Predicting Demand for Autonomous Vehicles

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Types of autonomous vehicles



Our

Focus

Today







Levels of AVs







System performs the lateral and longitudinal dynamic driving task in all situations encountered during the entire journey. No driver required.

Level 5 Full Automation

Adoption of innovations

• How a new technology diffuses

	adant	(%)	
	– adopt	100	
	— do not adopt	90 _	
		80	
	 adopt later 	70	
	Pagare describes adaption in five	60	
	nogers describes adoption in rive	50 _	
	categories	40 _	16% rat
		30 _	
	Adoption typically follows a S-curve	20	to take off
•	Rapid growth from 16%-80%	10 _	Initial diffusion

Opinion Leaders (13.5%)

0.

Innovators

(2.596)



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Learning from other innovations



- ----VCR
- Automobile
- Electricity
- ----Radio
- -----Refigerator
- Air Conditioning
- ----Clothes Dryer
- ----Color TV
- Microwave
- —VCR
- ----Computer
- ----Cell Phone
- ---Internet
- ---Digital Camera

5 Source: Asymco

Motivation

- One key question: when do vehicle owners decide to shift to autonomous vehicle (AV) technology?
 - Partial automation
 - Fully automation
- Main approaches (for individual AVs)
 - Estimation based on sales forecasts
 - Employing adoption patterns of previous vehicle technologies
 - Discrete choice models
 - Building upon the theory of Diffusion of Innovations (DOI)- (Emerging)
 - Aggregate level (*Bass model*)
 - Disaggregate level (*Agent-based*)

Aggregate approach- Bass model

- One of the initial models in DOI still used in many disciplines
- Bass sums the external and internal forces of diffusion of innovations with the Coefficient of Innovation (CoN) and Coefficient of Imitation (CoM)
 - CoN: Forces which are not influenced by the number of other adopters
 - CoM: Forces which grow more influential as the number of other adopters increases
- Extensions of the Bass model possible
 - To capture pricing and marketing strategies

Disadvantages of Bass model

Does not capture behavioral elements of adoption

- Who will adopt
- How the decision is made
- Will the adoption continue or not
- What will be the effect of one's own social ties
- Effect of marketing etc. —

































Agent Based Model

Capture disaggregate features

- Peer effects
- One's social network
- Resistance to new innovations
- Psychological barriers
- Marketing strategy implications
- And other features



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ABM Simulation framework



A CAV survey

- Performed at University of Memphis campus
- The survey was sent to over 2,500 full time employees (faculty and staff)
- Survey consisting of 41 questions and categorized in four sections
 - Socio-economic characteristics
 - Household characteristics
 - Social network of individuals
 - Resistances and incentives for AVs

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Please indicate your gender.				
Male				
Female				
Prefer not to disclose				
Please indicate your age.				
Less than 20	45-49			
20-24	50-54			
25-29	55-59			
30-34	60+			
35-39	Prefer not to disclose			
40-44				

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A CAV survey

- 327 complete responses received (13.3%)
- Reliability scores (on a seven-point scale)
 - Information received from peers: 5.58 (σ =1.08)
 - Media: 3.79 (σ =1.36)
 - Car dealership: 3.63 (σ =1.44)
- Willingness to pay for full automation
 - \$5,000 or less: 69.1%
 - \$20,000: only 5%
- Using the sample, a synthetic population of UofM is developed. Then a synthetic network is developed

AV perceptions

- Mobility and reduction in pollution – important.
- Improving social status among peers is the least important.

Risk of virus attack is considered as the most

Lost feeling of control more critical than safety concerns.



Synthetic Population and Network

- Synthetic population
 - Expand sample to population
 - 327 agents to over 2500 agents
- Synthetic Network
 - Using homophily principle
 - connection is a function of
 - geographical proximity
 - socio-demographic similarity
 - 8-dimensional coordinate system
 - age, gender, race, employment type, income level, disability status, teleworking habit, and college/division



Modeling Results: sales price reduction

- CAV price reduction rate increased from
 - 5% to 20% with an increment of 5%
- With 5%, only some 15% of individuals will adopt by 2050
- Share will reach about 90% if price is reduced at 20%
- Share will be close to 100% only if all adopters are satisfied



Modeling Results: advertisement

- DOI lit.: advertisement does initiate diffusion but its impact is limited
- Six levels if ad intensity
- No ad: CAV market share will be only 4% by 2050 (only innovators will adopt)
- There exist a cap for CAV share





Modeling Results: sensitivity analysis

Dissatisfied users and Negative WOM spreaders



Validation

- Additional data collected for validation (those not first participated in the survey)
- Followed the same procedure to assess if the pattern of demand is similar



Conclusions

- We couple the DOI theory and ABM to forecast long term adoption of CAVs
- We assume that there exists a social network among individuals through which they communicate
- Individuals can be subject to media advertisement (marketing)
- An individual's perceptions are dynamic and change over time when the individual is exposed to media advertisement or (dis)satisfied adopters
- The model results appeared reasonable along with validation results

Next step to apply the concept in TN

- A TDOT project to forecast AV adoption in the state of TN
- Survey design is currently ongoing
- More info in our next TNMUG meetings
- We appreciate any feedback!

Thank you and questions

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