TRANSFORM

Autonomous Vehicles: Public Policy Considerations and Consumer Interest in the GTHA

University of Toronto – Institute of Transportation Engineers

November 10, 2017

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based on joint paper with Kailey Laidlaw

Acknowledgements

- Thank you to Metrolinx and the City of Toronto for supporting this project.
- Graduate students involved in this project include:
  - Kailey Laidlaw
  - Tyler Olsen
  - Elyse Comeau
  - Eva Shi
- Leah Birnbaum led focus groups
- Thank you to graduate studio groups:
  - Fall 2016
  - Winter 2017

TRANSFORM Overview of Study

- Four components
  - Survey
  - Descriptive Statistics
  - Inferential Models and Scenarios
  - Focus Groups

- Parallel Studios
  - *Planning for Autonomous Vehicles: Imagining Alternative Futures* (Fall 2016 for City of Toronto Transportation Services)
  - *Autonomous Vehicles in the Greater Toronto and Hamilton Area: A Discussion on Policy and Professional Perspectives* (Winter 2017 for Metrolinx)

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Outline

- Policy Background
- Technology Background
- Existing Literature
- Research Approach
- Descriptive and Model Results
- Conclusions

Transportation Policy and the Political Economy

- Farmers & Mud →
- Predict and Provide →
- Managing Demand →
- Broad Policy Expectations →
- ???

Ontario Policy Context: Very Mode-Centric

- Bad

Good

Transportation Policy and the Political Economy

- Growth Plan (2006 / 2017)
- Provincial Policy Statement (2005 / 2014)
- Planning Act (1983… 2006)
- Greenbelt Plan (2005 / 2017)
- Oak Ridge Moraine Conservation Plan (2002)
- Climate Change Mitigation and Low-carbon Economy Act (2016)

- Requirement to “conform” with provincial policy and plans based on Planning Act.

Transportation Policy and the Political Economy

- Transit
  - “compact, transit-supportive communities…”
  - “reducing dependence on the automobile…”
  - “providing convenient access to intra- and inter-city transit.”
  - “…. balance of jobs and housing in communities… to increase the modal share for transit, walking and cycling.”
  - “prioritizing transit and goods movement over those of single occupant automobiles.”
  - “… municipalities… travel demand management…. Increase the modal share of alternatives to the automobile.”
  - “… increasing the modal share of transit…”
  - “… higher order transit and inter-regional transit links between urban growth centres…”

TRANSFORM Planning Process

- Transportation Infrastructure Process
  - MTO's GGH Multimodal Plan
  - Metrolinx's RTP

  - Environmental Review Process
    - Environmental Assessments
    - Transit Project Assessment Process (T-PAP)

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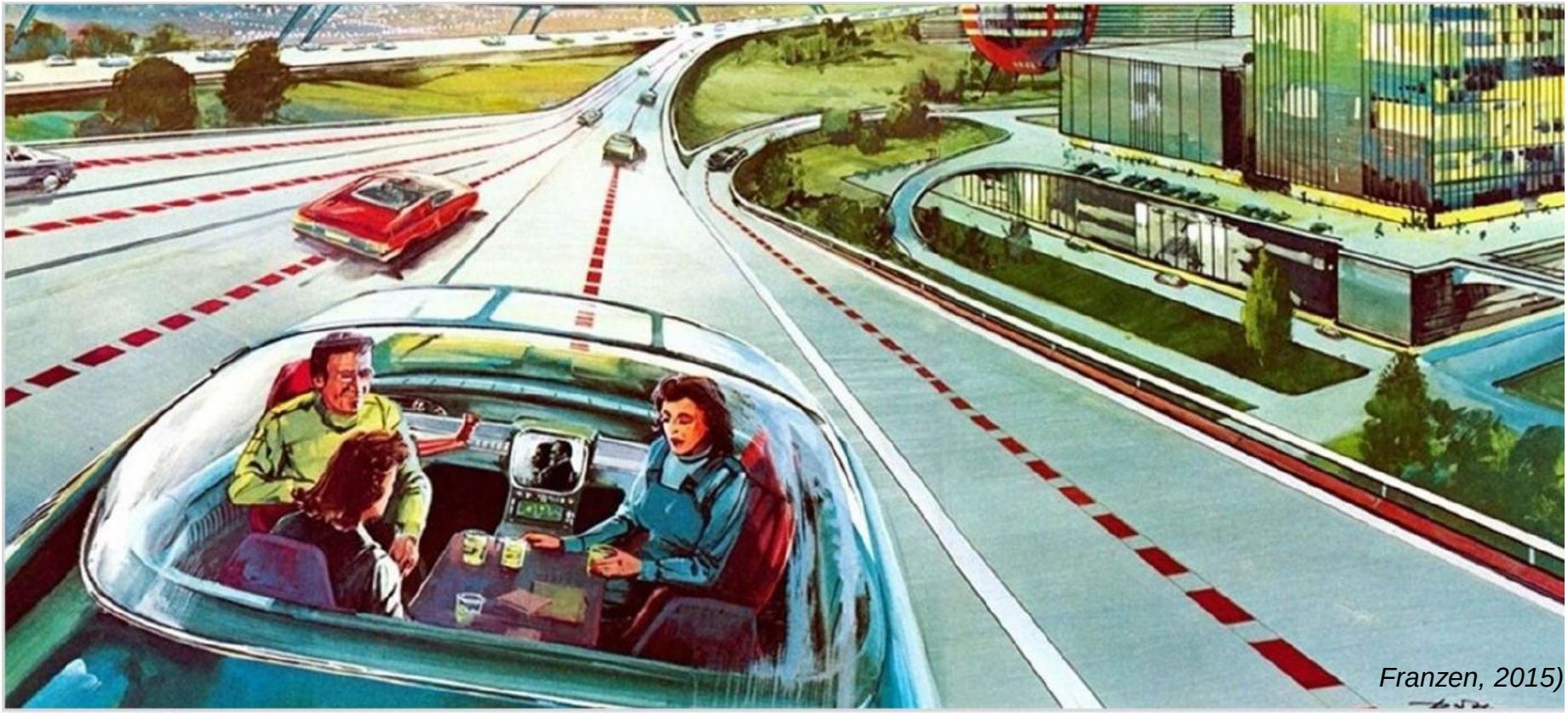
Technology Background

What are automated vehicles?

- Private Autonomous Vehicle (PAV)
- Shared Autonomous Vehicle (SAV)



Franzen, 2015)

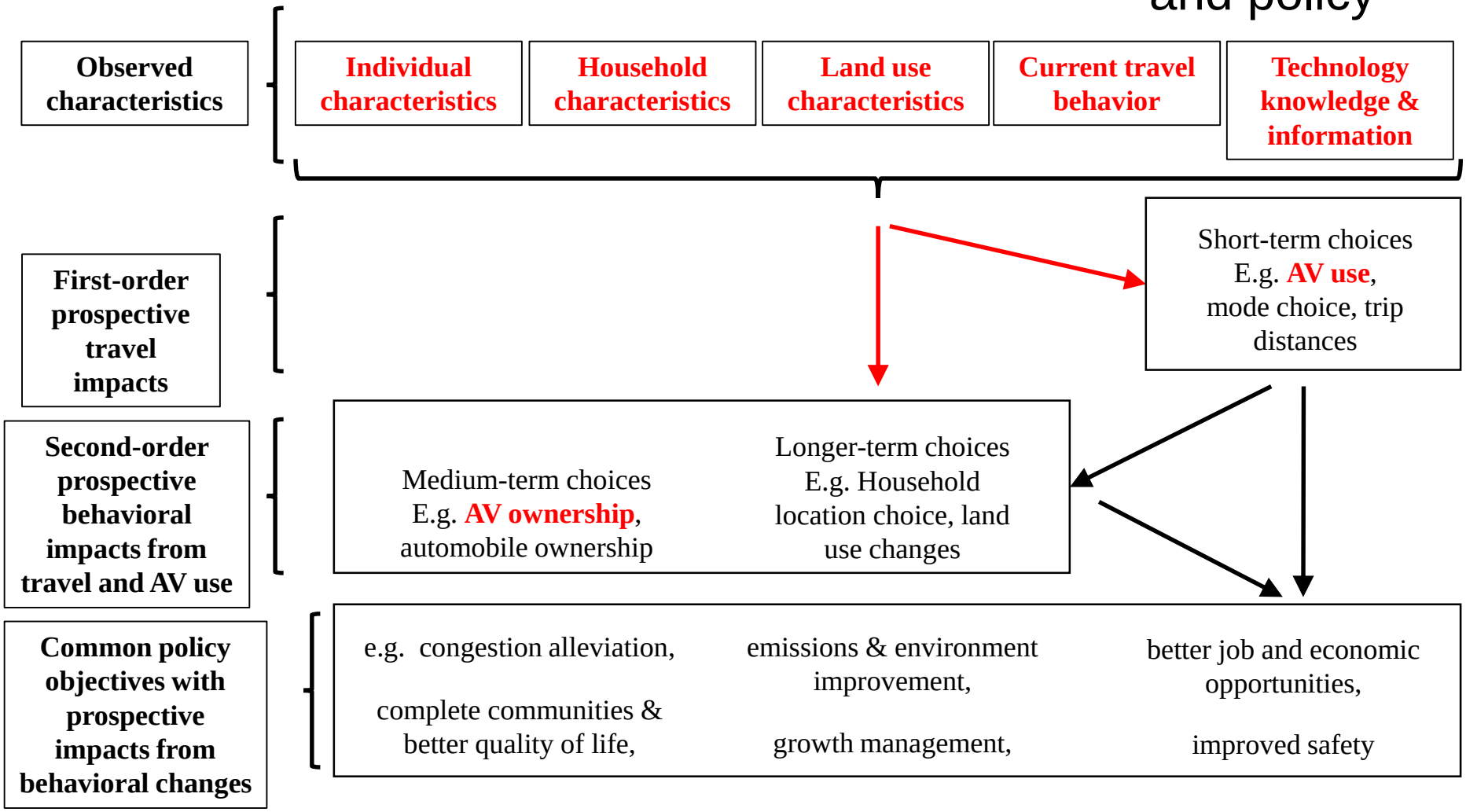
Why might autonomous vehicles matter for planning?

- Technology & behavior
  - Incentives and choices
  - Habits

- Planning and outcomes
  - AVs may change travel behavior
  - AVs may change other things planners (or the public) care about

- Planning and politics
  - AVs may redistribute benefits and costs (across functional areas & people)
  - AVs may be powerful as discourse

Behavioral elements of AVs, planning, and policy



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Existing Literature

Differences in consumer interest

- Information
  - Technology familiarity
- Travel
  - Auto ownership
  - Existing travel behavior
- Land Uses
  - Urban
- Individual characteristics
  - Age
  - Gender
  - Physical disabilities
  - Green values
  - Education
- Household characteristics
  - Income

- Study types
  - SP survey descriptive statistics
  - SP survey data and inferential models
  - Conjoint analysis
  - Forecasts and simulations

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Research Approach

Key Question

Who is expected to adopt and use autonomous vehicles?

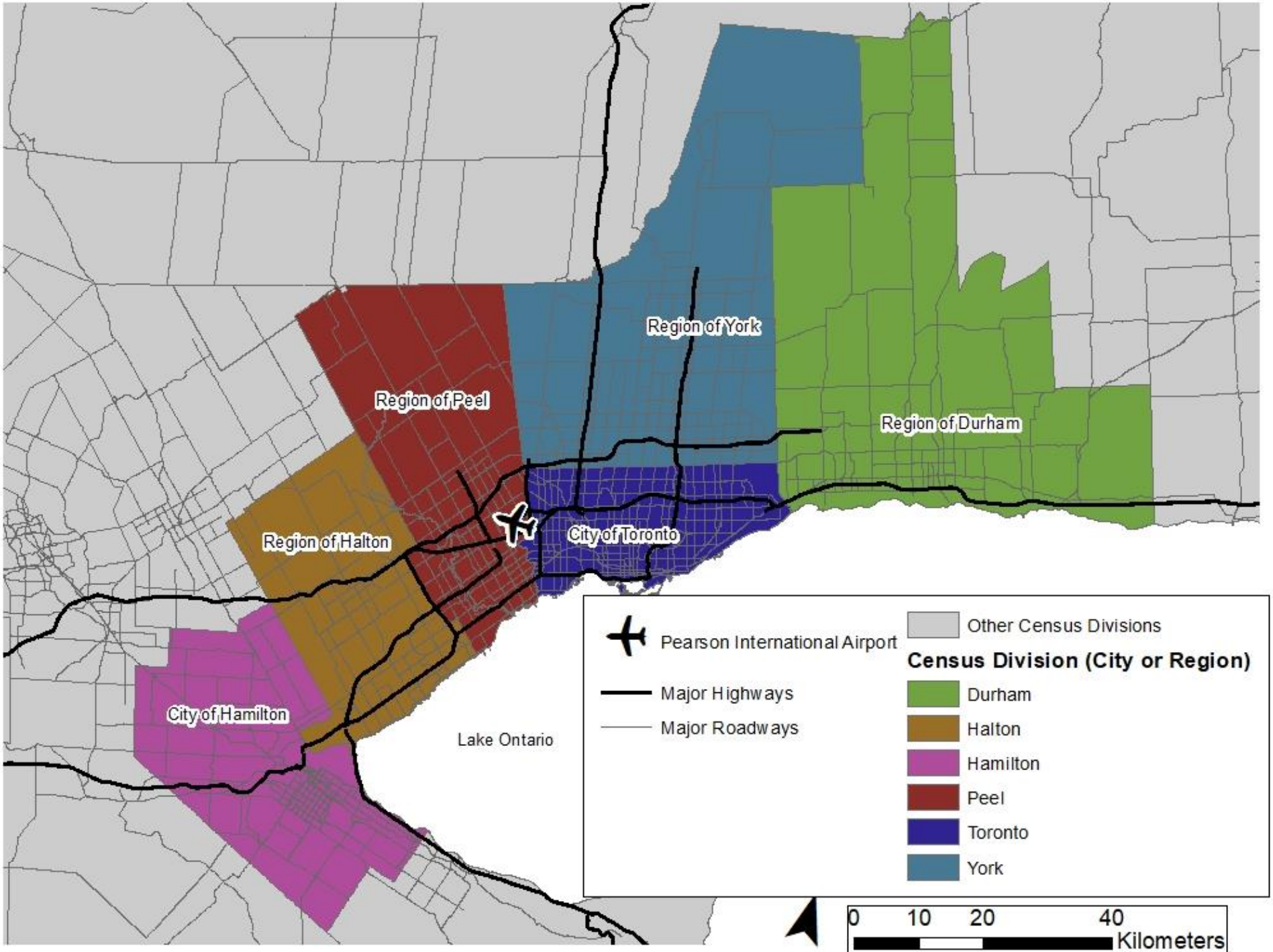
1. Purchasing a private AV
2. Using shared autonomous vehicles, not to access/egress public transit
3. Using shared autonomous vehicles, to access/egress public transit

GTHA AV Consumer Survey (Nov. 2016)

- Internet Survey: 15-25 minutes (20-min. mean); N=3,201
- Sample Approach
  - Stratified by region, sex, age

- Overview
  - Household & Individual Demographics
  - Employment and Commuting
  - Residence & Household
  - Vehicles Ownership and Daily Travel
  - General Attitudes
  - Driverless Car Attitudes
  - Driverless Cars and Public Policy

Region	No. of Respondents	% of Respondents
Durham Region	400	12.5%
Halton Region	300	9.4%
Hamilton	300	9.4%
Peel Region	500	15.6%
Toronto	1200	37.5%
York Region	501	15.7%
Total	**3201**	**100.0%**


Region of York
Region of Peel
Region of Durham
Region of Halton
City of Toronto
City of Hamilton
Lake Ontario
Pearson International Airport
Major Highways
Major Roadways
Other Census Divisions
Census Division (City or Region)
Durham
Halton
Hamilton
Peel
Toronto
York
0 10 20 40
Kilometers

Informed participants

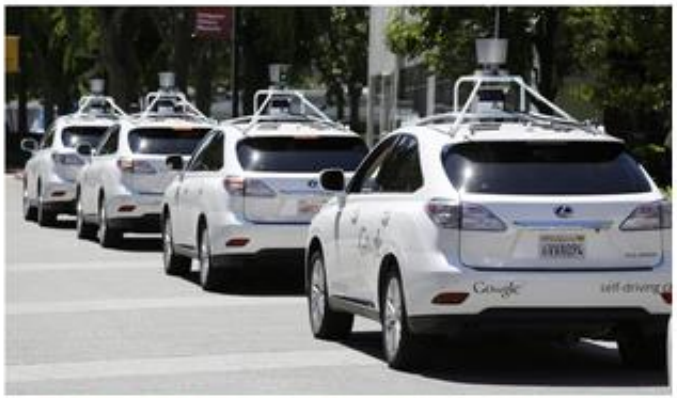
In this survey, we are interested in your preferences and opinions related to automated vehicles. Automated vehicles are cars which are equipped with technologies which reduce or eliminate the need for a human driver.

Some automated cars can make driving easier or safer but would still require a human driver.
These vehicles include driver assistance technologies, such as:

- *automatic parallel parking,*
- *vehicle communications to identify upcoming road conditions,*
- *adaptive cruise control, and*
- *automatic braking.*

Other automated vehicles are driverless cars which can navigate the streets with no need for a human driver.

These vehicles currently look like conventional cars.



http://cogeng.cafe24.com/wp/wp-content/uploads/2016/01/google.jpg

Identified some possible costs/benefits

Some driverless buses have also been designed and developed.

https://i.ytimg.com/vi/fEOT2sEps8Y/hqdefault.jpg

43%

Automated vehicles may improve the safety of travel.

Car collisions resulted in almost 2,000 fatalities and more than 10,000 serious injuries in Canada in 2013 (Transport Canada, 2013).

Over 90% of car collisions can be attributed to human error, such as drunk or distracted driving.

Google reported its first car collision caused by one of their driverless vehicles in February 2016. At that time Google's driverless vehicles had traveled more than 1.5 million kilometers with no human at the wheel.

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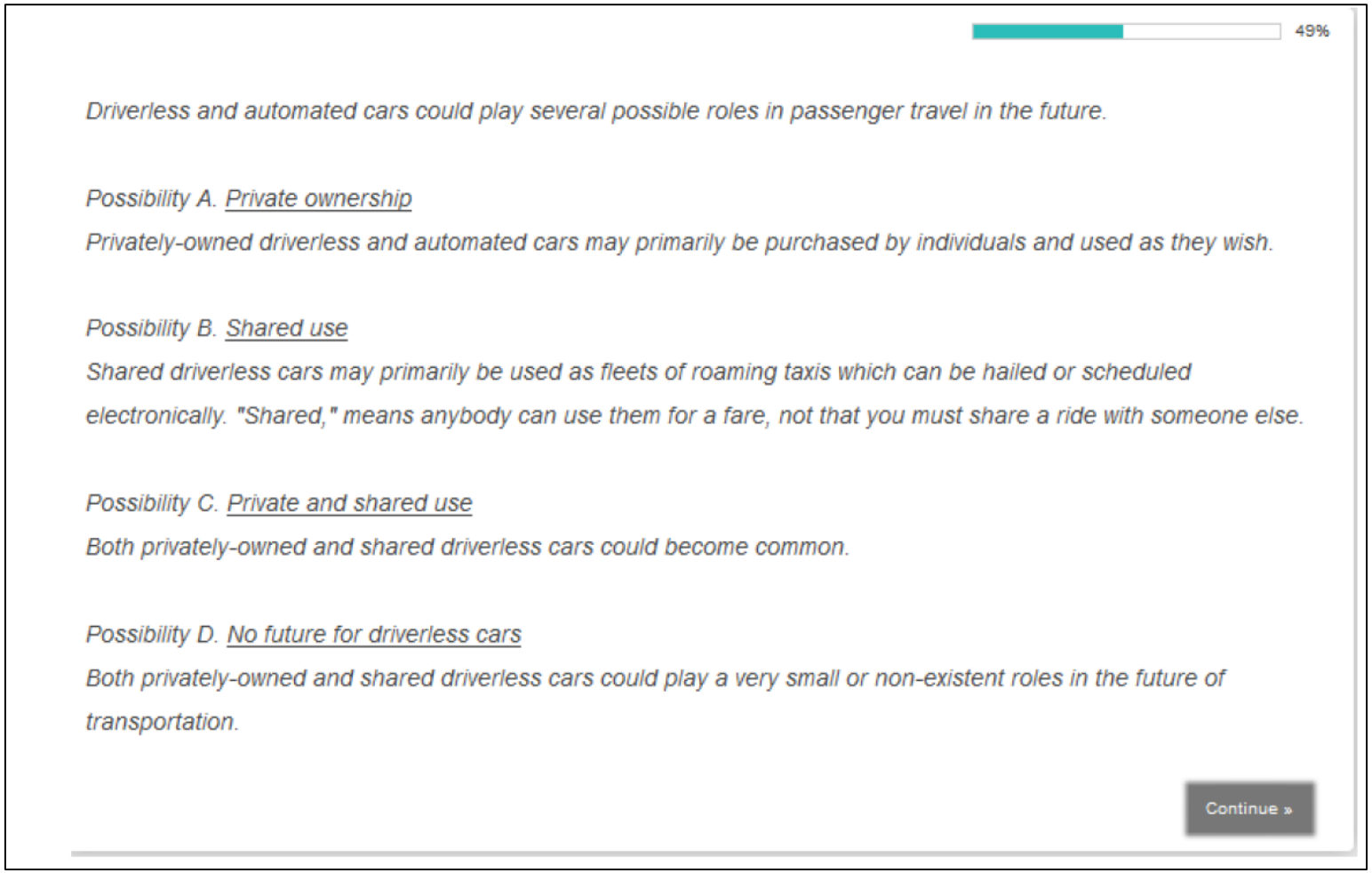
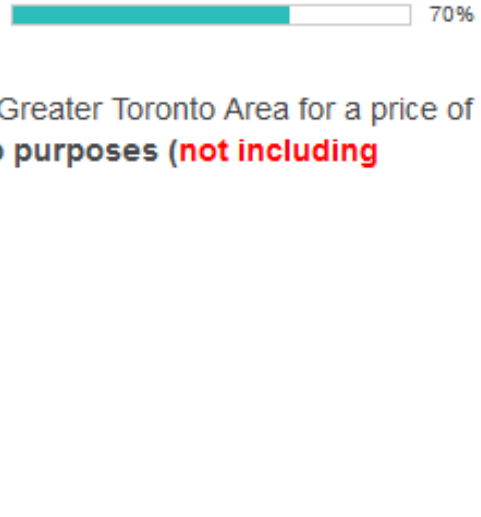
Highlighted differences in ownership models



Key dependent variables

If you are purchasing a new vehicle, how much more would you be willing to pay for it to be available as a fully driverless car as opposed to a conventional car ?

- I would not buy a driverless car
- Less than $1,000
- $1,000-$4,999
- $5,000 to $9,999
- $10,000 to $14,999
- More than $15,000



TRANSFORM Model Framework

- Ordered Probit Model

- Estimated
  - Stated interest to use/purchase at different price thresholds

- Accounted for
  - Socioeconomic Characteristics (age, income, gender, household size)
  - Technology (smartphone ownership)
  - Disability
  - Collision history
  - Recent travel (Uber ownership/use, regular commuting, auto travel)

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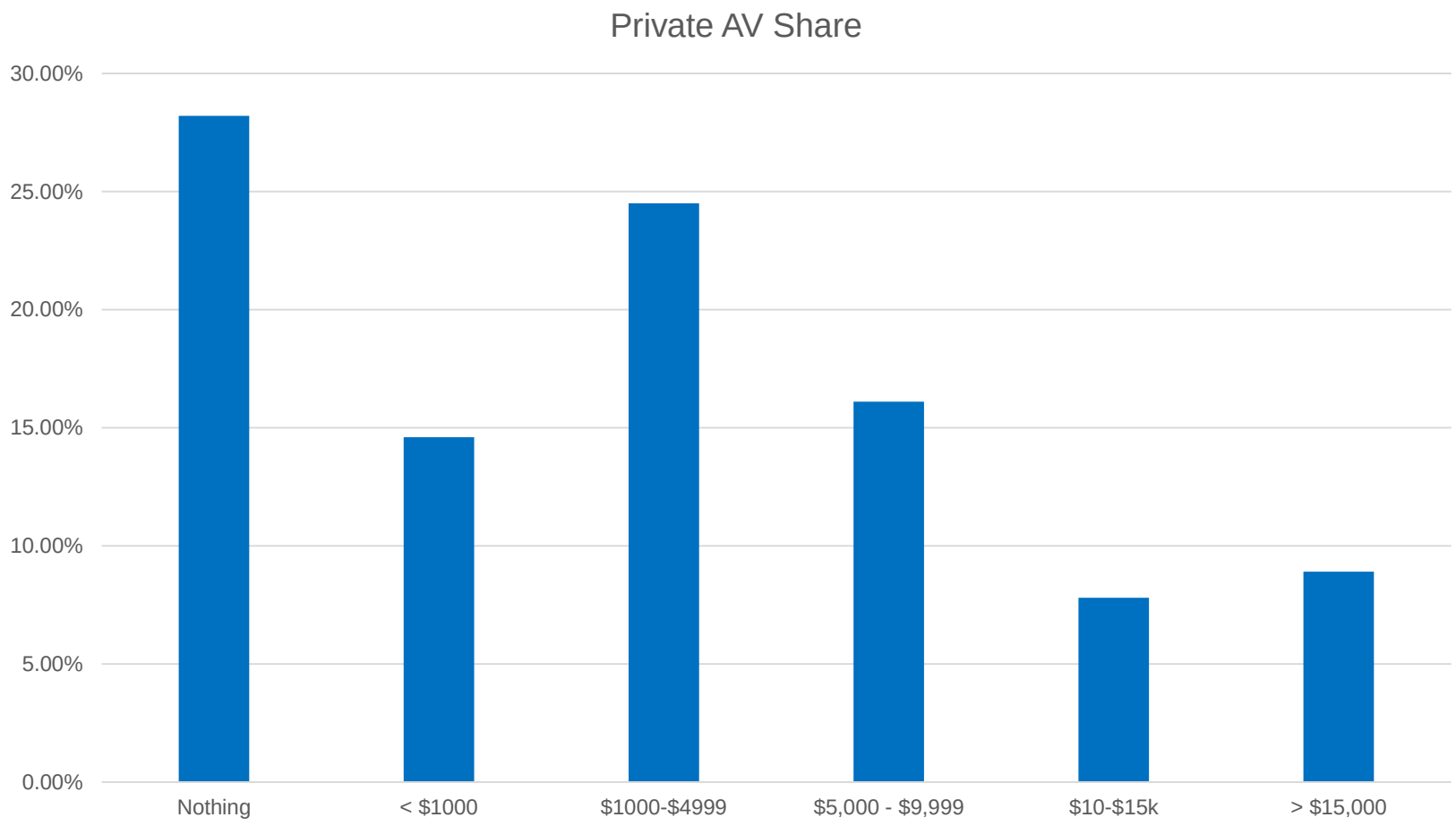
Results

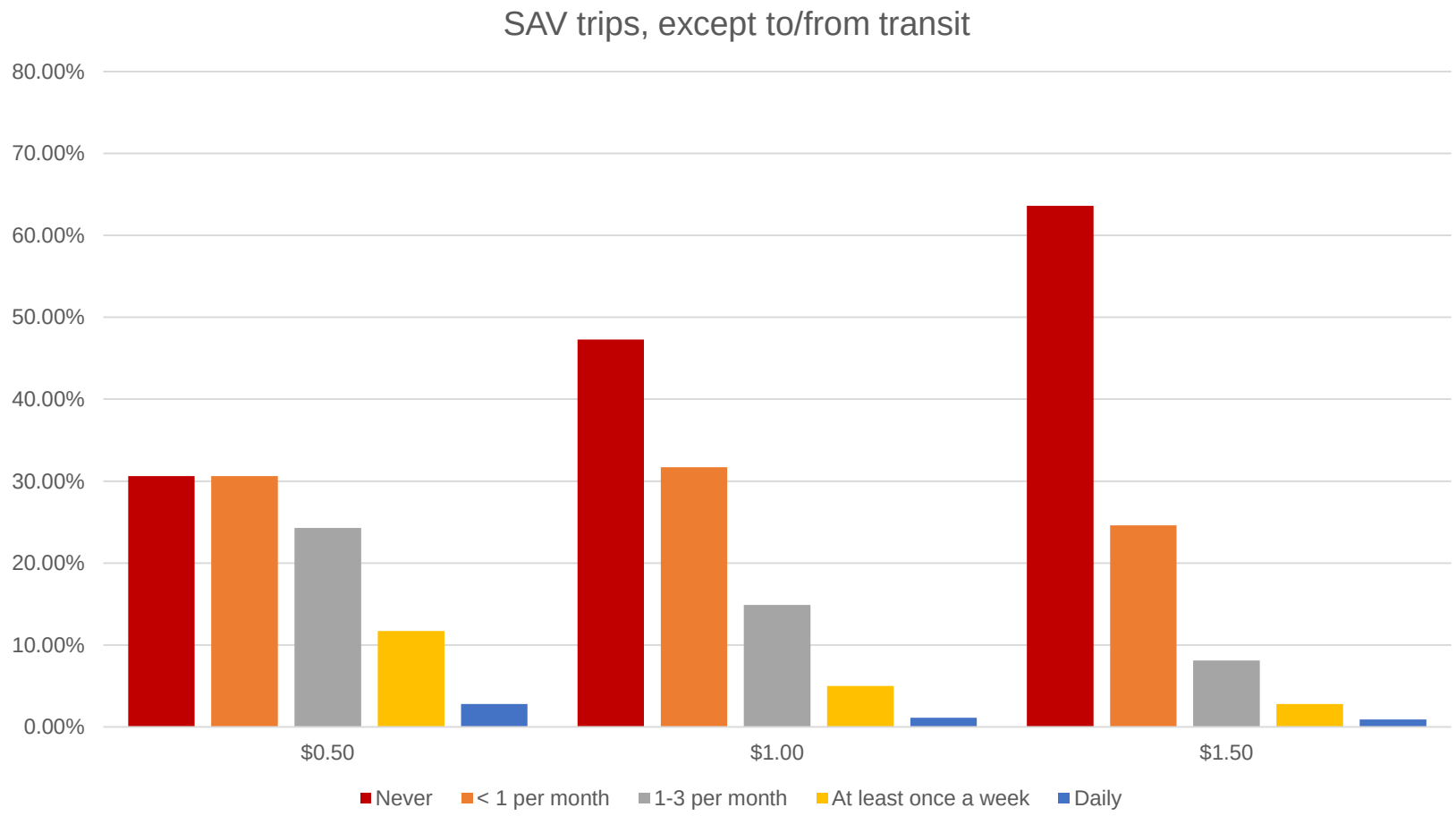
Descriptive Results

Model Results

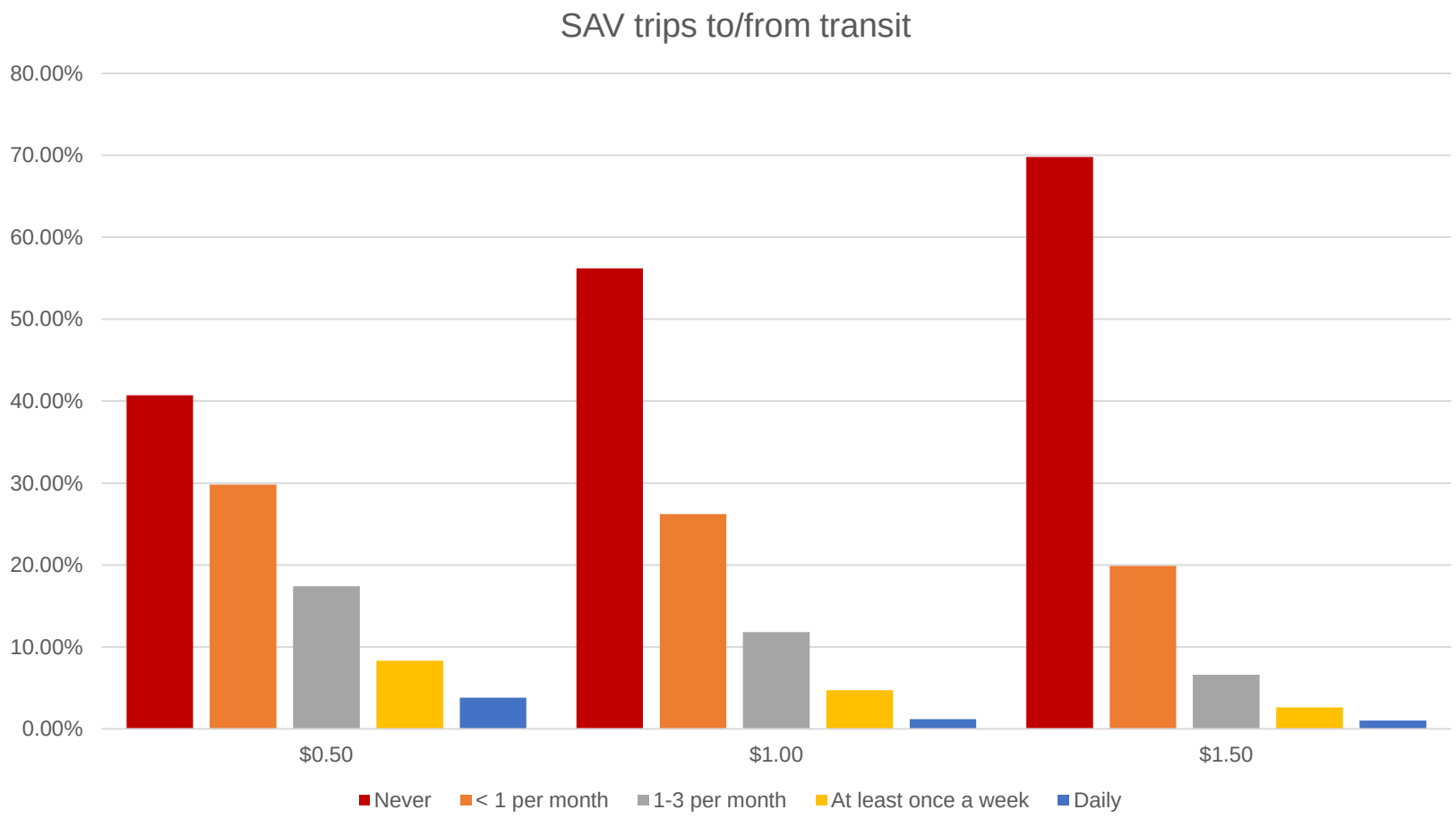
PAV stated premium



SAV trips at different prices ($ per kilometer) not to/from public transit



SAV trips to/from transit at different prices ($ per kilometer)



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"For what type of trips do you imagine using Uber-style shared driverless cars (independent of accessing public transit)?"

Work Trips. Frequency of stated Shared AV use at $0.50/km					
Primary Commuting Mode	Never	Less than o	1-3 times a	At least on	Daily
Non-commuter	2.90%	9.50%	13.80%	26.50%	22.60%
Auto driver (alone)	8.50%	17.10%	32.60%	54.40%	86.30%
Auto driver (with others)	18.00%		36.30%	40.40%	
Auto passenger		0.00%	40.80%		
Taxi/Uber	0.00%		56.40%		
Motorcycle			0.00%		
Walk	0.00%	28.60%	35.10%	64.80%	
Bicycle	0.00%				
GO Transit		22.60%	36.70%	45.30%	
Public Transit (excluding GO Transit)		20.50%	35.40%	58.00%	86.60%

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"For what type of trips do you imagine using Uber-style shared driverless cars (independent of accessing public transit)?"

Entertainment/Recreation. Frequency of stated Shared AV use at $0.50/km					
Primary Commuting Mode	Never	Less than o	1-3 times a	At least on	Daily
Non-commuter	12.50%	52.20%	71.40%	72.60%	81.20%
Auto driver (alone)	28.00%	67.20%	76.60%	77.90%	71.50%
Auto driver (with others)	46.00%	55.10%	57.80%	72.10%	
Auto passenger	50.50%	55.80%	69.90%	71.60%	0.00%
Taxi/Uber			59.00%		
Motorcycle			0.00%	0.00%	
Walk		72.40%	82.80%	80.90%	
Bicycle	0.00%				
GO Transit	23.60%	45.90%	77.30%	81.90%	
Public Transit (excluding GO Tr	12.30%	63.90%	72.00%	79.50%	77.90%

TRANSFORM

"For what type of trips do you imagine using Uber-style shared driverless cars (independent of accessing public transit)?"

Shopping/Errands. Frequency of stated Shared AV use at $0.50/km					
Primary Commuting Mode	Never	Less than o	1-3 times a	At least on	Daily
Non-commuter	8.50%	34.00%	61.80%	73.30%	59.20%
Auto driver (alone)	9.50%	24.20%	44.10%	47.10%	46.00%
Auto driver (with others)	18.60%	36.60%	58.80%	44.80%	
Auto passenger		39.40%	64.30%	56.60%	0.00%
Taxi/Uber	0.00%		67.70%		
Motorcycle			0.00%	0.00%	
Walk		37.90%	56.50%	69.50%	
Bicycle	0.00%			0.00%	
GO Transit		32.00%	38.20%	51.40%	
Public Transit (excluding GO Tr	8.40%	32.40%	50.40%	71.10%	82.70%

Major findings on PAV interest from model results

- Ordered Probit, N = 2,888; R.D. = 9401.8 and 9325.3

- Urbanists (but effects are halved when accounting for travel)
- Technology: having a smart phone & knowing about Google Car
- Travel:
  - those responsible for chauffeuring, Uber users,
  - drove >0 km by car yesterday, very weak for telecommuting & GO commuters (0.12-level)
- Demographics: the young
- Education: those with a professional (but not a graduate) degree
- Work: those that work at home or >60 hours per week

- Automobile ownership: <3 cars, no hybrid, primary car >$30,000

- Statistically insignificant:
  - Sex & disability
  - Occupations

Major findings on SAV interest (not to/from transit) from model results

- Ordered Probit; N=3,201; R.D. ranges from 5,660 to 8,804 (more explanation at higher prices)
- Information
  - Technology: having a smart phone & knowing about Google Car
- Travel
  - those responsible for chauffeuring, Uber users,
  - telecommuters and commuters by GO, walking, bicycling, and general public transit
  - Automobile ownership: <3 cars, no hybrid (at $0.50/km)
- Land Uses
  - Urbanists (but effects are halved when accounting for travel), apartment dwellers (weak)
- Demographics
  - the young, large households (at $0.50/km)
  - working > 60 hours/week (at higher price thresholds)
  - Not having a disability
  - Education: professional degrees and graduate degrees
  - Work: those that work at home or part time; those in construction & trades; those in professional/management,
  - Income <$175,000

Major findings on SAV interest (to/from transit) from model results

- Ordered Probit; N=3,201; R.D. ranges from 5,112 to 8.467 (more explanation at higher prices)
- Information
  - Technology: having a smart phone & knowing about Google Car
- Travel
  - those responsible for chauffeuring, Uber users,
  - telecommuters and commuters by GO, walking, bicycling, and general public transit
  - Automobile ownership: <3 cars, no hybrid (at $0.50/km)
- Land Uses
  - Urbanists (but effects are halved when accounting for travel), apartment dwellers (weak)
- Demographics
  - the young, males, large households (at $0.50/km)
  - working > 60 hours/week (at higher price thresholds)
  - Not having a disability
  - Education: professional degrees and graduate degrees only at $0.50/km
  - Work: those that work at home or part time; those in construction & trades; those in professional/management,
  - Income <$175,000

Table 1. Model Results: Willingness to Pay More for New Vehicle to be Fully Autonomous (Ordered Probit)

		Model 1	Model 2
	Variable	Estimate	Estimate
Individual Characteristics	Age<35 (binary)	0.154 ***	0.092 *
	Age>55 (binary	-0.202 ***	-0.185 **
	Prof. Grad. Degree (binary)	0.446 ***	0.413 **
	Other Grad. Degree (binary	0.037	0.039
	Male (binary)	0.048	0.016
	Non-binary sex (binary)	-0.231	-0.232
	Physical Disability (binary, agree or strongly agree)	0.012	0.055
	Crash history - one or more collisions as driver/passenger (binary)	-0.105 **	-0.104 **
Household Characteristics	Household Income (<$15k)	-0.521 ***	-0.438 **
	Household Income ($15-$40k)	-0.068	-0.05
	Household Income ($40-$60k)	-0.085	-0.061
	Household Income ($100-$125k)	-0.051	-0.102
	Household Income ($125-$175k)	0	-0.029
	Household Income (>$175k)	0.053	0.003
	Household Income (Prefer Not Answer)	-0.148 **	-0.143 **
	Household Income (Unknown)	-0.615 ***	-0.552 **
	Household Size	-0.016	-0.014
	One or More Household Members Under 16 (binary)	0.04	-0.029
Urban Design	Housing: Apartment	-0.049	-0.016
	Housing: Townhouse	0.042	0.047
	Housing: Unknown or Other	-0.228	-0.194
	Regional Job Density (within 10 km, natural-logged)	0.09 ***	0.055 *
Employment Characteristics	Job Status: Retired	-0.17 **	-0.139
	Job Status: Work at home, full/part time)	0.174 *	0.202 *
	Job Status: Unemployed, not in labor force, other	-0.035	0.034
	Occupation: Manufacturing/Construction/Trades	-0.122	-0.087
	Occupation: Professional/Management/Technical	0.025	0.019
	Occupation: Sales & service	-0.123	-0.12
	Occupation: Prefer not to answer	-0.287 **	-0.279 **
	Work >60 hours/week (binary)	0.249 **	0.212 *
Technology	Smartphone owner (binary)	0.229 ***	0.175 **
	Google car knowledge (binary)	0.224 ***	0.205 **
Travel and Commuting	Vehicle Ownership: 3 or more in household (binary)		-0.212
	Vehicle Ownership: primary vehicle is a hybrid (binary)		-0.345 **
	Vehicle Ownership: Primary vehicle costs $30k or more (binary)		0.144 **
	Chauffeurs one or more time per week (binary)		0.129 **
	Uber Use: yes, but not in the last 30 days		0.213 **
	Uber Use: 1-3 times/month		0.376 **
	Uber Use: 1 time / week		0.33 **
	Uber Use: 2 times / week or more		0.215
	Auto travel: traveled by car yesterday (binary)		0.113 *

Table 4. Model Results: Estimating Shared Autonomous Vehicle Trip Taking for All Trips Except to/from Transit Stations (Ordered Probit)

	DV = Stated Frequency of Shared Autonomous Vehicle Trips at different prices/km (N = 3,201)						
	Price per kilometer	$0.50	$0.50	$1.00	$1.00	$1.50	$1.50
		Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	Variable	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Individual Characteristics	Age<35 (binary)	0.225 ***	0.042	0.315 ***	0.11 **	0.374 ***	0.169 ***
	Age>55 (binary	-0.043	0.026	-0.119 *	-0.054	-0.037	0.027
	Prof. Grad. Degree (binary)	0.145	0.141	0.23	0.207	0.327 **	0.297 *
	Other Grad. Degree (binary	0.13 **	0.156 ***	0.164 ***	0.19 ***	0.188 ***	0.209 ***
	Male (binary)	0.048	0.024	0.008	-0.036	0.026	-0.02
	Non-binary sex (binary)	0.479 *	0.319	0.549 **	0.409	0.415	0.279
	Physical Disability (binary, agree or strongly agree)	-0.061	0.002	-0.136 **	-0.025	-0.249 ***	-0.124 **
	Crash history - one or more collisions as driver/passenger (binary)	0.052	0.062	0.005	0.023	-0.041	-0.012
Household Characteristics	Household Income (<$15k)	-0.112	-0.074	0.119	0.199	0.071	0.165
	Household Income ($15-$40k)	-0.195 ***	-0.207 ***	-0.121	-0.119	-0.069	-0.073
	Household Income ($40-$60k)	-0.015	-0.019	-0.036	-0.029	-0.001	0.011
	Household Income ($100-$125k)	-0.004	-0.073	0.003	-0.088	0.054	-0.035
	Household Income ($125-$175k)	0.012	0.009	-0.027	-0.051	-0.024	-0.048
	Household Income (>$175k)	-0.055	-0.097	-0.114	-0.19 **	-0.104	-0.163 *
	Household Income (Prefer Not Answer)	-0.207 ***	-0.184 ***	-0.258 ***	-0.224 ***	-0.272 ***	-0.233 ***
	Household Income (Unknown)	-0.373 ***	-0.333 ***	-0.297 **	-0.238 *	-0.243 *	-0.201
	Household Size	0.048 ***	0.058 ***	0.014	0.027	0.009	0.027
	One or More Household Members Under 16 (binary)	-0.048	-0.108 **	0.059	-0.033	0.151 ***	0.058
Urban Design	Housing: Apartment	0.084	0.101 *	-0.063	-0.026	-0.077	-0.048
	Housing: Townhouse	0.008	-0.005	-0.062	-0.078	-0.01	-0.043
	Housing: Unknown or Other	-0.036	-0.031	-0.066	-0.032	0.202	0.225
	Regional Job Density (within 10 km, natural-logged)	0.148 ***	0.058 *	0.175 ***	0.075 **	0.194 ***	0.096 ***
Employment Characteristics	Job Status: Retired	-0.114	0	-0.242 ***	-0.082	-0.311 ***	-0.111
	Job Status: Work at home, full/part time)	0.306 ***	0.38 ***	0.356 ***	0.473 ***	0.262 **	0.415 ***
	Job Status: Unemployed, not in labor force, other	0.14 *	0.269 ***	-0.023	0.169 **	-0.079	0.143 *
	Occupation: Manufacturing/Construction/Trades	0.127	0.216 **	0.143	0.263 ***	0.049	0.171
	Occupation: Professional/Management/Technical	0.015	0.023	-0.116 *	-0.122 *	-0.162 **	-0.178 ***
	Occupation: Sales & service	-0.034	-0.002	-0.081	-0.042	-0.088	-0.059
	Occupation: Prefer not to answer	-0.198 *	-0.175 *	-0.18 *	-0.139	-0.322 ***	-0.304 **
	Work >60 hours/week (binary)	0.091	0.036	0.28 **	0.213 *	0.357 ***	0.284 **
Technology	Smartphone owner (binary)	0.448 ***	0.399 ***	0.292 ***	0.221 ***	0.208 ***	0.135 *
	Google car knowledge (binary)	0.15 ***	0.122 ***	0.108 ***	0.064	0.113 **	0.056
Travel and Commuting	Vehicle Ownership: 3 or more in household (binary)		-0.434 ***		-0.538 ***		-0.621 ***
	Vehicle Ownership: primary vehicle is a hybrid (binary)		-0.242 *		-0.119		0.008
	Vehicle Ownership: Primary vehicle costs $30k or more (binary)		-0.06		0.039		0.029
	Chauffeurs one or more time per week (binary)		0.097 **		0.123 **		0.103 **
	Uber Use: yes, but not in the last 30 days		0.633 ***		0.567 ***		0.403 ***
	Uber Use: 1-3 times/month		0.708 ***		0.678 ***		0.604 ***
	Uber Use: 1 time / week		0.688 ***		0.943 ***		1.084 ***
	Uber Use: 2 times / week or more		0.918 ***		1.232 ***		1.257 ***
	Auto travel: traveled by car yesterday (binary)		-0.009		-0.025		0.033
	Teleworking: once per month or more (binary)		0.106 **		0.247 ***		0.287 ***
	Primary commute mode: GO Regional Transit (binary)		0.279 ***		0.364 ***		0.402 ***
	Primary commute mode: walking or cycling (binary)		0.258 **		0.215 **		0.446 ***
	Primary commute mode: other public transit (binary)		0.199 ***		0.232 ***		0.29 ***
	1|2 threshold	0.31 ***	0.419 ***	0.358 ***	0.564 ***	0.667 ***	0.962 ***
	2|3 threshold	1.15 ***	1.306 ***	1.289 ***	1.562 ***	1.567 ***	1.938 ***
	3|4 threshold	1.954 ***	2.152 ***	2.065 ***	2.394 ***	2.219 ***	2.65 ***
	4|5 threshold	2.829 ***	3.054 ***	2.834 ***	3.212 ***	2.85 ***	3.334 ***
	Observations	3,201	3,201	3,201	3,201	3,201	3,201
	Residual Deviance	8,804.2	8,540.8	7,386.9	7,068.1	5,960.5	5,660.6

Table 5. Model Results: Estimating Shared Autonomous Vehicle Trip Taking for Trips to/from Transit Stations (Ordered Probit)

	DV = Stated Frequency of Shared AV Trips at different prices/km						
	Price per kilometer	$0.50	$0.50	$1.00	$1.00	$1.50	$1.50
		Model 9	Model 10	Model 11	Model 12	Model 13	Model 14
	Variable	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Individual Characteristics	Age<35 (binary)	0.218 ***	0.063	0.367 ***	0.192 ***	0.449 ***	0.253 ***
	Age>55 (binary	-0.099	-0.053	0.009	0.058	-0.043	0.008
	Prof. Grad. Degree (binary)	0.24	0.197	0.459 ***	0.412 **	0.511 ***	0.474 ***
	Other Grad. Degree (binary	0.121 **	0.145 **	0.058	0.078	0.086	0.096
	Male (binary)	0.076 *	0.05	0.056	0.021	0.112 **	0.069
	Non-binary sex (binary)	0.49 *	0.357	0.659 **	0.559 **	0.697 **	0.614 **
	Physical Disability (binary, agree or strongly agree)	-0.129 **	-0.069	-0.211 ***	-0.114 **	-0.383 ***	-0.25 ***
	Crash history - one or more collisions as driver/passenger (binary)	-0.029	-0.021	-0.075 *	-0.061	-0.079	-0.054
Household Characteristics	Household Income (<$15k)	-0.016	0.09	0.081	0.236	0.161	0.304 *
	Household Income ($15-$40k)	-0.096	-0.075	-0.133	-0.099	0.009	0.048
	Household Income ($40-$60k)	0.041	0.062	0.009	0.044	0.032	0.065
	Household Income ($100-$125k)	-0.073	-0.138 **	-0.091	-0.177 **	-0.048	-0.15 *
	Household Income ($125-$175k)	0.022	0.013	0.005	-0.017	0.012	-0.023
	Household Income (>$175k)	-0.221 ***	-0.274 ***	-0.27 ***	-0.357 ***	-0.169 *	-0.265 ***
	Household Income (Prefer Not Answer)	-0.201 ***	-0.169 **	-0.234 ***	-0.187 **	-0.211 **	-0.156 *
	Household Income (Unknown)	-0.309 **	-0.215 *	-0.181	-0.056	-0.128	-0.02
	Household Size	0.037 **	0.035 *	-0.01	-0.012	-0.029	-0.018
	One or More Household Members Under 16 (binary)	0.067	-0.009	0.184 ***	0.086	0.279 ***	0.177 ***
Urban Design	Housing: Apartment	-0.012	0.033	-0.083	-0.026	-0.126 **	-0.065
	Housing: Townhouse	0.007	0.012	0.007	0.02	-0.053	-0.055
	Housing: Unknown or Other	-0.184	-0.141	-0.106	-0.058	0.018	0.057
	Regional Job Density (within 10 km, natural-logged)	0.116 ***	0.044	0.146 ***	0.065 *	0.147 ***	0.068 *
Employment Characteristics	Job Status: Retired	-0.02	0.126	-0.177 *	-0.003	-0.089	0.119
	Job Status: Work at home, full/part time)	0.183 *	0.279 ***	0.194 *	0.32 ***	0.198 *	0.347 ***
	Job Status: Unemployed, not in labor force, other	0.122	0.297 ***	0.075	0.301 ***	0.073	0.332 ***
	Occupation: Manufacturing/Construction/Trades	0.133	0.211 **	0.206 **	0.29 ***	0.222 **	0.326 ***
	Occupation: Professional/Management/Technical	0.081	0.091	0.025	0.031	-0.016	-0.018
	Occupation: Sales & service	0.032	0.071	0.006	0.038	0.106	0.145
	Occupation: Prefer not to answer	0.045	0.105	0.008	0.066	-0.175	-0.135
	Work >60 hours/week (binary)	0.171	0.122	0.226 *	0.175	0.427 ***	0.368 ***
Technology	Smartphone owner (binary)	0.378 ***	0.29 ***	0.269 ***	0.163 **	0.208 ***	0.107
	Google car knowledge (binary)	0.127 ***	0.088 **	0.128 ***	0.075 *	0.111 **	0.048
Travel and Commuting	Vehicle Ownership: 3 or more in household (binary)		-0.286 *		-0.231		-0.283
	Vehicle Ownership: primary vehicle is a hybrid (binary)		-0.214		-0.207		-0.233
	Vehicle Ownership: Primary vehicle costs $30k or more (binary)		-0.038		0.021		0.063
	Chauffeurs one or more time per week (binary)		0.174 ***		0.203 ***		0.148 ***
	Uber Use: yes, but not in the last 30 days		0.551 ***		0.514 ***		0.42 ***
	Uber Use: 1-3 times/month		0.6 ***		0.625 ***		0.614 ***
	Uber Use: 1 time / week		0.591 ***		0.81 ***		0.98 ***
	Uber Use: 2 times / week or more		0.725 ***		0.88 ***		1.184 ***
	Auto travel: traveled by car yesterday (binary)		0.187 ***		0.212 ***		0.15 **
	Teleworking: once per month or more (binary)		0.127 **		0.243 ***		0.335 ***
	Primary commute mode: GO Regional Transit (binary)		0.427 ***		0.289 ***		0.279 **
	Primary commute mode: walking or cycling (binary)		0.176 *		0.244 **		0.266 **
	Primary commute mode: other public transit (binary)		0.296 ***		0.295 ***		0.232 ***
	1|2 threshold	0.392 ***	0.7 ***	0.533 ***	0.941 ***	0.772 ***	1.204 ***
	2|3 threshold	1.204 ***	1.551 ***	1.358 ***	1.819 ***	1.593 ***	2.091 ***
	3|4 threshold	1.861 ***	2.241 ***	2.041 ***	2.544 ***	2.183 ***	2.747 ***
	4|5 threshold	2.485 ***	2.891 ***	2.769 ***	3.308 ***	2.754 ***	3.379 ***
	Observations	3,201	3,201	3,201	3,201	3,201	3,201
	Residual Deviance	8,467.8	8,238.3	6,894.5	6,638.5	5,373.8	5,112.6

TRANSFORM

Conclusion

Discussion

- Implications of survey descriptive results:
  - ± 1 SAV trip / month @ $0.50/km.
  - ± 8% PAVs @ $15k premium

- Who will be users?

  - Young, urbanists, technology-savvy, Uber-users, those with chauffeuring responsibilities, complex work patterns (flexibility or intense work), professional degrees,

  - PAVs – own few cars, not hybrids, have expensive cars (>$30,000),
  - SAVs – multi-modalists, telecommuters,

Public Policy Implications

- Planning for AVs will, by definition, shape the outlook of this technology
- Public policy considerations:
  - Disseminating information – could lead to higher adoption
  - Pricing – impacts likelihood of use.
  - Urban Design –long-term strategy.
  - Demographics - outside of policy domain.

  - GTHA: mode priorities will need to be revisited

Autonomous Vehicles and a Transit-First Policy Context

- Thought Scenario 1. “All AVs are cars”
  - Policy does not favor AVs
  - Policy may have least disfavor for PAVs

- Thought Scenario 2. “Private AVs are cars, but SAVs are not”
  - Policy does not favor AVs
  - Policy may have least disfavor for SAVs

- Thought Scenario 3. “Private AVs and SAVs are both transit”
  - Policy favors AVs, and especially PAVs

Christensen (1985) Thompson-Tuden Matrix

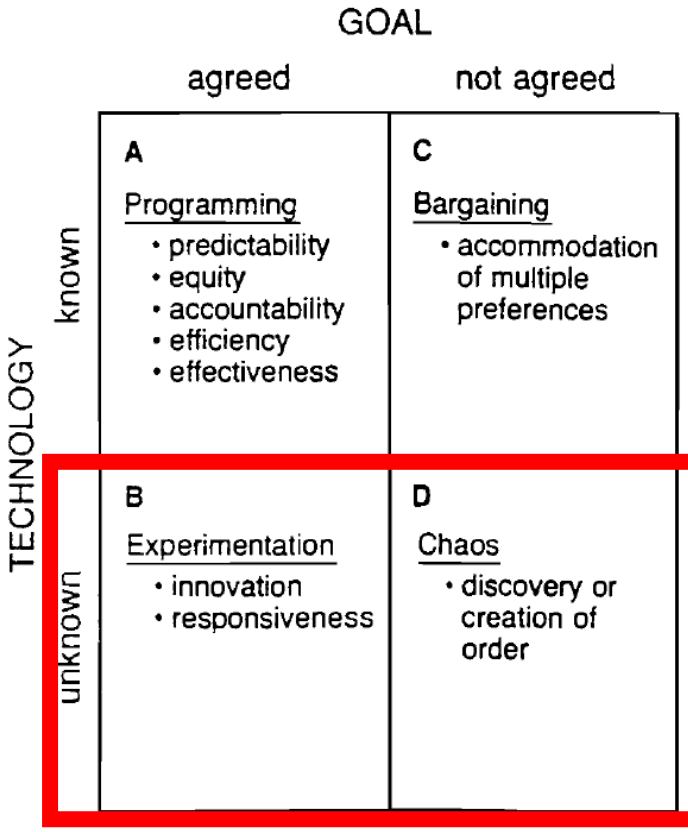

Figure 2. Expectations of government associated with prototype conditions of and responses to planning problems

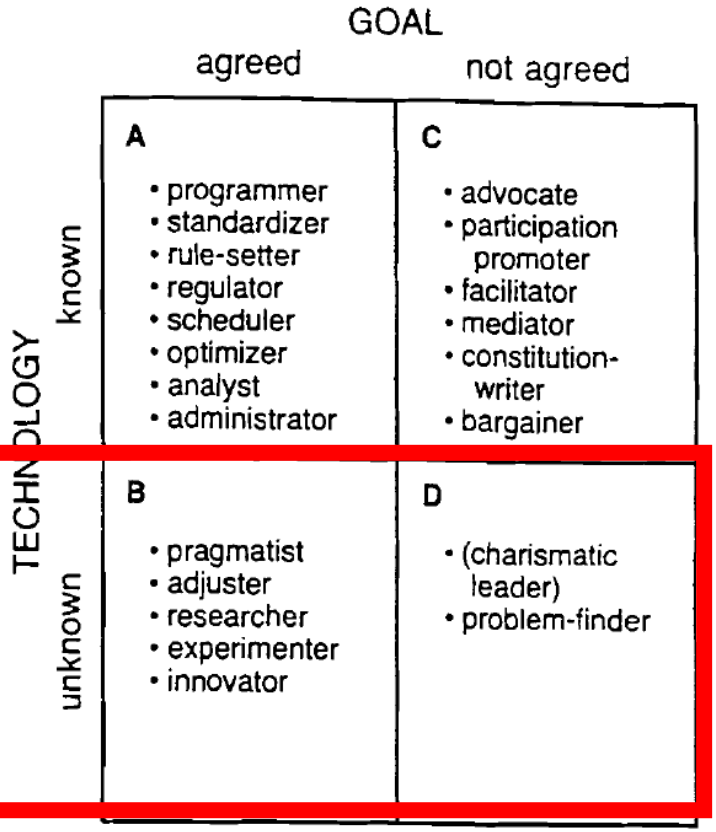

Figure 3. Planning roles categorized by planning conditions

Planning Process and Uncertainty

- Robust vs. Contingent Planning
- Precautionary Principle
- Scenario Planning
- Process Improvement Planning

TRANSFORM

Thank you to the City of Toronto and Metrolinx for support in this project.

Questions?

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