

# An Application of Attitudinal Structural Equation Modeling to Intercity Transportation Market Segmentation

---

Jeremy Mattson  
David Ripplinger  
Del Peterson

Transportation Research Board, 91<sup>st</sup> Annual Meeting  
Washington, DC  
January 24, 2012



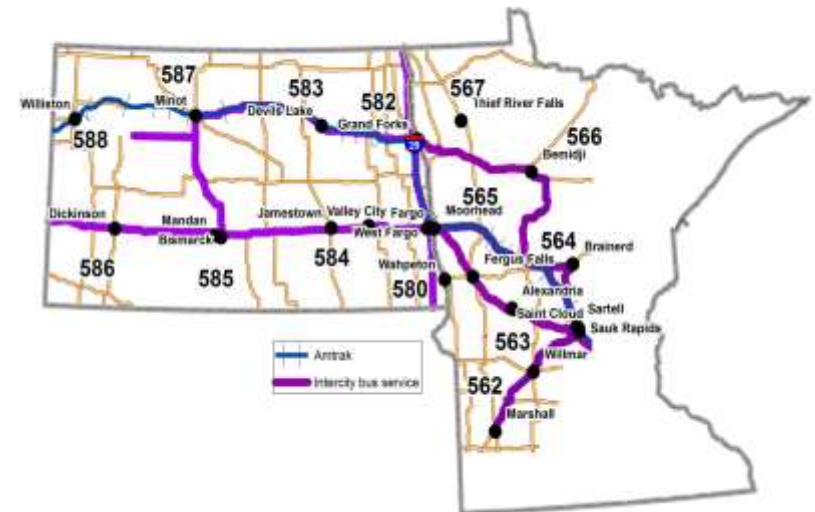
# Overview

- Intercity travel attitude and behavior data
- Survey of rural and small urban areas of Upper Midwest
- Segmenting intercity passenger transportation markets using attitudinal data
- Intercity travel behavior by market segment
  - Estimating intercity travel mode share
  - Changes to intercity transportation modal characteristics
- Conclusions
  - Strategic marketing and service design
  - Policy implications



# Survey

- Focus on regional, intercity travel
- North Dakota and NW/West Central Minnesota
- Age 18+
- Mail survey
  - 2,000 sent
  - 237 responses received (12.5%)
- 4 Sections
  - Current travel
  - Stated preference
  - Attitudes
  - Demographics



# Stated Preference Survey

- Choice set
  - Trip characteristics
    - Trip distance (30, 60, 240, 480 miles)
    - Personal or business
    - Alone or group
  - Five alternatives
    - Automobile
    - Air
    - Bus
    - Train
    - Van
  - Mode attributes
    - Travel time
    - Price
    - Service frequency
    - Transfer requirement



# Response to Opinion Questions

	Statement	Average Score
<b>Environmental Concern</b>		
	People who travel alone should pay more to help improve the environment.	3.1
	I would be willing to pay more when I travel if it would help the environment.	4.1
	I would switch to a different form of transportation if it would help the environment.	4.4
<b>Productivity/Reliability</b>		
	I would rather do something else with the time that I spend traveling.	5.8
	I like to make productive use of my time when traveling.	6.5
	I prefer a travel option that has a predictable travel time.	7.6
	I like to keep as close as possible to my departure and arrival schedules.	7.9
	If my travel options are delayed, I want to know the cause and length of the delay.	8.2
<b>Sensitivity to Time</b>		
	I would change my form of travel if it would save me some time.	6.3
	I always take the fastest route to my destination even if I have a cheaper alternative.	5.0

# Response to Opinion Questions

	Statement	Average Score
Flexibility		
	I need to make trips according to a fixed schedule.	5.4
	It's important to be able to change my travel plans at a moment's notice.	5.7
Privacy		
	I don't mind traveling with strangers.	4.9
	When traveling, I like to talk and visit with other people.	5.6
	I prefer to make trips alone, because I like the time to myself.	5.4
	Having privacy is important to me when I travel.	6.0
Comfort		
	Having a stress-free trip is more important than reaching my destination quickly.	6.7
	I don't mind long delays as long as I'm comfortable.	4.3
	It is important to have comfortable seats when I travel.	8.1
	I avoid traveling at certain times because it is too stressful.	6.0
	A clean vehicle is important to me.	7.7

# Analysis of Attitudes and Mode Choice

Statement	Mode Preference
Productive use of time.	More likely to choose air.
Prefer predictable travel time.	Less likely to choose air.
Willingness to travel with strangers.	More likely to choose alternatives to auto.
Concerned about being able to change travel plans at a moment's notice.	More likely to choose auto. Much less likely to choose air.
Concerned about having comfortable seats	Much less likely to choose air.
More concerned about having a stress-free trip than with reaching destination quickly.	Less likely to choose auto. More likely to choose van.
Concerned with cleanliness of vehicles.	More likely to choose auto.
People who ride a given mode are like me.	More likely to choose that given mode.

# Segmenting Markets

- Attitude-based intercity transportation markets are constructed using confirmatory factor analysis (CFA), structural equation modeling, and cluster analysis (following Shiftan et al. 2008, Outwater et al. 2003, 2004).
- CFA is used to verify the relationships between endogenous traveler attitudinal variables and latent (unobserved) attitudinal factors.
- Structural equation modeling is used to simultaneously estimate the relationship between traveler attitudes and exogenous socioeconomic characteristics.





# Segmenting Markets

- Cluster analysis is used to identify intercity transportation market segments.
- Market segment sizes of the entire market area are determined by assigning residents to segments based on their socio-economic characteristics, using 2008 Public Use Microdata Sample (PUMS) data collected by the U.S. Census.



# Verifying Attitudinal Variables

- CFA is used to verify the relationship between six latent attitudinal factors and 22 attitudinal variables.
- Six latent attitudinal factors:
  - Environmental concerns
  - Productivity/Reliability
  - Sensitivity to Time
  - Flexibility
  - Privacy
  - Comfort
- All individual variables are statistically significant.
- Goodness of Fit Index (GFI) = 0.78.

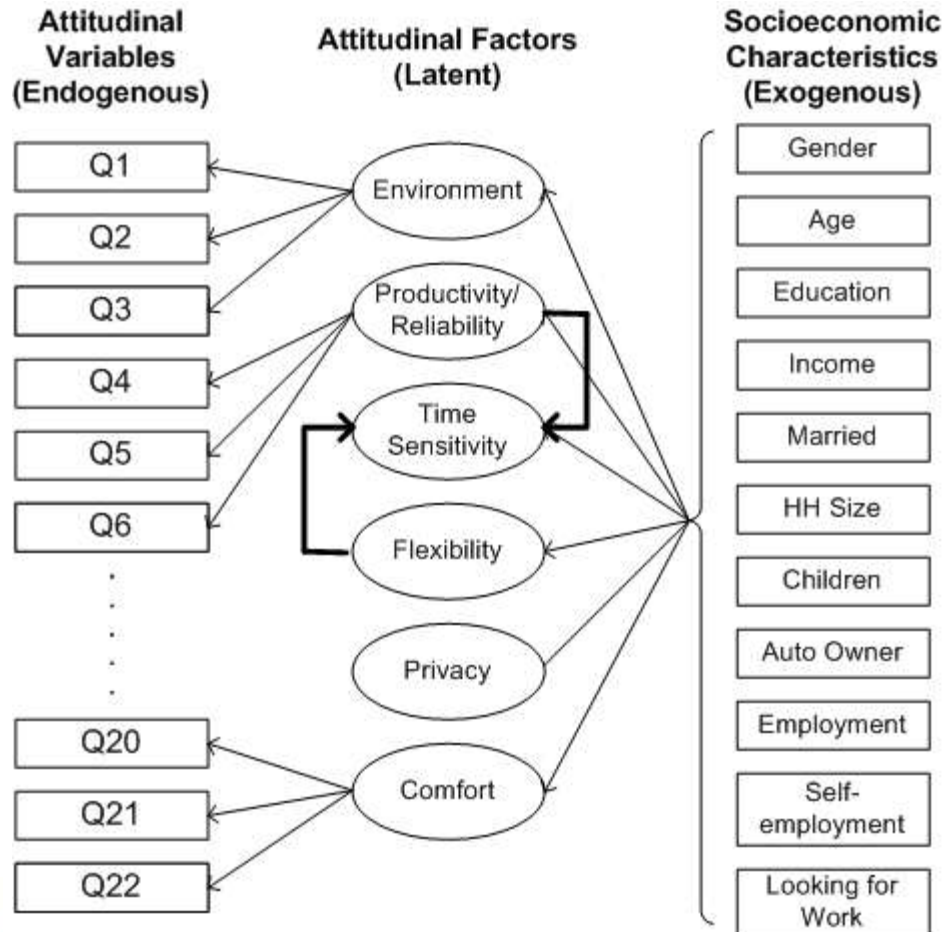


# Structural Equation Modeling

- The relationship between socioeconomic characteristics, latent attitudinal factors, and the responses to the attitudinal questions are modeled as a structural equation model (SEM).
- Socioeconomic characteristics are considered to impact all attitudinal factors.



# Intercity Transportation Structural Equation Model



# Intercity Transportation SEM Estimates

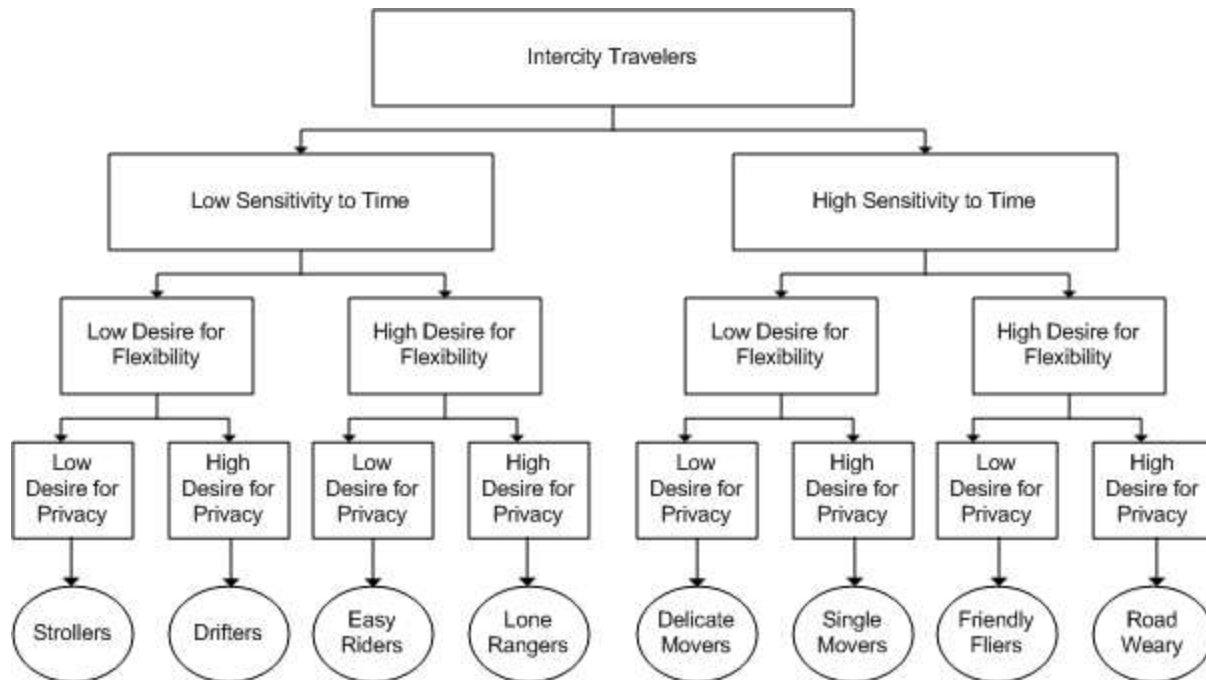
	Environment	Productivity/ Reliability	Time Sensitivity	Flexibility	Privacy	Comfort
Gender						
Male	0.07	-0.03	0.14	-0.08	-0.05	0.01
Age						
18-24	-0.09	0.05	-0.14	0.05	-0.13	0.05
25-34	-0.33**	0.05	0.02	-0.13	-0.34**	-0.11
35-44	-0.21*	0.19*	0.13	0.03	-0.19	0.13
45-54	-0.33**	0.21*	0.12	0.06	-0.39**	0.27**
55-64	-0.08	0.02	0.16	0.05	-0.12	0.01
Education						
High School or less	0.05	0.11	-0.06	-0	0.01	0.32**
Some College	0.01	-0.06	-0.24	-0.06	-0.01	0.29**
College Degree	0.13	0.06	-0.07	0.06	0.15	0.23**
Income						
<30 K	0.3**	0.04	0.17	0.04	0.07	-0.08
<60 K	0.15	-0.01	0.04	-0.01	-0	-0.16
<100 K	0.09	-0.02	-0.14	-0.02	-0.09	-0.23
<150 K	0.09	0.04	0.27*	0.03	-0.18	-0.01
Married	0.23	0.1	-0.06	0.1	0.02	0.11
Number of Children	0.14	0.25*	0.26	0.27	0.05	-0.1
Household Size	-0.15	-0.48**	-0.3	-0.18	-0.09	-0.14
Vehicle Presence	-0.12	0.02	0.04	0.02	0.04	0.19**
Employed	0.21**	0.17	0.36**	0.29**	0.03	0.07
Self-employed	-0.2**	-0.05	0.11	0.06	0.14	-0.13
Looking for Work	0.07	0.06	0.28**	-0.001	-0.05	0.11

# Attitude-based Market Segmentation

- Cluster analysis
- Eight clusters are used.
- Time sensitivity, flexibility, and privacy are found to have the greatest explanatory power for segmenting markets.
- Individual residents are assigned to each market segment based on their socioeconomic characteristics.



# Intercity Transportation Market Segments

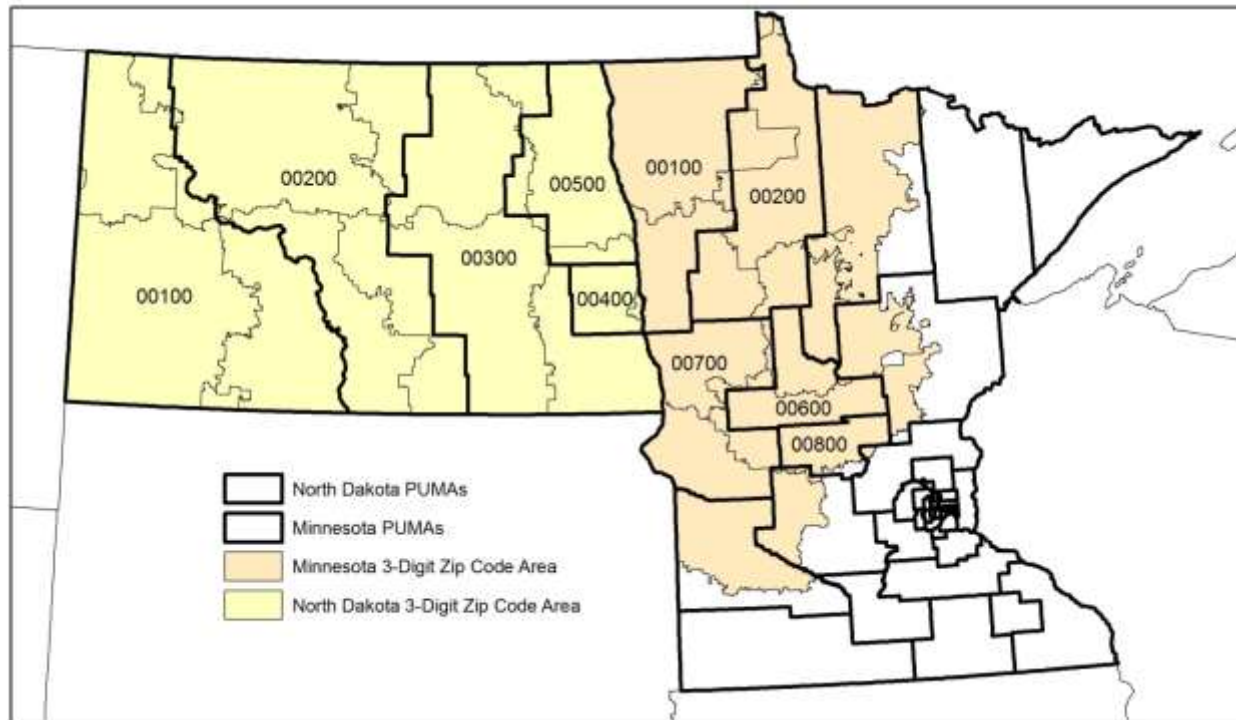


# Demographic Characteristics of Market Segments

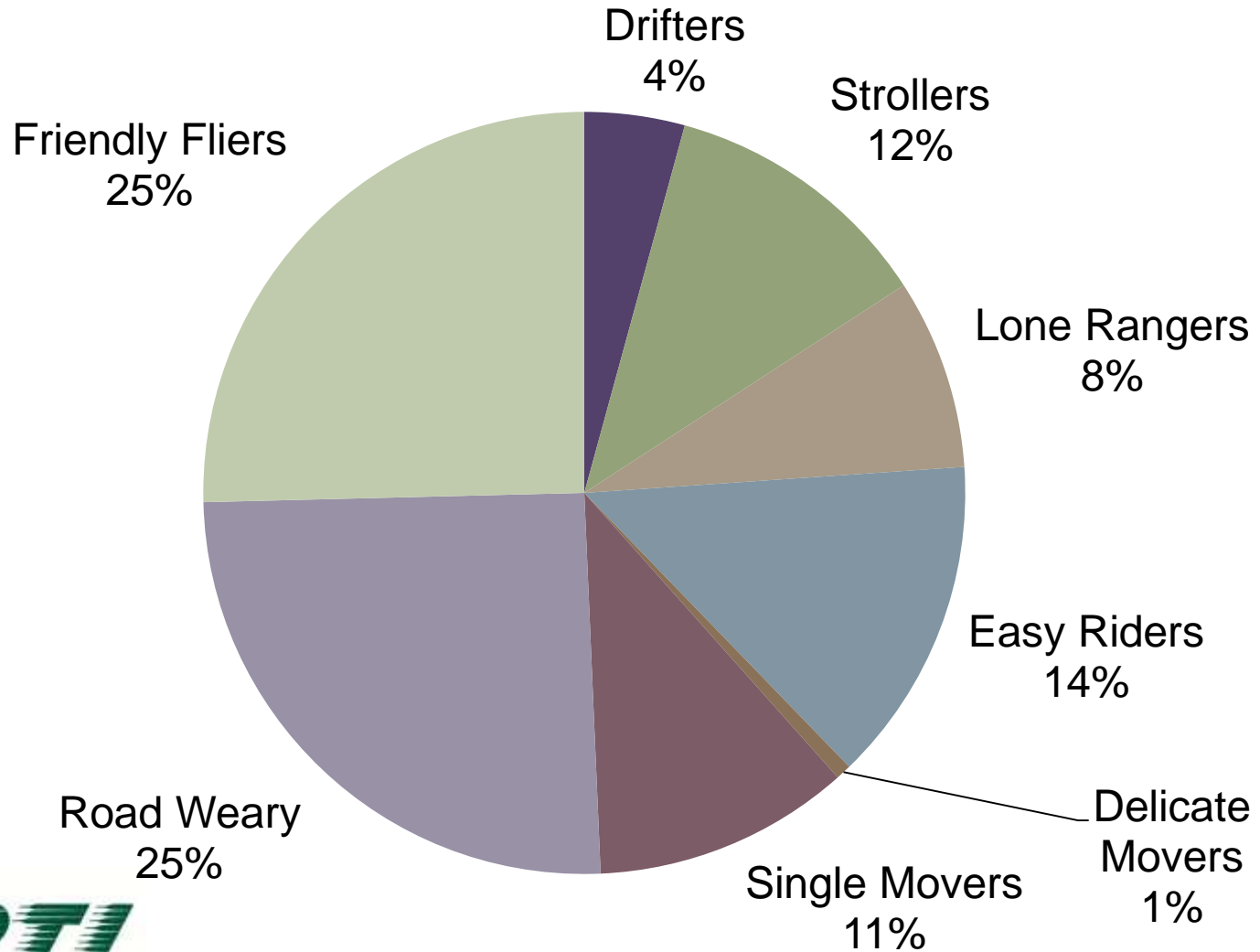
Market Segment	Male	Married	Children in Household	Household Income > \$60,000	Over age 65	At least some college	Employed	Avg household size
	-----Percentage-----							
Strollers	82	80	77	78	7	54	99	2.8
Drifters	66	65	69	52	6	55	97	2.8
Easy Riders	28	77	14	36	62	72	36	2.2
Lone Rangers	61	57	34	6	35	35	90	2.1
Delicate Movers	42	60	2	5	81	29	24	1.7
Single Movers	71	48	75	10	4	26	99	2.7
Friendly Fliers	35	65	74	67	8	74	86	3.3
Road Weary	56	77	88	45	5	60	97	3.0



# Market Area



# Relative Market Segment Sizes



# Intercity Travel Behavior by Market Segment

- Market segments are expected to respond differently to changes in price and product characteristics.
- Mode shares by market segment are estimated using socioeconomic characteristics for each market segment.
- Previously estimated multinomial logit model used to estimate mode shares.
  - Model was fit using stated preference and socioeconomic data.
  - Results show
    - Seniors less likely to travel by air
    - Men more likely to travel by automobile
    - Higher income individuals more likely to travel by automobile



# Intercity Transportation Mode Shares

	120-Mile Trip				
	Auto	Air	Bus	Train	Van
Strollers	0.86	0.01	0.03	0.07	0.03
Drifters	0.88	0.01	0.02	0.05	0.03
Easy Riders	0.75	0.00	0.08	0.09	0.09
Lone Rangers	0.74	0.00	0.11	0.09	0.06
Delicate Movers	0.68	0.00	0.12	0.09	0.10
Single Movers	0.80	0.00	0.07	0.08	0.05
Friendly Fliers	0.87	0.02	0.02	0.04	0.06
Road Weary	0.82	0.00	0.06	0.07	0.05
Total Market	0.82	0.01	0.05	0.07	0.05

# Intercity Transportation Mode Shares

	480-Mile Trip				
	Auto	Air	Bus	Train	Van
Strollers	0.86	0.07	0.02	0.04	0.02
Drifters	0.82	0.13	0.01	0.03	0.02
Easy Riders	0.82	0.04	0.05	0.05	0.05
Lone Rangers	0.85	0.00	0.06	0.05	0.03
Delicate Movers	0.81	0.00	0.07	0.06	0.06
Single Movers	0.84	0.05	0.04	0.04	0.03
Friendly Fliers	0.74	0.21	0.01	0.02	0.03
Road Weary	0.83	0.07	0.03	0.04	0.03
Total Market	0.81	0.10	0.03	0.04	0.03

# Intercity Bus and Rail Shares for 480-Mile Trips at Different Travel Speeds

	Bus			Rail		
	Low-Speed	Medium-Speed		Low-Speed	Medium-Speed	Higher-Speed
	-----Percentage-----					
Strollers	1.6	2.6		3.7	5.9	8.0
Drifters	1.0	1.6		2.6	4.2	5.8
Easy Riders	4.5	6.9		4.9	7.5	9.6
Lone Rangers	6.3	9.5		5.0	7.6	9.8
Delicate Movers	7.4	11.0		5.5	8.2	10.4
Single Movers	3.7	5.8		4.3	6.7	8.8
Friendly Fliers	0.8	1.3		1.8	2.8	3.9
Road Weary	3.0	4.7		3.7	5.8	7.7
Total Market	2.8	4.3		3.5	5.5	7.3

# Conclusions

- Attitudes regarding travel time, flexibility, and privacy are the most important, so service changes and marketing strategies regarding these factors would have the greatest influence.
- Strollers (low sensitivity to time, flexibility, and privacy) are a target market for intercity bus and rail.
- Delicate Movers, Lone Rangers, and Easy Riders (older, middle-to-low incomes) are most likely to travel by bus, rail, or van.



# Conclusions

- Changing demographics will influence demand for different modes of travel.
- Reducing travel time for rail and bus significantly increases mode share.
- Environmental sensitivity is a significant attitudinal factor, though not as important as others.





# QUESTIONS?

---

**Jeremy Mattson**

**Associate Research Fellow**

**Small Urban & Rural Transit Center**

**Upper Great Plains Transportation Institute**

**North Dakota State University**

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

**[www.surtc.org](http://www.surtc.org)**

