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.
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

Transportation cost savings
- Costs that would have been incurred if transit rider used different mode in absence of transit

Low-cost mobility benefits
- Benefits of trips made that would otherwise be foregone in the absence of transit

Economic impacts
- Economic activity resulting from the existence of transit operations
Categorization of Transit Benefits

- Public Transportation Benefits
  - Transportation Cost Savings
  - Low Cost Mobility Benefits
  - Economic Impacts

- Vehicle Ownership and Operation Expenses
- Chauffeuring Cost Savings
- Taxi Trip Cost Savings
- Travel Time Cost Savings
- Crash Cost Savings
- Emission Cost Savings

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

- **Car**: 12.8%
- **Ride with someone**: 22.8%
- **Taxi**: 11.7%
- **Walk**: 26.7%
- **Bicycle**: 4.5%
- **Not Make Trip**: 21.5%


Demand Response: Trip Alternatives in the Absence of Transit

- **I would not go**: 31.30%
- **Drive Myself**: 4.90%
- **Ride with someone else**: 51%
- **Walk**: 5.05%
- **Taxi**: 6.90%
- **Bicycle**: 0.85%

Source: Mattson et al. (forthcoming)
Small Urban: Transit Trip Purpose

- Work, 39.4%
- Medical, 5.3%
- Education, 18.8%
- Shopping, Social, Church, or Personal Business, 31.3%
- Other, 5.3%


Rural: Transit Trip Purpose

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Transit Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td>Work</td>
<td>41.0%</td>
</tr>
<tr>
<td>Medical</td>
<td>6.3%</td>
</tr>
<tr>
<td>Education</td>
<td>10.4%</td>
</tr>
<tr>
<td>Shopping, Recreation and Tourism</td>
<td>38.0%</td>
</tr>
<tr>
<td>Other</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

Source: 2012 Rural Transit Fact Book
Benefit Category 1: Transportation Cost Savings

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
Benefit Category 2: Low-Cost Mobility Benefits

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
Change in Consumer Surplus with the Introduction of Transit

Unit Costs Used for Monetizing Transit Benefits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle ownership and operating cost ($/mile)</td>
<td>$0.65</td>
</tr>
<tr>
<td>Chauffeuring costs ($/mile)</td>
<td>$1.05</td>
</tr>
<tr>
<td>Taxi fare ($/mile)</td>
<td>$2.25</td>
</tr>
<tr>
<td>Value of travel time ($/hour)</td>
<td>$4.14</td>
</tr>
<tr>
<td>Crash costs ($/vehicle mile)</td>
<td></td>
</tr>
<tr>
<td>Transit</td>
<td>$0.29</td>
</tr>
<tr>
<td>Automobile</td>
<td>$0.10</td>
</tr>
<tr>
<td>Emission costs ($/vehicle mile)</td>
<td></td>
</tr>
<tr>
<td>Transit</td>
<td>$0.15</td>
</tr>
<tr>
<td>Automobile</td>
<td>$0.06</td>
</tr>
<tr>
<td>Cost of foregone trips ($/one-way trip)</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>$357</td>
</tr>
<tr>
<td>Work</td>
<td>$49</td>
</tr>
</tbody>
</table>
Benefit Category 3: Economic Impacts

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
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
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

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

## Small Urban Transit: Benefits Summary

<table>
<thead>
<tr>
<th>Transit Benefit Category</th>
<th>Fixed Route Bus (MB)</th>
<th>Demand Response (DR)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transportation Cost Savings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Ownership and Operation Costs</td>
<td>$109,504,604</td>
<td>$3,736,711</td>
<td>$113,241,314</td>
</tr>
<tr>
<td>Chauffeuring Costs</td>
<td>$157,544,484</td>
<td>$40,035,876</td>
<td>$197,580,360</td>
</tr>
<tr>
<td>Taxi Cost Savings</td>
<td>$346,479,411</td>
<td>$18,214,264</td>
<td>$364,693,675</td>
</tr>
<tr>
<td>Travel Time Cost Savings</td>
<td>-$148,062,294</td>
<td>-$17,202,571</td>
<td>-$165,264,865</td>
</tr>
<tr>
<td>Accident Cost Savings</td>
<td>$41,930,026</td>
<td>-$17,631,822</td>
<td>$24,298,205</td>
</tr>
<tr>
<td>Emission Cost Savings</td>
<td>$5,504,437</td>
<td>-$8,914,173</td>
<td>-$3,409,736</td>
</tr>
<tr>
<td><strong>Total Transportation Cost Savings</strong></td>
<td>$512,900,668</td>
<td>$18,238,285</td>
<td>$531,138,953</td>
</tr>
<tr>
<td><strong>Low Cost Mobility Benefits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foregone Medical Trip Benefits</td>
<td>$1,362,173,952</td>
<td>$100,952,297</td>
<td>$1,463,126,250</td>
</tr>
<tr>
<td>Foregone Work Trip Benefits</td>
<td>$1,389,891,143</td>
<td>$103,006,451</td>
<td>$1,492,897,594</td>
</tr>
<tr>
<td>Other Foregone Trip Benefits</td>
<td>$160,459,212</td>
<td>$21,690,446</td>
<td>$182,149,657</td>
</tr>
<tr>
<td><strong>Total Transit Benefits</strong></td>
<td>($3,425,424,975)</td>
<td>($243,887,479)</td>
<td>$3,669,312,454</td>
</tr>
</tbody>
</table>

**Note:** Percentages indicate the proportion of total transit benefits.
Transit Cost Data

**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
**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

### Transit Benefits

<table>
<thead>
<tr>
<th>Benefit Category</th>
<th>Small Urban Areas</th>
<th>Rural Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle ownership and operation cost savings</td>
<td>$113,241,314</td>
<td>$42,414,445</td>
</tr>
<tr>
<td>Chauffeuring Cost Savings</td>
<td>$197,580,360</td>
<td>$133,984,226</td>
</tr>
<tr>
<td>Taxi cost savings</td>
<td>$364,693,674</td>
<td>$147,655,815</td>
</tr>
<tr>
<td>Travel time cost savings</td>
<td>$165,264,864</td>
<td>$64,230,510</td>
</tr>
<tr>
<td>Accident cost savings</td>
<td>$24,298,205</td>
<td>$16,041,822</td>
</tr>
<tr>
<td>Emission cost savings</td>
<td>$364,693,674</td>
<td>$147,655,815</td>
</tr>
<tr>
<td>Cost of foregone medical trips</td>
<td>$1,463,126,250</td>
<td>$733,454,303</td>
</tr>
<tr>
<td>Cost of foregone work trips</td>
<td>$1,492,897,594</td>
<td>$552,325,683</td>
</tr>
<tr>
<td>Cost of other foregone trips</td>
<td>$182,149,657</td>
<td>$91,573,788</td>
</tr>
<tr>
<td>Total Transit Benefits</td>
<td>$3,669,312,454</td>
<td>$1,599,011,322</td>
</tr>
</tbody>
</table>

### Transit Costs

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Small Urban Areas</th>
<th>Rural Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Expenses</td>
<td>$1,581,017,438</td>
<td>$1,322,556,555</td>
</tr>
<tr>
<td>Capital Expenses</td>
<td>$117,565,000</td>
<td>$113,346,800</td>
</tr>
<tr>
<td>Total Transit Costs</td>
<td>$1,698,582,438</td>
<td>$1,435,903,355</td>
</tr>
</tbody>
</table>

### Benefit Cost Ratios

| Benefit Cost Ratios | 2.16 | 1.12 |

---

## Benefit Cost Ratios: National Summary

<table>
<thead>
<tr>
<th>Fixed Route Bus Service</th>
<th>Demand Response Service</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Urban Transit</td>
<td>2.60</td>
<td>0.64</td>
</tr>
<tr>
<td>Rural Transit</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Base Case</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Transit Benefits</strong></td>
<td>5,277</td>
<td>9,935 (88%)</td>
<td>5,287 (0%)</td>
<td>5,322 (1%)</td>
<td>6,337 (20%)</td>
<td>4,216 (-20%)</td>
<td>5,327 (1%)</td>
</tr>
<tr>
<td><strong>Benefit Cost Ratio</strong></td>
<td>1.68</td>
<td>3.17</td>
<td>1.69</td>
<td>1.70</td>
<td>2.02</td>
<td>1.35</td>
<td>1.70</td>
</tr>
</tbody>
</table>
## Economic Impacts from Spending on Transit in North Dakota

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

### 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?

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Jeremy Mattson: jeremy.w.mattson@ndsu.edu