

# Cost-Benefit Analysis of Rural and Small Urban Transit

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Ranjit Godavarthy  
Jeremy Mattson  
Elvis Ndembe

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## Introduction

- The value of transit services in rural and small urban areas is largely unmeasured and impacts are often unidentified
- Some benefits lend themselves easily to quantification while others do not
- Information is needed for both costs and benefits of transit operations to support investment decisions



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## Objectives

- Review previous cost-benefit research for rural and small urban areas
- Develop a methodology for assessing benefits at the national, regional, and statewide levels
- Estimate the economic costs and benefits of rural and small urban transit
- Identify and describe social, environmental, and other benefits

## Scope of Research

- Small urban and rural transit agencies across the country
- Small urban defined as urban transit agencies serving area with population under 200,000
- Data from NTD and Rural NTD
- 1,392 rural agencies and 351 small urban agencies
- Fixed-route bus and demand response service studied
- Results presented at national, regional, and state levels



## Previous Research

**Skolnik and Schreiner  
(1998)**

- Studied small urban area of Connecticut
- Benefit/cost ratio of 9.7 to 1

**Burkhardt (1999)**

- National and local analyses of rural systems
- Returns on investment of 3 to 1

**Southworth et al.  
(2002, 2005)**

- Rural and small urban systems in Tennessee
- Benefits of rural systems vary significantly
- Benefit/cost ratios greater than 1.0

**HLB Decision  
Economics (2003, 2006)**

- Studied Wisconsin
- Return on investment of 6 to 1

**HDR Decision  
Economics (2011)**

- Conducted in South Dakota
- Every dollar spent generated \$1.90 in economic activity

## Research on Foregone Trips

### Health care trips

- Previous studies have shown ability to drive and use of transit increases number of health care trips
- TCRP (Web-Only Doc 29) report by Hughes-Cromwick et al. (2005) conducted cost-benefit analysis of providing NEMT for seven chronic conditions and five preventive conditions
  - Benefit is the difference between well-managed and poorly-managed care, which can include reduction in more costly care and improved quality of life
  - Net health care benefits of increased access to NEMT exceeded additional costs
  - Transportation is relatively inexpensive compared to cost of health care
- Other studies have considered home healthcare costs or medical institutionalization costs avoided

## Research on Foregone Trips

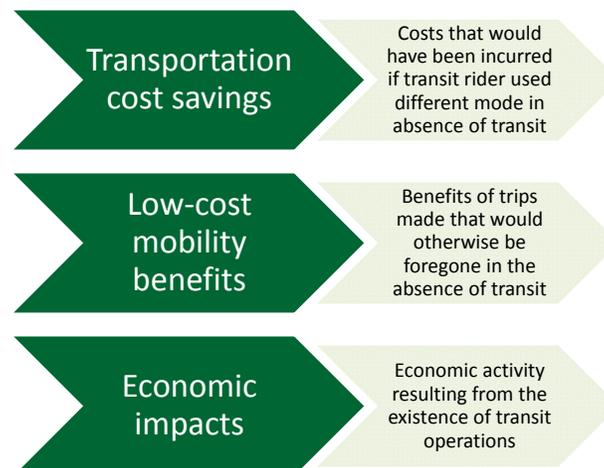
### Work trips

- Many rely on transit as a means to travel to work
- Studies have estimated value of lost work trip as value of lost wages
- HLB Decision Economics estimated the benefit of providing work trips as the impact it has on reducing public assistance spending – They found there would be a 12% increase in spending in Wisconsin without transit
- HDR Decision Economics similarly estimated the increase in welfare recipients

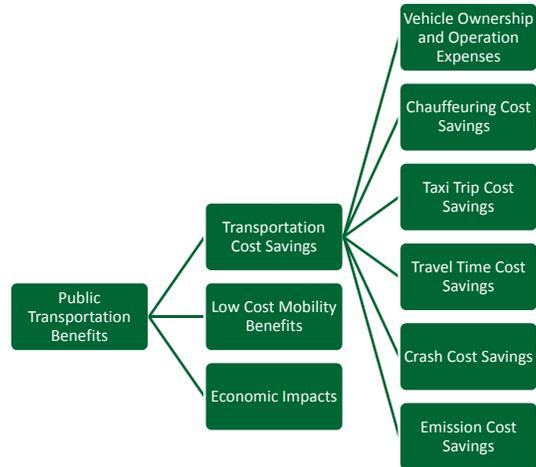
### Other trips

- Education trips: Differences in expected earnings
- Shopping trips: Shopping expenditures per trip

## Categorization of Transit Benefits



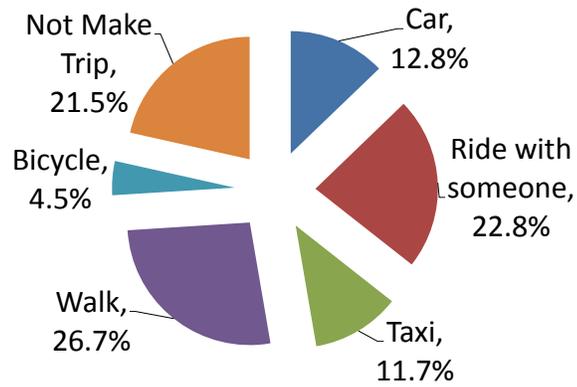
## Categorization of Transit Benefits



## Study Methodology

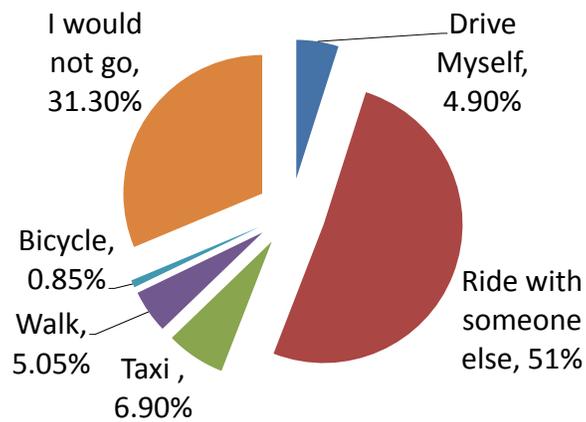
-  Travel behavior in the absence of transit: alternative modes and foregone trips
-  Trip purpose information
-  Costs incurred on alternative modes
-  Value of foregone trips, by trip purpose
-  Economic impacts from operations
-  Compare calculated benefits with costs of providing transit

### Fixed Route Bus: Trip Alternatives in Absence of Transit



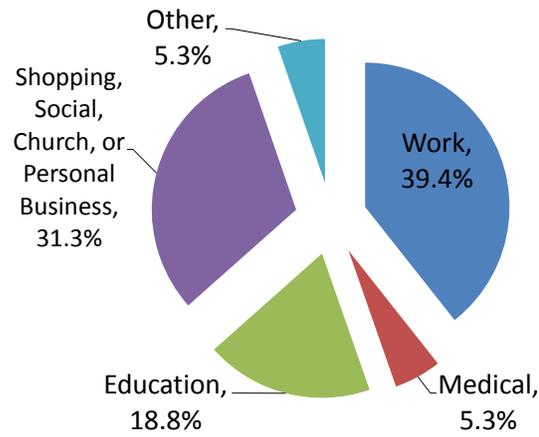
Source: Transit Performance Monitoring System (TPMS) (2002)

### Demand Response: Trip Alternatives in the Absence of Transit



Source: Mattson et al. (forthcoming)

### Small Urban: Transit Trip Purpose



Source: Transit Performance Monitoring System (TPMS) (2002)

### Rural: Transit Trip Purpose

Trip Purpose	Transit Trips	
	Urban	Rural
<b>Work</b>	41.0%	40.6%
<b>Medical</b>	6.3%	7.4%
<b>Education</b>	10.4%	20.4%
<b>Shopping, Recreation and Tourism</b>	38.0%	29.1%
<b>Other</b>	4.4%	2.5%

Source: 2012 Rural Transit Fact Book



## Benefit Category 1: Transportation Cost Savings

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### Vehicle Ownership and Operation Cost Savings

- Some riders would choose to drive in the absence of transit
- AAA cost estimates used: \$0.65 per mile



### Avoided Chauffeuring Costs

- Some would get a ride from a family member or friend
- Litman (2012) estimated the cost as \$1.05 per chauffeured mile



### Taxi Fare Savings

- Some would take a taxi
- An average taxi fare of \$2.25 per mile was used from Litman (2012)



### Travel Time Savings

- Travel time differences between transit and other modes monetized



### Crash Cost Savings

- Differences in crash costs between transit and other modes



### Environmental Emission Cost Savings

- Differences in emissions costs between transit and other modes

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## Benefit Category 2: Low-Cost Mobility Benefits

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## Benefit of Providing New Trips

### Medical trips

- Cost difference between well-managed and poorly-managed care, plus improvements in quality of life, minus additional medical costs incurred, divided by number of trips required

### Work trips

- Reduction in TANF and SNAP benefits

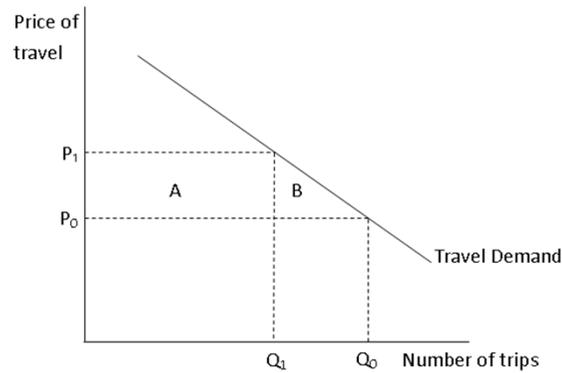
### Other trips

- Change in consumer surplus

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## Change in Consumer Surplus with the Introduction of Transit



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## Unit Costs Used for Monetizing Transit Benefits

Parameter	Value
Vehicle ownership and operating cost (\$/mile)	\$0.65
Chauffeur costs (\$/mile)	\$1.05
Taxi fare (\$/mile)	\$2.25
Value of travel time (\$/hour)	\$4.14
Crash costs (\$/vehicle mile)	
Transit	\$0.29
Automobile	\$0.10
Emission costs (\$/vehicle mile)	
Transit	\$0.15
Automobile	\$0.06
Cost of foregone trips (\$/one-way trip)	
Medical	\$357
Work	\$49

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## Benefit Category 3: Economic Impacts

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## Economic Impacts of Spending on Transit

- Direct effects**
  - Jobs created directly by the transit system
- Indirect effects**
  - Jobs and income spent in industries that supply inputs to transit
- Induced economic activity**
  - Economic activity resulting from income generated through both direct and indirect effects

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## Economic Impacts of Spending on Transit

- Chu (2013) developed a tool to estimate economic impacts of spending on transit
- Regional Input-Output Modeling System (RIMS II) multipliers
- Economic impacts vary based on source of funds and share of spending that occurs within the community
- Chu's tool was applied to the state of North Dakota



## Results

## Estimated Transportation Cost Savings and Low-Cost Mobility Benefits

### Rural Transit

- Total Transit Benefits of \$1.6 billion are observed in 2011.
- *Transit Benefits*: \$934 million (58%) are observed in fixed route bus and \$673 million (42%) are observed in demand response service.
- Average transit benefits per trip: \$14.56
- Average benefits of fixed route bus: \$13.50 per trip
- Average benefits of demand response: \$16.35 per trip

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### Rural Transit: Benefits Summary

Transit Benefit Category	Fixed Route Bus (MB)	Demand Response (DR)	Total
<b>Transportation Cost Savings</b>			
Vehicle Ownership and Operation Costs	\$34,548,296	\$7,866,150	\$42,414,445
Chauffeuring Costs	\$49,704,699	\$84,279,527	\$133,984,227
Taxi Cost Savings	\$109,312,967	\$38,342,849	\$147,655,816
Travel Time Cost Savings	-\$19,560,594	-\$36,213,133	-\$55,773,727
Accident Cost Savings	\$29,212,649	-\$13,170,826	\$16,041,823
Emission Cost Savings	-\$7,079,055	-\$47,129,195	-\$54,208,250
<b>Total Transportation Cost Savings</b>	<b>\$196,138,962 (21%)</b>	<b>\$33,975,372 (5%)</b>	<b>\$230,114,334 (14%)</b>
<b>Low Cost Mobility Benefits</b>			
Foregone Medical Trip Benefits	\$393,088,598	\$340,365,706	\$733,454,304
Foregone Work Trip Benefits	\$296,014,254	\$256,311,430	\$552,325,684
Other Foregone Trip Benefits	\$49,078,193	\$42,495,595	\$91,573,788
		\$639,172,731	
<b>Total Low Cost Mobility Benefits</b>	<b>\$738,181,045 (79%)</b>	<b>(95%)</b>	<b>\$1,377,353,776 (86%)</b>
<b>Total Transit Benefits</b>	<b>\$934,320,007 (100%)</b>	<b>(100%)</b>	<b>\$1,607,468,110 (100%)</b>

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## Small Urban Transit

- Total Transit Benefits of \$3.7 billion are observed in 2011.
- Transit Benefits: \$3.4 billion (93.4%) are observed in fixed route bus and \$244 million (6.6%) are observed in demand response service.
- Average transit benefits per trip: \$10.43
- Average benefits of fixed route bus: \$10.23 per trip
- Average benefits of demand response: \$14.31 per trip

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## Small Urban Transit: Benefits Summary

Transit Benefit Category	Fixed Route Bus (MB)	Demand Response (DR)	Total
<b>Transportation Cost Savings</b>			
Vehicle Ownership and Operation Costs	\$109,504,604	\$3,736,711	\$113,241,314
Chauffeur Costs	\$157,544,484	\$40,035,876	\$197,580,360
Taxi Cost Savings	\$346,479,411	\$18,214,264	\$364,693,675
Travel Time Cost Savings	-\$148,062,294	-\$17,202,571	-\$165,264,865
Accident Cost Savings	\$41,930,026	-\$17,631,822	\$24,298,205
Emission Cost Savings	\$5,504,437	-\$8,914,173	-\$3,409,736
<i>Total Transportation Cost Savings</i>	<i>(15%)</i>	<i>(7.5%)</i>	<i>(14.5%)</i>
<b>Low Cost Mobility Benefits</b>			
Foregone Medical Trip Benefits	\$1,362,173,952	\$100,952,297	\$1,463,126,250
Foregone Work Trip Benefits	\$1,389,891,143	\$103,006,451	\$1,492,897,594
Other Foregone Trip Benefits	\$160,459,212	\$21,690,446	\$182,149,657
	\$2,912,524,307	\$225,649,194	\$3,138,173,501
<i>Total Low Cost Mobility Benefits</i>	<i>(85%)</i>	<i>(92.5%)</i>	<i>(85.5%)</i>
	\$3,425,424,975	\$243,887,479	\$3,669,312,454
<b>Total Transit Benefits</b>	<b>(100%)</b>	<b>(100%)</b>	<b>(100%)</b>

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# Transit Cost Data

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## Rural Transit: Transit Cost Data

- Transit cost data was obtained from NTD database

**Operating Expenses:**

- Average Rural Transit Trip: \$10.78 per trip
- Demand Response Trip: \$17.31 per trip
- Fixed Route Bus Trip: \$6.96 per trip

**Operation Expenses and Capital Costs:**

- Average Rural Transit Trip: \$11.71 per trip

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## Small Urban Transit: Transit Cost Data

- Transit cost data was obtained from NTD database

### ***Operating Expenses:***

- Average Small Urban Transit Trip: \$4.49 per trip
- Demand Response Trip: \$21.39 per trip
- Fixed Route Bus Trip: \$3.63 per trip



## Benefit-Cost Analysis

## National Summary: Transit Benefits, Costs, and Their Analysis Results

Benefit Category	Transit Benefits			
	Small Urban Areas		Rural Areas	
	Transit Benefits	Benefits/Trip	Transit Benefits	Benefits/Trip
Vehicle ownership and operation cost savings	\$113,241,314	\$0.32	\$42,414,445	\$0.38
Chauffeuring Cost Savings	\$197,580,360	\$0.56	\$133,984,226	\$1.21
Taxi cost savings	\$364,693,674	\$1.04	\$147,655,815	\$1.34
Travel time cost savings	-\$165,264,864	-\$0.47	-\$64,230,510	-\$0.58
Accident cost savings	\$24,298,205	\$0.07	\$16,041,822	\$0.15
Emission cost savings	-\$3,409,736	-\$0.01	-\$54,208,250	-\$0.49
Cost of foregone medical trips	\$1,463,126,250	\$4.16	\$733,454,303	\$6.65
Cost of foregone work trips	\$1,492,897,594	\$4.24	\$552,325,683	\$5.00
Cost of other foregone trips	\$182,149,657	\$0.52	\$91,573,788	\$0.83
<b>Total Transit Benefits</b>	<b>\$3,669,312,454</b>	<b>\$10.43</b>	<b>\$1,599,011,322</b>	<b>\$14.49</b>
Cost Category	Transit Costs			
	Small Urban Areas		Rural Areas	
	Transit Costs	Cost/Trip	Transit Costs	Cost/Trip
Operational Expenses	1,581,017,438	\$4.49	1,322,556,555	\$11.98
Capital Expenses	117,565,000	\$0.33	113,346,800	\$1.03
<b>Total Transit Costs</b>	<b>1,698,582,438</b>	<b>\$4.83</b>	<b>1,435,903,355</b>	<b>\$13.01</b>
Benefit Cost Ratios				
<b>Benefit/Cost Ratio</b>	<b>2.16</b>		<b>1.12</b>	



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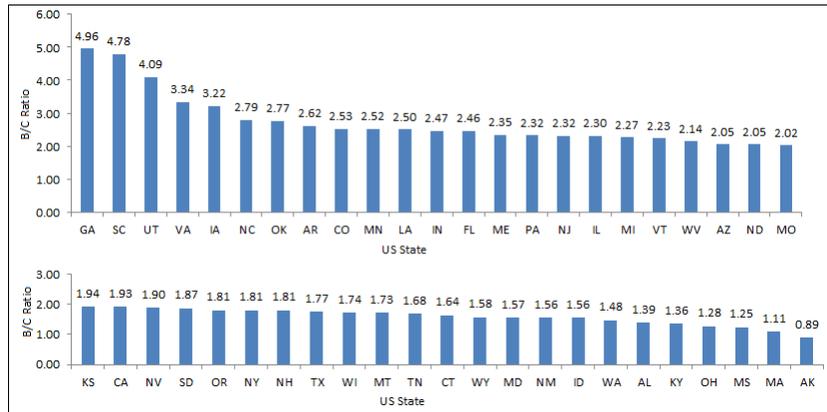
## Benefit Cost Ratios: National Summary

	Fixed Route Bus Service	Demand Response Service	Total
Small Urban Transit	2.60	0.64	2.16
Rural Transit	-	-	1.12



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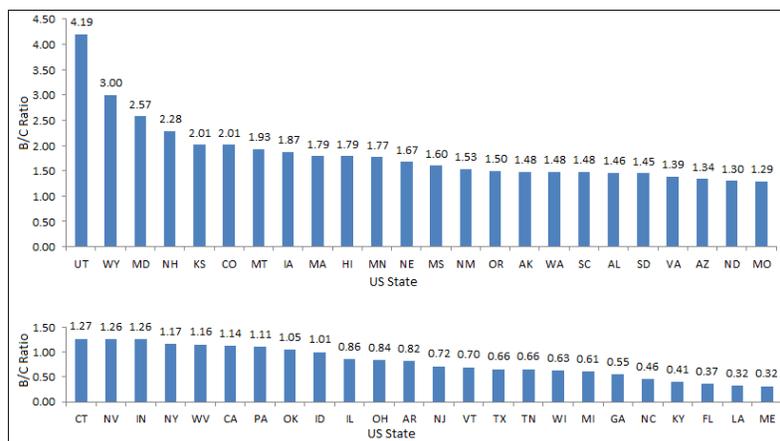
## Ranking of US States: Benefit-Cost Ratio of Transit in Small Urban Areas



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## Ranking of US States: Benefit-Cost Ratio of Transit in Rural Areas



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## Sensitivity Analysis

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## Sensitivity Analysis

- For monetizing the transit benefits, many assumptions were made regarding travel behavior and unit costs from previous studies.
- Useful to understand national transit benefits by using different unit costs and travel behavior from base condition.
- Six scenarios were considered for sensitivity analysis.

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## Sensitivity Analysis

- Scenario 1** • Foregone trips increased to 50%
- Scenario 2** • Walk/bicycle trips decreased by half for fixed-route
- Scenario 3** • Automobile cost increased from \$0.65 to \$0.84 per mile
- Scenario 4** • Cost of foregone medical and work trips increased 25%
- Scenario 5** • Cost of foregone medical and work trips decreased 25%
- Scenario 6** • Value of travel time for transit and automobile set equal

## Sensitivity Analysis Results

	Transit Benefits (in Millions)						
	Base Case	1	2	3	4	5	6
<b>Total Transit Benefits</b>	5,277	9,935 (88%)	5,287 (0%)	5,322 (1%)	6,337 (20%)	4,216 (-20%)	5,327 (1%)
<b>Benefit Cost Ratio</b>	1.68	3.17	1.69	1.70	2.02	1.35	1.70

## Economic Impacts from Spending on Transit in North Dakota

Type of Spending	Type of Impacts			
	Output	Value Added	Earnings	Jobs
	For every \$1 invested			For every \$1 million invested
<b>Unit Gross Impacts</b>				
Total Spending	\$1.35	<b>\$0.57</b>	\$0.37	10.3
<b>Unit Net Impacts</b> <b>(Local dollars: 25% operating, 5% capital)</b>				
Total Spending	\$1.02	<b>\$0.43</b>	\$0.28	7.8
<b>Unit Net Impacts</b> <b>(Local dollars: 50% operating, 20% capital)</b>				
Total Spending	\$0.69	<b>\$0.29</b>	\$0.19	5.3



## Summary and Conclusions

## Summary and Conclusions

- Fixed route bus service and demand response service were considered for benefit cost analysis in small urban and rural areas.
- Transportation cost savings and low cost mobility benefits were only analyzed for total transit benefits.
- Economic development benefits were not analyzed except for the state of North Dakota.
- Demand response service in US was not found to have any travel time cost savings, crash cost savings, and emission cost savings in small urban and rural areas.
- Travel time cost savings did not exist for fixed route bus service in small urban and rural areas.

### ***Low Cost Mobility Benefits (Foregone Trip Benefits)***

- Low cost mobility benefits were observed substantially high and have a major share in the total transit benefits and are considered crucial transit benefits.
- More than 90% of total transit benefits for demand response service were contributed by low cost mobility benefits.
- More than 79% of total transit benefits for fixed route bus service were contributed by low cost mobility benefits.

### ***Operating Costs***

- Average operating cost per rural transit trip was observed as \$10.78 and average cost per small urban transit trip was observed as \$4.49.

***Benefit-Cost Ratio***

- Benefit cost ratios can be higher than analyzed in this study because economic development benefits were not considered in the total transit benefits for analysis
- Small urban transit has comparatively high benefit cost ratio (2.16) than rural transit (1.12).
- Small urban transit has proved that fixed route bus has a benefit cost ratio of \$2.60 and demand response service has a benefit cost ratio of 0.64.

***Sensitivity Analysis:***

- Assuming 50% of the total trips would not be made when there is no transit has increased the total transit benefits by 88%.
- Increasing the cost of foregone medical trip and work trip by 25% has increased the total transit benefits by 20%



Thank you!  
Questions?

Ranjit Godavarthy:  
[ranjitprasad.godavar@ndsu.edu](mailto:ranjitprasad.godavar@ndsu.edu)

Jeremy Mattson:  
[jeremy.w.mattson@ndsu.edu](mailto:jeremy.w.mattson@ndsu.edu)

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