

The Benefits of Transit in the United States: A Review and Analysis of Benefit-Cost Studies



MTI Report WP 12-04



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REPORT WP 12-04

THE BENEFITS OF TRANSIT IN THE UNITED STATES: A REVIEW AND ANALYSIS OF BENEFIT-COST STUDIES

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EXECUTIVE SUMMARY

This white paper documents the findings from a review of available research literature on the benefits and costs of transit systems in the United States. The primary goals of this research were to 1) identify benefit-cost (b-c) ratio estimates for U.S. transit systems, and 2) identify the main categories of monetized benefits that derive from transit services in the U.S. The assembled data will help planners, advocates and policy-makers by:

1. Providing a resource of collected benefit-cost ratios and other quantifiable, monetized benefits of transit,
2. Identifying the key monetized benefits of transit that may be of interest to planners, advocates, and policy-makers, and
3. Providing a collection of monetized transit benefits that might be useful to researchers seeking ways to advance the methods for quantifying benefits and costs.

A review and analysis of the available b-c ratio estimates for transit systems in the U.S. found wide variation among sources. Some of these differences are attributable to the population sizes and densities of the service areas—the context—with rural and small urban areas generally yielding lower b-c values than urbanized areas.

However, substantial differences remained even after the context was accounted for, suggesting that analysts are using different methods of analysis and that appropriate transit investments in rural and small urban areas can yield benefits substantially greater than costs. The benefits of transit were measurable and strong in a variety of operating environments not just in large cities. Key findings from this review and analysis were:

- **Substantial transit benefits in rural and small urban areas:** While two studies for rural area transit services found ratios either below or slightly above “1” for every dollar spent (Godavarthy et al. 2014 and Penet 2011), Burkhardt et al. (1998) found values ranging from a respectable 1.67 to a high of 4.22. Further investigations revealed that these substantial differences among studies were due to Burkhardt et al.’s measurement of the economic benefits to riders and transit-dependent populations. These findings suggest that appropriate transit investments in rural and small urban areas can yield benefits substantially higher than costs. Small urban b-c ratios were even better, ranging from 1.23 (Penet 2011) to a remarkable 9.70 for Danbury, Connecticut (Skolnik and Schreiner 1998).
- **Transit pays for itself in congestion relief benefits for mid- to large-sized urban areas:** According to this report’s analysis of Harford’s (2006) b-c study of transit systems in mid- to large-sized metropolitan areas, congestion relief benefits from transit investments begin to exceed transit costs for metro areas of 2.5 million people or larger.
- **Jobs and economic stimulus are among the largest benefit categories from transit investments:** Benefits to jobs and the economy were found to be one of the

most important categories in the b-c studies reviewed. While these benefits tended to be larger in urbanized areas compared with small urban and rural areas, smaller population areas stand to gain substantially from transit services, with between 40%-46% of total transit benefits attributable to jobs and the economy.

- **Transit improves health care access and outcomes while reducing costs:** Few of the published b-c studies surveyed for this white paper measured the health care cost benefits of transit. However, Godavarthy et al. (2014) found that giving people low-cost and reliable transit access to medical services decreases the tendency of low-income people living in rural and small urban areas to forgo treatments, thereby improving public health and reducing the costs of health care to society.
- **Transit saves people money:** While the financial benefits of transit in rural areas are generally low compared with the total costs of transit, small urban areas receive somewhat larger benefits. In addition, transit services in urbanized areas added the most money to peoples' pocketbooks relative to costs. Overall, this is an important benefit category for transit services.
- **Low b-c ratios aside, transit saves lives:** The safety and security benefits of transit were low compared with the total costs of transit in the studies reviewed here. However, this paper finds evidence that b-c analysis methods are likely undervaluing the important role transit plays in reducing accidents and injuries and the costs to society from both. In brief, existing analytic methods struggle with properly valuing human life and health in monetary terms. Some argue that transit's benefits (safety and otherwise) are low because most people choose auto travel over transit. However, this paper presents a brief but compelling argument that this is largely due to a history of underinvestment in transit services in the U.S., coupled with the predominance of auto-oriented land use planning and development.
- **Greenhouse gas emissions, air quality, and other important but undervalued transit benefits categories should be considered:** This paper concludes that several benefit categories should be considered for research and possible incorporation into future b-c estimation practices. The benefits of transit for fighting climate change through reduced greenhouse gas emissions, reducing dependence on foreign oil, increasing property values, encouraging more compact/transit-oriented development patterns, and improving emergency response services all were found to have received little attention from b-c studies. This is likely due, at least in part, to the lack of research investment in developing the rigorous analytic methods required for reliably and accurately measuring both the costs of these factors to society (climate change being a prominent example) and the benefits transit can yield in these areas. All merit further consideration and attention from policy-makers, academicians, and analyst practitioners.

I. INTRODUCTION

This white paper documents the findings from a review of available research literature on the benefits and costs of transit systems in the United States. Transit systems and collections of systems—as opposed to individual transit projects, routes, or lines—were targeted specifically for this research because the benefits and costs of entire systems are more likely to reflect the benefits and costs of transit for society as a whole.

As such, the primary goals of this research were to 1) identify benefit-cost (b-c) ratio estimates for U.S. transit systems, and 2) identify the main categories of monetized benefits that derive from transit services in the U.S. The assembled data will help planners, advocates and policy-makers by:

1. Providing a resource of collected benefit-cost ratios and other quantifiable, monetized benefits of transit,
2. Identifying the key benefits (monetized) of transit that may be of interest to planners, advocates and policy-makers, and
3. Providing a collection of monetized transit benefits that might be useful to researchers seeking ways to advance the methods for quantifying benefits and costs.

The first section briefly describes the methodology used to collect and analyze the transit benefits and costs data. The next section provides an overview of benefit-cost data collected from a review of the research and planning practice literature. This is followed by a presentation of the key benefits of transit as identified, measured, and analyzed in the benefit-cost literature. Finally, this white paper concludes with a summary of key findings from this research and suggests avenues for future work.

II. METHODOLOGY

The information and analysis presented in this white paper were developed primarily from a review of the available literature on benefit-cost (b-c) estimates of existing transit systems in the United States. The literature search was performed through a combination of online searches using standard search tools (e.g., Google), more specialized online search tools and databases (i.e., Google Scholar and the Transportation Research Information Services [TRIS]), and online and on-site searches at the University of California, Berkeley's Institute for Transportation Studies (ITS) Library.

Once the appropriate literature was identified and obtained, it was reviewed and evaluated according to three criteria. The literature was required to:

1. Contain benefit-cost estimates for U.S. transit systems and not, as mentioned previously, to measure individual transit projects, routes, or lines;
2. Provide detailed breakdowns of methods and results for individual benefit categories; and
3. Use methodologically sound estimation methods generally consistent with current best practices.

Once an inventory of the literature meeting these criteria was complete, the b-c estimates from each were organized according to the type of study area (e.g., rural, small urban, urban, etc.) and transit services provided. Patterns were identified and analyzed, as discussed in the "Benefit-Cost Ratios of Transit Services in the United States" section.

Through the process of organizing and analyzing these b-c estimates, categories of monetary transit benefits were also identified. The relative value and contribution of each benefit category to the total b-c estimates was then evaluated by breaking the estimated monetary value each analysis team gave them, as reported in their published findings, into benefit categories. The estimated dollar value for each benefit category was then divided by the total estimated costs of providing the transit services, thus creating a benefit-specific b-c ratio for each category. This allowed the benefits from each published study to be compared on an equal basis. As much as possible, it compared "apples-to-apples."

Where appropriate, additional literature on the benefits of transit (i.e., not from the b-c literature) was obtained and included in this white paper in order to cast light on specific issues or questions as they arose in the analytical process. Furthermore, it is important to note that while the non-monetary benefits of transit—such as social capital, quality of life, or "sense of place"—are not included in this analysis because they are not easily quantifiable, these benefits may be substantial and should be considered beyond the narrow confines of what b-c researchers and analysts currently measure.

III. BENEFIT-COST RATIOS OF TRANSIT SERVICES IN THE UNITED STATES

Understanding and measuring the benefits and costs of transit may seem straightforward at first glance, but there are many issues—big and small—that can be considered. As a result, there is a good deal of variation in what is counted in benefit-cost assessments.

In general, transit benefits the most people and is most cost-efficient in urban environments both large and small. Cities provide dense collections of riders (i.e., fare-paying customers) who want to make trips to dense collections of destinations. Transit planners try to make the best match of transit investments that will connect these origins and destinations with the fastest, most direct routes possible. Generally speaking, the more density, the more riders who can be served, and the more the investments pay off. However, this white paper finds evidence that transit pays off even in small urban and rural areas when the right transit investments are made. Thus, the ways transit pays off—the benefits—are as diverse as the communities it serves. This makes measurement difficult, but academics and practitioners have made strides in recent years in developing and applying consistent methods for measuring the benefits and costs of transit.

RURAL AND SMALL URBAN TRANSIT BENEFIT-COST RATIOS

A number of recent studies have estimated benefit-cost ratios for various classes of transit services (bus, rail, etc.) or transit services in different environments (rural, small urban, large urban). As mentioned previously, the highest benefit-cost ratios tend to be found in larger urban areas. Nevertheless, researchers have found cases of rural transit services that provide a net monetary benefit to their communities (i.e., a benefit-cost ratio greater than “1”). Table 1 provides a summary of the benefit-cost ratios for rural and small urban areas. Detailed, b-c estimates from Godavarthy et al. for rural and small urban areas in most U.S. states can be found in Appendix A, Table 3.

Table 1. Rural and Small Urban Benefit-Cost Ratios

Study Area	Benefit-Cost Ratio	Source
U.S. Small Urban & Rural		Godavarthy et al. (2014)
Rural	1.12	
Small Urban	2.16	
South Dakota	2.30	Penet (2011)
Rural	0.47	
Small Urban	1.23	
Urbanized	2.96	
Danbury, Connecticut (Small Urban)	9.70	Skolnik and Schreiner (1998)
Select U.S. Rural Transit Agencies		Burkhardt et al. (1998)
Blacksburg Transit, Virginia	1.67	
COLTS (Lee County), Maryland	4.22	
County Commuter, Maryland	3.18	
Delta Area Rural Transportation System, Mississippi	3.55	

Study Area	Benefit-Cost Ratio	Source
JAUNT, Inc., Virginia	1.85	
Pee Dee Regional Transportation Authority, North Carolina	3.25	
STAR, Sweetwater County, Wyoming	3.03	
Zuni Entrepreneurial Enterprises, New Mexico	4.22	

Rural areas are perhaps among the most challenging environments in which to plan and operate transit services due to low ridership, dispersed land use patterns, and low populations. Benefit-cost estimates for rural area transit services reflect these narrow margins, with several studies finding ratios either below or slightly above “1”. Godavarthy et al. (2014) found that rural transit services produce \$US1.12 for every dollar spent, which is a slight net benefit while Penet (2011) found that rural areas of South Dakota receive only 47 cents for every dollar spent. However, in a survey of select rural transit agencies from across the U.S., Burkhardt et al. (1998) found values ranging from a respectable 1.67 to a high of 4.22. Burkhardt et al.’s methods may help explain these high values. Their attention to the economic benefits to riders and transit-dependent populations led them to conclude that these benefits were the main generators of the high b-c ratios found in rural areas.

Burkhardt et al.’s encouraging findings aside, studies of small urban transit services generally tend to yield larger benefits. In their survey of U.S. small urban transit agencies, Godavarthy et al. (2014) found an average benefit-cost ratio of 2.16, indicating that benefits are generally more than double the costs. In a more focused study of small urban areas in South Dakota, Penet (2011) estimated a benefit-cost value of 1.23. This value is substantially lower than Godavarthy et al. found for small urban areas. However, comparison of the methodologies used by each research team suggests they used different definitions of “small urban.” While Godavarthy et al. classified areas with fewer than 200,000 people as small urban, Penet classified areas with between 2,500 and 50,000 people as small urban and those with populations between 50,000 and 200,000 as urbanized. Combining Penet’s urbanized and small urban benefit-cost ratio estimates (2.96 and 1.23 respectively) would likely yield an estimate somewhere close to the 2.16 value found for small urban areas by Godavarthy et al. Finally, a benefit-cost ratio of 9.7—the highest found in researching this white paper—was estimated by Skolnik and Schreiner (1998) for Danbury, Connecticut, a small urban area.

URBAN TRANSIT BENEFIT-COST RATIOS

Table 2 provides a summary of the benefit-cost ratios for larger, urban areas.

Table 2. Benefit-Cost Ratios for Urbanized Areas: Comparing Congestion-Only Estimates (Harford) vs. a Multiple-Benefit Estimate (Goldsmith et al.)

Study Area	Benefit-Cost Ratio	Source
Urbanized Areas (UZAs) by Population		Harford (2006)
700,000 - 1,000,000	0.75	
1,000,001 - 2,500,000	0.85	
2,500,001 - 5,000,000	1.34	

Study Area	Benefit-Cost Ratio	Source
5,000,001 - 8,000,000	1.32	
8,000,001 and over	1.62	
Anchorage, Alaska (300,000)	1.71	Goldsmith et al. (2006)

Harford (2006) estimated and compared benefit-cost ratios for urbanized areas (UZAs) across the U.S., reporting individual benefit-cost ratios by UZA, with low, medium, and high estimates for each. For the purposes of this white paper and ease of interpretation, the averaged medium b-c ratio scores for UZAs grouped by population are presented in Table 2.

At first glance, Harford's estimates appear surprisingly low compared with those found for rural and small urban areas (Table 1). While rural and small urban areas yielded estimates ranging from 0.47 to 9.7, Harford's estimates ranged from 0.75 for UZAs between 700,000 and 1 million and 1.62 for the largest UZAs of 8,000,000 and over.

Additional comparisons with Goldsmith et al.'s (2006) benefit-cost analysis of Anchorage, Alaska's People Mover transit system deepen the mystery. While Anchorage's population is roughly 300,000, its estimated b-c ratio of 1.71 is higher than the best average b-c ratio found by Harford for UZAs over 8 million people.

Closer inspection of the methods used by Harford compared with the other sources previously mentioned suggests the reason for these inconsistencies. Harford measured only the benefits of transit to reducing congestion, but the other researchers included measurements of other benefits such as access to jobs and services for transit-dependent populations, savings from owning fewer automobiles, and the economic benefits of transit systems to their communities. In short, Harford's estimates were more narrowly focused while other researchers took a more wide-ranging approach to benefits measurement.

Inconsistencies among researchers notwithstanding, Harford's findings show a steady progression of increasing benefits from transit as population increases. In other words, larger cities receive more directly measurable monetary benefits. More to the point, because Harford measured only the beneficial effects of transit on auto congestion, the larger the metropolitan area, the more congestion they are likely to have, and the more congestion relief benefits they stand to gain from transit investments.

THE BENEFITS OF TRANSIT

As the methods for estimating b-c ratios for transit have improved—with more categories of benefits added to accepted and expected practice—the understanding of the range of benefits transit provides to society have expanded as well. With the exception of congestion, early b-c transit estimates were generally focused on measuring the direct benefits that transit brought to riders. Over time, methods for quantifying the benefits to the larger society (i.e., non-riders) and the environment have been developed as well.

Based in part on a review of the b-c studies reviewed for this white paper, the following key benefits of transit were the most-often cited and measured:

- Traffic Congestion
- Jobs and the Economy
- Health Care Costs
- Saving Money
- Safety and Security

These benefit categories are discussed in greater detail below, to the extent that the benefits were measured and reported in such a way that the unique contribution of each could be separated from the others and analyzed.

TRAFFIC CONGESTION

Traffic congestion features prominently in much of the discourse about the benefits of transit. Review of Figure 1 suggests that, in general, the larger the metropolitan area, the more people suffer from congestion-caused delay when driving.

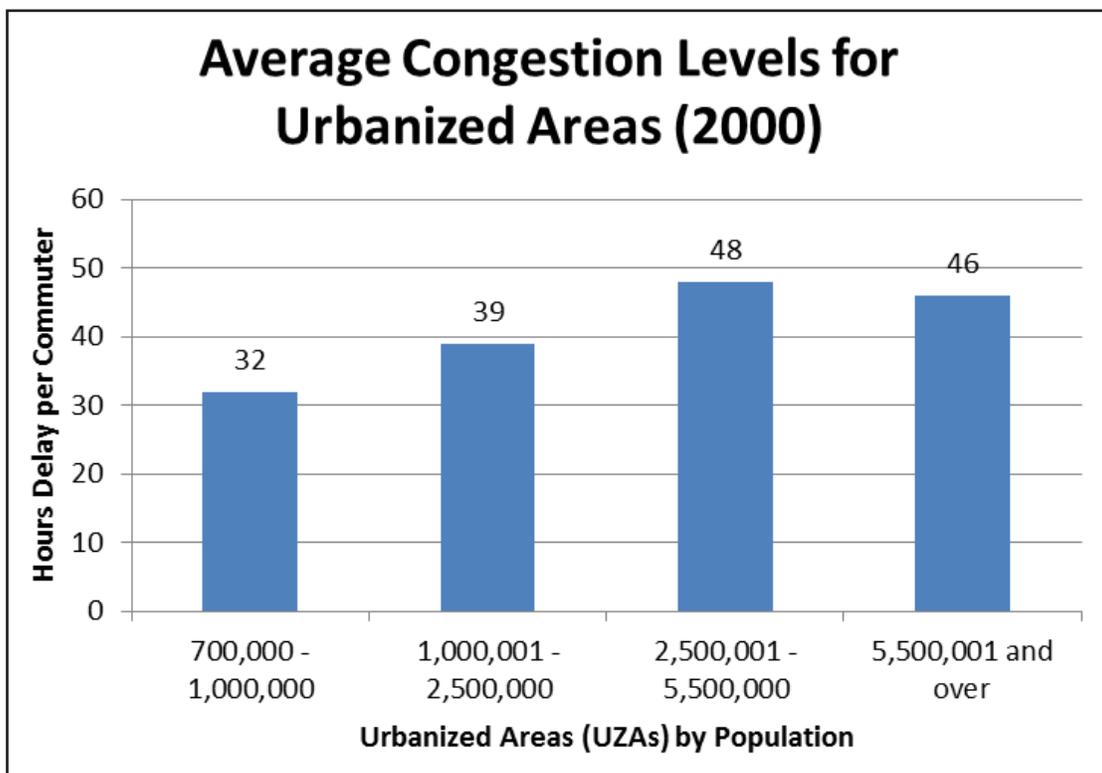


Figure 1. Congestion-Caused Delay by Size of Metropolitan Area (UZA)

Source: Texas Transportation Institute (2012).

It is interesting to note that, while average delay experienced by drivers increases for metropolitan areas between 700,000 and 5.5 million people, delay drops slightly for the largest areas—areas that also tend to have the most comprehensive transit service

networks in the U.S. While not verifiable from the research presented here, it is reasonable to suggest that the largest metropolitan areas benefit from their transit investments in terms of congestion relief.

The beneficial effects of transit investments on large metropolitan congestion are supported by Harford's (2006) b-c ratio estimates for urbanized areas in the U.S. Because Harford included only the savings from congestion relief in his measurements, his b-c ratios provide a picture of when transit begins to pay for itself in terms of congestion relief. Figure 2 suggests that, on average, the benefit of congestion relief (not including other benefits) does not exceed the total costs of transit until metropolitan areas grow to more than 2.5 million people.

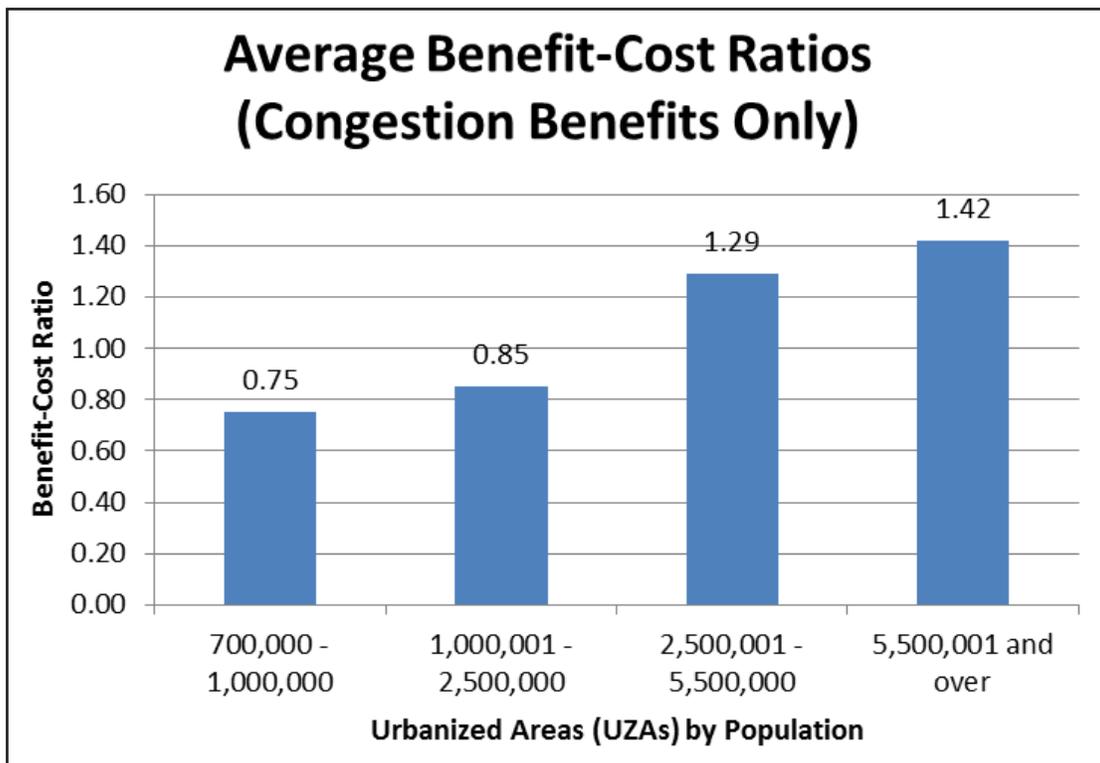


Figure 2. Average Benefit-Cost Ratios by Urbanized Area Population Using Only Congestion Savings Benefits

Source: Based on findings from Harford (2006).

However, the size of a metropolitan area is not the only important factor determining the amount of congestion relief from transit; the type of transit investments in an area also makes a difference. The congestion benefits from transit are illustrated by Litman (2012) in Figure 3, where greater investments in transit yield greater benefits from reduced congestion costs.

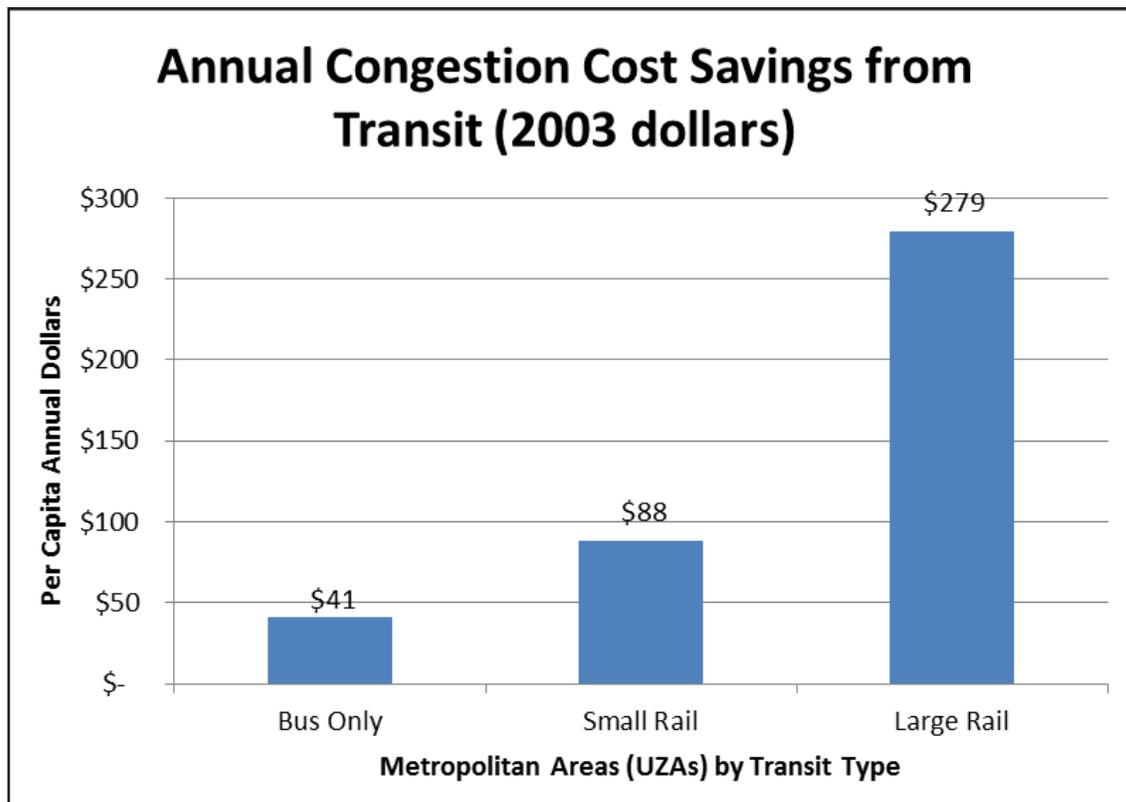


Figure 3. Annual Per Capita Congestion Cost Savings from Transit in U.S. Cities by Type of Transit Available

Source: Litman (2012).

According to Litman (2012), areas that invest in “large rail” systems, in which rail is major component of the transportation system, reap more than three times the benefits in congestion savings than those that invested in “small rail,” in which rail is a minor component of the transportation system, and nearly seven times the benefits compared with “bus only” areas.

JOBS AND THE ECONOMY

The benefits of transit to jobs and the economy also feature prominently in system-level b-c studies. Review of Figure 4 suggests that at the statewide level, transit has a net benefit (exceeding all costs for providing transit in the state) for producing jobs and stimulating the economy.

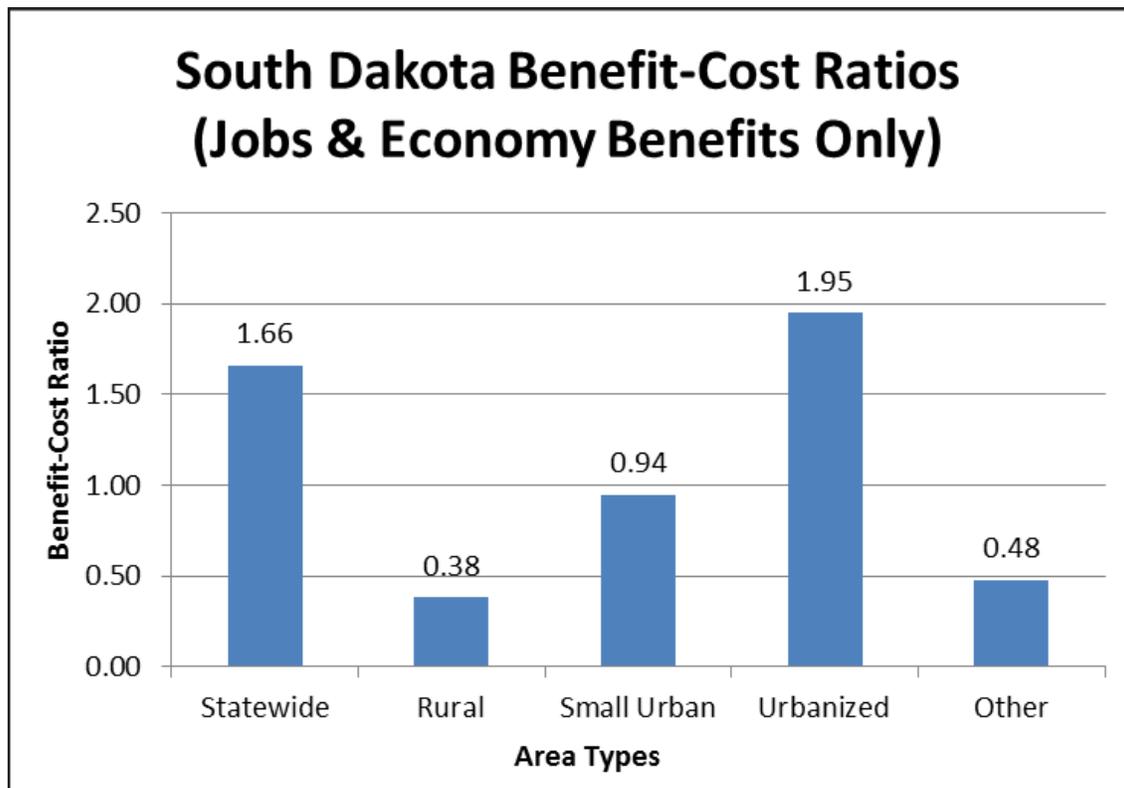


Figure 4. Benefit-Cost Ratios for South Dakota Using Only Jobs and Economy Benefits

Source: Based on Penet (2012).

Similar to Harford's (2012) findings for congestion benefits at the national level, the more urbanized the service area, the higher the b-c ratio for jobs and the economy. However, it is important to note that virtually all the net-positive benefits at the statewide level estimated by Penet (2012) are due to the net-positive jobs and economy-benefits from the most urbanized transit service areas in the state. Rural and small urban areas tend to capture fewer economic and employment benefits from transit services, at least as measured by Penet. However, the share of total benefits is substantial for both, with jobs and economy benefits paying for more than one-third of total transit costs in rural areas and almost breaking even in small urban areas.¹

Godavarthy et al.'s (2014) similar jobs and the economy benefits estimates for rural and small urban areas in the U.S. as a whole supports this conclusion. Figure 5 shows similar b-c estimates from Godavarthy et al. compared to Penet's for the benefits to jobs and the economy compared with the costs of providing transit to rural and small urban areas.

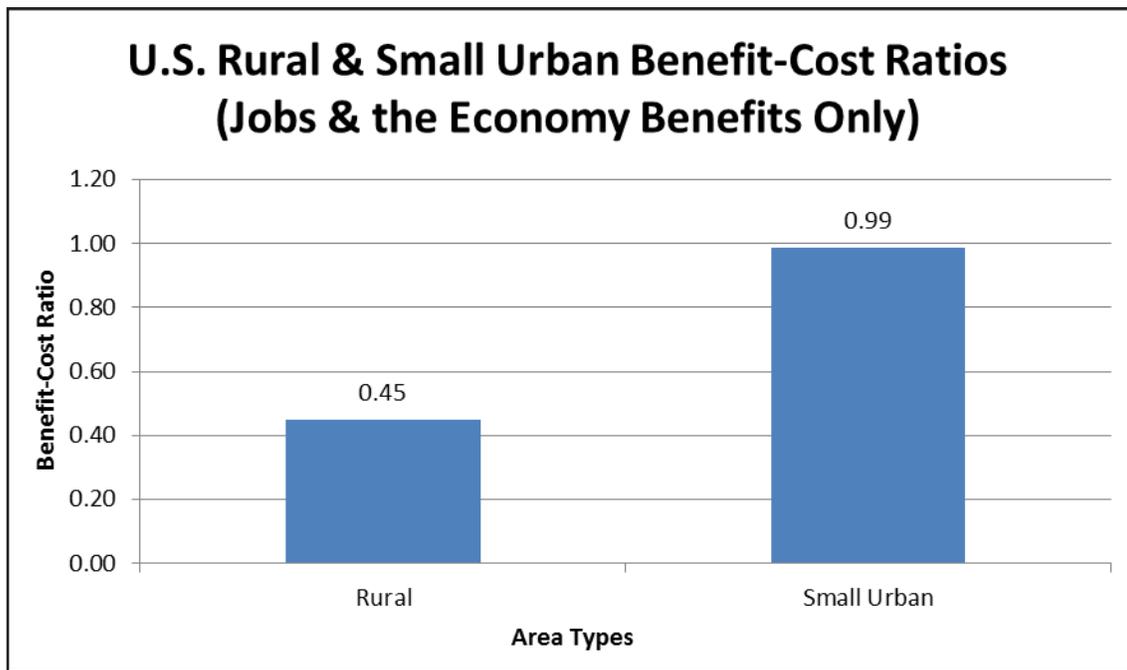


Figure 5. U.S. Rural and Small Urban Area Benefit-Cost Ratios Using Only Jobs and the Economy Benefits

Source: Based on Godavarthy et al. (2014).

Nevertheless, it is also important to note that the economic and employment benefits of transit in all areas of both studies (Penet 2012 and Godavarthy et al. 2014) make up a large share of total transit benefits. Moreover, they play an important role in producing net-positive benefits—compared with costs—of providing transit in small urban and urbanized areas in South Dakota (Penet 2012) and in rural and small urban areas in the U.S. overall (Godavarthy et al. 2014). Closer inspection of the methods used by these two research teams suggests that Godavarthy et al. (2014) found a b-c ratio greater than “1” for rural areas because they included the health care cost benefits of transit.

Finally, it is important to note that while both studies found substantial economic benefits of transit for rural and small urban areas across the U.S., many other public and private investments have the potential to yield greater economic benefits than transit does. Therefore, transit is best viewed not as a single-benefit tool, but rather as a collection of multiple benefits that address a host of societal needs.

HEALTH CARE COSTS

While most studies did not explicitly measure the effects of transit service availability on the costs of health care, Godavarthy et al. (2014) reasoned that many low income people living in rural or small urban areas with poor access to transportation and relatively long trips from home to medical services will forgo their medical trips and treatments. Therefore, transit can play a critical role in reducing health care costs and improving outcomes. Wallace et al. (2005, 2006) estimated that 3.6 million Americans do not obtain medical care every year because they lack adequate transportation. Hughes-Cromwick et al. (2005) found that these people are disadvantaged in other ways than simply their

access to transportation. They are disproportionately older, low income, female, minorities, and without college degrees. As a consequence, those lacking transportation have an inordinately high prevalence of disease. In turn, the costs to society from people who lack adequate transportation access to medical care are high because foregoing health care trips can lead to more expensive treatments later.

Godavarthy et al.'s (2014) benefit-cost analysis of rural and small urban area transit services found that reduced health care costs make up between 40% (small urban) and 42% (rural) of total benefits from transit services in these areas (Figure 6).²

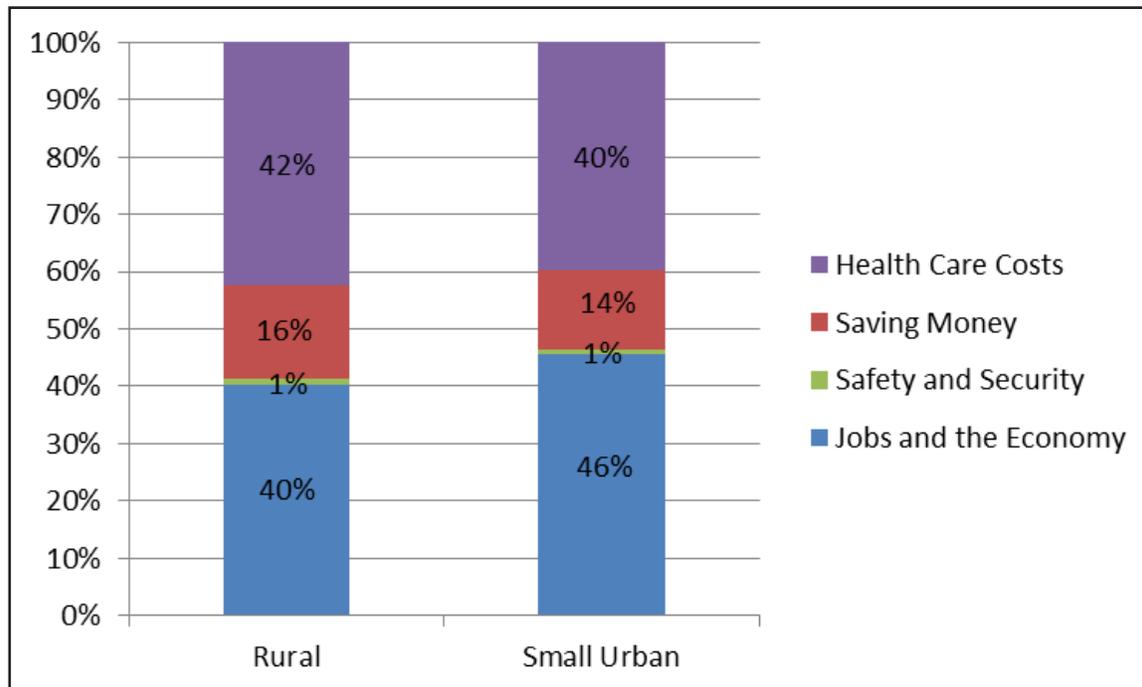


Figure 6. Share of Total Benefits for Each Benefit Category for Rural and Small Urban Areas in the U.S.

Source: Based on Godavarthy et al. (2014).

Figure 6 suggests the benefits of providing transit in rural areas are large. But using only the health care costs b-c ratios shown in Figure 7 suggests that these benefits relative to the high costs of providing transit services there are smaller than the health care costs b-c ratios for small urban areas.

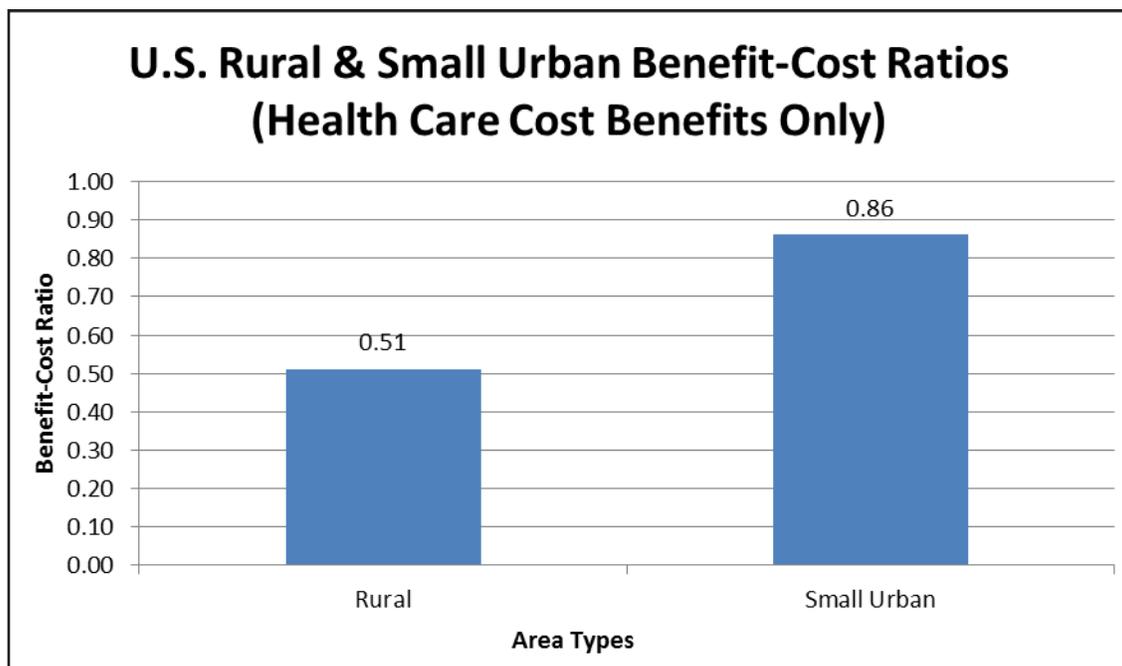


Figure 7. U.S. Rural and Small Urban Area Benefit-Cost Ratios Using Only Health Care Cost Benefits

Source: Based on Godavarthy et al. (2014).

Nevertheless, reduced health care costs are an important reason why, overall, Godavarthy et al. (2014) found the benefits outweigh the costs of providing transit services in rural (1.12) and small urban (2.16) areas (Table 1).

SAVING MONEY

People with access to quality public transit tend to spend less on transportation. If they own an automobile, taking transit instead of driving reduces the amount they spend on fuel and operating costs. If they have access to high-quality transit, they may not need to own an automobile at all, in which case they stand to save substantially more. When other transportation costs such as taxi fares and the inconveniences and more hidden costs of getting a ride from someone else are considered as well, public transit starts to look like an effective money-saving tool.

To illustrate the benefits of transit investments for people's finances, Litman (2012) compared the average annual per capita expenditures on transportation for urban areas with bus only, small rail, and large rail systems. Figure 8 summarizes these results, showing that per capita annual transportation expenditures are roughly the same for metropolitan areas with bus only and small rail systems (\$3,332 and \$3,350 respectively), but they drop dramatically to \$2,808 for large-rail cities. For the sake of comparison, the average per capita cost of owning and operating the U.S. average 1.9 vehicles per household is shown as well.

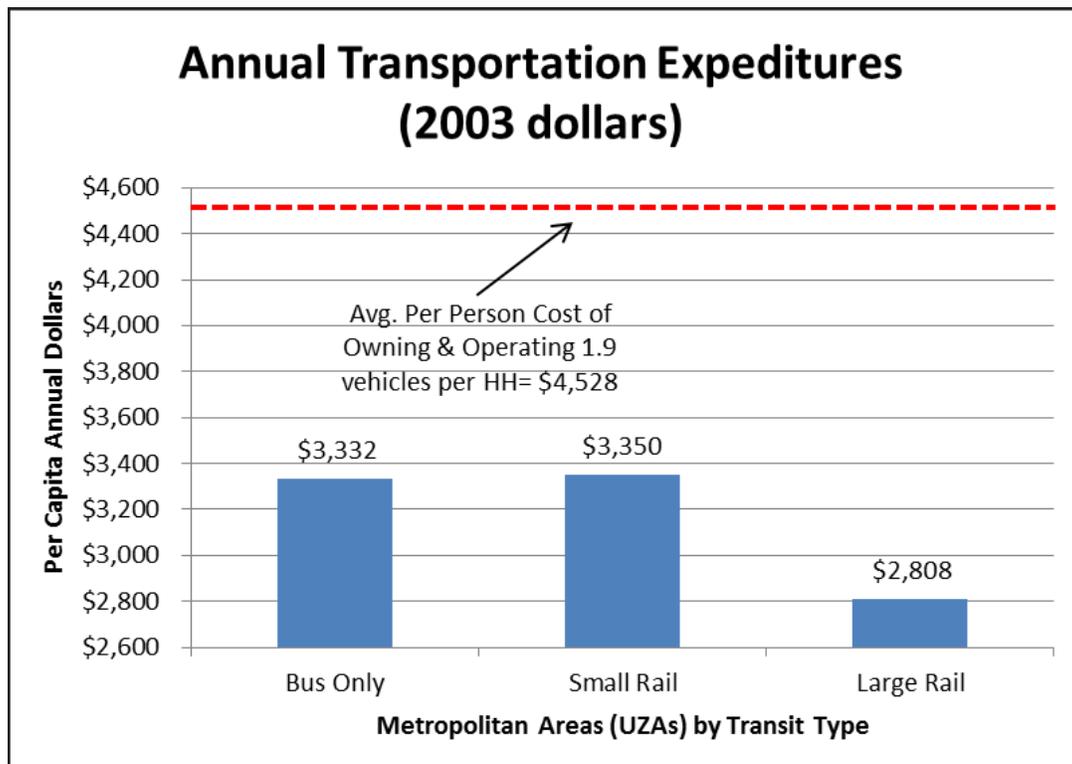


Figure 8. Annual Per Capita Transportation Expenditures in U.S. Cities by Type of Transit Available³

Sources: Litman (2012).

While this analysis does not control for potentially significant influences such as population, densities, vehicle ownership, and other socio-economic factors, it illustrates the importance of considering the impacts of transit investments on personal finances.

To address the effects of urban context (e.g., population size, densities, etc.) on the savings people derive from access to transit, Figure 9 compares the benefit-cost ratios derived from three sources (Penet 2012; Godavarthy 2014; and Goldsmith 2006).

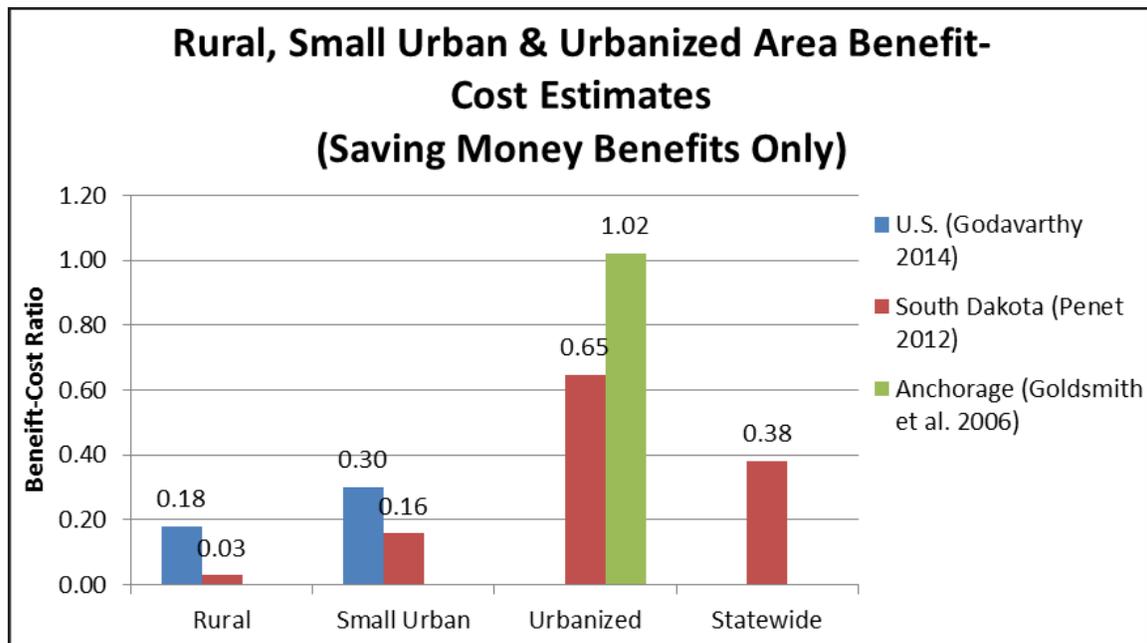


Figure 9. Benefit-Cost Ratios for Using Only Benefits of Saving Money from Transit Availability

Sources: Based on Penet (2012); Godavarthy et al. (2014); and Goldsmith et al. (2006).

As seen for other transit benefit categories, the size of the service area and its population play an important role in determining the amount of financial benefits relative to costs that people derive from access to transit. Figure 9 shows that the financial benefits of transit in rural areas of the U.S. (Godavarthy 2014) and South Dakota (Penet 2012) are low compared with costs. Specifically, rural areas of South Dakota receive a very small b-c ratio of 0.03, indicating 3 cents return to benefit people's personal finances from every dollar spent on public transit. Rural areas in the U.S. overall receive a somewhat larger (but still low) b-c ratio of 0.18, indicating 18 cents return to benefit people's finances from every transit dollar spent.

Small urban areas receive somewhat larger benefits, with a personal-savings-only b-c ratio of 0.16 in South Dakota and 0.30 in the U.S. overall. Transit services in larger, urbanized areas added the most money to peoples' pocketbooks relative to the costs of providing those services, with a b-c ratio of 0.65 in South Dakota and an impressive 1.02 in Anchorage, Alaska.

SAFETY AND SECURITY: A SMALLER BUT STILL IMPORTANT BENEFIT CATEGORY

Despite the fact that the safety and security benefit category consistently produced low benefits in the b-c estimates surveyed for this white paper, its importance to society suggests closer attention is needed. A recent study by AAA shows that when the total annual costs to American society are tallied, traffic collisions cost \$299.5 billion—more than three times the \$97.7 billion annual costs of congestion (American Automobile Association 2011). The portion of those costs attributable only to medical costs and lost economic productivity are

about \$80 billion annually (Centers for Disease Control and Prevention 2014). To break those figures down a bit more, each fatal collision costs an average of \$6 million per incident (Coupland 2011), taking approximately \$900 out of each American's pocket and sapping 1.9% of annual growth from the U.S. national economy (National Highway Traffic Safety Administration 2014).

Generally, safety and security benefits from transit improve public health and well-being. However, measuring fatalities and injuries from transportation in terms of the amount of money saved and spent (i.e., benefits and costs) is difficult and fraught with controversy. It requires placing a dollar value on human life and health. While benefit-cost analysts and researchers have made important strides over the years in this area, comparison of the transportation-related fatalities statistics and the safety and security benefits of transit b-c estimates suggest that substantial improvements are needed before analysts learn to routinely and appropriately value the contributions transit services can make to public health.

According to the National Safety Council (NSC), taking the bus is 170 times safer than riding in a car. In fact, national data show that public transit is among the safest ways to travel. On average from 2000 through 2009, transit bus travel resulted in 0.11 deaths per billion passenger-miles, compared with 7.3 deaths for motor vehicles (Savage 2013).

Figure 10 shows that even when fatalities to non-riders are included, the death rates for bus and rail transit are substantially lower than for passenger vehicles and light trucks.

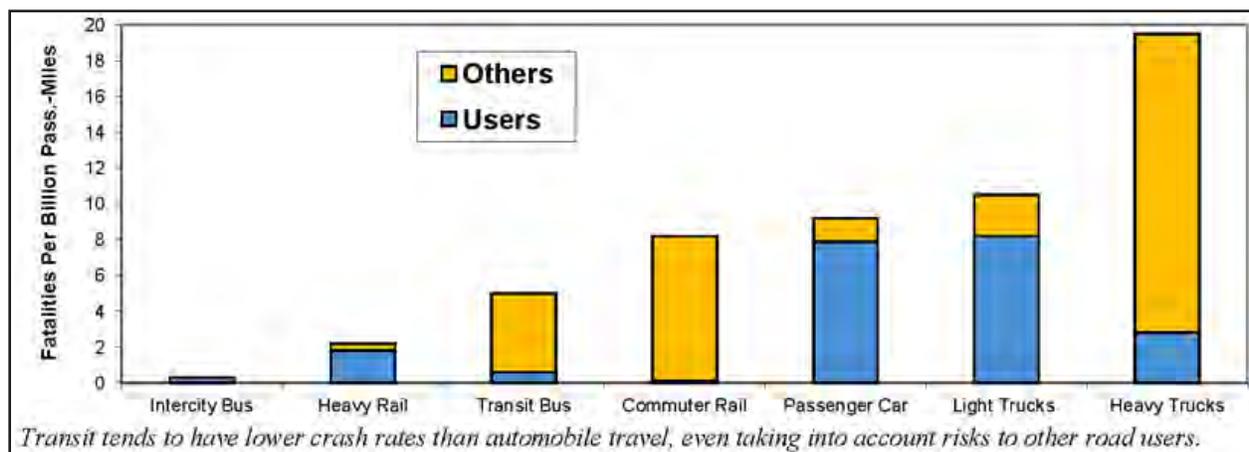


Figure 10. Fatality Rates by Mode of Travel (2002)

Source: Litman (2012).

However, comparing safety and security benefit estimates of Godavarthy et al. (2014), Penet (2012) and Goldsmith et al. (2006) for rural, small urban and urbanized areas, the b-c ratios ranged between less than 0.01 to roughly 0.04. Therefore, the benefit-cost estimates found and reviewed for this white paper suggest that in dollar terms, the safety and security benefits of transit are very low compared to costs, at least when using the methods and assumptions of the analysts responsible for these estimates. Comparing the evidence presented in Figure 10 and the safety and security benefit estimates cited above, we are faced with seemingly contradictory findings, in which transit is clearly much safer than driving, but these benefits do not show up in dollar terms when compared

with the costs, at least using standard b-c estimation methods. There are other possible explanations for this discrepancy beyond the methodological issues mentioned above (for example, analysts may not appropriately value human life and health in dollar terms).

First, while transit is clearly safer overall than automobile travel, these benefits are realized only when people ride transit. In other words, the reason safety and security b-c ratios are so low is that not enough people take transit.

However, an important reason people choose driving over transit is because of a history of under-investment in transit and the predominance of auto-oriented sprawling development in the U.S. – in other words, many people would choose transit in the U.S. instead of driving if they had access to safe and affordable transit options.

Figure 11 illustrates the potential for increasing the safety benefits, relative to costs, of transit through a combination of transit investments coupled with transit-oriented land use planning.

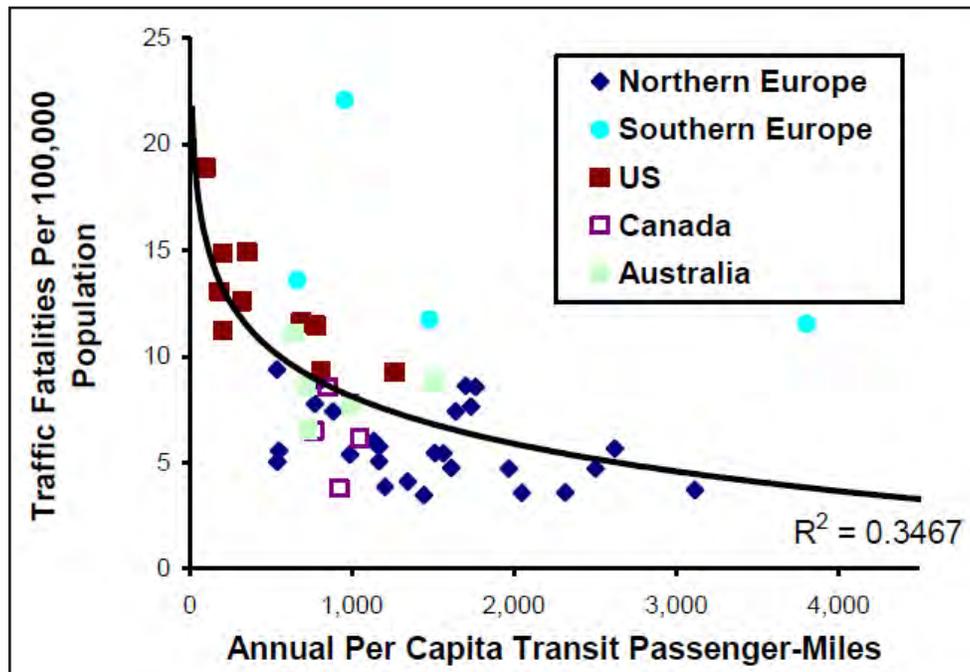


Figure 11. Traffic Fatalities versus Travel by Transit

Source: Litman (2012).

With greater investments in public transit and more transit-friendly land use patterns in Northern Europe, the number of traffic fatalities per 100,000 people is substantially lower than in the U.S. While this finding might be explained by cultural or economic differences between American and European societies, similar patterns are found within the U.S. as well. Figure 12 illustrates how land use patterns affect traffic fatality rates.

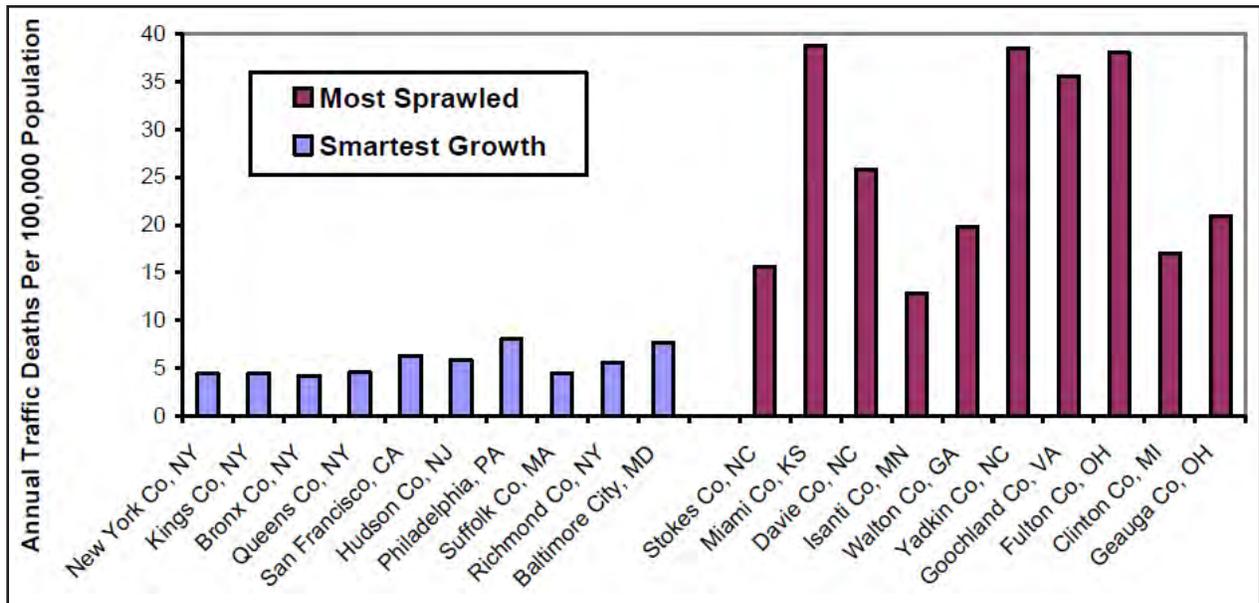


Figure 12. Annual Traffic Fatality Rates for the 10 Most Sprawled and 10 Least Sprawled Counties in the U.S.

Source: Litman (2012).

The most sprawled counties in the U.S. have substantially higher traffic fatalities than the least sprawled counties. When Figure 12 is viewed together with Figure 10, which shows the safety benefits of transit compared with auto travel, the combined potential safety benefits of transit and transit-oriented development patterns become clear. It is reasonable to expect that through a combination of these planning and policy tools and improved b-c safety and security estimation methods, transit would take on a larger share of b-c calculations and would improve the total benefit-cost ratio of transit, including all benefit categories.

IV. SUMMARY AND CONCLUSIONS

A review and analysis of the available b-c ratio estimates for transit systems in the U.S. found a wide variation among sources. Some of these differences are attributable to the population size and densities of the service areas—the context—with rural and small urban areas generally yielding lower b-c values than urbanized areas.

However, substantial differences remained even after the context was accounted for, suggesting that analysts are using different methods of analysis and that appropriate transit investments in rural and small urban areas can yield benefits substantially greater than costs. Closer inspection of the methods used by Harford (2012)—who produced significantly lower b-c estimates for all context/area types than other analysts—found that this source measured only the transit benefits of congestion relief. When analysts included measurements of other benefit categories, b-c ratios tended to be higher for transit services in most contexts.

Review of the b-c studies collected for this white paper found the following key benefits of transit:

- Traffic Congestion
- Jobs and the Economy
- Health Care Costs
- Saving Money
- Safety and Security

Analysis of the effects of transit on traffic congestion suggests that the size of the metropolitan area and the type of transit provided are critical to determining when transit investments pay off, considering only congestion cost savings. In general, large transit (heavy rail) investments in metropolitan areas larger than 2.5 million people tend to pay for themselves in terms of congestion relief, although there are exceptions.

Benefits to jobs and the economy were found to be one of the most important categories in the b-c studies reviewed. While these benefits tended to be larger in urbanized compared with small urban and rural areas, smaller population areas stand to gain substantially from transit services, with between 40% and 46% of total transit benefits attributable to jobs and the economy.

Few of the published b-c studies surveyed for this white paper measured the health care cost benefits of transit. However, Godavarthy et al. (2014) found that giving people low-cost and reliable transit access to medical services decreases the tendency of low-income people living in rural and small urban areas to forgo treatments, thereby improving public health and reducing the costs of health care to society. These findings suggest that b-c analysts should consider routinely measuring these benefits in the future.

Transit also saves people money. While the financial benefits of transit in rural areas are generally low compared with costs, small urban areas receive somewhat larger benefits, and transit services in urbanized areas added the most money to peoples' pocketbooks relative to costs.

Two possible explanations were offered for the low b-c ratios found for the transit safety and security benefits. First, because people in the U.S. choose driving instead of transit, the safety and security benefits of transit to society are small. But before concluding that transit is not an effective tool for improving public health and well-being in the U.S., the second explanation—building on the first—suggests that Americans choose to drive instead of ride transit because of a history of underinvestment in transit services in the U.S., coupled with the predominance of auto-oriented land use planning and development.

Finally, based on this review and analysis of the b-c literature, several benefit categories should be considered for research and possible incorporation into future b-c estimation practices. Further consideration should be given to the benefits of transit for fighting climate change by reducing greenhouse gas emissions, reducing dependence on foreign oil, increasing property values, encouraging more compact/transit-oriented development patterns, and improving emergency response services.

APPENDIX A: STATEWIDE SMALL URBAN AND RURAL TRANSIT BENEFIT-COST RATIOS

Table 3. Statewide Small Urban and Rural Area Transit Benefit-Cost Ratios

State	Benefit-cost Ratio				
	Small Urban Areas			Rural Areas	Statewide Benefit-cost Ratios
	Fixed- route Bus	Demand- response	Total		
Alabama (AL)	1.92	1.09	1.39	1.46	1.43
Alaska (AK)	1.31	0.16	0.89	1.48	1.35
Arizona (AZ)	2.21	0.35	2.05	1.34	1.89
Arkansas (AR)	3.06	0.46	2.62	0.82	1.86
California (CA)	2.33	0.58	1.93	1.14	1.69
Colorado (CO)	2.79	0.57	2.53	2.01	2.14
Connecticut (CT)	2.19	0.45	1.64	1.27	1.60
Delaware (DE)	-	-	-	-	-
District of Columbia (DC)	-	-	-	-	-
Florida (FL)	3.24	0.62	2.46	0.37	1.82
Georgia (GA)	5.49	0.48	4.96	0.55	2.74
Hawaii (HI)	-	-	-	-	-
Idaho (ID)	2.97	0.81	1.56	1.01	1.20
Illinois (IL)	2.53	0.73	2.30	0.86	1.80
Indiana (IN)	2.82	0.66	2.47	1.26	2.07
Iowa (IA)	3.69	0.82	3.22	1.87	2.60
Kansas (KS)	2.26	0.45	1.94	2.01	1.97
Kentucky (KY)	1.66	0.58	1.36	0.41	0.45
Louisiana (LA)	3.33	0.29	2.50	0.32	1.53
Maine (ME)	2.53	1.01	2.35	0.32	0.91
Maryland (MD)	2.02	0.53	1.57	2.57	2.06
Massachusetts (MA)	1.33	0.57	1.11	1.79	1.28
Michigan (MI)	3.14	0.86	2.27	0.61	1.40
Minnesota (MN)	2.86	0.58	2.52	1.77	2.11
Mississippi (MS)	1.44	0.65	1.25	1.60	1.41
Missouri (MO)	2.30	0.84	2.02	1.29	1.59
Montana (MT)	1.97	0.60	1.73	1.93	1.83
Nebraska (NE)	-	-	-	-	-
Nevada (NV)	2.39	0.70	1.90	1.26	1.34
New Hampshire (NH)	2.08	0.34	1.81	2.28	1.96
New Jersey (NJ)	2.87	0.62	2.32	0.72	1.51
New Mexico (NM)	1.80	0.56	1.56	1.53	1.54
New York (NY)	2.03	0.55	1.81	1.17	1.55
North Carolina (NC)	3.30	0.57	2.79	0.46	1.61
North Dakota (ND)	2.61	0.90	2.05	1.30	1.73
Ohio (OH)	2.03	0.71	1.28	0.84	1.05

Table 3, continued

State	Benefit-cost Ratio				
	Small Urban Areas			Rural Areas	Statewide Benefit-cost Ratios
	Fixed- route Bus	Demand- response	Total		
Oklahoma (OK)	3.35	0.58	2.77	1.05	1.28
Oregon (OR)	2.15	0.52	1.81	1.50	1.61
Pennsylvania (PA)	2.74	0.85	2.32	1.11	1.86
Rhode Island (RI)	-	-	-	-	-
South Carolina (SC)	3.93	6.43	4.78	1.48	1.87
South Dakota (SD)	2.93	0.69	1.87	1.45	1.62
Tennessee (TN)	1.90	0.64	1.68	0.66	1.18
Texas (TX)	2.42	0.56	1.77	0.66	1.29
Utah (UT)	4.85	0.40	4.09	4.19	4.14
Vermont (VT)	2.46	0.43	2.23	0.70	1.16
Virginia (VA)	3.55	0.51	3.34	1.39	2.86
Washington (WA)	1.81	0.38	1.48	1.48	1.48
West Virginia (WV)	2.29	0.42	2.14	1.16	1.82
Wisconsin (WI)	1.97	0.75	1.74	0.63	1.45
Wyoming (WY)	2.42	0.66	1.58	3.00	2.63
Total	2.60	0.64	2.16	1.12	1.68

Source: Godavarthy et al. (2014).

ENDNOTES

1. It is important to note that transit provides critical economic and social links for typically underserved and economically disadvantaged populations. These benefits are not accounted for with standard b-c estimation methods. Appropriately measuring and valuing transit's equity benefits is an ongoing challenge for b-c analysts.
2. The air quality benefits of transit were removed from and these estimates because they were small and negative.
3. According to the U.S. DOT's Bureau of Transportation Statistics (http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_03_17.html), the total household cost of owning and driving a car (15K miles/year) was approximately \$6,125 (in 2003 dollars). With an average of 1.9 vehicles per household (http://usatoday30.usatoday.com/news/nation/2003-08-30-outnumbered-cars_x.htm) and with 2.57 individuals per household (<http://www.census.gov/population/socdemo/hh-fam/tabHH-6.pdf>), the total cost of household vehicle ownership and operation per person was approximately \$4,528 in 2003.

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Dr. Ferrell began his planning career in 1995 working for the Metropolitan Transportation Commission (MTC) on intelligent transportation system (ITS) applications for traffic management. Since 2000, he has worked as a transportation consultant, and in 2010 he co-founded CFA Consultants, a transportation planning and research firm. Dr. Ferrell completed his doctoral studies in city and regional planning at the University of California, Berkeley in 2005. His studies focus on the relationships between transportation and land use. His research experience includes the evaluation of transit facilities, transportation policy analysis, transportation and land use interactions, travel behavior, and the analysis of institutional structures. As a practitioner, he has developed traffic impact studies for mixed-use, infill, and transit-oriented projects; analyzed the impacts of specific and general plans; planned and implemented intelligent transportation systems; and developed bicycle and pedestrian plans. He recently completed TCRP Report 145, *Reinventing the Urban Interstate: A New Paradigm for Multimodal Corridors*. He has also taught several graduate planning classes in the San José State University Urban Planning Department and the University of California, Berkeley City and Regional Planning Department.

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