Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future

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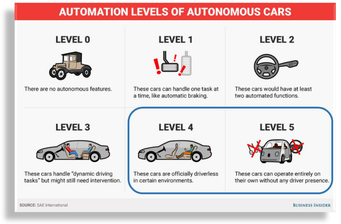
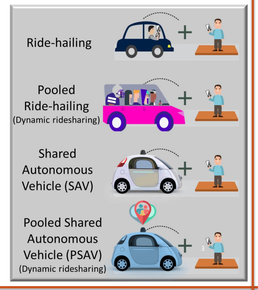
Terminology

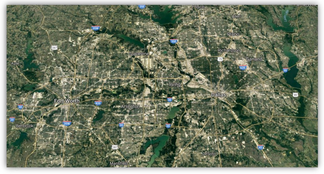
Autonomous Vehicles (AVs)





Study Area: Dallas-Fort Worth Metropolex

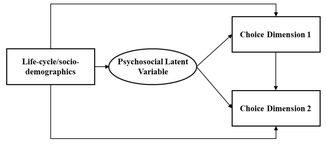
- Dallas-Fort Worth MSA
  - Fastest growing metropolitan area in the U.S.
  - Car-dominated and spread urban area



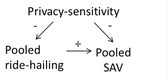
- Population: 7.4 million
- Area: 24,059 km^2 (308/ km^2; 1,500/km^2
- Public transit mode share: 2% of all trips
- Commute mode share: 81% drive alone

Overcoming Empirical Challenges

- Multivariate models with stochastic latent variables
  - GHDM
    - Create jointness
    - Control for self-selection
    - Allow for observed and unobserved taste-heterogeneity



- **Self-selection effects**



- **Taste heterogeneity**

Privacy-sensitivity ⟶ PSAV

Pax *Privacy-sensitivity ⟶ PSAV

Value of Travel Time and Willingness to Share Computation

$$E(VTT_q) = \frac{\beta_{TT_1} E(z^*_{TS_q}) + \beta_{TT_2} E(z^*_{IPTT_q}) + \beta_{TT_3}}{\beta_{COST}} \qquad Var(VTT_q) = \frac{1}{\beta^2_{COST}} \left(\beta^2_{TT_1} + \beta^2_{TT_2}\right)$$

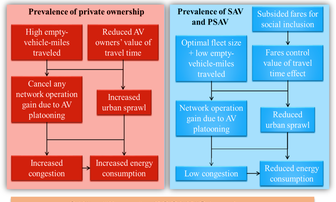
$$E(WTS_q) = \frac{\beta_{AP_1} E(z^*_{PS_q}) + \beta_{AP_2}}{\beta_{COST}} \qquad Var(WTS_q) = \frac{\beta^2_{AP_1}}{\beta^2_{COST}}$$

Main implications

- Need to promote pooling now
  - Privacy-concerns
  - Millennial's pooling experiences
    - why they don't want to share anymore?
    - Security concerns?
  - Solution: Social-network-based ridesharing?
- Productive use of travel time
  - Already impacting ride-hailing adoption
  - High-income groups: may **travel more and alone!**
    - Implications to transportation equity
- Importance of distinguishing trip purposes when investigating VTT and WTS
  - Aversion to strangers is lower for commute purposes
    - Easier to promote pooled SAV use for commute trips than for leisure trips
    - To SUPPLY researchers: time efficient pooled SAV system has great potential to induce sharing
- Need for more WTS studies
  - Experiment limitations
    - revealed/stated and
    - attribute levels
  - Heterogeneity in cost-sensitivity

Motivation: Automation, Sharing & Pooling

System's perspective: need for pooling and sharing!



SAVs still require POOLING to reduce:
- Congestion (Levin et al., 2017)
- Empty VMT (Fagnant and Kockelman, 2018)
- Waiting times (Liu et al., 2018; Wang et al., 2018)

…pooling and sharing in the user's perspective

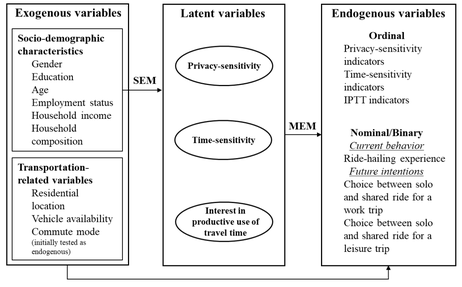
- Similar to drive alone
  - Flexible routes: door-to-door
  - Real-time scheduling
- But still… need to break habits
- Sharing rides with strangers
- Delays due to pick-up/drop-off of other passengers
  - Walk to/from a pick-up/drop-off
- Requirement: familiarity with ICT

Data & Sample

- **Online survey**
  - **revealed and stated choices**
- Sample of 1,607 commuters
  - Convenience sample
- Fall 2017

Variable		Count	%
Gender	Female	668	41.57
	Male	939	58.43
Age	18 to 34	261	16.24
	35 to 44	360	22.4
	45 to 54	432	26.88
	55 to 64	423	26.32
	65 or more	131	8.16
Race	Non-Hispanic White	1205	74.98
	Non-Hispanic Black	102	6.35
	Hispanic	109	6.78
	Other	191	11.89
Education (degree)	Associate or lower	392	24.40
	Undergraduate	724	45.05
	Graduate	491	30.55
Household income	Under $49,999	184	11.45
	$50,000-$99,999	443	27.57
	$100,000-$149,999	496	30.86
	$150,000-$199,999	269	16.74
	$200,000 or more	215	13.38

Analytic Framework



SEM Results

Variables (base category)	Structural Equations Model Component Results					
	Privacy-sensitivity		Time-sensitivity		IPTT	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Gender (male)						
Female	--	--	0.183	4.27	--	--
Age (≥55 years)						
18 to 34	0.168	1.84	--	--	0.326	4.87
35 to 44	0.137	4.09	0.265	5.26	0.256	4.54
45 to 54	--	--	--	--	--	--
Race (other races)						
Non-Hispanic White	0.131	3.76	--	--	--	--
Education (≤ undergraduate degree)						
Graduate degree	--	--	--	--	0.133	4.32
Employment (full-time)						
Part-time employee	--	--	-0.382	-4.71	--	--
Self-employed	--	--	-0.119	-1.97	--	--
Household income (< $150,000)						
$150,000-$199,999	--	--	--	--	0.092	2.84
$200,000 or more	0.350	5.16	0.298	4.26	0.092	2.84
Correlations between latent variables						
Privacy-sensitivity	1.000	n/a				
Time-sensitivity	0.241	7.59	1.000	n/a		
IPTT	-0.115	-2.67	-0.071	-2.71	1.000	n/a

Objectives

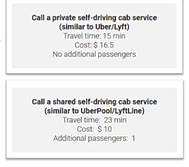
- Understand the acceptance of shared rides by travelers
- **Develop the notion of willingness to share (WTS)**
  - Money value attributed by an individual to traveling alone (i.e., to not share) compared to riding with strangers
- Understand the impacts of current ride-hailing experiences on future SAV use intentions
- Compare people's sensitivities to delays and their concerns about being in a car with strangers
  - Psychosocial and financial trade-offs: preferences toward fare discounts, travel times, and presence of strangers in the vehicle

The Stated Choice Experiment

Attributes				
Solo option		Shared option		
Fare structure	Travel time	Discount	Additional travel time	Additional passengers
Base fare: $1 **Cost per minute: $0.1** **Cost per mile: $0.91** **Service fee: $2.45**	10 minutes	20%	4 minutes	1
Base fare: $1 **Cost per minute: $0.1** **Cost per mile: $0.70** **Service fee: $-**	15 minutes	40%	8 minutes	2
Base fare: $1 **Cost per minute: $0.1** **Cost per mile: $0.40** **Service fee: $-**	20 minutes	60%	10 minutes	3

- Similar scenarios for commute trips
- Maximum number of additional passengers = 3

Imagine that ride-hailing services (similar to Uber and Lyft) use self-driving vehicles for all of their clients. Imagine also that you plan to go out on a **leisure activity** and you will use one of these ride-sourcing services.
In the three scenarios described below, which option would you choose?

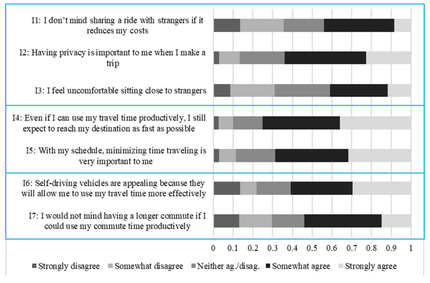


Latent Variables' Attitudinal Indicators

Privacy-sensitivity

Time-sensitivity

Interest in productive use of travel time



VTT & WTS

- VTT sample average estimate is $26.5 for work travel and $23.2 for leisure travel
- WTS sample average estimate is $0.50 for work travel and $0.90 for leisure travel – per additional individual
- Individuals are willing to pay 14% more to reduce a minute in a commute trip compared to a leisure trip
- Individuals are willing to pay 84% more to avoid an additional passenger in a leisure trip compared to a commute trip
- Reducing one passenger in a commute trip has the same monetary value as reducing the travel time by 1.10 minutes.
  - For a leisure trip, the equivalent value is 2.33 minutes

Acknowledgements

cintra

CTR D-STOP

CAPES

CIÊNCIA SEM FRONTEIRAS

[a] The University of Melbourne, Australia; [b] The University of Texas at Austin

collaborate. innovate. educate.