own fewer vehicles, make fewer vehicle trips, and rely more on alternative modes than in more automobile-oriented areas (Cambridge Systematics 1994; Gard 2007; Liu 2007). These impacts can be durable; many older urban neighborhoods that developed along streetcar lines retain transit oriented features decades after their rail services discontinue.

For example, Goldstein (2007) found that household located within walking distance of a rail transit stations drive 30% less on average than if located in less transit-accessible locations. A study of California transit-oriented development travel characteristics found that California transit station area residents are approximately five times more likely to commute by transit than average workers in the same city (Lund, Cervero and Willson 2004). Office workers within 1/2 mile of rail transit stations to have transit commute shares averaging 19% as compared to 5% regionwide. Average transit share for residents within 1/2 mile of the station was 27% compared to 7% for people living between 1/2 mile and 3 miles of the station.

Gard (2007) found that TOD typically increases per capita transit ridership 2-5 times and reduces vehicle trip generation 8% to 32% compared with conventional development. Automobile travel declines and public transit travel increases as households locate closer to San Francisco region rail and ferry terminals drive, as indicated in Figures 3a and 3b. Arrington, et al. (2008), found that Transit-Oriented Developments generate much less (about half) the automobile trips as conventional, automobile-oriented development. Liu (2007) used National Household Travel Survey and Census data to measure how various geographic and household characteristics affect household vehicle travel and fuel consumption. The results indicate that, holding other factors constant, households in regions with rail transit systems (including small and large systems) drive 6% fewer annual miles and consume 11% less fuel on average than otherwise comparable households in regions that lack rail.

Figures 3a and 3b **Transit Accessibility Impacts on Travel** (MTC 2006)





Automobile travel decreases and transit commute mode share increases with proximity to rail and ferry stations.

In other words, rail transit reduces automobile travel in two different ways: *directly* when a traveler shifts a trip from automobile to rail, and *indirectly* when it creates more accessible land use and reduces automobile ownership in an area. These indirect impacts can be large. Research summarized in Table 3 indicates that each rail transit passenger-mile leverages 1.4 to 9 automobile vehicle-miles reduced (also see Neff, 1996, and Newman and Kenworthy, 1999, p. 87). This study finds similar results.

Table 3 **Transit VMT Reduction Leverage Effects** (Holtzclaw 2000; ICF 2008 & 2010)

Study	Cities	Veh.-Mile Reduction Per Transit Pass.-Mile	
		Older Systems	Newer Systems
Pushkarev-Zupan	NY, Chicago, Phil, SF, Bost, Clev.	4	
Newman-Kenworthy	Bost., Chicago, NY, SF, DC	2.9	
Newman-Kenworthy	23 Developed/country cities	3.6	
Holtzclaw, 1991	San Francisco and Walnut Creek	8	4
Holtzclaw, 1994	San Francisco and Walnut Creek	9	1.4
ICF, 2008	U.S. cities	3-4	
This Study	*130 U.S. cities*	*4.0*	

This table summarizes results from several studies indicating that rail transit leverages indirect vehicle travel reductions. Each transit passenger-mile represents 1.4-9.0 miles of reduced vehicle-miles. This study finds similar results.

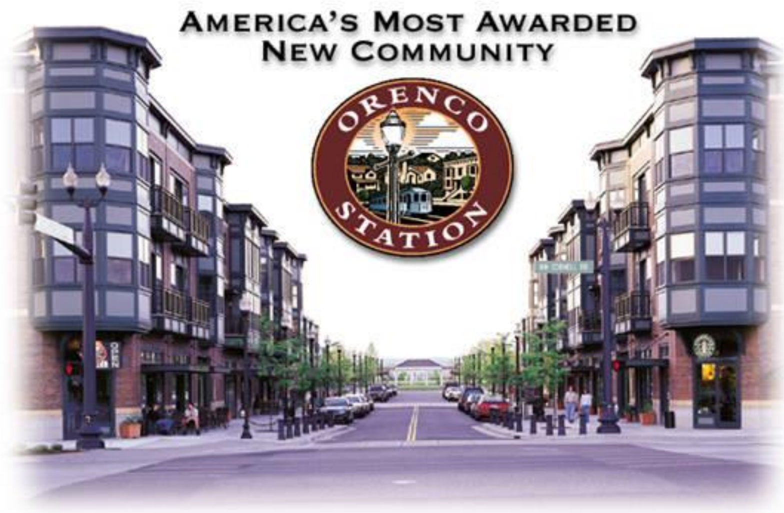
This may partly reflect *self-selection* (also called *sorting*), the tendency of people to choose locations based on their transport abilities and preferences (Cao, Mokhtarian and Handy 2006 & 2008; Cervero 2007). For example, households that, by necessity or preference, drive less and rely more on alternative modes are likely to choose transit-oriented areas. Lower vehicle travel rates in TODs may simply reflect a concentration of such households rather than an overall reduction. Some observed geographic differences in travel behavior reflect these effects (Cervero 2007, estimates up to 40%), so it is inappropriate to assume that households which move from an automobile-oriented to transit-oriented locations necessarily reduce vehicle travel to neighborhood averages. Self-selection reduces local traffic and parking problems (a building or neighborhood will generate less parking demand and fewer trips if it attracts less residents who own fewer cars and drive less), but not regional traffic problems.

However, there is plenty of evidence that only a minor portion of the differences in per capita vehicle ownership and use between transit-oriented and automobile-oriented locations results from self-selection (Cervero and Arrington 2008). That urban regions with rail transit have significantly lower per capita vehicle-travel indicates that impacts are more than sorting between neighborhoods. Before-and-after studies also indicate that residents significantly reduce vehicle ownership and use after moving to transit oriented areas. Of residents moving into Portland, Oregon's new transit oriented developments, 30% reduced their vehicle ownership and 69% increased public transit use (Podobnik 2002; Switzer 2003). The probability of a household owning a motor vehicle decreases by about a third when residents move into such neighborhoods (Hess and Ong 2002).

Bento, et al (2003) found that "rail supply has the largest effect on driving of all our sprawl and transit variables." They concluded that a 10% increase in rail service reduces the probability of driving 4.2% or 40 annual vehicle miles per capita (70 VMT if New York City is included in the analysis), compared with just a one mile reduced by a 10% increase in bus service. That study found a 3.0 elasticity of rail transit ridership with regard to transit service supply (7.0 including New York), indicating significant network effects, that is, the more complete the transit network, the more ridership it receives.

Renne (2005) found that in major U.S. metropolitan regions transit commuting decline dramatically during the last three decades (from 19.0% in 1970 to 7.1% in 2000), but much smaller declines in the 103 TODs within those regions (from 15.1% in 1970 to 16.7% in 2000). TODs in Portland, OR and Washington D.C., which strongly promote transit, experienced significant (58%) ridership growth. Households in TODs also owned fewer vehicles (35.3% of TOD households own two or more vehicles compared with 55.3% in regions overall), although TOD residents have higher average incomes.

Baum-Snow and Kahn (2005) found that, although transit mode share declined in most cities between 1970 and 1990, the decline was much smaller in cities with rail transit. They found that transit commute rates declined 23% (from 30% to 23%) in "old rail" cities (cities that have well-established rail transit systems in 1970), 20% (from 8% to 6%) in "new rail" cities (cities that build rail transit lines between 1970 and 1990), and 60% (5% to 2%) in cities without rail. At a census tract level they found higher rates of transit ridership in residential areas near both old and new rail transit lines, than in similar areas not served by transit. In all three groups declines stopped between 1990 and 2000.



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.

A key question is whether new rail systems can affect transportation and land use patterns sufficiently fast enough to be considered worthwhile investments, since land use patterns generally change slowly. Evidence from some cities indicates they can. As described above, Portland has several new transit oriented neighborhoods where residents tend to own fewer cars, drive less, and use public transit more than they otherwise would. As a result, regional transit ridership is increasing and automobile travel declining relative to the national average, as indicated in Figures 4a and 4b.

Figure 4a & 4b **Portland Transportation Trends**

Figure 4a **Transit Trends** (APTA Data)

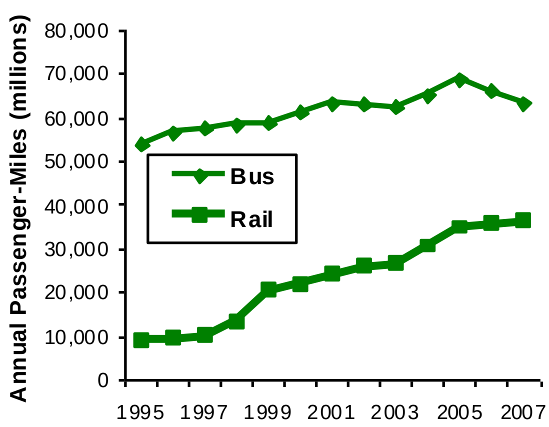
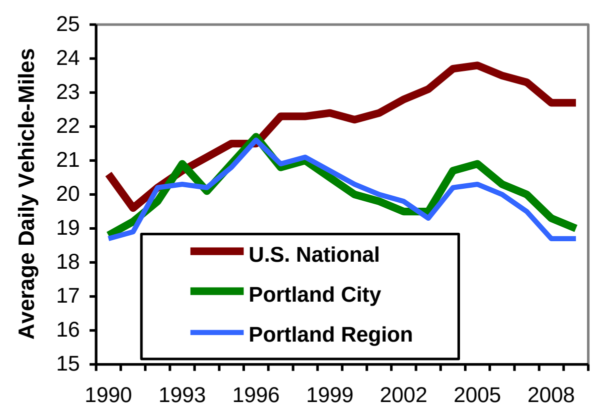


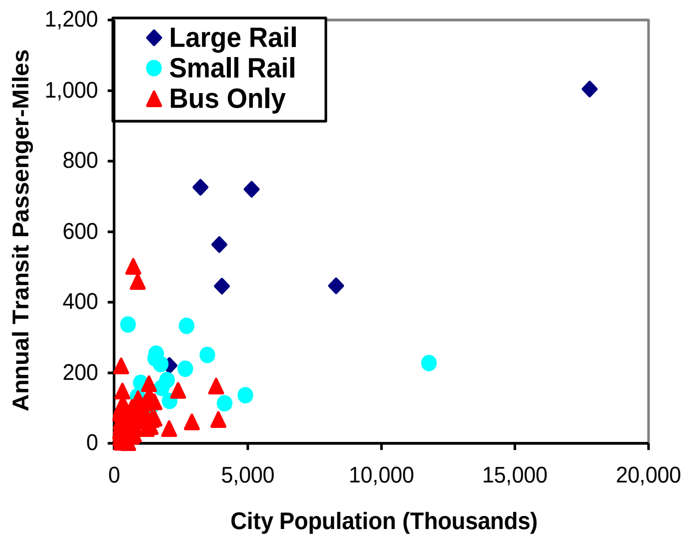
Figure 4b ***VTM Trends*** (Portland Metro data)



Portland region rail transit ridership is growing faster than bus ridership. Per capita vehicle travel is approximately 15% below the national average. (Portland Metro data at http://library.oregonmetro.gov/files//1990-2009_dvmt-portland-us.pdf).

Chatman (2013) argues that many of the factors that reduce vehicle travel in transit-oriented areas, such as more compact and mixed development with reduced parking supply, can be implemented without rail. Bus transit tends to have less impact on land use development and so does less to reduce vehicle travel. Bus transit programs that include incentives such as parking cash-out and location-efficient development have greater effects, but generally less than if implemented with rail transit (VTPI 2004).

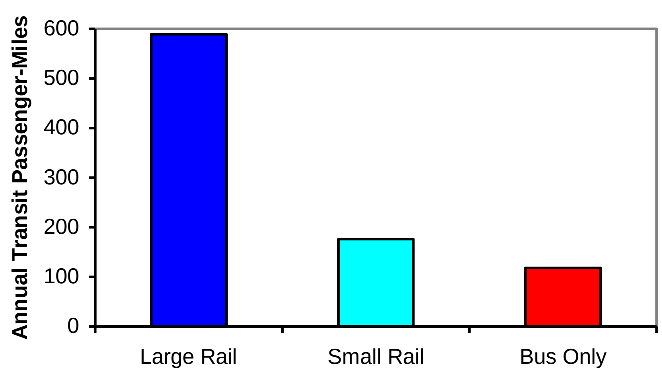
Figure 5 **Per Capita Transit Travel** (FTA 2001)



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 size.

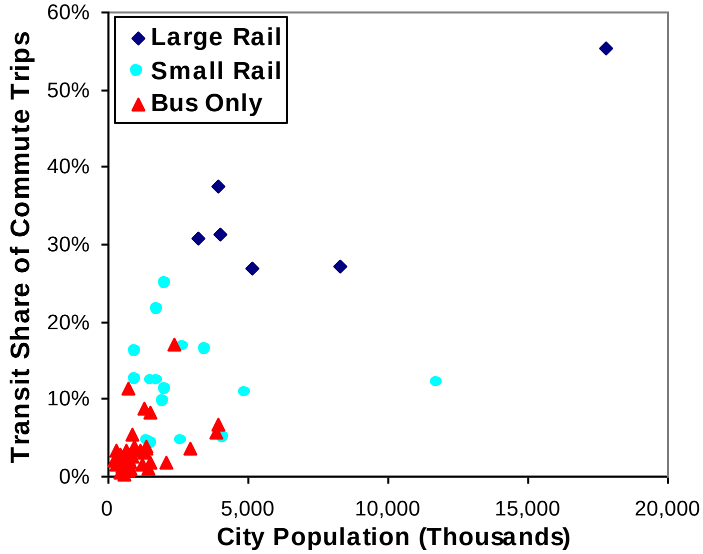
Per-capita transit ridership is far higher in rail transit cities, as illustrated in Figures 5 and 6. Annual per capita transit passenger-miles average 589 in Large Rail cities (520 excluding New York), 176 passenger-miles in Small Rail cities, and 118 passenger-miles in Bus Only cities. Although this 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 5, indicating high ridership for their population.

Figure 6 **Annual Per Capita Transit Ridership** (FTA 2001)



This graph compares average transit ridership between different types of cities.

Figure 7 **Transit Commute Share** (Census 2002)



Rail cities tend to have high transit mode share relative to their size.

Figures 7 and 8 show that Large Rail cities have relatively high transit commute mode shares. Large Rail cities have 34.8% transit mode share (30.7% excluding New York), compared with 11.0% for Small Rail and 4.5% for Bus Only cities. Although this can be partly explained by differences in city size, the graph shows that Large Rail city residents tend to use transit more than in comparable size cities that lack such systems.

Figure 8 **Transit Commute Mode Share**

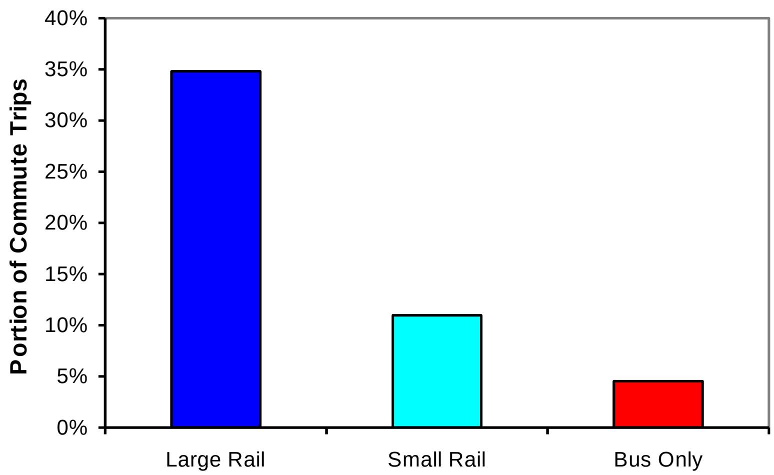
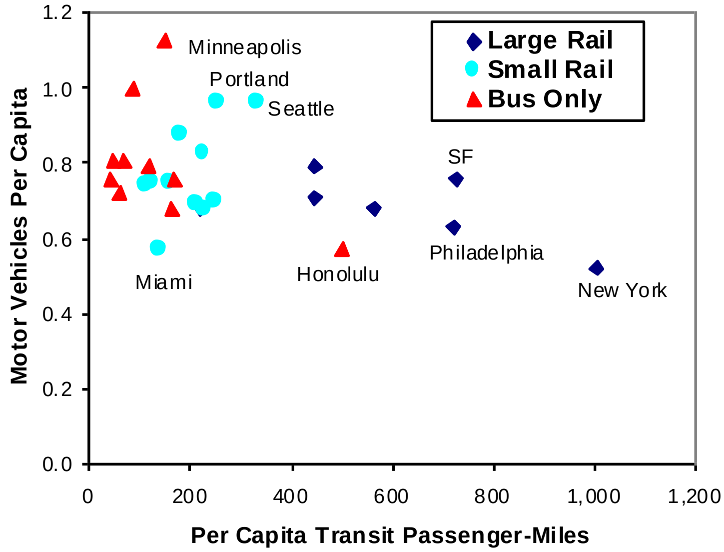


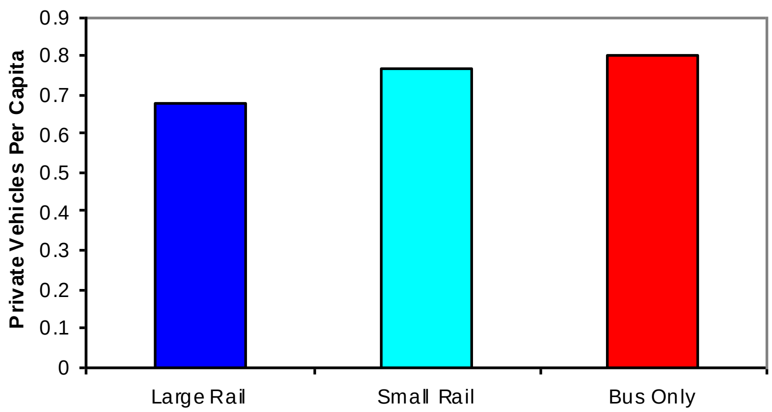
Figure 9 shows that per capita vehicle ownership declines with rail transit. Large Rail city residents own 0.68 vehicles per capita (0.71 excluding New York), as opposed to 0.77 in Small Rail cities, and 0.80 in Bus Only cities, as illustrated in Figure 9. This is particularly notable because Large Rail city residents have higher average incomes than residents of other types of cities, which generally increases vehicle ownership. 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.

Figure 9 **Per Capita Vehicle Ownership** (BLS 2003)



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

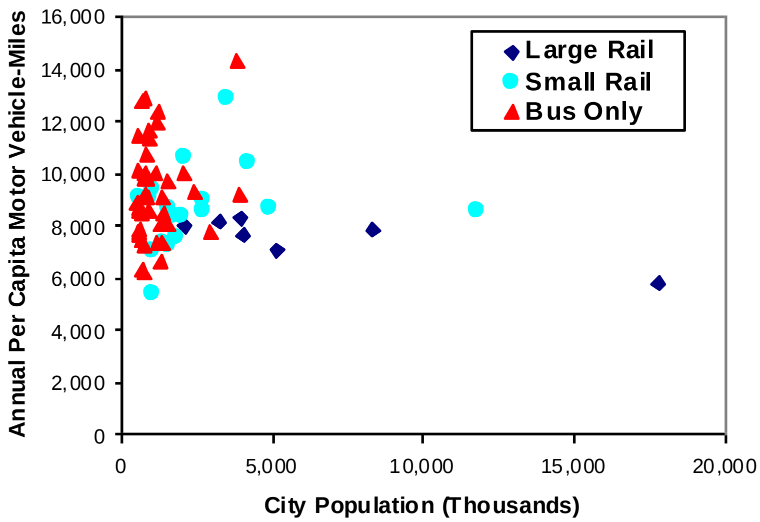
Figure10 **Per Capita Private Vehicle Ownership**



Residents of Large Rail cities tend to own fewer motor vehicles than residents of other cities.

Figure 11 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, as illustrated in Figure 11.

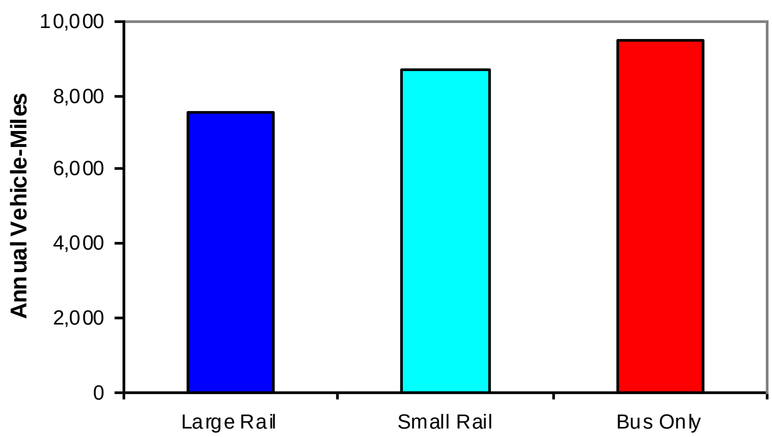
Figure 11 **Average Per Capita Annual Vehicle Mileage** (FHWA 2002, Table 71)



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

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 does not explain these differences.

Figure 12 **Annual Per Capita Vehicle-Miles**



Residents of Large Rail cities drive about 20% less per year than residents of cities that lack rail transit, despite their higher average annual incomes which normally increases vehicle travel.

Congestion Impacts

Traffic congestion costs consist of incremental delay, stress, vehicle operating costs and pollution that a vehicle imposes on other road users. Congestion reduction is a primary transportation improvement objective. Special care is needed to accurately evaluate transit congestion reduction impacts ("Congestion Costs," Litman 2009). Traffic congestion tends to increase with city size, and since rail transit systems are generally developed as cities grow large and experience severe congestion, cities with rail transit tend to have worse congestion than those without. However, it is wrong to conclude that rail transit *causes* congestion or that congestion problems would be as severe without rail.

Congestion is a non-linear function: once a roadway reaches capacity even a small reduction in volumes can significantly reduce delays. For example, a 5% reduction in peak-hour traffic volumes on a road at 90% capacity can reduce delay by 20% or more. Transit can provide significant congestion reduction benefits, even if it only carries a small portion of total regional travel, because it offers an alternative on the most congested corridors. Reducing just a few percent of vehicles on such roads can significantly reduce total regional congestion costs.

Congestion reduction benefits can be difficult to evaluate because urban traffic tends to maintain equilibrium: traffic volumes grow until congestion delays discourage additional peak-period trips. Grade-separated transit acts as a pressure-relief value, reducing the point of congestion equilibrium, as described in the box below. Although congestion never disappears, it is far less intense than would occur if such transit did not exist.

How Transit Reduces Traffic Congestion (Litman 2006)
Urban traffic congestion tends to maintain equilibrium. If congestion increases, people change destinations, routes, travel time and modes to avoid delays, and if it declines they take additional peak-period trips. If roadway capacity increases, it will be partly filled by this latent demand (potential additional peak-period vehicle trips). Reducing this point of equilibrium is the only way to reduce congestion over the long run. The quality of travel alternatives has a significant effect on this equilibrium: If alternatives are inferior, few motorists will shift mode and the level of equilibrium will be high. If travel alternatives are relatively attractive, more motorists will shift modes, resulting in a lower equilibrium. Improving travel options can therefore benefit all travelers on a corridor, both those who shift modes and those who continue to drive. Shifts to alternative modes not only reduce congestion on a particular highway, they also reduce traffic discharged onto surface streets, providing "downstream" congestion reduction benefits.

To reduce congestion, transit must attract discretionary riders (travelers who would otherwise drive), which requires fast, comfortable, convenient and affordable service. When transit is faster than driving a portion of travelers shift mode until congestion declines to the point that transit attracts no additional riders. As a result, the faster and more comfortable the transit service, the faster the traffic speeds on parallel highways. This is indicated by studies which find that door-to-door travel times for motorists tend to converge with those of grade-separated transit (Mogridge 1990; Lewis and Williams 1999; Vuchic 1999), and by studies such as this one which find that congestion costs are lower in cities with grade-separated transit systems.

To reduce traffic congestion transit services must:

- Serve a major share of major urban corridors and destinations.
- Offer high quality service (relatively convenient, fast, frequent and comfortable) that is attractive to peak-period travelers.
- Be grade separated (with bus lanes or separated rail lines), so transit travel is relatively fast compared with driving under congested conditions.
- Be relatively affordable, with low fares and discounts targeted at peak-period travelers.

Rail travel is often slower than driving. According to the 1995 National Personal Travel Survey, travel by light rail average 15.4 miles-per-hour (MPH), heavy rail 20.3 MPH, and commuter rail 31.6 MPH, while automobile travel averages about 35 MPH (NPTS 1999). Travel surveys generally find that door-to-door (including walking and waiting time) transit commute take about twice as long as automobile commutes, suggesting that transit investments are an ineffective way of saving travel time. However, it is important to take several factors into account when comparing transit and automobile travel speeds.

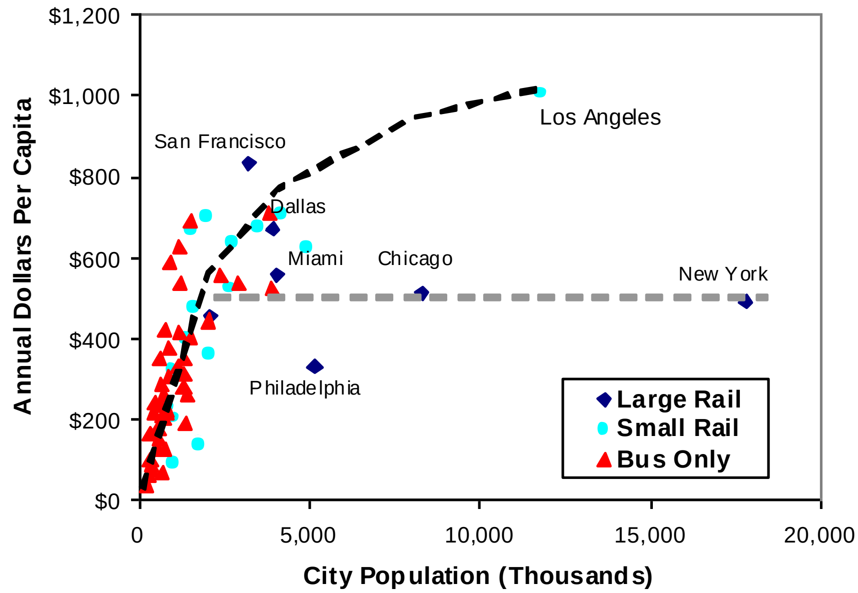
That national or regional average automobile travel speeds are higher than rail is irrelevant; what matters is their relative speeds on a particular corridor. Automobile travel tends to be slower and commute travel times higher in large cities where rail transit is most common. For example, although automobile commute speeds average 39 mph in rural areas, they average only 33 mph in cities with more than 3 million residents (NPTS 1999). Automobile travel speeds tend to be even slower on the congested urban corridors typically served by rail transit. Even if transit is slower than driving on average, rail is faster for specific trips because it is grade separated.

Even if transit travel takes more time measured by the clock, the additional time may have a lower cost to travelers than the same time spent driving because it imposes less stress. Passengers using high-quality transit (passengers have comfortable seats and vehicles are safe, clean, reliable and quiet), can read, work and rest. Various studies indicate that consumers place a higher cost on time spent driving than travel as a passenger, and drivers' time costs increase as congestion becomes more intense (Li 2003; Litman 2008). Passengers' travel time costs typically average 35% of wages, while drivers' time costs 50% of wages, with a premium of 33% for Level of Service (LOS) D, 67% for LOS E, and 100% for LOS F ("Travel Time," Litman 2009).

Of course, every trip is unique. Transit is sometimes not an option, because it does not serve a destination, travelers must carry special loads, or need a vehicle at work. Some travelers cannot take rail because they want to smoke or have difficulty with the walking links of transit trips. Some people dislike riding transit, or simply prefer driving. But that does not negate the benefits of high quality transit; if available, travelers can select the mode that best meets their needs and preferences. This maximizes transport system efficiency (since shifts to transit reduce traffic and parking congestion) and consumer benefits (since it allows consumers to choose the option they prefer).

Several studies using various methodologies indicate that high quality transit tends to reduce vehicle traffic congestion on a corridor (Lewis and Williams 1999; Litman 2006) The Texas Transportation Institute's (TTI's) annual *Urban Mobility Study* provides several congestion indicators. Some, such as per-capita congestion delay or cost, are more appropriate than others for evaluating transit impacts because they account for time savings resulting from mode shifts and more accessible land use. Measured this way, Large Rail cities have substantially less congestion than comparable size cities, as illustrated in Figure 13.

Figure 13 **Congestion Costs** (TTI 2003)

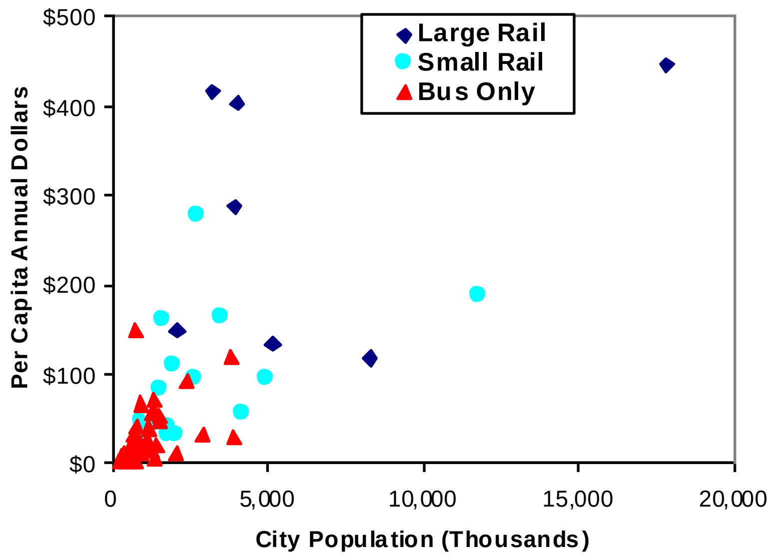


In Bus Only and Small Rail cities, traffic congestion costs tend to increase with city size, as indicated by the dashed curve. But Large Rail cities do not follow this pattern. They have substantially lower congestion costs than comparable size cities. As a result, New York and Chicago have about half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

Winston and Langer (2004) found that motorist and truck congestion delay declines in a city as rail transit mileage expands, but increases as bus transit mileage expands, apparently because bus transit attracts fewer motorists, contributes to traffic congestion, and has less positive impact on land use accessibility. Garrett (2004) found that traffic congestion growth declined somewhat in some U.S. cities after light rail service began. In Baltimore the congestion index increased an average of 2.8% annually before light rail, but only 1.5% annually after. In Sacramento the index grew 4.5% annually before light rail but only 2.2% after. In St. Louis the index grew an average of 0.89% before light rail, and 0.86% after. Between 1998 and 2003, Portland's population grew 14%, yet per capita congestion delay did not increase, possibly due to transit improvements that significantly increased transit ridership (TTI 2005). Other studies find similar results (LRN 2001).

Nelson, et al (2006) used a regional transport model to estimate transit system benefits, including direct users benefits and the congestion-reduction benefits to motorists. They found that rail transit generates congestion-reduction benefits that exceed subsidies.

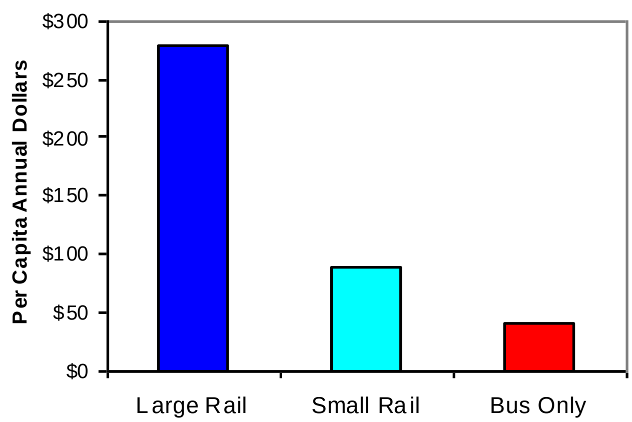
Figure 14 **Transit Congestion Cost Savings** (TTI 2003)



This figure illustrates per capita congestion cost savings due to transit service.

Figures 14 and 15 compare congestion cost savings provided by public transit for various cities, as estimated by the Texas Transportation Institute. Large Rail cities have greater transit congestion reductions than other cities. Of the 50 largest cities, Large Rail cities average $279 savings per capita, compared with $88 Small Rail cities, and $41 for Bus Only cities. These savings total more than $14.0 billion in Large Rail cities, $5.4 billion in Small Rail cities, and $1.8 billion dollars in Bus Only cities (considering only the 50 largest U.S. cities), indicating that rail provides $19.4 billion annual congestion cost savings. These savings approximately equal total U.S. public transit subsidies.

Figure 15 **Transit Congestion Cost Savings** (TTI 2003)



Large Rail cities achieve large transit congestion cost savings.

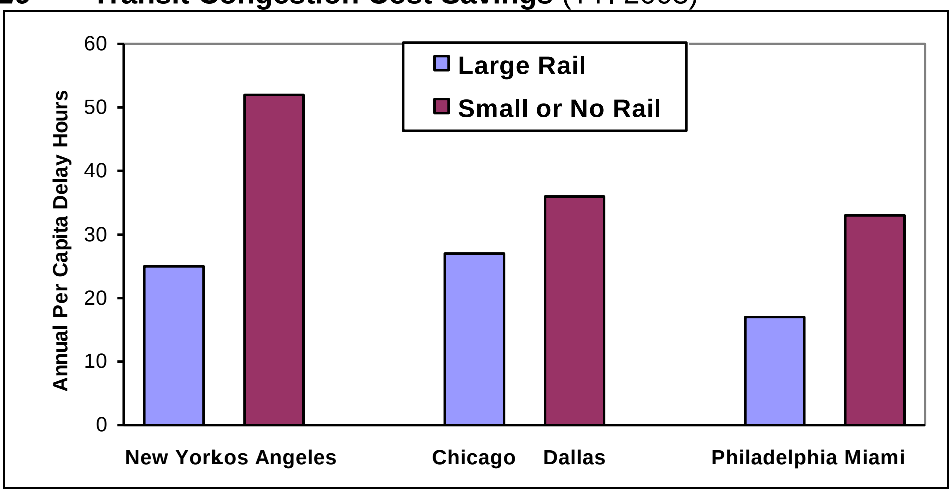
Table 4 **Congestion Delay In Six Largest U.S. Cities**

Large Rail			Small Rail		
City	Population	Congestion Delay	City	Population	Congestion Delay
New York	17,799,861	25	Los Angeles	11,789,487	52
Chicago	8,307,904	27	Miami	4,919,036	33
Philadelphia	5,149,079	17	Dallas	4,145,659	36
Averages	*7,814,211*	*23*	*Averages*	*5,213,545*	*40*

Of the six largest U.S. cities, the three with Large Rail systems have about half the congestion delay as the three that lack such systems.

Table 4 and Figure 16 show matched pair analysis compare per capita congestion costs of three Large Rail cities (New York, Chicago and Philadelphia) similar size Small Rail cities (Los Angeles, Miami and Dallas). Residents of the three Large Rail cities experienced about half congestion costs as in Small Rail cities. Similar patterns are found in developing countries such as India (Wilbur Smith 2008).

Figure 16 **Transit Congestion Cost Savings** (TTI 2003)



Matched-pair analysis shows that cities with large rail transit systems have significant less per capita traffic congestion delay than similar size cities that have small or no rail transit. This suggests that rail transit significantly reduces congestion costs.

Baum-Snow and Kahn (2005) found significantly lower average commute travel times around rail transit stations than in otherwise comparable areas that lack rail. They estimate that these savings total 50,000 hours per day in Washington DC, and smaller amounts in other cities. Another indicator of transit's congestion reduction benefits is the increased traffic delay that occurs in rail-oriented cities when the transit system stops for any reason, such as a mechanical failure or strike. For example, Lo and Hall (2006) found that highway traffic speeds declined as much as 20% and rush hour duration increased significantly during the 2003 Los Angeles transit strike, despite the fact that transit has only a 6.6% regional commute mode share. Speed reductions were particularly large along rail transit corridors.

This leaves little doubt that rail transit reduces per capita congestion costs. However, this does not mean that such cities lack congestion. In fact, congestion, measured as roadway Level-of-Service or average traffic speeds, is often quite intense in these cities because they are large and dense. However, people in these cities have travel alternatives available on congested corridor, and tend to drive less, and so they experience significantly less congestion delay each year.

Critics sometimes claim that rail transit does not reduce traffic congestion, ignoring the evidence presented in this and other studies (Litman 2006). In some cases they ignore factors such as city size, and so conclude incorrectly that rail transit causes congestion. They often use inappropriate congestion indicators, such as the *Travel Time Index*, which only measures delay to roadway (automobile and bus) traffic, and so ignores delay reductions when people shift to transit, and from transit-oriented development that reduces travel distances. That the travel time index actually implies that congestion declines if residents increase their vehicle mileage and total travel time, for example, due to more dispersed land use if the additional driving occurs in less congested conditions.

Cost Effectiveness

Rail transit systems may appear costly due to various special factors:

- New transit projects must overcome decades of underinvestment in grade-separated transit.
- Transit must provide a high quality of service to attract discretionary riders out of their cars.
- Rail transit is generally constructed in the densest part of a city where any transportation project is costly, due to high land values, numerous design constraints, and many impacts.
- Rail transit projects often include special amenities such as community redevelopment and streetscape improvements which provide additional benefits, besides just mobility.
- Rail transit projects include tracks, trains, stations, and sometimes parking facilities. It is inappropriate to compare rail system costs with just the cost of adding roadway capacity; comparisons should also include vehicle and parking costs needed for automobile travel.

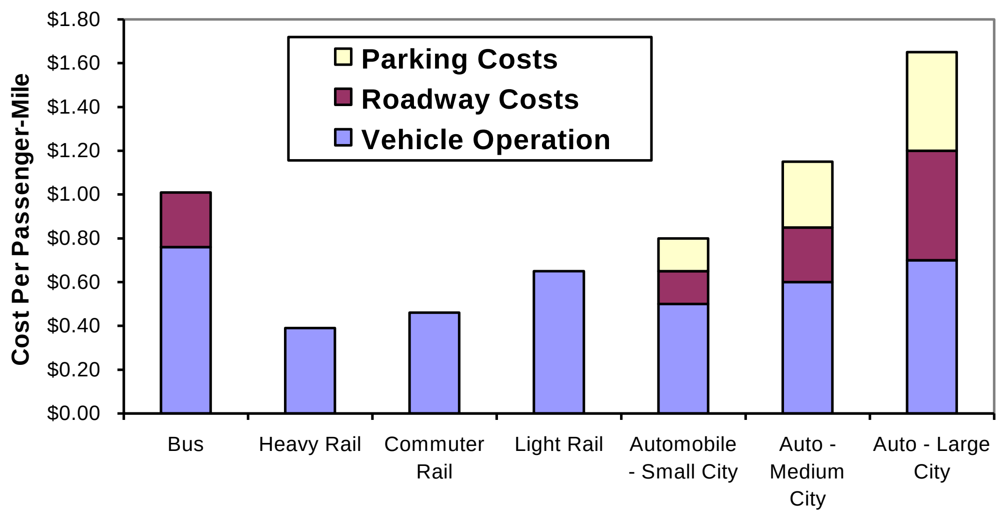
Table 5 **Typical Automobile Commute Trip Costs** (Litman 2009)

	Small City	Medium City	Large City
Average Vehicle Costs (per vehicle-mile)	50¢	60¢	70¢
Roadway Capacity Cost (per vehicle-mile)	15¢	25¢	50¢
Parking (per day/per mile for 20-mile round trip)	$3.00 (15¢)	$6.00 (30¢)	$9.00 (45¢)
Total Per Mile Costs	*$1.05*	*$1.70*	*$2.35*

This table illustrates typical costs for an automobile commute for various size cities.

Most people never purchase a road or individual parking space and so greatly underestimate the full cost of accommodating additional urban automobile travel, taking into account vehicle, road and parking costs. Table 5 and Figure 17 show typical estimates of these costs.

Figure 17 **Average Costs By Mode** (APTA 2002; Litman 2009)

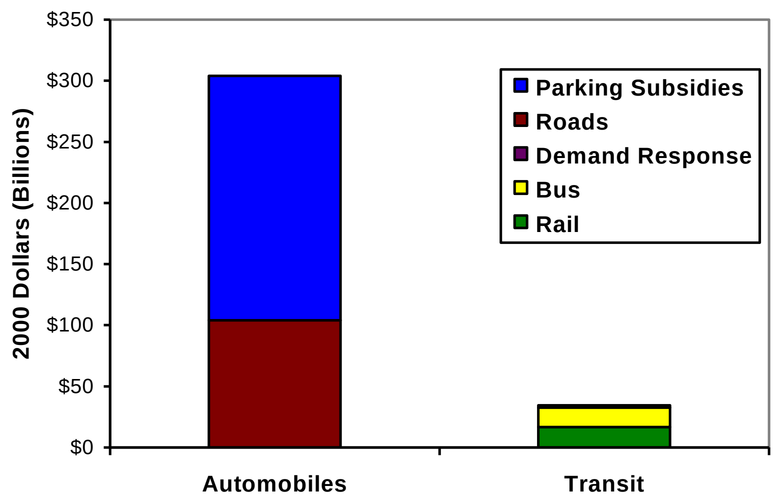


This figure compares costs per passenger-mile of various modes. Rail transit costs are usually less than combined road, vehicle and parking costs, particularly in large cities.

Critics often claim that rail transit is more costly than bus or automobile transport, but this often reflects faulty analysis. They usually consider just a small portion of total transit benefits and underestimate the actual costs of accommodating additional automobile travel under the same conditions, taking into account the high costs of increasing road and parking capacity on major urban corridors. When all benefits and costs are considered, rail transit often turns out to be the most cost effective way of accommodating additional urban travel.

Claims that rail transit projects consume an excessive portion of transportation budgets also tend to reflect incomplete analysis. For example, of $167 billion total federal, state and local government transportation expenditures in 2000, $104 billion was for roads, $15.9 billion for bus transit, $1.8 billion for demand-response services, and $16.7 billion for rail. The cost of parking at destinations is estimated to total more than $200 billion annually (Litman 2009). Rail transit expenditures equal about 5% of total automobile facility costs (roads and parking), as illustrated in Figure 18.

Figure 18 **Transportation Expenditures** (Litman 2009; BTS 2003, Table 3-29a)



Transit subsidies represent about 19% of total government expenditures on transportation services, less than half of which is for rail transit. Rail transit represents less than 5% of total expenditures on roads, parking subsidies and transit.

When a major rail transit project is under construction most of the cost is included in a particular transportation agency's capital budget, so for a few years it appears relatively large. This is no different than other major investments, including highway projects and bridges, or a household's automobile purchase, which may appear exceptionally large compared with a single year's budget. When averaged over a larger time period (rail transit capital investments have 20-50 year operating lives), or over several cities, transit capital projects represent a small portion of total government transportation expenditures.

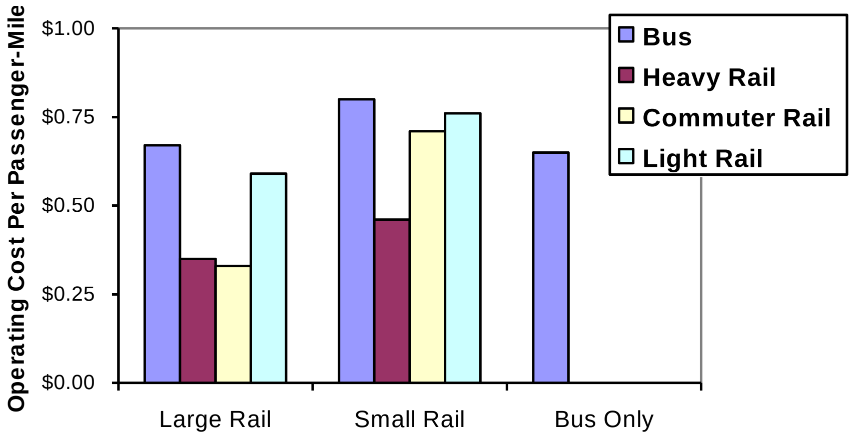
Rail systems are sometimes justified for special reasons. For example, New Orleans and Seattle have popular tourist trolley systems which have high costs per passenger-mile, because they are small and serve short trips, but are considered worthwhile investments because they contribute a special ambiance and attract visitors. Rail transit may also be justified to support growth at a particular commercial center or sport arena, since it is not economically possible for a center to expand beyond about 10,000 employee or visitors without a significant portion arriving by transit, due to road and parking constraint. Because diesel buses are noisy and smelly, large bus terminals are less suitable than rail stations for accommodating large numbers of transit passengers. Although rail systems may seem costly, a significant portion of their costs are often offset by increased property values, business activity and productivity gains (Smith and Gihring 2003).

Special care is needed when comparing automobile and transit funding. Transit is funded to help achieve various objectives, including congestion reduction, road and parking facility cost savings, consumer cost savings, basic mobility for disadvantaged people, increased safety, pollution reduction and support for strategic development objectives. For efficiency-justified funding (to reduce costs such as congestion, facility costs, accidents and pollution) transit and automobile transport can be compared using measures of cost effectiveness, such as costs per passenger-mile or benefit/cost ratio, to identify the cheapest option. In that case, there is no particular reason to subsidize a transit trip more than an automobile trip, provided all costs (including road and parking costs, traffic services, congestion and crash risk impacts on other road users, and environmental impacts) are considered.

However, for equity-justified service (providing basic mobility to disadvantaged people) there are reasons to subsidize transit more than automobile travel, because transit bears additional costs to accommodate people with disabilities (such as wheelchair lifts), and many non-drivers have low incomes, so greater public subsidies are justified on equity grounds. Since many of these people cannot drive, the alternative must include the cost of a driver, so transit costs should be compared with taxi service costs (or a combination of taxi and chauffeured automobile travel, taking into account the value of time by family members and friends who drive), not simply with vehicle costs.

Care is also needed when comparing different types of transit. Buses are generally cheaper to operate than trains *per vehicle-mile*, but trains have more capacity and so are cheaper *per passenger-mile* on routes with high demand. Similarly, costs *per vehicle-mile* or *vehicle-hour* tend to be higher in larger cities, due to increased congestion and higher wages, but ridership also tends to be higher, reducing costs *per passenger-mile*. For example, according to APTA data, bus employees earn an average of $46,139 annually in wages and benefits, compared with $81,307 for regional rail transit employees, due to differences in job classifications and prevailing wage rates, but costs per passenger-mile tend to be much lower in larger cities due to the higher load factors and efficiencies.

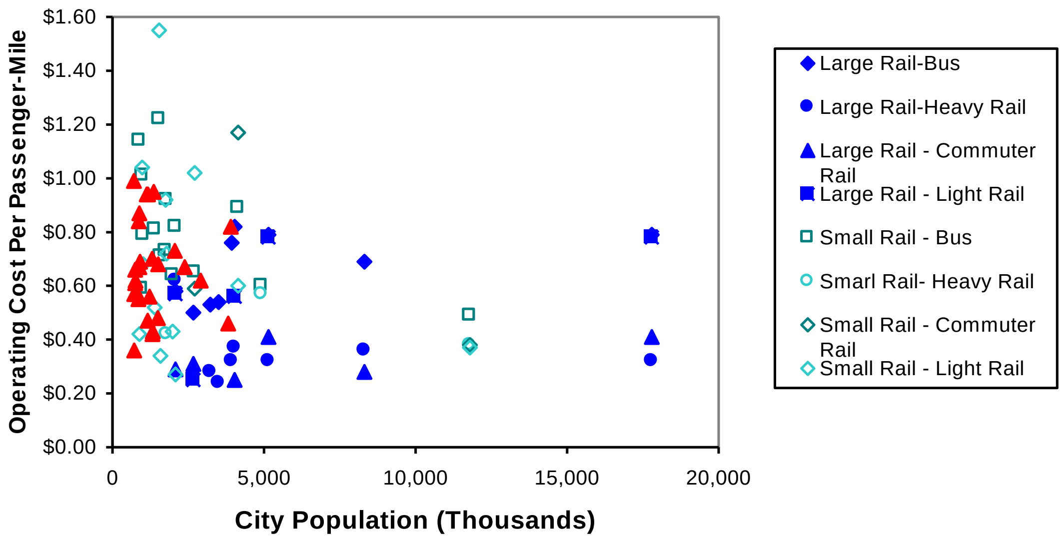
Figure 19 **Average Operating Cost By Mode and City Category** (APTA 2002)



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.

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 figures 19 and 20.

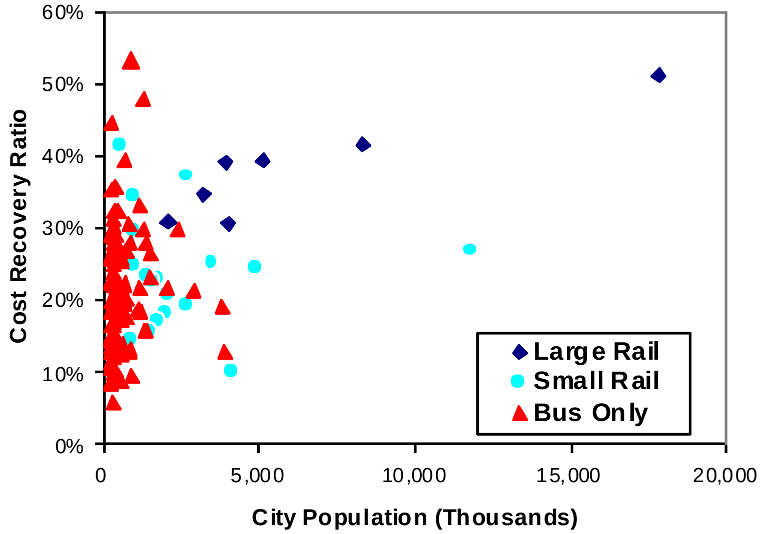
Figure 20 **Operating Cost By Mode And City Category** (APTA 2002)



Large Rail transit systems tend to have lower operating costs than Small Rail systems.

Rail transit systems also tend to have greater cost recovery, that is, a larger portion of operating costs are paid by fares, as illustrated in Figure 21. 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.

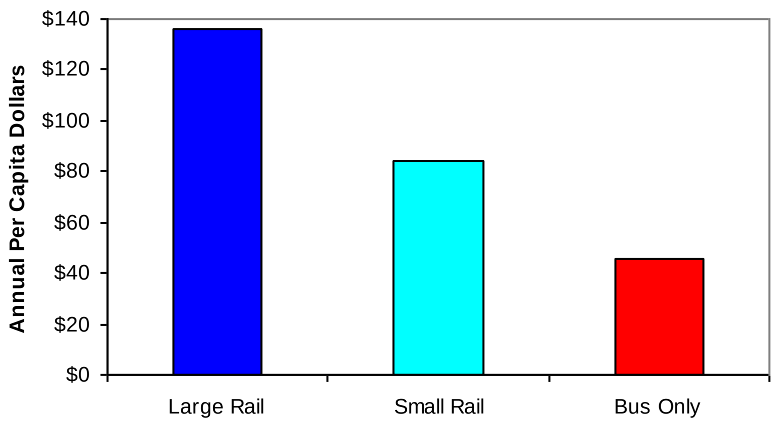
Figure 21 **Transit System Cost Recovery** (FTA 2001)



Transit system cost recovery (the portion of total operating costs for all transit modes paid by fares) tends to be higher for Large Rail than for Small Rail or Bus Only systems, even accounting for city size. This suggests that rail transit can increase cost effectiveness.

Some critics argue that rail transit absorbs an excessive portion of transit funding, reducing funding for bus services. But total transit funding tends to increase with rail service as indicated in Figure 22. Thompson and Matoff (2003) find that Bus Only cities such as Columbus, Ohio spend less per capita on transit than cities with rail systems, such as Portland, San Diego and Seattle. This suggests that rail and bus investments are complements rather than substitutes, because transit gains broader political support and decision-makers realize the value of improved and more integrated transit systems. This may not be true in every case, but there is no evidence that rail system development necessarily reduces bus funding or service quality.

Figure 22 **Annual Per Capita Transit Expenditures**



Total per capita transit funding tends to be much higher in Large Rail cities.

Road and Parking Cost Savings

To the degree that rail transit reduces automobile ownership and use it can provide road and parking facility cost savings (Litman 2009; Topp 2009). Reductions in vehicle ownership reduce residential parking costs, and reductions in vehicle trips reduce roadway costs and parking costs at destinations. These benefits tend to be particularly large because rail serves dense urban areas where road and parking facility costs are particularly high.

A survey of 17 transit-oriented developments (TOD) in five U.S. metropolitan areas showed that vehicle trips per dwelling unit were substantially below what the Institute of Transportation Engineer's *Trip Generation* manual estimates (Cervero and Arrington 2009). During a typical weekday the surveyed TOD housing projects averaged 44% fewer vehicle trips than the manual estimates (3.754 versus 6.715), ranging from 70-90% lower for projects near downtown to 15-25% lower in low-density suburbs. Similarly, a parking and traffic generation study of Portland, Oregon transit oriented developments recorded 0.73 vehicles per housing unit, about half the 1.3 value in the ITE *Parking Generation Handbook*, and 0.15 to 0.29 vehicle trips per dwelling unit in the AM period and 0.16 to 0.24 vehicle trips per dwelling in the PM period, about half the 0.34 AM and 0.38 PM values in the *Trip Generation Handbook* (PSU ITE Student Chapter 2007).

Table 6 illustrates estimated road and parking cost savings, based on the automobile trip substitution rates and cost values from Table 4. This only considers road and parking cost savings by trips shifted from automobile to transit, it does not account for the additional savings from the automobile trip reductions leveraged by transit oriented development.

Table 6 **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**

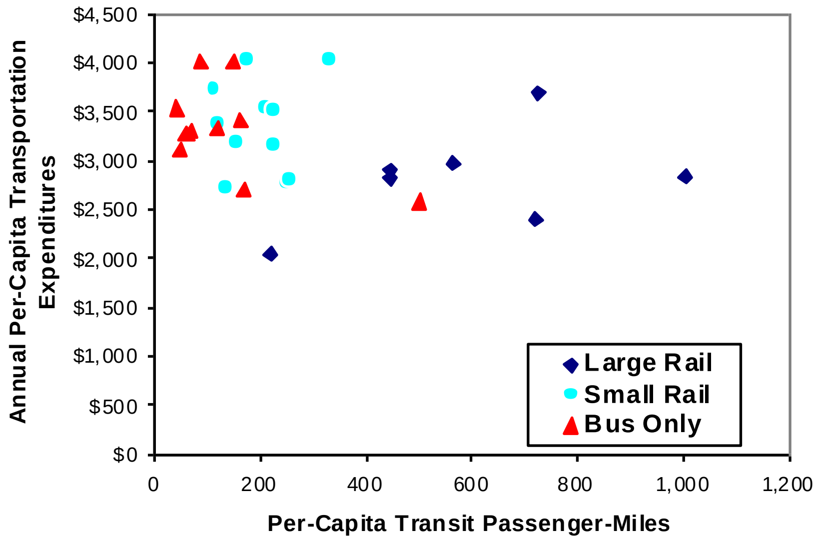
This table shows estimated road and parking cost savings from automobile travel shifted to transit.

Residential parking costs range from about $400 annually for a surface lot in an area with low land values, up to $2,600 annually for underground parking (Litman 2004a). Parking costs tend to be particularly high in dense urban areas, so it is reasonable to estimate that parking costs average at least $800 in rail transit cities. 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

About 18% of total household expenditures are devoted to vehicles and transit fares (BLS, 2003). Rail transit reduces these costs. Large Rail city residents spend $2,808 on average on vehicles and transit ($2,803 excluding New York), compared with $3,350 in Small Rail cities and $3,332 in Bus Only cities, despite 7% higher average incomes, which normally increases spending. Figures 23 and 24 illustrate these differences.

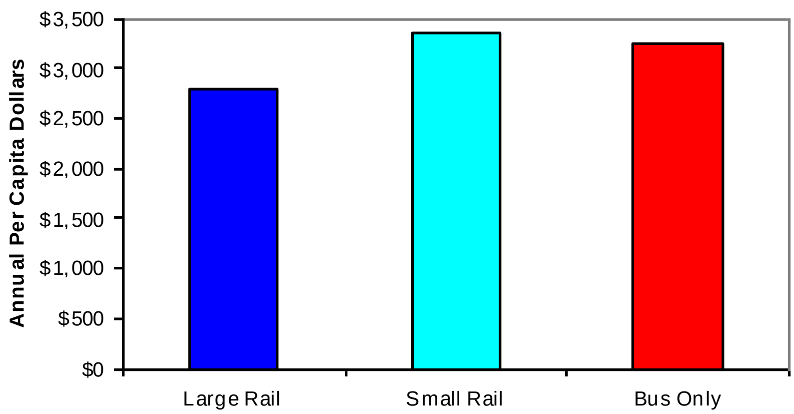
Figure 23 **Transport Expenditures** (BLS 2003)



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

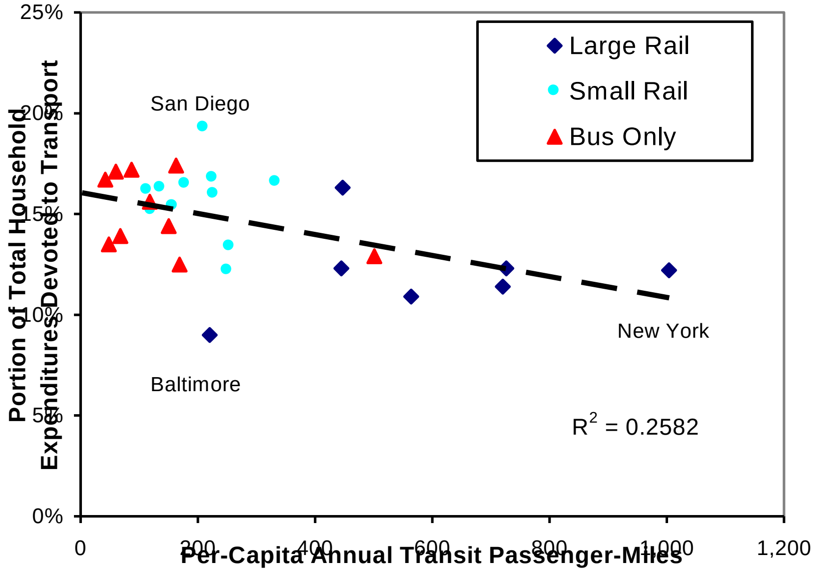
Large Rail city residents save $22.6 billion in total compared with what consumers spend on transportation in Bus Only cities. These savings are greater than all transit subsidies in the U.S., indicating substantial net economic benefits.

Figure 24 **Annual Per Capita Consumer Expenditures on Transportation**



Large Rail city residents save about $500 annually per capita on total transportation expenses.

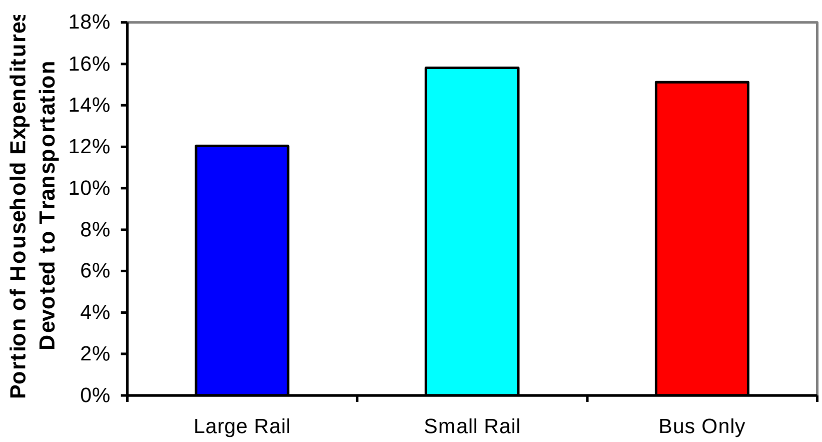
Figure 25 **Percent Transport Expenditures** (BLS 2003)



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

Figures 25 and 26 compare 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. International comparisons show similar patterns (Kenworthy and Laube 2000).

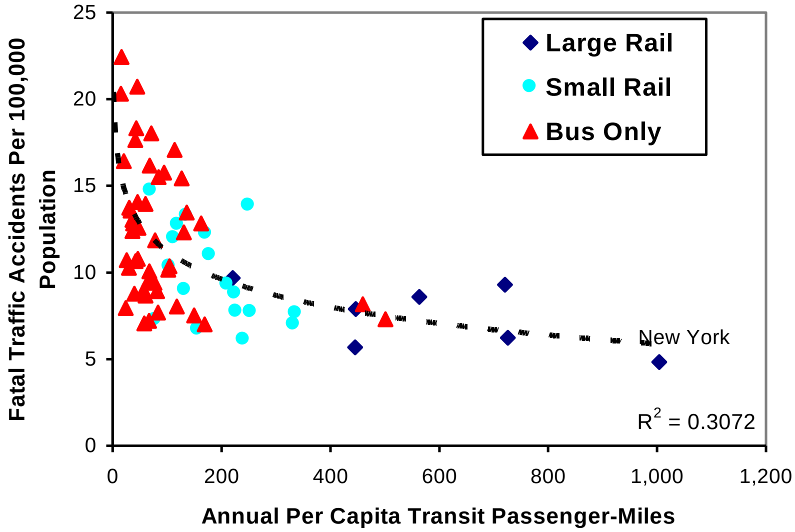
Figure 26 **Percent Transport Expenditures**



Safety Impacts

Traffic accidents impose significant costs (Litman 2009). Despite traffic safety efforts, vehicle accidents continue to be the largest cause of deaths and disabilities for people in the prime of life, imposing many billions of dollars in annual economic costs.

Figure 27 **Traffic Deaths** (NHTSA Data, published in Ewing, Pendall and Chen 2002)



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

Rail transit cities have significantly lower per capita traffic death rates, as illustrated in Figures 27 and 28. 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 about 2,500 more annual traffic deaths, plus increased disabilities, injuries and property damages. This represents $50 billion in annual savings, based on USDOT recommended values for crash reduction benefits.

Figure 28 **Annual Per Capita Traffic Deaths**

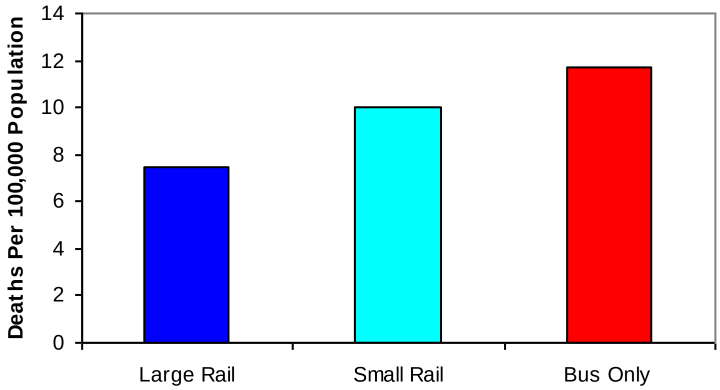
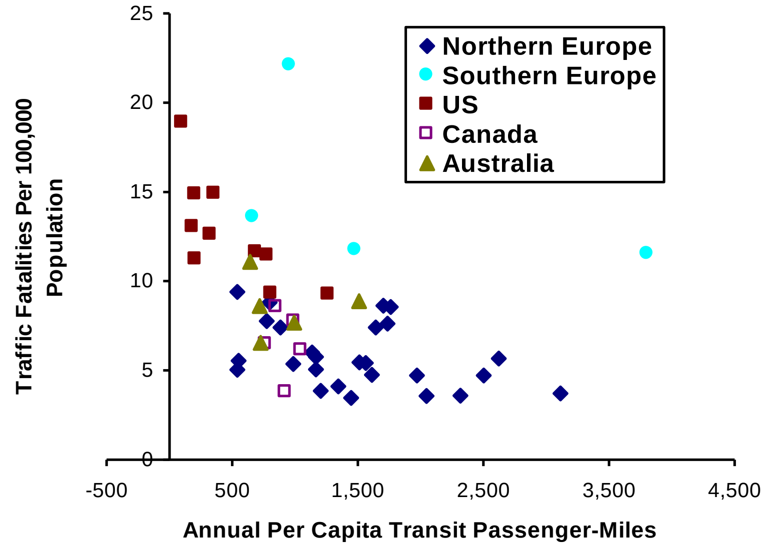


Figure 29 **International Traffic Deaths** (Kenworthy and Laube 2000)



International data indicate that crash rates decline with increased transit ridership.

Figure 29 shows international data which also indicate that per capita traffic fatalities decline with increased transit ridership (see additional discussion in Litman and Fitzroy, 2005). Table 7 shows per capita traffic fatality and injury crash rates for various modes, indicating that in the U.K., where urban rail transit systems are well established, deaths and injury rates are quite low compared with other modes.

Table 7 **UK Crash Rates Per Billion Pass-Kms** (Steer Davies Gleave 2005, Table 7.3)

Mode	Killed	Killed and Injured
Motorcycle	112	5,549
Cycling	33	4,525
Walking	48	2,335
Private car	3	337
Bus or Coach	0.1	196
Heavy Rail	0.1	13
Light Rail	0.00002	0.00007

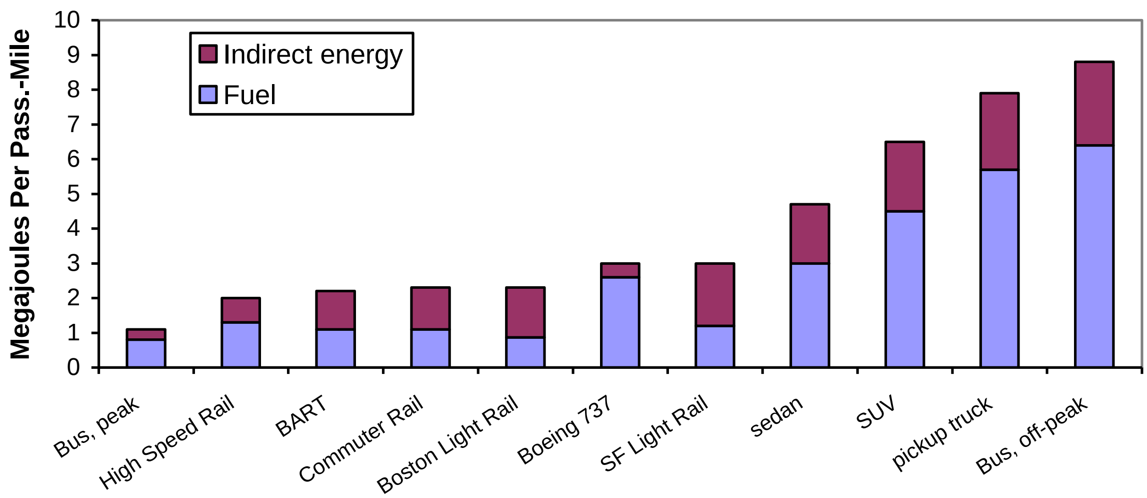
British data indicate that rail transit has very low traffic fatality rates per passenger-kilometer compared with other modes.

Energy and Emission Reductions

High quality public transit can provide substantial energy conservation and emission reduction benefits (Shapiro, Hassett and Arnold 2002; Sarzynski, Brown and Southworth 2008; ICF 2008 and 2010; CNT 2010). North American transit systems are not very energy efficient because they are structured to primarily to provide basic mobility to non-drivers, often in sprawled locations. However, urban transit consumes a quarter as much energy as driving per passenger-mile (Figure 30), electric powered transit produces minimal local air and noise emissions, and transit-oriented community residents consume less transport fuel due to reduced driving. Bailey (2007) found that household located within ¾-mile of rail stations save 512 gallons of fuel annually due to reduced driving and international studies indicate that per capita energy consumption declines with more transit use (Kenworthy and Laube 2000). In addition:

- Transit encouragement strategies that improve service efficiency (such as grade separation), increase load factors (such as financial incentives), increase land use accessibility (transit-oriented development), or reduce emission rates (such as improved engines and electric propulsion) can provide large energy savings and emission reductions.
- Transit oriented development tends to reduce short vehicle trips which have high per-mile energy consumption and emission rates due to cold starts and congested conditions. As a result, each 1% of mileage reduced typically reduces air emissions by 2-3%.
- Rail tends to reduce emissions in densely populated areas, such as commercial centers and transit terminals, and so reduces people's exposure to harmful emissions such as CO, toxics and particulates, compared with conventional diesel buses.
- Newer technologies are reducing emission rates. For example, newer diesel buses produce much lower emissions than in the past.

Figure 30 **Lifecycle Energy Consumption, Megajoules Per Passenger-mile**
(Aurbach, http://pedshed.net/?p=219, based on Chester and Horvath 2008)



This figure compares fuel and embodied energy (energy used for vehicle and facility construction and maintenance) for various transport modes.

Economic Development Impacts

Economic Development refers to progress toward a community's economic goals, including increased productivity, employment, income, business activity, investment and tax revenue. Public transit can provide economic development benefits described below, particularly rail transit because it serves large cities where cost savings and productivity gains tend to be high (Ahlfeldt and Feddersen 2010; Banister and Thurstain-Goodwin 2011; Cambridge Systematics 1998; Prud'homme and Lee 1998; Forkenbrock and Weisbrod 2001; MKI 2003; Hass-Klau, Crampton and Benjari 2004; Litman 2009b; Sadler and Wampler 2013).

Transportation System Cost Savings and Efficiency Gains

As described earlier, by attracting discretionary travelers, increasing transit ridership, and providing a catalyst for more efficient land use, rail transit provides various cost savings and efficiency gains, including congestion reduction, road and parking cost savings, consumer savings, reduced crash damages, and improved public health. These economic savings and efficiency benefits filter through the economy as savings to consumers, businesses and governments, making a region more productive and competitive.

Shifting Consumer Expenditures

Expenditures on automobiles, fuel and roadway facilities provide relatively little regional economic activity because they are capital intensive and largely imported from other areas. A study using national input-output table data found that each 1% of regional travel shifted from automobile to public transit increases regional income about $2.9 million, resulting in 226 additional regional jobs (Miller, Robison and Lahr 1999). Similarly, at a national level, a million dollars spent on public transit services generates 31.3 jobs, compared with 17.3 jobs if the same amount is spent on a typical bundle of other goods, 13.7 jobs if spent on vehicles, and 12.8 jobs if spent on fuel, as summarized in Table 8.[2] As a result, policies that help consumers save on fuel and vehicles, or shift expenditures from automobiles to public transit, tend to support economic development.

Table 8 **Economic Impacts per $1 Million Expenditures** (Chmelynski 2008)

Expense category	Value Added 2006 Dollars	Employment FTEs*	Compensation 2006 Dollars
Auto fuel	$1,139,110	12.8	$516,438
Other vehicle expenses	$1,088,845	13.7	$600,082
Household bundles			
Including auto expenses	$1,278,440	17.0	$625,533
Redistributed auto expenses	$1,292,362	17.3	$627,465
Public transit	$1,815,823	31.3	$1,591,993

In 2006, a million dollars shifted from fuel to general consumer expenditures generated 4.5 domestic jobs, and if shifted to public transit expenditures generated 18.5 jobs. These impacts are likely to increase as oil import costs rise. (FTE = Full-Time Equivalent employees)*

[2] The IMPLAN model includes assumptions that exaggerate the employment and business activity generated by fuel and vehicle expenditures, and so underestimates the economic benefits of transport cost savings. For example, it assigns gas station jobs to fuel sales, although these businesses make most of their profits from food, cigarettes and lottery sales. The model also exaggerates the portion of vehicle inputs produced domestically and ignores for economic costs of trade deficits resulting from petroleum imports.

As described earlier, Large Rail city residents spend $448 annually less on average per capita on transportation than Bus Only city residents despite their higher incomes and longer average commute distances, totaling $22.6 billion in savings. If each million dollars in consumer expenditures shifted from automobile expenses to general consumer expenditures provides an average of 8.6 jobs and $219,000 in regional income, as indicated in Table 6, rail transit provides a total of 194,114 additional jobs and $4.9 billion in additional regional income in those cities.

These impacts are likely to increase in the future as international oil prices rise, U.S. oil production declines, and vehicle production becomes more automated. Although exact impacts are uncertain and impossible to predict with precision, between 2010 and 2020 a million dollars shifted from fuel to general consumer expenditures is likely to generate at least six jobs, and after 2020 at least eight jobs. This indicates that current planning decisions can support future economic development by encouraging transport system diversity and efficiency so consumers can reduce their spending on vehicles and fuel. For example, transport policies and investments that reduce U.S. per capita fuel consumption by 20% would save consumers $100-200 billion annual dollars, provide comparable indirect economic benefits, and generate 1 to 2 million domestic jobs.

Agglomeration Efficiencies
Land use density and clustering tend to provide agglomeration benefits, which can reduce the costs of providing public services and increase productivity due to improved accessibility and network effects (Banister and Thurstain-Goodwin 2011; Bettencourt, et al. 2007; CTOD 2011). One published study found that doubling a county-level density index is associated with a 6% increase in state-level productivity (Haughwout 2000). Meijers and Burger (2009) found that metropolitan region labor productivity declines with population dispersion (a higher proportion of residents live outside urban centres), and increases with polycentric development (multiple business districts, cities and towns within a metropolitan region, rather than a single large central business district and central city). This suggests that regional rail transit systems with transit oriented development around stations tend to support regional economic development by encouraging efficient polycentric land use patterns. Although these impacts are difficult to measure, they are likely to be large.

Increased Property Values
Transit oriented development tends to increase local property values due to improved accessibility and livability in that area (CNT 2013; Eppli and Tu, 2000; Smith and Gihring, 2003; CTS 2009b). Transit stations often provide a catalyst for various neighborhood improvements such as urban redevelopment, historic preservation, improved pedestrian conditions and New Urbanist design practices. A portion of these property value gains may be economic transfers (property value increases in one area are offset by property value reductions at other locations), but increased property values resulting from agglomeration efficiencies, shifted consumer expenditures, transportation efficiency and community redevelopment are true economic gains that increase productivity. Many businesses prefer to locate near rail stations to improve access for employees and customers; some employers say that employees who commute by rail are

more productive since they avoid the stress and uncertainty of driving on congested roads. Table 9 summarizes property value increases measured near rail transit stations in various European and North American cities.

Table 9 **Rail Station Property Value Impacts** (Hass-Klau, Cramption and Benjari 2004)

City	Factor	Difference
Newcastle upon Tyne	House prices	+20%
Greater Manchester	Not stated	+10%
Portland	House prices	+10%
Portland Gresham	Residential rent	>5%
Strasbourg	Residential rent	+7%
Strasbourg	Office rent	+10-15%
Rouen	Rent and houses	+10%
Hannover	Residential rent	+5%
Freiburg	Residential rent	+3%
Freiburg	Office rent	+15-20%
Montpellier	Property values	Positive, no figure given
Orléans	Apartment rents	None-initially negative due to noise
Nantes	Not stated	Small increase
Nantes	Commercial property	Higher values
Saarbrűcken	Not stated	None-initially negative due to noise
Bremen	Office rents	+50% in most cases

Various studies indicate that proximity to rail stations tends to increase property values.

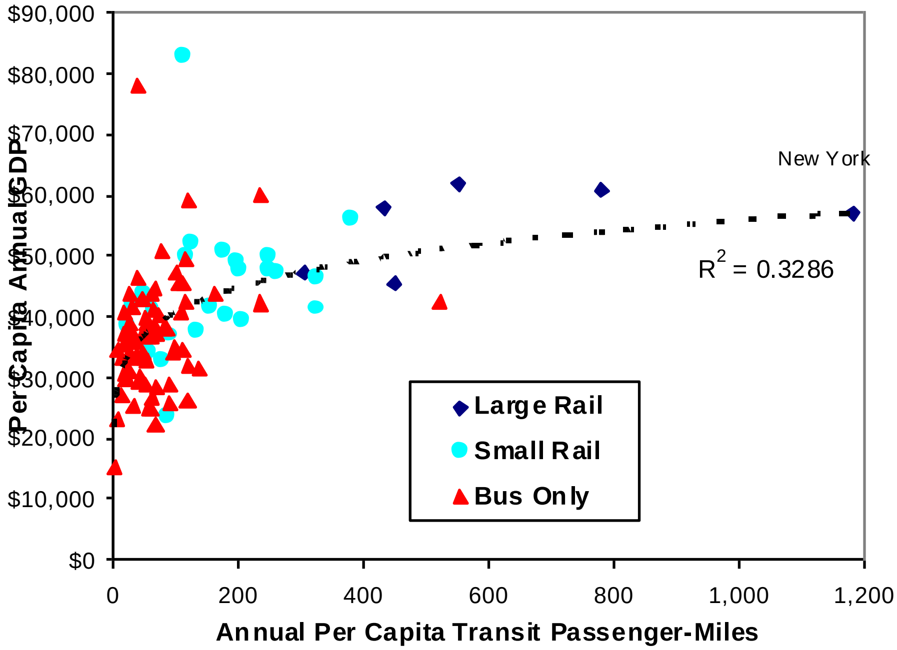
Community Redevelopment

Current development patterns tend to abandon older neighborhoods as new communities are built at the urban fringe. This tends to be inefficient in terms of infrastructure (roads, schools and other facilities in urban areas are underused while new facilities must be built in suburban areas) and in terms of social capital (many older neighborhoods have unique cultures, traditions and human relationships). This results, in part, from growing automobile traffic through older neighborhoods caused by urban fringe residents. Rail transit can provide a catalyst for urban redevelopment by improving accessibility and reducing automobile traffic problems. High quality transit also supports tourism and convention industry development. One study found that hotels near rail transit stations that connect regional airports have significantly higher occupancy and room rates than other hotels (Grisby 2013). A unique transit service can be a popular tourist activity, help create community identity, which stimulates economic development.

Summary of Economic Productivity Gains

As a result of these various economic benefits, per capita productivity tends to increase with public transit use, as illustrated in Figure 31. Of course, other factors besides public transit contribute to this relationship: per capita transit ridership tends to increase with city size, density and fuel price, and declines with increased per capita automobile travel, all of which tend to increase per capita GDP (Litman 2009b), but high quality public transit supports these other factors, and so contributes to economic development indirectly.

Figure 31 **GDP Versus Transit Ridership** (Litman 2009b)



GDP tends to increase with per capita transit travel. This probably reflect a combination of economic savings and benefits from reduced vehicle travel which reduces economic costs, and more compact, accessible land use which supports agglomeration efficiencies.

The report, *Transit and Regional Economic Development* (CTOD 2011) found that certain high-skill "knowledge-based" industries (professional, scientific, information services, finance, and insurance sectors) tend to concentrate in higher density regional commercial centers. Transit-oriented commercial centers are gaining jobs, especially in high-skill sectors like knowledge-based industries, although their share of total regional employment has declined for most industrial sectors during the last few decades. The portion of total jobs easily accessed by public transit tends to increase with rail and BRT systems, indicating that developing such systems improves overall transit accessibility.

Other studies indicate significant economic development benefits from rail transit. EDRG (2007) used quantitative analysis to estimate that the current Chicago region transit plan provides an estimated 21% annual return on investments, an enhanced plan would provide a 34% return, and adopting Transit-Oriented Development, as proposed in the region's official comprehensive plan, would increase the annual return to 61%. Failure to maintain the transit system will harm the region's commuters and the economy, estimated at over $2 billion annually.

Other Benefits

Transit in general, and rail transit in particular, can provide important but difficult to measure benefits (Forkenbrock and Weisbrod 2001). These are described briefly below.

Improved Mobility For Non-Drivers

Automobile-dependent transport and land use patterns disadvantages non-drivers. Transit improvements and transit oriented development increase mobility and accessibility options for non-drivers. Since non-drivers tend to be physically, economically and socially disadvantaged compared with drivers, this increases equity, in addition to reducing costs and increasing economic productivity.

For example, a study investigated how construction of Minneapolis's Hiawatha light rail line affects low-wage workers' job access (CTS 2010). After the rail line was completed the number of low-wage jobs accessible by 30 minutes of peak period transit travel increased by 14,000 jobs in station areas and 4,000 jobs in areas with direct light-rail bus connections. This resulted from a combination of improved transit networks, and a concentration of low-wage workers and jobs moving to light-rail station areas.

Avoided Chauffeuring

Chauffeuring refers to additional automobile travel specifically to carry a passenger. It excludes *ridesharing*, which means additional passengers in a vehicle that would be making a trip anyway. Some motorists spend a significant amount of time chauffeuring children to school and sports activities, family members to jobs, and elderly relatives on errands. Such trips can be particularly inefficient if they require drivers to make an empty return trip, so a five-mile passenger trip produces ten miles of total vehicle travel. Drivers sometimes enjoy chauffeuring, for example, when it gives busy family members or friends time to visit. However, chauffeuring can be an undesirable burden, for example, when it conflicts with other important activities. Quality transit service and transit oriented development allows drivers to avoid undesirable chauffeuring trips.

Option Value

Transit services provide *option value*, referring to the value people place on having a service available regardless of whether they currently use it (ECONorthwest and PBQD 2002). Transit provides basic mobility when needed, such as when a personal vehicle has a mechanical failure or a disaster limits automobile travel.

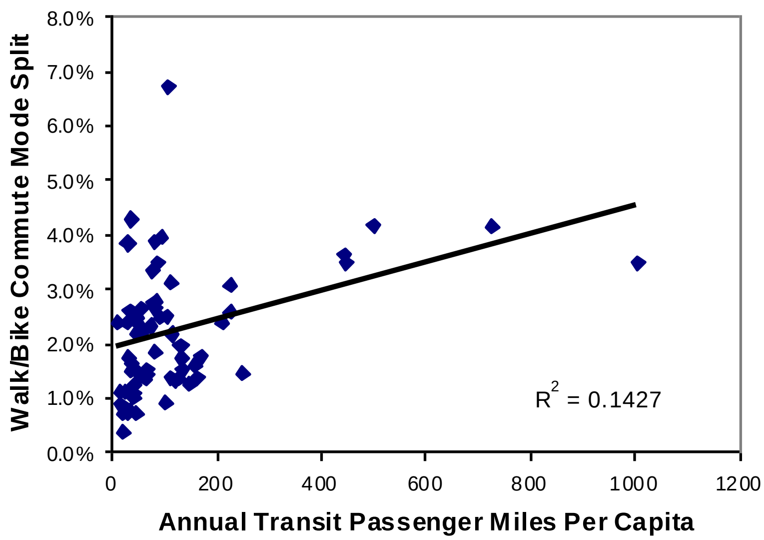
Community Livability

Community Livability refers to the environmental and social quality of an area as perceived by residents, employees, customers and visitors. Rail transit and transit-oriented development can help improve community livability in several ways, including urban redevelopment, reduced vehicle traffic, reduced air and noise pollution, improved pedestrian facilities, and greater flexibility in parking requirements and street design. This provides direct benefits to residents, increases property values and can increase retail and tourist activity in an area.

Improved Public Health

Since most transit trips involve walking or cycling links, and transit oriented development improves walking and cycling conditions, it tends to improve public health (Litman 2010b). Researchers from the University of Pennsylvania, Drexel University and the RAND Corporation found that construction of a light-rail transit (LRT) system increased physical activity (walking) and reduced users weight and obesity rates (MacDonald, et al. 2010). Specifically, before-and-after surveys of Charlotte, North Carolina LRT passengers found that body mass index declined an average of 1.18 kg/m2 compared to non-LRT users in the same area over a 12-18 month period, equivalent to a loss of 6.45 lbs for a person who is 5'5. LRT users were also 81% less likely to become obese over time.

Figure 32 **Transit And Walk/Bike Commute Mode share** (FTA 2001)



Transit and nonmotorized travel are complementary. As per capita transit travel increases so does walking and cycling.

Commuting by transit also tends to be less stressful than by car and so improves physical and mental health (Wener, Evans and Boately 2005).

Comparing Benefits and Costs

Table 10 summarizes U.S. transit service expenditures and revenues. Rail subsidies (operating and capital expenses minus fare revenues) totaled $12.5 billion in 2002, averaging about $140 per capita when divided among the 90 million residents of cities with rail transit systems, compared with $13.8 billion bus transit subsides, which averages about $50 per capita when divided among 278 million U.S. residents. This indicates that the incremental cost of rail transit is about $90 annually per capita.

Table 10 **U.S. Transit Expenses and Revenues By Mode** (APTA, 2002)

	Bus	Trolley Bus	Demand Response	*Total Bus*	Heavy Rail	Commuter Rail	Light Rail	*Rail Total*
Capital Expenses (m)	$3,028	$188	$173	*$3,389*	$4,564	$2,371	$1,723	*$8,659*
Operating Expenses (m)	$12,586	$187	$1,636	*$14,408*	$4,268	$2,995	$778	*$8,041*
Total Expenses (m)	$15,613	$374	$1,809	*$17,797*	$8,832	$5,366	$2,502	*$16,699*
Fare Revenues (m)	$3,731	$60	$185	*$3,976*	$2,493	$1,449	$226	*$4,167*
Subsidy (Total Exp. - Fares)	$11,882	$315	$1,624	***$13,821***	$6,339	$3,917	$2,276	***$12,532***
Percent Subsidy	76%	84%	90%	*83%*	72%	73%	91%	*79%*

m=million

This compares with $67.7 billon in estimated monetized (measuring in monetary units) benefits identified in this study, as summarized in Table 11. This indicates that, considering just impacts suitable for monetization, economic benefits greatly exceed subsidies. Rail transit provides additional benefits unsuited to monetization, including economic development, improved mobility for non-drivers, community livability and improved public health. People who do not currently use rail transit benefit from reduced traffic and parking congestion, and other benefits dispersed through the economy.

Table 11 **Rail Transit Monetized Benefits**

Cost Savings	Billions
Congestion cost savings	$19.4
Consumer transportation cost savings	$22.6
Roadway Cost Savings	$8.0
Destination Parking Cost Savings	$7.3
Residential Parking Cost Savings	$4.8
Accident cost savings	$50.0
Totals	*$112*

Other researchers using other analysis methods find similar results. Cervero and Guerra (2011) evaluated the costs and benefits of 24 North American rail systems. Of those, 14 provide net benefits, and all 24 together provide $13 to $17 billion annual net benefits. They predict that these benefits would increase with increased development densities along transit routes. Nelson, et al (2006) used a regional transport model to estimate the benefits of the local transit system to transit users and the congestion-reduction benefits to motorists. They found that rail transit generates congestion-reduction benefits that exceed rail subsidies, the combined benefits of rail and bus transit exceed local transit subsidies, and these benefits are progressive with respect to income.

Rail Versus Bus Transit

There is considerable debate over the relative merits of bus and rail transit (Hass-Klau, et al. 2003; Pascall 2001; GAO 2001; Thompson and Matoff 2003; Balaker 2004; Litman 2004a; Henry and Litman 2006; Hidalgo and Carrigan 2010). Some key issues are discussed here.

Rail transit tends to provide better service quality that attracts more riders, particularly discretionary users (Tennyson 1988; Pratt 1999; FTA 2002; Currie 2005). For example, a free bus line to downtown Tacoma, Washington attracted less than 500 daily riders, but when it was replaced with a light rail line, ridership increased to more than 2,400 a day. Rail can carry more passengers per vehicle which reduces labor costs, requires less land per peak passenger-trip, and causes less noise and air pollution compared with diesel buses. As a result, rail is more suitable for high-density areas. Rail transit is considered a prestige service that gains more public support, and provides a catalyst for urban redevelopment and more compact, multi-modal development patterns. Voters are often more willing to support funding for rail than for bus service. Transit-oriented land use patterns can increase property values and economic productivity by improving accessibility, reducing costs, improving livability and providing economies of agglomeration. In some cases, increased property values offset most or all transit subsidy costs. This does not generally occur with bus service.

A study by Schumann (2005) compares transit system performance in two similar size cities. The Sacramento Regional Transit District began building a Light Rail Transit system in 1985, while the Central Ohio Transit Authority failed in its efforts establish a similar system in Columbus, Ohio and so only offers bus transit. During the following 17 years, transit service and ridership increased significantly in Sacramento but declined in Columbus, while operating costs per passenger-mile increased much more in Columbus than in Sacramento, as indicated in the table below.

Table 12 **Columbus and Sacramento Transit Performance** (Schumann 2005)

	1985			2002			Change	
	CO	SA	SA/CO	CO	SA	SA/CO	CO	SA
County Population (000)	*914*	*903*	*99%*	*1,084*	*1,302*	*120%*	*19%*	*44%*
Unlinked trips (000)	25,889	16,051	62%	16,246	26,610	164%	-37%	66%
Trips per capita	28.3	17.8	63%	15.0	20.4	136%	-47%	15%
Passenger miles (000)	121,408	93,473	77%	66,760	119,008	178%	-45%	27%
Passenger miles per capita	132.8	103.5	78%	61.6	91.4	148%	-54%	-12%
Transit vehicles	343	217	63%	298	250	84%	-13	15
Revenue vehicle miles	9,098	8,569	94	8,994	9,866	110%	-1%	15%
Operating expenses ($000)	$33,310	$25,681	77%	$62,877	$82,477	131%	89%	221%
Constant operating expenses (2002 $000)	$55,694	$42,939	77%	$62,877	$82,477	131%	113%	192%
Constant operating expenses per passenger-mile 2002$	$0.46	$0.46	100%	$0.94	$0.69	74%	205%	151%

CO = Columbus; SA = Sacramento; SA/CO = Sacramento/Columbus; 1985 to 2002 consumer price index change = 1.672.

In addition, voters appear more willing to support dedicated funding for transit systems that include rail transit service. In 1988, a year after the first rail line began operations, Sacramento country voters approved a referendum which provided sales tax funding to operate and expand the transit system. The article's author argues that Sacramento's first rail "starter" line gained public support for continual transit service improvements. Out of four Columbus area transit funding referenda between 1986 and 1995, only one passed. As a result of funding shortfalls the transit system has raised fares and reduced service, which helps explain the decline in transit ridership. The author argues that, had Columbus had a rail line in the 1980s there would probably have been more support for public transit funding, leading to a more attractive system and higher ridership now.

Figure 33 **Transit Ridership Changes – 1996 to 2003** (Henry and Litman 2006)

Between 1996 and 2003 total transit use increased much faster in cities that have new or expanded rail service than in cities that only expanded bus service.

Henry and Litman (2006) used U.S. Federal Transit Administration data to compare transit system performance in U.S. urban areas that expanded rail systems with those that only expanded bus systems. The analysis indicates that cities which expanded rail systems significantly outperformed cities that only expanded bus systems in terms of ridership and operating cost efficiency, as summarized in figures 33 and 34.

Figure 34 **Change in Operating Costs Per Passenger-Mile** (Henry and Litman 2006)

Between 1996 and 2003 real operating costs per passenger-mile declined in cities that have new or expanded rail service, but increased in cities that only expanded bus service.

However, BRT systems have proven successful at attracting riders and stimulating transit-oriented development (Hidalgo and Carrigan 2010). In a detailed analysis Bruun (2005) found that in a typical case, both Light Rail Transit (LRT) and Bus Rapid Transit (BRT) have lower operating costs per passenger-space-kilometer during base periods than regular buses. For trunk line capacities below about 1,600 spaces-per-hour, BRT tends to be cheapest, while above 2,000 spaces-per-hour BRT headways become so short that traffic signal priority becomes ineffective, reducing service efficiency and increasing unit costs. The marginal cost of adding off-peak service is lowest for LRT, higher for BRT, and highest for regular buses.

Key differences between bus and rail transit are summarized on the next page. Each is most appropriate in particular situations. Bus is best serving areas with more dispersed destinations and lower demand. Rail is best serving corridors where destinations are concentrated, such as large commercial centers and mixed-use urban villages, or as a catalyst to create more accessible, multi-modal communities. Rail tends to attract more riders within a given area, but buses can cover larger areas. Both become more efficient and effective at achieving planning objectives if implemented with supportive policies that improve service quality, create supportive land use patterns and encourage ridership.

Bus Transit

Flexibility. Bus routes can change and expand when needed, for example, if a roadway is closed, or if destinations or demand changes.

Requires no special facilities. Buses can use existing roadways, and general traffic lanes can be converted into a busway.

More suitable for dispersed land use, and so can serve a greater rider catchment area.

Several routes can converge onto one busway, reducing the need for transfers. For example, buses that start at several suburban communities can all use a busway to a city center.

Lower capital costs.

Is used more by transit dependent people, so bus service improvements provide greater equity benefits.

Rail Transit

Greater demand. Rail tends to attract more discretionary riders than buses.

Greater comfort, including larger seats with more legroom, more space per passenger, and smother and quieter ride.

More voter support for rail than for bus improvements.

Greater maximum capacity. Rail requires less space and is more cost effective on high volume routes.

Greater travel speed and reliability, where rail transit is grade separated.

More positive land use impacts. Rail tends to be a catalyst for more accessible development patterns.

Increased property values near transit stations.

Less air and noise pollution, particularly if electric powered.

Rails stations tend to be more pleasant than bus stations, so rail is more appropriate where many transit vehicles congregate.

Rail transit can be compared to a better quality automobile: it costs more initially but provides higher quality service and greater long-run value. As consumers become wealthier and accustomed to higher quality goods it is reasonable that they should demand features such as more leg-room, comfortable seats, smoother and quieter ride (and therefore better ability to read, converse, and rest), and greater travel speed associated with grade-separated service. The preference of rail over bus can be considered an expression of consumer sovereignty, that is, people’s willingness to pay extra for the amenities they prefer.

This is not to degrade bus transit. Rail and bus are complementary; rail is only appropriate on major corridors and relies on bus transit as feeder service. Bus systems can be designed with many of the attributes that attract discretionary travelers (grade separation, attractive vehicles, attractive stations that provide a catalyst for transit oriented development), and so can provide congestion, accident and emission reduction benefits. Many of the transit encouragement strategies encourage bus as well as rail ridership.

Hiawatha Ridership exceeds Projections
Laurie Blake, "Light-Rail Ridership: A Love Story," *Minneapolis Star Tribune* (*www.startribune.com/stories/462/5724628.html*), November 14, 2005

When his carpool collapses for a day, John Healy has no qualms about riding light rail to work in downtown Minneapolis. "It seems a little more predictable and regular than the bus," he said...there is always another one coming." Healy is a new breed of transit rider – willing to take trains, but rarely, if ever, climbing aboard a bus. A 2004 survey found that 40% of Hiawatha's riders are like Healy – not bus riders before train service began. This preference for rail largely explains why the Hiawatha ridership is exceeding projections. Preconstruction predictions did not factor in positive attitudes toward the train. The Hiawatha ridership is 65% higher than predicted. In October, an estimated 742,000 riders used the line.

Rail's smooth ride and consistent schedule make it appealing to riders who would not consider the bus. The permanence of the track and the frequency of service make it easy to use without knowing a schedule. Within one year, light rail has emerged as the single busiest transit line in the metro area.

What Converts Like
The train made a transit convert of Jennifer Johnson of south Minneapolis, who said she and her husband never went downtown before the rail line opened. Now they go twice a month on the Hiawatha. "It's quick, it's clean, it's safe and little kids love the train," said Johnson, who had her child in tow. Flight attendant Cara Cobb, from Detroit, said it was the quick, direct rail service that prompted her to take the train from the Minneapolis-St. Paul Airport to the Mall of America during a break from work. "It was cheap and it was fun and we didn't have to wait long," she said. Had she ever taken a bus to the mall? Cobb shrugged. "I don't know where you get a bus at the airport."

Burnsville retiree Warren Nordley drove to Bloomington to catch the train to a University of Minnesota class. "I personally enjoy it," he said. "I feel it is a much more pleasant way to go than the bus. The big open windows – it's just a more pleasant feeling. And you are totally immune to the traffic." Nordley said he believes that men in general find the bus "beneath their dignity – it's just not classy enough." As a transit advocate, he prefers the train, but "either bus or train are far superior to driving your car."

Repercussions for the Future
The Metropolitan Council based its rail-rider predictions on bus-rider behavior. Wary of overstated ridership, the FTA discouraged even a 25% padding for rail preference, said Natalio Diaz, Council transportation planning director. "Now we have real numbers from observed behavior," Diaz said. "About 40% of the riders are people who were not using the bus. That is a huge amount."

Officials have spent more than a year correcting the metro area's forecasting methods to better reflect rail's appeal. This change could be important for ridership predictions on a proposed central corridor rail line along University Avenue linking St. Paul and Minneapolis. An upcoming environmental impact statement will compare the pros and cons of a rail line with bus rapid transit. Ridership will be central to that comparison and a key part of the choice between rail or bus, Diaz said.

Evaluating Rail Transit Criticism

This section evaluates common rail transit criticisms. For more information see, "Evaluating Rail Transit Criticism" (Litman 2004c), "The First Casualty of a Non-Existent War" (Litman 2011) and CFTE (2005).

Rail transit is not appropriate in every situation, and even the best transit program can be improved. Rail transit supporters should therefore welcome legitimate criticism to help identify possible problems and opportunities for improvement. However, some types of criticism are not helpful, because they misrepresent issues and reflect inaccurate analysis. It is therefore helpful to examine and evaluate rail transit criticisms to identify legitimate issues and concerns, and to recognize errors and misrepresentations.

A good research document provides readers with the information they need to make an informed assessment, including an overview of issues and information sources, discussion of various perspectives and evaluation methods, and information that both supports and contradicts (if any exists) the authors conclusions (Litman, 2004b). Many transit studies do this, providing accurate and useful analysis.

But some critics provide inaccurate information and biased analysis intended to present rail transit in a negative light. They fail to use best practices for accurate transit evaluation. They ignoring other perspectives, and suppress data that contradict their arguments. These critics tend to consider a relatively limited set of transit impacts, as summarized in Table 13. As a result, they tend to understate the full benefits of transit.

Table 13 **Impacts Considered and Overlooked** (Litman 2004a)

Usually Considered	Often Overlooked
Financial costs to governments Vehicle operating costs (fuel, tolls, tire wear) Travel time (reduced congestion) Per-mile crash risk Project construction environmental impacts	Downstream congestion impacts Impacts on non-motorized travel Parking costs Vehicle ownership costs (depreciation, insurance, etc.) Project construction traffic delays Impacts of generated traffic Indirect environmental impacts Strategic land use impacts Impacts on transportation diversity (particularly mobility for non-drivers) Equity impacts Per-capita crash risk Impacts on physical activity and public health

Older transportation evaluation models tended to focus on a limited set of impacts, which tends to undervalue transit services and improvements.

Specific examples of rail transit criticism are examined in the following pages.

Washington's War on Cars and the Suburbs

A paper by Wendell Cox (2010) titled, *Washington's War on Cars and the Suburbs: Secretary LaHood's False Claims on Roads and Transit* criticizes USDOT transit investment plans, arguing that rail transit benefits are unproven and exaggerated. It criticizes this report, the source of many of the Secretary's claims. Cox's criticisms violate basic principles of good scholarship and debate (Litman 2004b). His criticisms are critiqued below and in more detail in Litman (2011). The table below summarizes his conclusions (first two columns), and my critique (right column).

Table 6 **Critique of Cox's Conclusions** (Litman 2011)

Issue	Cox's Criticism	My Critique
Vehicle travel impacts	Public transit, particularly new rail systems, cannot attract motorists	Numerous studies indicate that high quality transit does attract discretionary travelers, and with supportive land use policies will leverage additional VMT reductions. Cox's evidence is weak and ignores leverage effects.
Cost efficiency	Public transit has excessive costs and declining cost efficiency (increasing cents per passenger-mile).	High quality transit has high construction but lower operating costs than basic transit, and provides many benefits which offset any additional costs. Cox exaggerates transit costs and ignores many benefits.
Consumer preferences	Most people prefer automobile travel and automobile-dependent communities.	Many people cannot drive and current demographic and economic trends are increasing demand for alternative modes and transit-oriented development. Providing high quality public transit responds to this demand.
Economic benefits	Purported benefits are minuscule and unachievable, and offset by additional transit service costs.	Cox only considers a small portion of transit economic benefits. Subsequent analysis indicates even greater benefits than originally estimated.
Energy savings	USDOE data indicate small differences between auto and transit energy use. Future cars will be even more efficient.	Cox ignores new research on lifecycle energy consumption and the energy savings provided by vehicle travel reductions. He ignores future transit energy efficiency improvements.
Congestion cost savings	Work trip travel times are longer in large-rail metropolitan areas.	Many studies indicate that high quality, grade separated transit reduces congestion costs.
Consumer transportation cost savings	Transportation (and housing) costs are higher, not lower, in large rail metropolitan areas.	Many studies indicate that high quality transit provides large consumer savings, particularly for lower-income households. Cox uses data that ignore these impacts.
Road and parking savings	The estimates are invalid because they are based upon automobile driver attraction rates far beyond the levels indicated by experience.	Multiple data sources indicate that 50-80% of rail trips substitute for driving, and transit-oriented development reduces per capita vehicle ownership and use, providing road and parking facility cost savings.
Accident cost savings	Purported savings are insufficient to deter households from using cars to achieve important economic and other benefits.	This is a non-sequitur. Only if high quality transit service is available can people choose it, and experience indicates they will. Safety benefits are large and provide another justification for high quality transit.

The two left columns are from Cox's paper. The right column is my critique. Cox misrepresents issues and data, ignores impact categories, and relies largely on his own studies that lack peer review.

"Urban Rail: Uses and Misuses" *(Cox 2000 and 2010)*

Wendell Cox makes the following claims in a policy statement titled *Urban Rail: Uses and Misuses*. Responses to his claims are in italics.

- Virtually no traffic congestion reduction has occurred as a result of building new urban rail systems.
  As this report shows, cities with well-established rail transit have substantially lower per capita traffic congestion delay than cities with smaller or no rail system. Cities with new or expanding rail transit systems often experience reductions in vehicle ownership and use along rail corridors, attributed to a combination of transit improvements and transit-oriented development (see box).

Transit Improvements Help Reduce Vehicle Ownership and Use (www.translink.bc.ca)
In 2004 the city of Vancouver recorded a small decline in the number of automobiles registered in the city, and a reduction in downtown automobile trips, reversing a growth trend between 1994 and 2003. Small decreases were also recorded in some nearby suburbs, and others saw a reduction in the growth rate. Experts conclude that this results from increased transit services and a growing preference for urban lifestyle. "There are some fundamental changes going on," says David Baxter of the research firm Urban Futures. "It's increasingly possible to live in Vancouver without a motor vehicle."

Commuters are increasingly selecting alternative modes. Transit ridership rose by 9.5% in the first half of this year compared to the same period last year, and was 24.6% higher than 2002. Bus trips increased by 11.1%, and rail trips increased by 5.4%. A customer survey found that that 42% of riders on the SkyTrain, 49% on the West Coast Express, 35% on the 99B bus route and 25% on the 98B route switched from commuting by car. "The numbers show that demand for public transit continues to grow in response to the significant expansion of services."

- Virtually any public benefit that has been achieved through urban rail could have been achieved for considerably less by other strategies.
  As this study shows, rail provides unique benefits. Rail transit reduces per capita congestion delays, traffic fatalities, consumer costs, and transit operating costs, increases transit service cost recovery, and provide other benefits. This occurs because rail tends to attract more discretionary riders than buses, does not require the ability to drive like a private automobile, avoids congestion if grade separated, and helps increase land use accessibility.

- Where the automobile has become the dominant form of transport, and where urban areas have become decentralized and highly suburbanized, there are simply not a sufficient number of people going to the same place at the same time to justify urban rail. As a result, it is typically less expensive to provide a new car for each new rider than to build an urban rail system.
  Many people are moving back into cities, and many suburbs are becoming more urbanized. If a travel corridor has enough travel demand to create significant congestion there is often enough demand to justify some form of grade-separated transit. Claims that it is cheaper to provide a new car rather than build an urban rail system overlook significant costs, including the costs of roadway capacity and parking facilities at destinations, and the costs of increased traffic congestion, traffic accidents and pollution emissions. It also ignores the fact that many transit users cannot or should not drive, and other benefits of rail transit.

"Great Rail Disasters" *(O'Toole 2004)*

Great Rail Disasters argues that rail transit is ineffective at improving transportation system performance and wasteful. Other rail critics, such as Balaker (2004), have citied O'Toole's study heavily. *Great Rail Disasters* uses a thirteen-component index created by the author to evaluate rail transit system performance. This analysis framework appears to be carefully designed to portray rail transit in a negative way. The report contains several fundamental omissions and misrepresentations. Major errors include:

- Failing to differentiate between cities with relatively large, well-established rail systems and those with smaller and newer systems that cannot be expected to have significant impacts on regional transportation performance.
- Lack of with-and-without analysis. There are virtually no comparisons between cities that have rail and those that do not. It is therefore impossible to identify rail transit impacts.
- Evaluating congestion impacts based on "Travel Time Index" values. Of the various congestion indicators this is one of the least appropriate for evaluating grade-separated transit, since it only considers delays to road vehicles, ignoring benefits to people who shift to transit, and from vehicle traffic reductions due to more accessible land use.
- Failing to compare individual cities and national trends. During the time period used for analysis, from 1970 to 2000, transit ridership and mode share declined nationally, so a lower rate of decline could be considered successful compared with most other cities.
- Failing to account for additional factors that affect transportation and urban development conditions, such as city size, changes in population and employment.
- Ignoring and understating significant costs of automobile travel. Vehicle expenses are included when calculating transit costs, but vehicle and parking expenses are ignored when calculating automobile costs.
- Exaggerating transit development costs. Claims, such as "Regions that emphasize rail transit typically spend 30 to 80 percent of their transportation capital budgets on transit" are unverified and generally only true for certain regions and years, not when costs are averaged over larger areas and times.
- Presenting outdated data as current, including examples from the 1960s through early 80's, and airport ridership data from 1990.
- Ignoring other benefits of rail transit, such as parking cost savings, consumer cost savings and increased property values in areas with rail transit systems.
- Failing to reference documents that reflect current best practices in transit evaluation, such as ECONorthwest and PBQD (2002) or Litman (2004) or provide any information showing alternative perspectives.

Great Rail Disasters' bias is revealed in its analysis of Portland, Oregon. According to many of its own indicators Portland's rail system is successful, with increasing transit ridership and commute mode share. Still, O'Toole concludes that Portland's rail system is harmful because it involves transit-oriented development, which he claims is harmful to consumers. Yet, there is plenty of evidence that many consumers want to live in transit-oriented communities (Reconnecting America 2004).

"Light Rail Boon or Boondoggle" *(Castelazo and Garrett 2004)*

An article by Molly D. Castelazo and Thomas A. Garrett ("Light Rail: Boon or Boondoggle" 2004) argues that light rail investments are inefficient. Their analysis contains several critical errors. They ignore many costs of automobile transportation, including roadway costs, consumer costs, downstream congestion, parking facility costs, accident costs and pollution impacts. They use *average* cost values that underestimate the actual costs of accommodating increased automobile traffic in dense urban areas. They claim that light rail is more costly than automobile or bus transport, based on a national cost value of 54.4¢ per passenger-mile for light rail, although the actual cost in St. Louis is just 27¢, which is lower than either automobile or bus costs. They claim that light rail only provides short-term congestion and pollution reduction benefits, which is untrue, and indicates that they are unfamiliar with the issues.

Castelazo and Garrett argue that it would be cheaper to provide low-income motorists with a car than light rail transit service. This overlooks several important points.

- First, transit is subsidized for several reasons besides providing mobility to lower-income travelers. Only a small portion of transit subsidies could efficiently or equitably be shifted to any one of these objectives.
- Second, many transit riders cannot or should not drive. Subsidized cars would not solve their mobility problems, and would tend to increase higher-risk driving.
- Third, substituting car ownership for transit service is more expensive than they claim. Eliminating scheduled transit service would force riders who cannot drive to use demand-response or taxi services, which have far higher costs than simply driving a car.
- Fourth, increased vehicle traffic on busy urban corridors would significantly increase traffic congestion, road and parking costs, accidents, pollution and other external costs. Castelazo and Garrett underestimate these costs. In footnote 3 they calculate that giving 7,700 vehicles to current rail users would only increase regional congestion by 0.5%. But rail users commute on the city's most congested corridors, so congestion impacts will be proportionately large. The Texas Transportation Institute calculates that St. Louis traffic congestion costs totaled $738 million in 2001. If 7,700 additional downtown automobile commuters increases congestion 2.5-5.0%, this represents $18 to $37 million in additional annual congestion costs.
- Fifth, there are substantial practical problems subsiding cars. Castelazo and Garrett apparently assume that the 7,700 rail transit riders they identify as being unable to afford a car are a distinct, identifiable group. In fact, they consist of a much larger group, many of whom only use transit occasionally. As a result, it would be necessary to offer a much larger number of households a part-time car, with provisions that account for constant changes in their mobility needs and abilities. Like any subsidy program, it would face substantial administrative costs and require complex rules to determine who receives how much subsidy in a fair and effective way. It would create perverse incentives, rewarding poverty and automobile dependency.
- Finally, as described earlier, rail transit can provide a catalyst for mixed-use, walkable urban villages and residential neighborhoods where it is possible to live and participate in normal activities without needing a car, which is particularly beneficial to non-drivers.

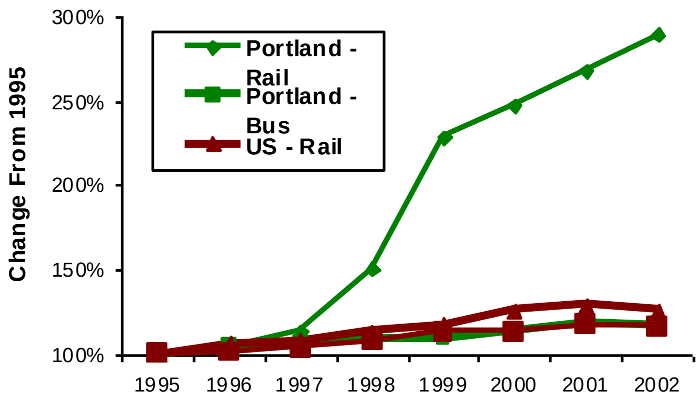
Possible Offsetting Factors

This study indicates that rail transit can provide various economic, social and environmental benefits, which in total significantly exceed rail system costs. It is worth investigating whether additional factors may offset these benefits, making rail transit harmful overall as some critics claim. Four possible factors are discussed below.

First, it is possible that these benefits are offset by disadvantages from reduced driving and transit oriented development. This would be true if automobile travel and sprawl were truly superior and universally preferred by consumers, but there is considerable evidence that at the margin (compared with current travel and land use patterns) many people would prefer to drive less, rely more on other modes, and live in more accessible, multi-modal communities (Litman 2009c; PPIC 2002). This demand is likely to increase due to shifting demographics and consumer preferences (Reconnecting America 2004).

A second possible counter-argument is that the superior performance of cities with rail transit is not *caused* by the rail service, but is simply an association resulting from other factors, such as these city's age or size. Some evidence supports this, since the cities with the best performance are old and large (New York, Chicago, Boston and Philadelphia). This argument implies that, although older cities with rail transit systems may have more efficient land use patterns that provide various benefits, it is impossible to create such land use patterns now, so new rail systems or expanding smaller rail systems may fail to achieve significant benefits, at least for many decades.

Figure 35 **U.S. and Portland Transit Travel Trends** (APTA & FHWA Data)



Portland rail transit ridership is growing much faster than national trends.

However, there are indications that new rail transit services can have desirable effects if implemented with supportive policies. For example, transit ridership has grown significantly in Portland in response to the city's rail system expansion, as indicated in Figure 35. Greater growth rates occur on particular corridors and in neighborhoods served by rail, as described earlier in this report. This suggests that significant positive impacts are possible, and the debate can shift from *whether* new rail systems can achieve planning objectives, to *how* to best accomplish this (discussed in the next section).

Table 14 investigates the influence of city size on transportation system performance, using matched pair analysis of cities of comparable size with and without major rail transit systems. In nearly all cases, Large Rail performs better than Small Rail of comparable size (no large cities are classified as Bus Only). This indicates that rail transit systems really do provide performance benefits. The magnitude of these benefits suggests that rail is particularly important in large or growing cities.

Table 14 **Matched Pair Comparison Of Six Large U.S. Cities**

City	Category	Population	Transit Ridership	Congestion Costs	Traffic Fatalities	Consumer Costs	Cost Efficiency
			Per capita Pass.-Miles	Avg. Per-capita congestion costs	Deaths per 100,000 pop.	Per capita expenditures	Transit Cost Recovery
Chicago	Large Rail	8,307,904	447	515	7.9	$2,824	42%
Los Angeles	Small Rail	11,789,487	227	1005	7.8	$3,165	27%
Difference		*-42%*	*49%*	*-95%*	*2%*	*-12%*	*35%*
Philadelphia	Large Rail	5,149,079	720	330	9.3	$2,395	39%
Miami	Small Rail	4,919,036	136	625	13.3	$2,720	25%
Difference		*4%*	*81%*	*-89%*	*-43%*	*-14%*	*38%*
Boston	Large Rail	4,032,484	445	560	5.7	$2,897	31%
Dallas	Small Rail	4,145,659	113	710	12.0	$3,723	10%
Difference		*-3%*	*75%*	*-27%*	*-111%*	*-28%*	*67%*

This table compares the three largest Large Rail and the three largest Small Rail cities. Large Rail cities perform significantly better in nearly every category.

A third counter-argument is that bus transit could provide equal benefits as rail at a lower cost. This does not appear to be the case. Rail offers greater benefits due to its ability to attract more discretionary travelers and provide a catalyst for more efficient land use. Costs per passenger-mile are often lower for rail than bus transit, and unit costs for all forms of transit tend to be lower in cities with large, well-established rail systems. This indicates that in appropriate conditions, rail can be the more cost effective transit option.

Of course, there are plenty of situations in which rail transit is not cost effective due to inadequate demand, unusually high construction costs, or a lack of integration with transportation and land use policies, and other transit options should be selected. Rail transit projects should not be implemented simply for prestige or to obtain federal funds (Dittmar 1997). Rail transit should only be implemented in urban areas that desire to become more multi-modal, and are willing to make an adequate commitment.

Although it is important to consider these arguments and perspectives when evaluating rail transit, there is no evidence that they eliminate rail transit benefits. On the contrary, even when these factors are taken into account, existing rail transit systems clearly provide significant net benefits, and new rail transit services can provide net benefits if they are properly planned, with features to optimize service quality, attract ridership and create supportive land use, such as those described in the next section.

Increasing Rail Transit Benefits

Rail transit is sometimes criticized for poor service or low ridership. These concerns can often be addressed by implementing various strategies that improve service and increase ridership, many of which are justified on other grounds such as fairness, consumer benefits and cost savings. Examples are described below.

- *Service Improvements.* There are various ways to make rail transit faster, more convenient and more comfortable, and therefore more attractive to travelers.
- *Parking Management*. Parking management includes parking "cash out" (employees who receive free parking can choose cash or a transit subsidy instead), "unbundling" (renters only pay for the amount of parking they actually want), and more flexible parking requirements. These strategies often increase transit ridership by 10-30%.
- *Commute Trip Reduction (CTR) Programs.* CTR programs give commuters resources and incentives to reduce their automobile trips. They typically include financial incentives (parking cash out and transit allowances), transit promotion, parking management, flextime and guaranteed ride home services. Such programs typically reduce 10-40% automobile commute trip among affected employees, about a third of which shift to transit.
- *Nonmotorized Improvements.* Walking and cycling are important travel modes in their own right, and provide access to public transit. In many situations nonmotorized improvements may increase transit ridership 10-40% over what would otherwise occur.
- *Marketing and User Information*. Improved route schedules and maps, wayfinding information, webpages and marketing programs can often increase transit use by 10-25%.
- *Transit Oriented Development* (TOD) refers to residential and commercial areas designed to maximize access by public transit and nonmotorized modes. This means that development is clustered in an areas with high level of transit service, and good walking and cycling conditions. Residents of TODs typically use transit 25-50% more than residents of otherwise comparable communities.
- *Transit Fare Innovations.* Smart cards make transit use more convenient and allow transit agencies to offer new discounts, such as lower rates during off-peak periods, for special groups and for bulk ticket purchase.
- *Campus and School Transport Management Programs*. These programs improve travel options and reduce trips at schools and campus facilities. This often includes free or discounted transit passes to students and sometimes staff (called a "UPASS"). Such programs often increase transit ridership 30-100% among affected groups.
- *Road Pricing Reforms.* Congestion pricing, distance-based fees and Pay-As-You-Drive vehicle insurance are justified on equity and efficiency grounds, and can increase transit ridership.

Rail transit experiences significant economies of scale and network effects, that is, the larger the system, the more useful it is, the more ridership it attracts, the more it will be integrated into overall transportation and land use patterns, and so the more total benefits it will provide.

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.

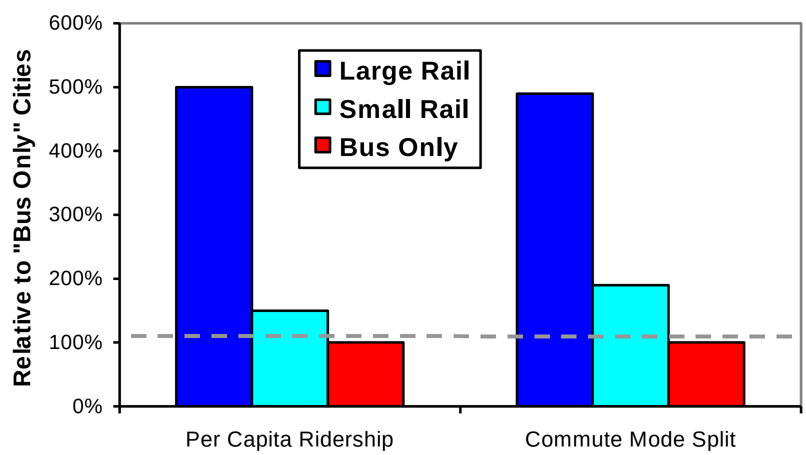
Table 15 **Transportation Performance Comparison**

	Definition	Large Rail	Small Rail	Bus Only
Ridership	Annual Passenger-Miles Per Capita	589	176	118
Commute Mode share	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. "Large Rail" cities outperform "Small Rail" and "Bus Only" cities in all except congestion delays. When city size is taken into account, Large Rail cities outperform by this factor too.

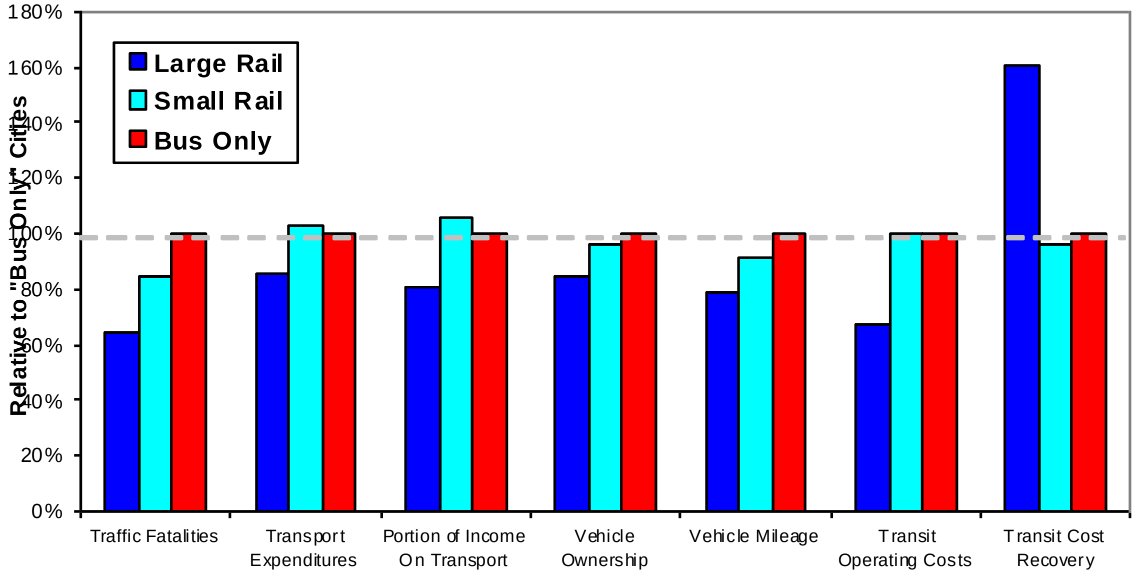
For this study, U.S. cities were divided into *Large Rail* (rail serves a significant portion of local travel), *Small Rail* (rail serves a minor portion of local travel), and *Bus Only* (city has no rail transit system). This analysis indicates that Large Rail cities have significantly superior transport system performance, as summarized in Table 15 and illustrated in figures 36 and 37.

Figure 36 **Transit Ridership and Commute Mode share Comparison**



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

Figure 37 **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:

- Four times the per capita transit ridership.
- A fifth lower per capita vehicle mileage.
- 30-50% lower per capita congestion costs.
- A third lower per-capita traffic fatality rates.
- 20% smaller portion of household budgets devoted to transport, saving about $500 annually per capita.
- A third lower transit operating costs.
- 58% higher transit service cost recovery.
- Improved fitness and health (since most transit trips have walking or cycling links, so transit travelers are much more likely to achieve physical activity targets than motorists).
- Increased money circulating in local economies (since transit travelers spend significantly less on imported vehicles and fuel, leaving more money to spend on other goods which tend to have more local input).
- More efficient land use and higher property values.
- Improved environmental performance.

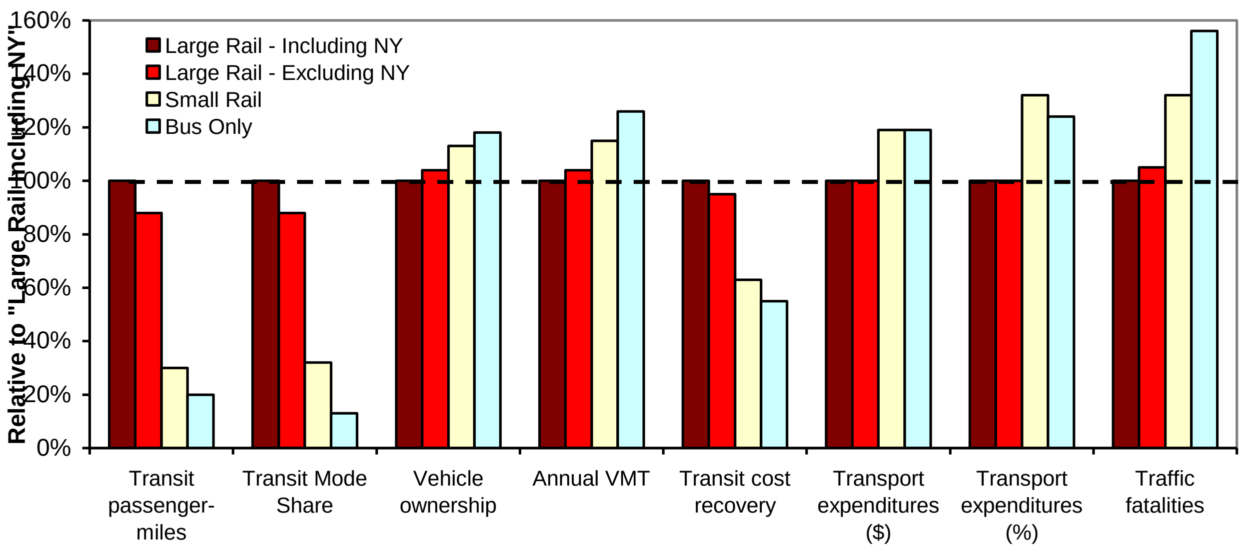
Some critics have argued (apparently without bothering to analyze the data) that these impacts and benefits are dominated by New York City, and so are unachievable in most communities (Cox 2010). Table 16 and Figure 38 show these analysis results including and excluding New York City. This indicates that the critics are wrong. Excluding New York City has only a small effect on most analysis results.

Table 16 **New York Impacts on Analysis Results** (Litman 2004a)

	Large Rail - Including NY	Large Rail - Excluding NY	Small Rail	Bus Only
Annual transit passenger-miles per capita	589	520	176	118
Central City Transit Mode Share	34.8%	30.7%	11.0%	4.5%
Vehicle ownership per capita	0.68	0.71	0.77	0.80
Annual VMT per capita	7,548	7,840	8,679	9,506
Transit cost recovery	38%	36%	24%	21%
Transport expenditures per capita	$2,808	$2,803	$3,350	$3,332
Household income devoted to transport	12.0%	12.0%	15.8%	14.9%
Traffic fatalities per 100,000 residents	7.5	7.9	9.9	11.7

This table summarizes this study's results including and excluding New York City.

Figure 38 **New York Impacts on Analysis Results** (Litman 2004a)



Critics claim that rail transit benefits are dominated by New York City. They are wrong. In most cases, excluding New York has little impact on results.

These benefits result largely 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 significant costs. 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. However, 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 $50 billion in reduced crash damages.

From a household's perspective, rail transit provides a positive return on investment (Litman 2010). 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 analysis 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 who would otherwise drive. This requires quality services that respond to user preferences, and are implemented with support strategies such as rider incentives and transit-oriented development. Rail systems experience significant economies of scale and network effects: the more complete the system the more it helps achieve transportation and land use planning objectives. For this reason, often the best response to criticism is to expand and increase support for rail systems.

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 facilities 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.

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