Partially automated vehicles and travel behavior

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Introduction

| SAE Level	SAE Name	Description
0	No Automation	The human driver controls all aspects of driving always. The vehicle may have warning systems.
1	Driver Assistance	The vehicle may be able to control steering or acceleration/deceleration using information from the external environment. The human driver performs all driving tasks.
2	Partial Automation	The vehicle may be able to control both steering and acceleration/deceleration using information from the external environment. The human driver performs all driving tasks.
3	Conditional Automation	The vehicle can control all driving tasks (steering, acceleration/deceleration) and monitors the environment. A human driver may need to respond to a request to take over the vehicle and acts as the back-up system.
4	High Automation	The vehicle can control all driving tasks (steering, acceleration/deceleration) and monitors the environment. The vehicle may request a human to intervene though intervention is not necessary.
5	Full Automation	The vehicle can control all driving tasks (steering, acceleration/deceleration) and monitors the environment. The human could choose the manage the vehicle if they desire.

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Method

- Questionnaire survey on electrification, automation, and shared vehicles
  - Including section on use partial automation (Tesla with Autopilot)
- 36 States
- 3002 respondents
  - 424 Tesla with Autopilot
- March to April 2018

Tesla autopilot user clusters

- Frequent clear weather freeway users

- Semi-frequent users (clear weather, empty roads, freeways)

- Frequent users (any weather, road, or traffic conditions)

- Infrequent users

- Non-automated vehicle owners
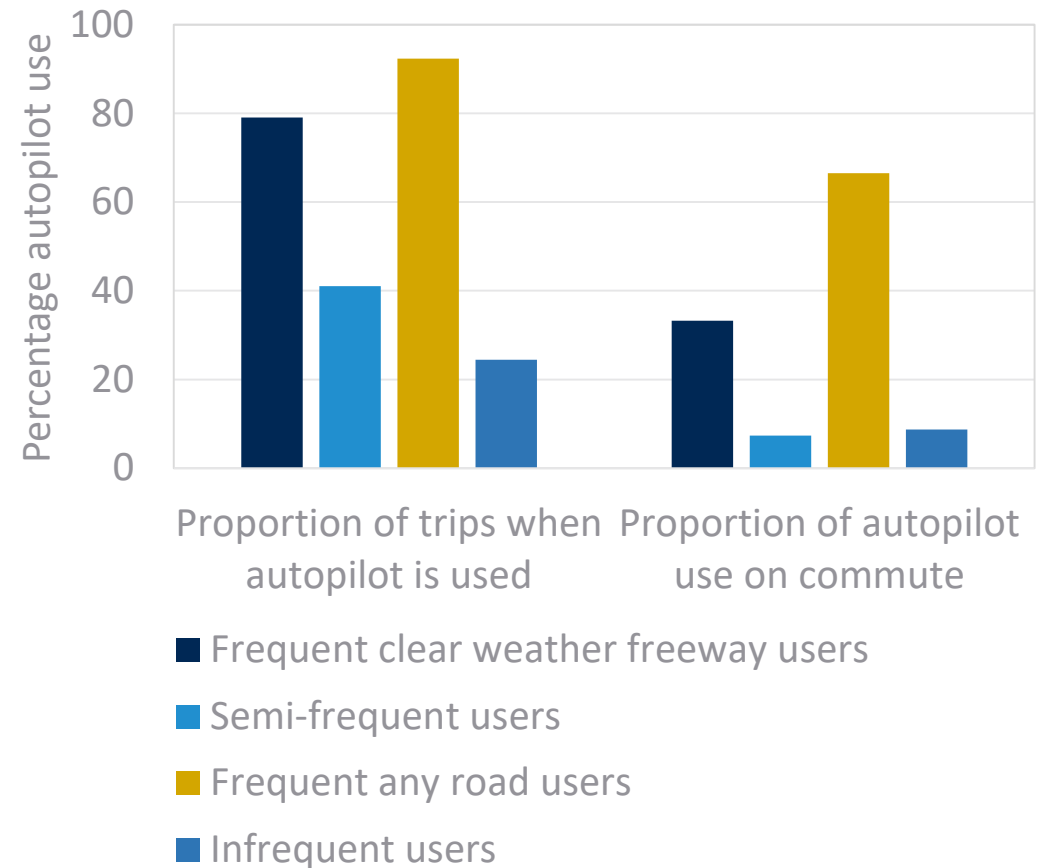
n=424

Annual VMT of user clusters

- Frequent clear weather freeway users - 14,809 miles

- Semi-frequent users - 10,590 miles

- Frequent any road users -14,853 miles

- Infrequent users - 9,143 miles

- Non-automated vehicles - 9,795 miles

Self reported changes in travel

- Autopilot users report undertaking more weekend travel because of autopilot

- No change to weekday travel

- 2018 California Survey of Tesla Buyers
  - More weekend travel
  - More willing to travel at times of congestion
 - If autopilot was no longer able to be used they would travel less

Summary

- Potential for partial automation to increase:
  - VMT
  - Weekend travel
  - Driving during congested times
- All of which could lead to an increase in energy consumption

- Future work
  - Larger survey in California just completed with 1820 Tesla owners
  - Qualitative interviews with partially automated vehicle owners
  - Begin surveying L2 automated vehicles from other brands (Nissan, Audi, BMW, Mercedes, GM, Kia, etc.)

Thanks

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Additional slides
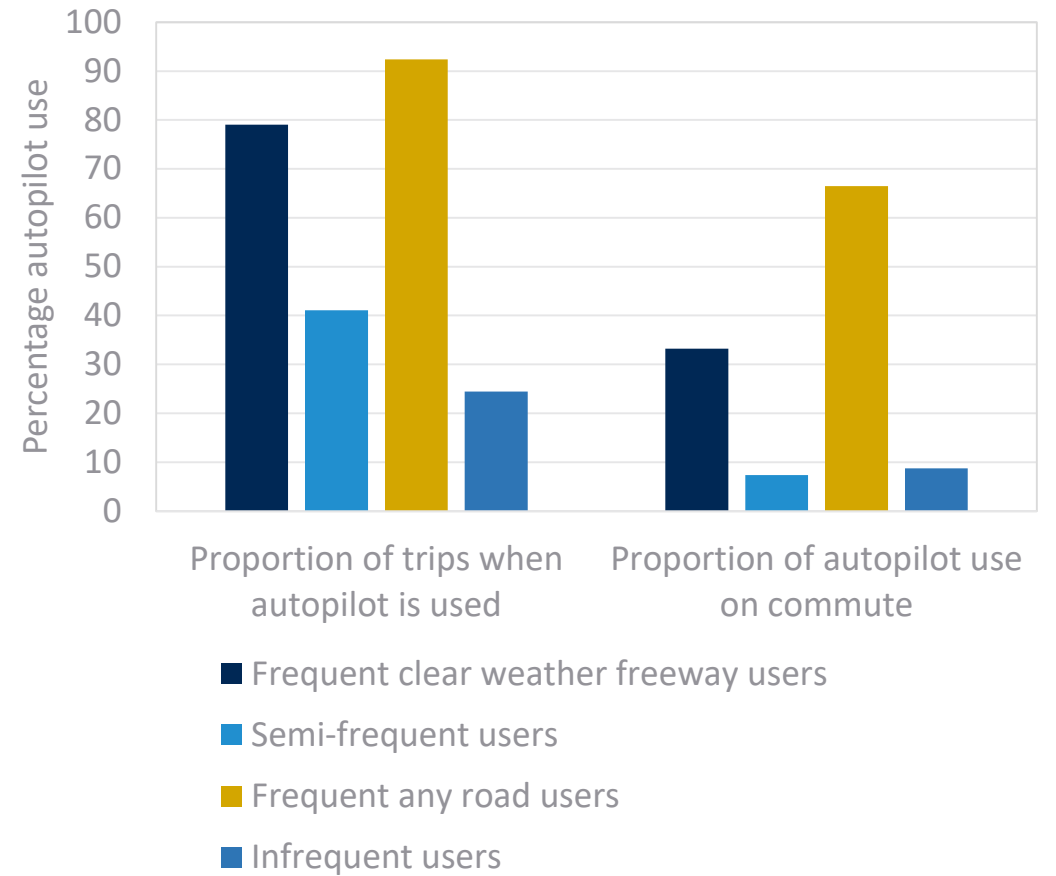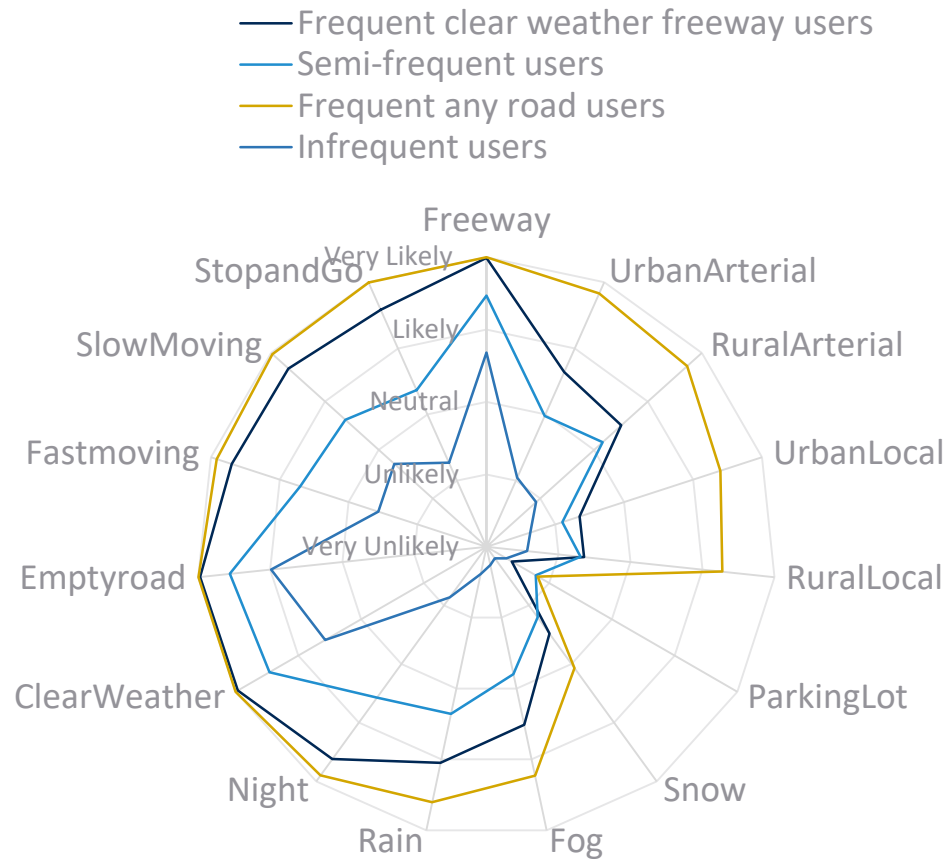
Covariates	Frequent clear weather freeway users			Semi-frequent users			Frequent any road users			Infrequent users			Non-automated Tesla owners				
	Estimate	z-value		Estimate	z-value		Estimate	z-value		Estimate	z-value		Estimate	z-value		Wald	p-value
Age	-0.0197	-1.9908	**	0	-0.0029		0.0218	1.5208		-0.0039	-0.2452		0.0019	0.1668		5.2244	0.27
Male_1	0.6128	2.1453	**	-0.0318	-0.1282		0.4476	1.1742		-0.5051	-1.4329		-0.5235	-1.6771	*	8.1962	0.085
Household Size	-0.1594	-1.6511	*	0.0018	0.0172		-0.2019	-1.3312		0.1335	0.7458		0.226	1.6752	*	6.4465	0.17
Postgrad	-0.4069	-2.0251	**	-0.3284	-1.6083		-0.1369	-0.4887		0.1688	0.5279		0.7035	2.2263	**	8.5728	0.073
Income	0.0001	0.124		0.001	1.2441		-0.0002	-0.179		0.002	1.4837		-0.0029	-2.3098	**	6.8969	0.14
Commute Distance	0.0064	0.9927		-0.0259	-1.7322	*	0.0076	1.0606		0.0103	0.8749		0.0016	0.1756		3.3103	0.51
VMT	0.0001	3.7164	***	0	-0.3496		0.0001	3.3841	***	-0.0001	-1.9853	**	-0.0001	-1.7892	*	18.4026	0.001
Detached_1	0.5232	1.2243		-0.4285	-1.2419		-0.2341	-0.5478		-0.2679	-0.4026		0.4073	0.6941		3.5763	0.47
Frustrated Commuter	-0.1135	-1.2369		0.0274	0.2797		0.1107	0.8063		-0.1694	-1.0298		0.1448	1.098		4.0773	0.4
Technophobe	-0.187	-1.8673	*	0.1502	1.6714	*	-0.3915	-2.2596	**	0.2346	1.6697	*	0.1936	1.3912		11.1967	0.024
Driving Enthusiast	-0.0093	-0.127		0.1309	1.7706	*	0.1526	1.4342		-0.149	-1.4751		-0.1252	-1.0853		7.0323	0.13

*<0.10, **<0.05, ***<0.01