Estimating Ridership of Rural Demand-Response Transit Services for the General Public

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Objective

Develop a model for estimating demand for rural demand-response transit services for the general public
Previous Demand Models

TCRP Report 161: *Methods for Forecasting Demand and Quantifying Need for Rural Passenger Transportation*

- General public rural passenger transportation
- Passenger transportation specifically related to social services or other programs
- Fixed-route transit in micropolitan areas
- Commuter services from rural counties to urban centers

ADA Paratransit Research

- Goodwill and Joslin (2013) *Forecasting Paratransit Services Demand - Review and Recommendations.*
  National Center for Transit Research, University of South Florida.
TCRP Report 161: Demand for rural general public, non-program-related service

• Two methods
  – Peer data
    • Passenger trips per capita, passenger trips per vehicle mile, passenger trips per vehicle hour
    • Calculate mean, median, and ranges for systems in similar settings
  – Demand function developed based on 2009 rural NTD data
    • Based on the assumption that older adults, people with mobility limitations, and people without access to a vehicle represent the main users of these services

\[
\text{Non-program Demand (trips per year)} = (2.20 \times \text{Population Age 60+}) + (5.21 \times \text{Mobility Limited Population Age 18-64}) + (1.52 \times \text{Residents of Household Having No Vehicle})
\]
Factors Affecting Ridership

• Demand for the service
  – Population
  – Demographics

• Level of service provided/Service characteristics
  – Days per week
  – Hours per day
  – Advance reservation requirements
  – Both demand-response and fixed-route?
  – Overlap in service area?
  – Regional or cultural differences, tribal transit?

• Cost of the service
Population and Demand-Response Transit Ridership
Models

• Two models
• Data sources
  – Model #1
    • Rural National Transit Database, 2013
    • American Community Survey (ACS) 2009-2013 5-year estimates
  – Model #2
    • Survey of rural transit agencies
Model #1

• Ridership is determined by:
  – Demand factors
    • Service area population
    • Demographic characteristics of service area
      – Percentage older adult (65 or older)
      – Percentage without a vehicle
      – Percentage with a disability
  – Service characteristics
    • Operates both fixed-route and demand-response
    • Service area overlaps
    • Serves only a municipality
  – Fare level
  – Other
    • Tribal transit
    • Region

• Data for 731 agencies for 2013
Limitations of Rural NTD Data

• Incomplete and imprecise service area information
• No data:
  – Hours per day
  – Days per week
  – Advance reservation requirements
  – Type of service provided
Survey of Transit Agencies

• Previous study conducted in North Dakota and Florida
Survey of Transit Agencies

• Collected detailed information
  – Geographic service area
  – Span of service
  – Advance reservation requirements
  – Service eligibility and type

• Additional surveys conducted nationwide

• Data collected for 68 rural demand-response transit agencies
Model #2

• Ridership is determined by:
  – Service area population
  – Hours of service per day
  – Days of service per week
  – Advance reservation time
  – Operates both fixed-route and demand response
  – Fare level
<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Estimated coefficient</th>
<th>Standard error</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Population)</td>
<td>0.83</td>
<td>0.02</td>
<td>0.000</td>
</tr>
<tr>
<td>Percentage elderly</td>
<td>7.99</td>
<td>0.99</td>
<td>0.000</td>
</tr>
<tr>
<td>Percentage with no vehicle</td>
<td>21.15</td>
<td>5.65</td>
<td>0.000</td>
</tr>
<tr>
<td>Percentage with disability</td>
<td>-0.46</td>
<td>1.20</td>
<td>0.703</td>
</tr>
<tr>
<td>Fixed-route</td>
<td>-0.65</td>
<td>0.11</td>
<td>0.000</td>
</tr>
<tr>
<td>Percentage overlap</td>
<td>-0.41</td>
<td>0.10</td>
<td>0.000</td>
</tr>
<tr>
<td>Municipality</td>
<td>0.77</td>
<td>0.10</td>
<td>0.000</td>
</tr>
<tr>
<td>Tribal</td>
<td>0.30</td>
<td>0.31</td>
<td>0.333</td>
</tr>
<tr>
<td>Ln(Fare)</td>
<td>-0.24</td>
<td>0.04</td>
<td>0.000</td>
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<tr>
<td>Region 1</td>
<td>-0.60</td>
<td>0.33</td>
<td>0.071</td>
</tr>
<tr>
<td>Region 2</td>
<td>-0.57</td>
<td>0.42</td>
<td>0.170</td>
</tr>
<tr>
<td>Region 3</td>
<td>-0.56</td>
<td>0.25</td>
<td>0.027</td>
</tr>
<tr>
<td>Region 4</td>
<td>-0.81</td>
<td>0.19</td>
<td>0.000</td>
</tr>
<tr>
<td>Region 5</td>
<td>0.50</td>
<td>0.20</td>
<td>0.012</td>
</tr>
<tr>
<td>Region 6</td>
<td>-0.15</td>
<td>0.22</td>
<td>0.480</td>
</tr>
<tr>
<td>Region 7</td>
<td>-0.36</td>
<td>0.19</td>
<td>0.057</td>
</tr>
<tr>
<td>Region 8</td>
<td>0.09</td>
<td>0.19</td>
<td>0.628</td>
</tr>
<tr>
<td>Region 9</td>
<td>0.16</td>
<td>0.25</td>
<td>0.523</td>
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</tbody>
</table>
Results: Model #1

- **Population** has a positive effect on ridership.
  - A 1% increase in population leads to a 0.83% increase in ridership.

- **Demographics** impact ridership.
  - Areas with a higher percentage of older adults or households without access to a vehicle have higher levels of ridership.
  - If the percentage of the population that is aged 65 or older increases by one percentage point, ridership increases by 8%.
  - If the percentage of the population without a vehicle increases by one percentage point, ridership increases by 21%.
Results: Model #1

• Agencies that provide both fixed-route and demand-response service have lower levels of demand-response ridership than agencies that provide just demand-response service, after accounting for all other variables.

• Agencies that serve areas where more than one transit provider is available have lower levels of ridership.

• Demand-response providers that strictly serve a municipality have higher levels of ridership than those serving a larger geographic area, after accounting for population and other factors.
Results: Model #1

- **Fares** have a negative impact on ridership. A 1% increase in fares leads to a 0.24% reduction in ridership.

- There are some **regional differences** in ridership not accounted for by these variables. Notably, region 5 agencies have higher levels of ridership, and agencies in regions 3 and 4 have lower levels.
Out-of-Sample Validation

- Results from the model were used to predict ridership for 2014
- Predicted ridership was compared to actual ridership

<table>
<thead>
<tr>
<th>Population</th>
<th>Model #1</th>
<th>TCRP 161 Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population under 100,000 (n=688)</td>
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<td></td>
</tr>
<tr>
<td>RMSE</td>
<td>55,579</td>
<td>73,941</td>
</tr>
<tr>
<td>MAE</td>
<td>23,506</td>
<td>28,669</td>
</tr>
<tr>
<td>Population under 50,000 (n=544)</td>
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<td></td>
</tr>
<tr>
<td>RMSE</td>
<td>48,231</td>
<td>71,439</td>
</tr>
<tr>
<td>MAE</td>
<td>19,536</td>
<td>26,027</td>
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</table>
## Results: Model #2

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Estimated Coefficient</th>
<th>Standard Error</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Population)</td>
<td>0.69</td>
<td>0.07</td>
<td>&lt;.0001</td>
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<tr>
<td>Percentage population with 6 or 7 days</td>
<td>1.65</td>
<td>0.80</td>
<td>0.0439</td>
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<td>Percentage population with 5 days</td>
<td>1.41</td>
<td>0.69</td>
<td>0.046</td>
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<tr>
<td>Percentage population with 12 or more hours</td>
<td>0.50</td>
<td>0.43</td>
<td>0.2545</td>
</tr>
<tr>
<td>Percentage population with less than 5 hours</td>
<td>-0.40</td>
<td>1.20</td>
<td>0.7397</td>
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<tr>
<td>Same-day reservation</td>
<td>2.01</td>
<td>0.55</td>
<td>0.0006</td>
</tr>
<tr>
<td>Prior-day reservation</td>
<td>1.24</td>
<td>0.56</td>
<td>0.0321</td>
</tr>
<tr>
<td>Fixed-route</td>
<td>-0.65</td>
<td>0.39</td>
<td>0.1013</td>
</tr>
<tr>
<td>Ln(Fare)</td>
<td>-0.12</td>
<td>0.07</td>
<td>0.0843</td>
</tr>
</tbody>
</table>
Results: Model #2

• **Population** has a positive effect on ridership.
  – A 1% increase in population leads to a 0.69% increase in ridership.

• Ridership is impacted by the **number of days that service is available**.
  – As the percentage of service area population with service 5 days per week increases by one percentage point, ridership increases 1.41%.
  – Ridership increases 1.65% as the percentage of service area population with service 6 or 7 days per week increases by one percentage point.
Results: Model #2

- **Advance reservation time** has a negative impact on ridership.
  - Compared to agencies that require reservation two or more days in advance, ridership is 124% higher for providers that require reservation one day in advance and 201% higher for agencies that allow same-day service.

- Agencies that provide both fixed-route and demand-response service have lower levels of demand-response ridership than agencies that provide just demand-response service, after accounting for all other variables.

- **Fares** have a negative impact on ridership.
  - A 1% increase in fares leads to a 0.12% reduction in ridership.
Applications

• Forecast demand for new service
• Estimate the impact of service changes
  – Geographic coverage
  – Span of service
  – Fares
  – Reservation requirements
• Project future ridership based on population and demographic changes
Conclusions

• **Demographic characteristics** are important
  – Older adults
  – People without access to a vehicle
• **Geographic characteristics** of service are important
• **Fare** elasticity estimated at -0.12 to -0.24
• **Availability of service/quality of service** impacts ridership
  – Agencies providing more days of service had higher levels of service
  – Advance reservation time is important
Conclusions

• Two new tools for estimating ridership
• A greater number of variables and more specific service information improves the performance
• Limited by data availability
• Identify high-productivity systems
• Many factors specific to each agency and community not captured by the model
Thank you!

Questions?

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www.surtc.org