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POTENTIAL IMPLICATIONS OF AUTONOMOUS VEHICLES ON PERSONAL VEHICLE OWNERSHIP AND DEMAND FOR PUBLIC TRANSIT

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OUTLINE

- Introduction – Objectives
- Survey Design
- Descriptive Statistics – Model Specification
- Results
- Key Takeaways
- Limitations/Future Work



INTRODUCTION

Background Information

- Private vehicle as a status symbol.
- AVs can substitute and transform traditional transportation modes.
- Address parking congestion.
- Increase accessibility leading to urban sprawl.
- Alter land use and location choices affecting the economic development.
- Be synergistic with electrification to lower energy use and emissions.
- Benefit disadvantaged groups, advocate social justice.

Traditional non-autonomous vehicles

- Non-autonomous vehicles are intended for personal and/or work use.

Personal autonomous vehicles

- Personal autonomous vehicles owned by individuals and shared by a single family.

Shared autonomous vehicles

- Similar to existing ride-sharing services, without the driver.
- Can also be defined as "taxi-robots".

Pooled shared autonomous vehicles

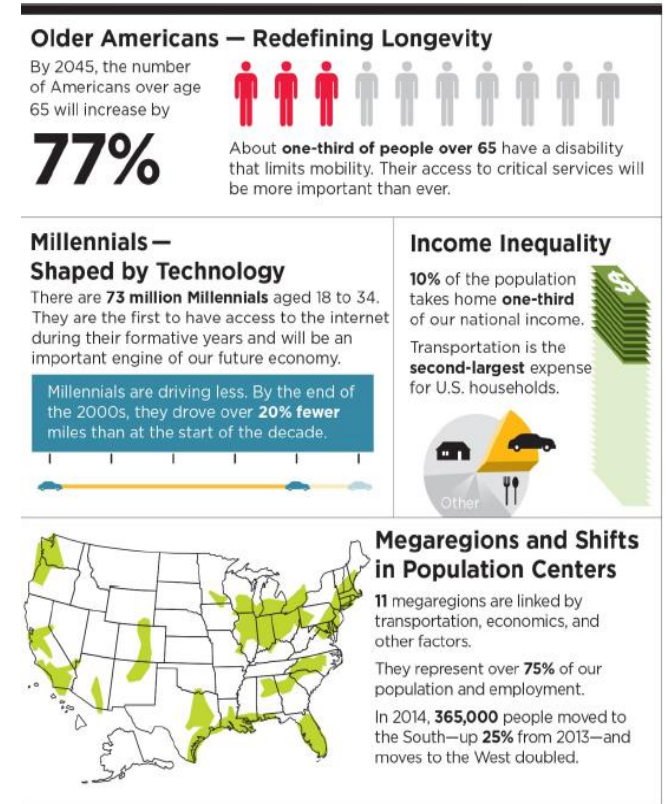
- Similar to existing pooled ride-sharing services.
- Shared autonomous vehicles that can accommodate multiple riders at different points simultaneously.

*Expected types of vehicles on road networks by 2030
(Litman, 2019, Krueger et al., 2016)*

INTRODUCTION

Current and Emerging Trends

- U.S. household: 2.5 people and 1.75 vehicles.
- Since 1996: transit ridership +30% vs. population +20%.
- Diffusion of AVs can change these statistics dramatically.
- Emergence of AVs leads to implications of vehicle ownership as a second order effect.
- Recent studies focused on market acceptance.
- Substitution ratios (# non-AVs → 1 AV).
- Lack knowledge on the perceived impacts driving people's decisions to postpone the purchase of non-AVs in different time frames.
- Public transportation users deemed as early adopters.



*Beyond traffic 2045: Trends and choices. (2015).
Washington, D.C. U.S.
Department of
Transportation.*

STUDY OBJECTIVES

- 1) Understanding what influences decisions of postponing the purchase, keeping or giving up private vehicle ownership of non-AVs in the short and long run.
- 2) Assessing the intention to switch from public transportation in favor of ride-sharing services operated in AVs.



SURVEY DESIGN

Empirical Setting

- Metropolitan area of Chicago - advanced multimodal transportation system
- Metropolitan area of Indianapolis – car-oriented culture
- 400 completed responses – November 2017/March 2018
 - 5% of margin of error and 95% confidence level
- Hard quotas on gender and age groups (Census data)
- Online distribution
- Residents over 18 years old
- Approval from IRB:
 - IRB Protocols #1701018708 and #1801020160

Representative
sample



Chicago



Indianapolis

SURVEY DESIGN

1st section:

Questions regarding people's awareness towards advances on AVs

2nd section:

Questions about people's travel characteristics

3rd section:

Factors affecting people's behavioral intention to ride in AVs
- Attitudinal questions

4th section:

Mode choice experiment

5th section:

Socio-demographic questions



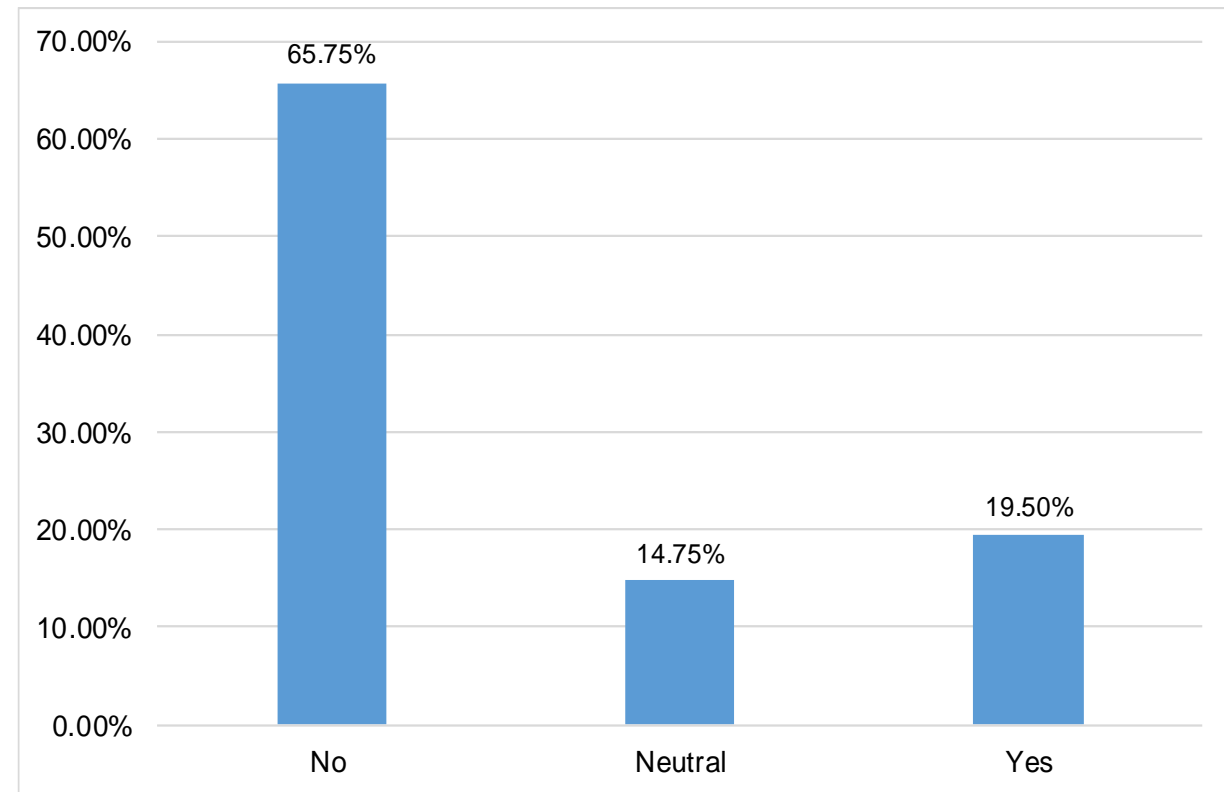
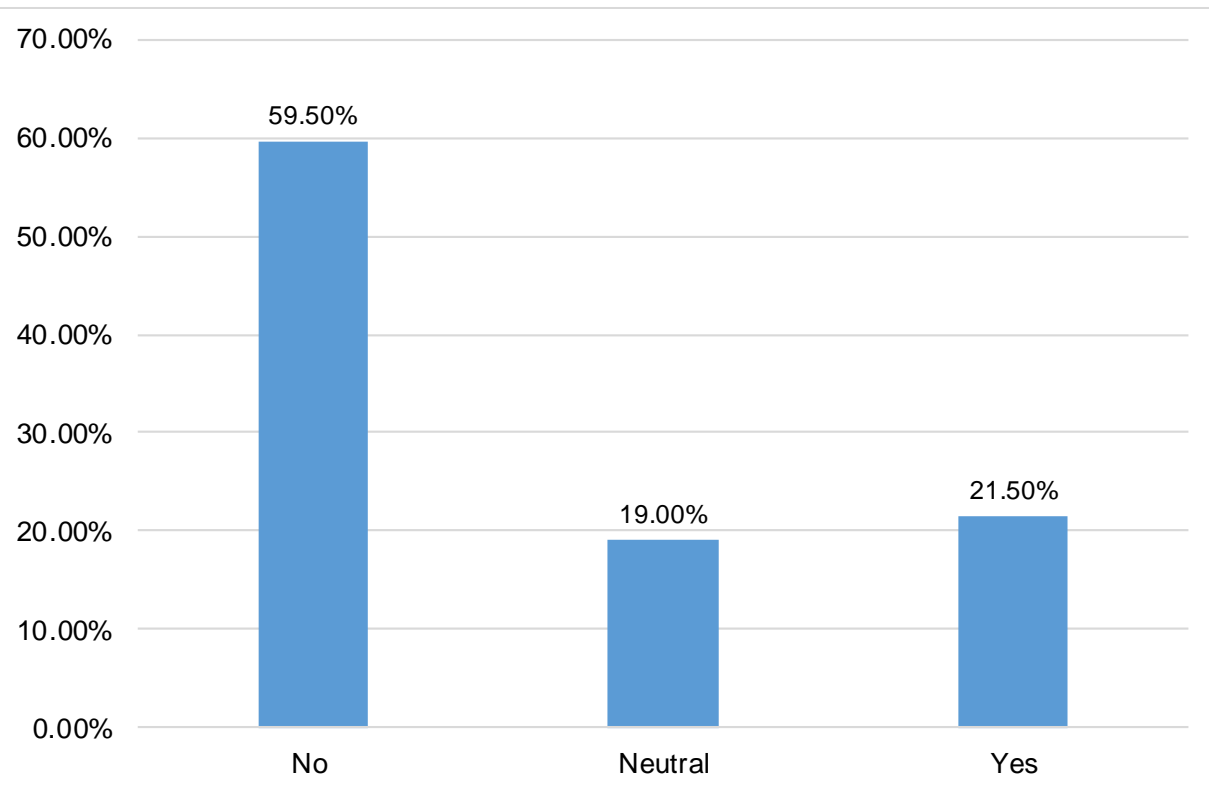
DESCRIPTIVE STATISTICS

Private Vehicle Ownership

Intention to postpone the purchase of non-AV due to the introduction of AVs

Chicago

Indianapolis

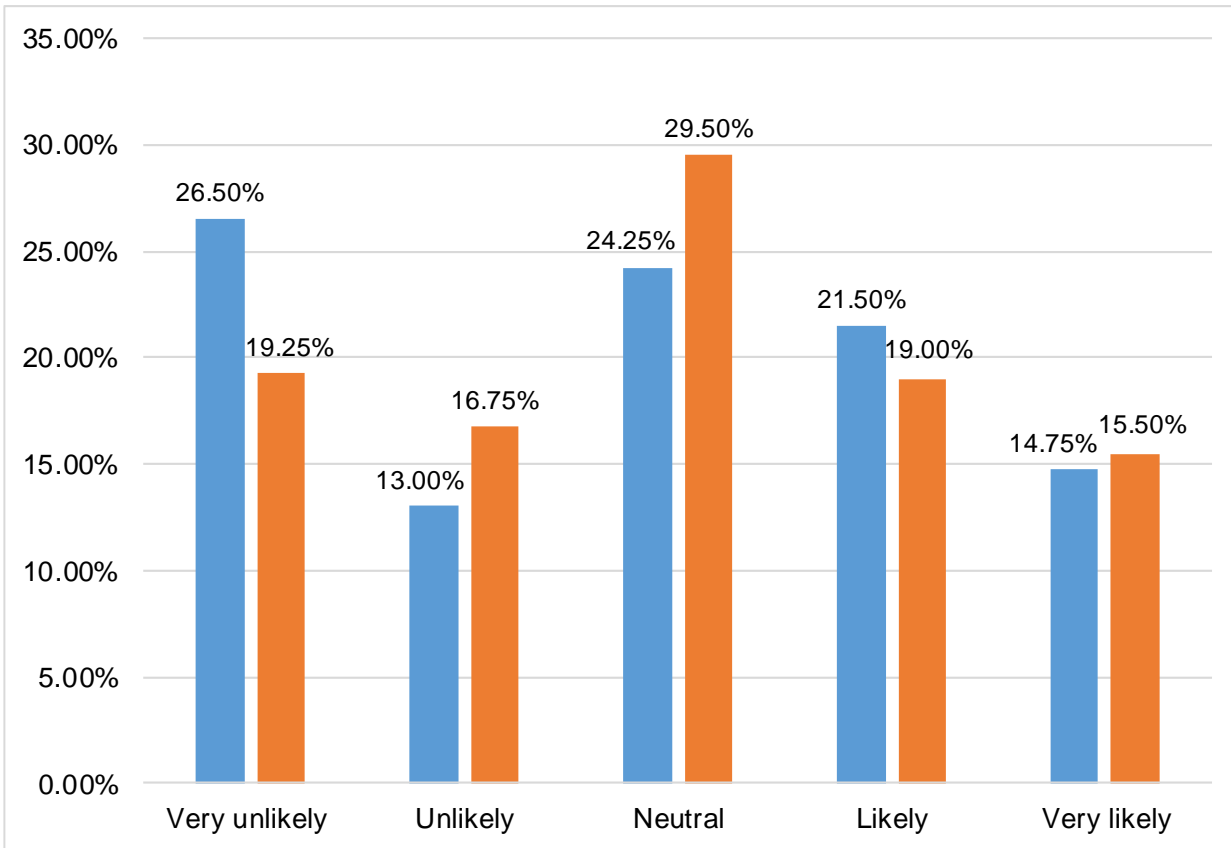


DESCRIPTIVE STATISTICS

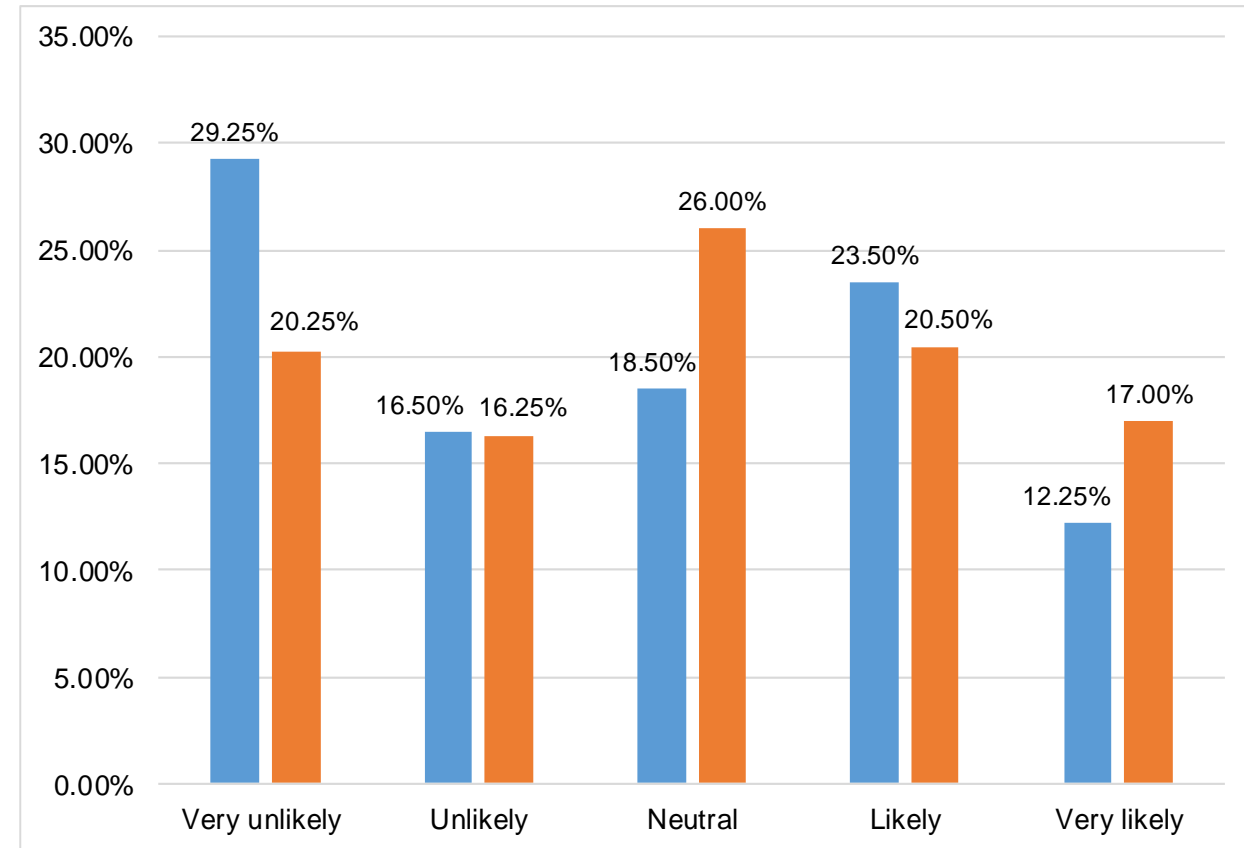
Private Vehicle Ownership

Likelihood for having **one non-AV in the short run** and **zero non-AVs in the long run** after the introduction of AVs

Chicago



Indianapolis

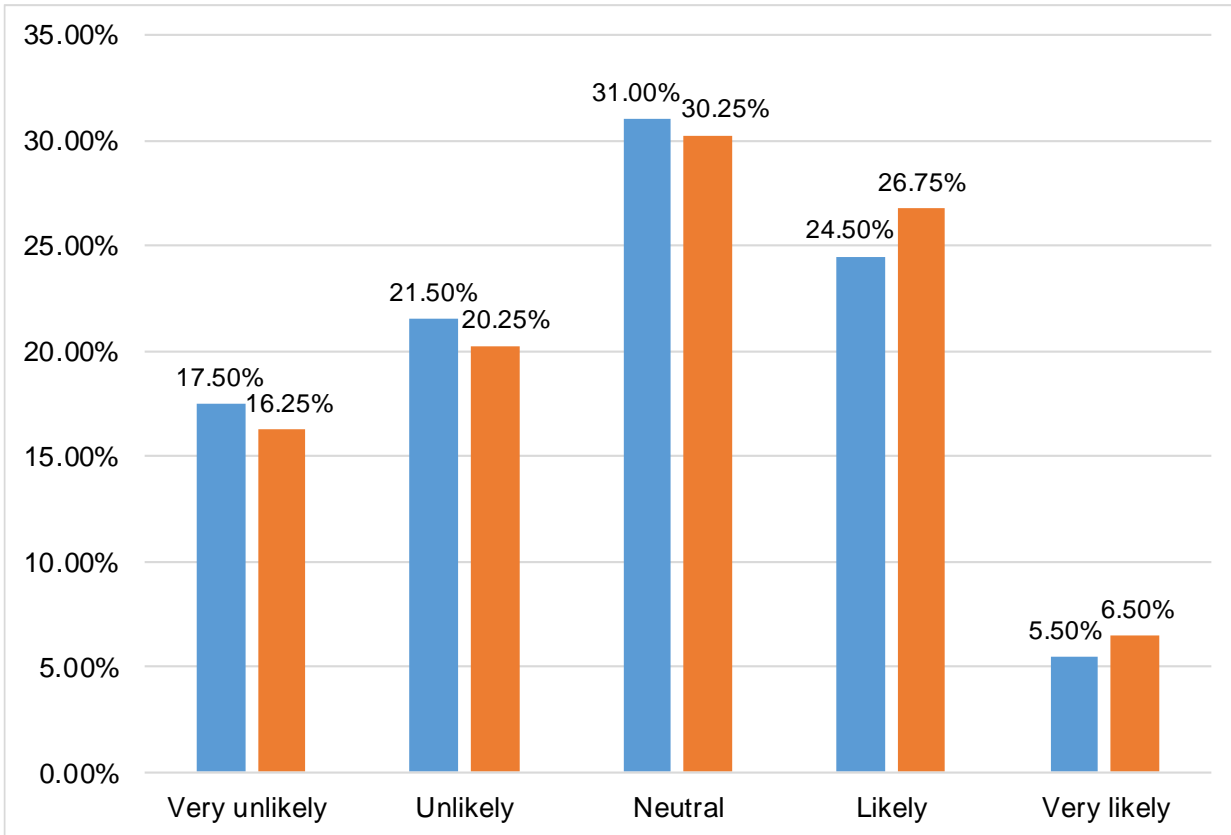


DESCRIPTIVE STATISTICS

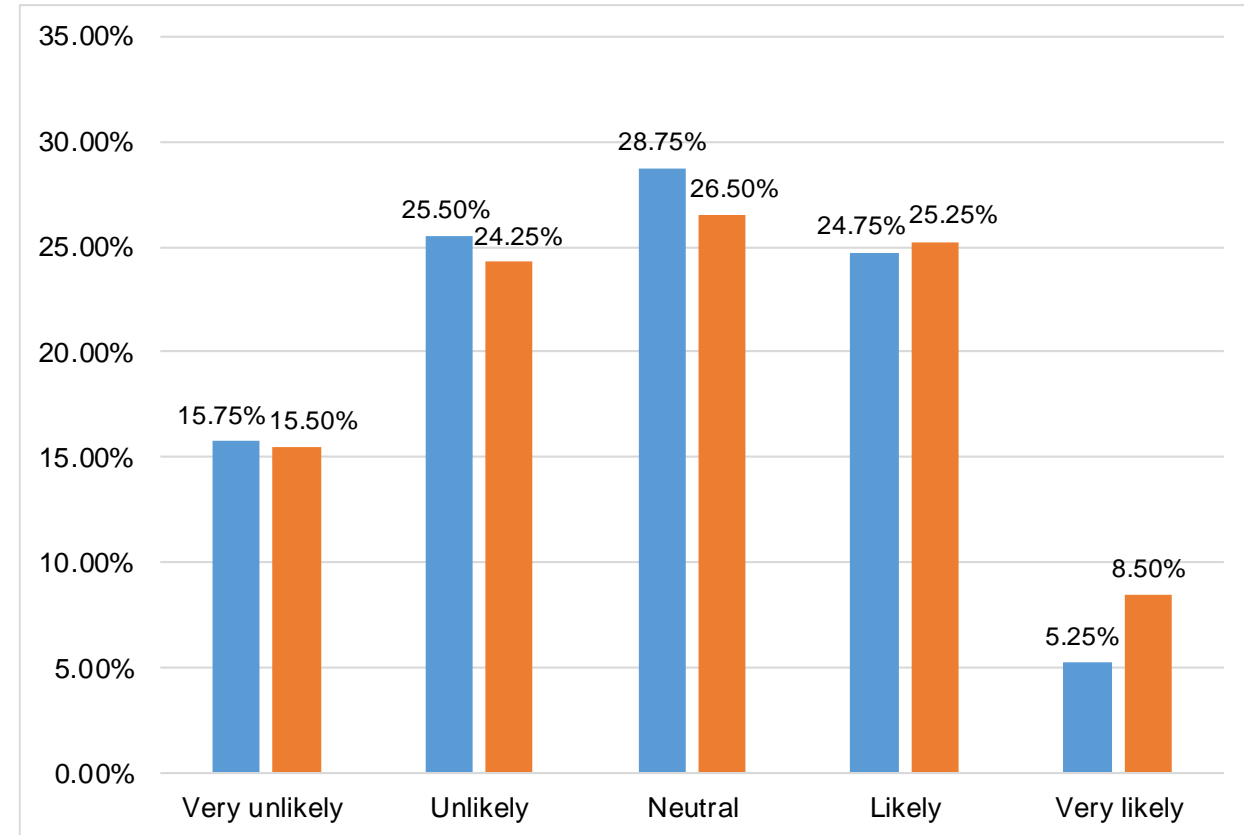
Public Transportation

Intention to switch from public transportation in favor of using ride-sharing services on AVs in the **short** and **long** run

Chicago



Indianapolis



MODEL SPECIFICATION

- Most common modeling technique to assess vehicle ownership and mode choice decisions is discrete choice.
- Cross-correlation between the dependent variables (correlation coefficient of 0.80) of short and long term.
- Bivariate Ordered Probit as a system.



RESULTS – PRIVATE VEHICLE OWNERSHIP

Variable	Short term - 1 non AV	Long term - 0 non AV
Awareness		
Respondents with highest level of awareness towards Uber's self-driving vehicles? (1: yes, 0: no)	+	
Respondents with highest level of awareness towards a set of features called 'autopilot' provided in some versions of Tesla vehicles (1: yes, 0: no)		+
Travel characteristics variables		
Respondents who indicated that their primary commuting mode of travel is private vehicle and make zero social/recreational trips per week (1: yes, 0: no)		-
Respondents who indicated that their primary mode of travel for social/recreational trips is bus (1: yes, 0: no)	+	+
Respondents who indicated that have a car sharing account (1: yes, 0: no)	+	+
Respondents who indicated that drive less than 10,000 miles per year (1: yes, 0: no)	+	+
Perceptions / Opinions / Attitudes		
Respondents who agreed or strongly agreed, on average, that they are positive towards trying innovations – early adopters	+	+
Respondents who agreed or strongly agreed, on average, that their decisions are affected by their social circle – subjective norms	+	
Respondents who agreed or strongly agreed, on average, that they do not trust strangers - distrust of strangers**	-	

Perceptions / Opinions / Attitudes		
Respondents who agreed or strongly agreed, on average, that AVs are compatible with their lifestyle, daily needs or personal values and attitude - compatibility**		+
Respondents who agreed or strongly agreed, on average, that they have safety concerns on riding in AVs – safety concerns**	-	-
Mode choice-related factors		
Respondents who rated level of cost in travel as a very or extremely important factor when they make mode choice decisions (1: yes, 0: no)	+	+
Respondents who rated level of reliability in travel as a very or extremely important factor when they make mode choice decisions (1: yes, 0: no)	+	
Socio-demographics		
Respondents who are over 55 years old (1: yes, 0: no)	-	-
Respondents who have annual income over \$100,000 (1: yes, 0: no)	+	+
Respondents who indicated that they work full time (1: yes, 0: no)	+	+
Respondents who indicated that they are students (1: yes, 0: no)		+
Respondents who indicated that they own or have access to 1-2 vehicles in their households (1: yes, 0: no)	+	

RESULTS – PUBLIC TRANSPORTATION

Variable	Short term	Long term
Awareness		
Respondents with highest level of awareness towards a set of features called 'autopilot' provided in some versions of Tesla vehicles (1: yes, 0: no)	+	+
Travel characteristics variables		
Respondents who indicated that have a car sharing account (1: yes, 0: no)	+	+
Respondents who indicated that drive less than 10,000 miles per year (1: yes, 0: no)	+	+
Respondents who indicated that drive less than 20,000 miles per year (1: yes, 0: no)		+
Perceptions / Opinions / Attitudes		
Respondents who agreed or strongly agreed, on average, that they are positive towards trying innovations – early adopters	+	+
Respondents who agreed or strongly agreed, on average, that their decisions are affected by their social circle – subjective norms	+	+
Respondents who agreed or strongly agreed, on average, that they have safety concerns on riding in AVs – safety concerns**	-	

Mode choice-related factors		
Respondents who rated level of reliability in travel as a very or extremely important factor when they make mode choice decisions (1: yes, 0: no)	+	
Respondents who rated level of flexibility in travel as a very or extremely important factor when they make mode choice decisions (1: yes, 0: no)	+	+
Socio-demographics		
Respondents who are between 18-34 years old (1: yes, 0: no)	+	+
Respondents who have annual income less than \$50,000 (1: yes, 0: no)	+	+
Respondents who indicated that they are students (1: yes, 0: no)		+
Respondents who indicated that they own or have access to 0-1 vehicles in their households (1: yes, 0: no)	+	

KEY TAKEAWAYS

People shifting away from private vehicle ownership and public transit to AVs:

- individuals with high level of awareness;
- influenced by their social circle;
- familiar with car-sharing or ride-hailing services;
- individuals that value cost as important for mode choice decisions;
- individuals that value reliability and flexibility as important for mode choice decisions;
- young age groups.



KEY TAKEAWAYS

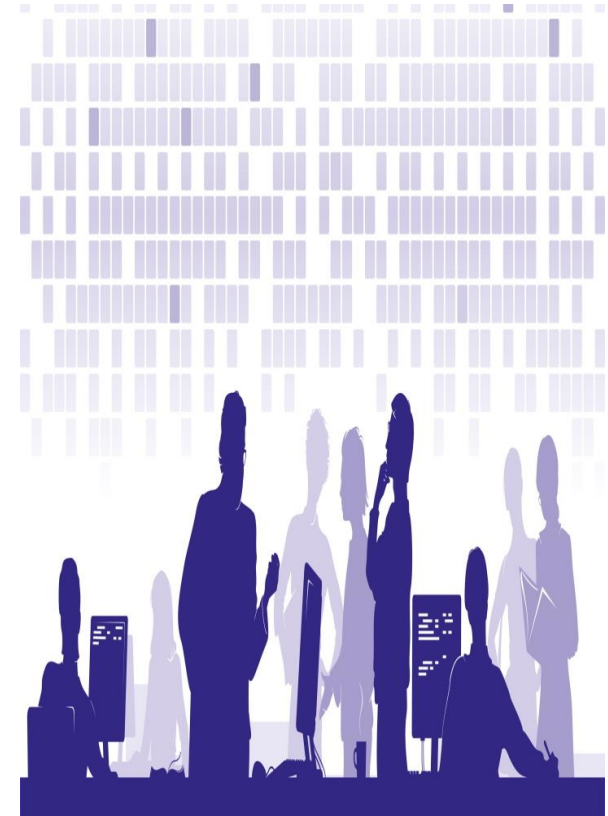
People postponing these decisions:

- commuting using their private vehicles;
- individuals with low trust of the technology;
- individuals with safety concerns;
- older individuals.



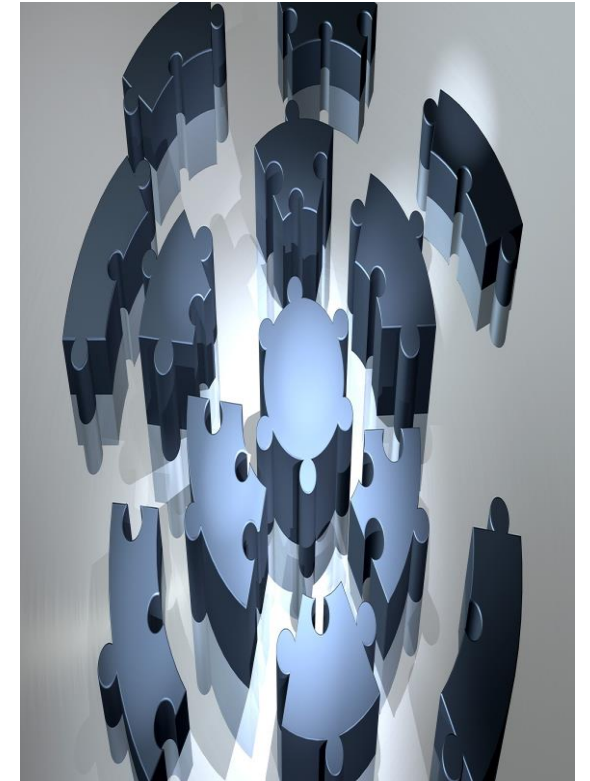
IMPLICATIONS

- Increase public awareness/acceptance with marketing campaigns (e.g. Waymo – ride-hailing services available to users).
- Trade-off of perceived benefit vs. perceived risk.
- Financial incentives to transportation disadvantaged groups leading to increase of accessibility and mobility.
- Complementing services to public transportation
 - feeder modes for first and last mile trips;
 - premium on-demand services with lower capacity but higher flexibility and comfort (increase attractiveness of public transportation).
- Rebates for vehicles with automated safety features, discounts of insurance services for AVs.



LIMITATIONS/FUTURE WORK

- Stated preference survey – hypothetical nature.
- Cross-sectional study – longitudinal study.
- Wider testing in different urban areas (travel behavior, habits – culture).



ACKNOWLEDGEMENTS



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<https://engineering.purdue.edu/STSRG>



Purdue Policy Research Institute



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