



Spatial and Demographic Sub-Markets Informing Preferences for Electric Vehicles in Canada



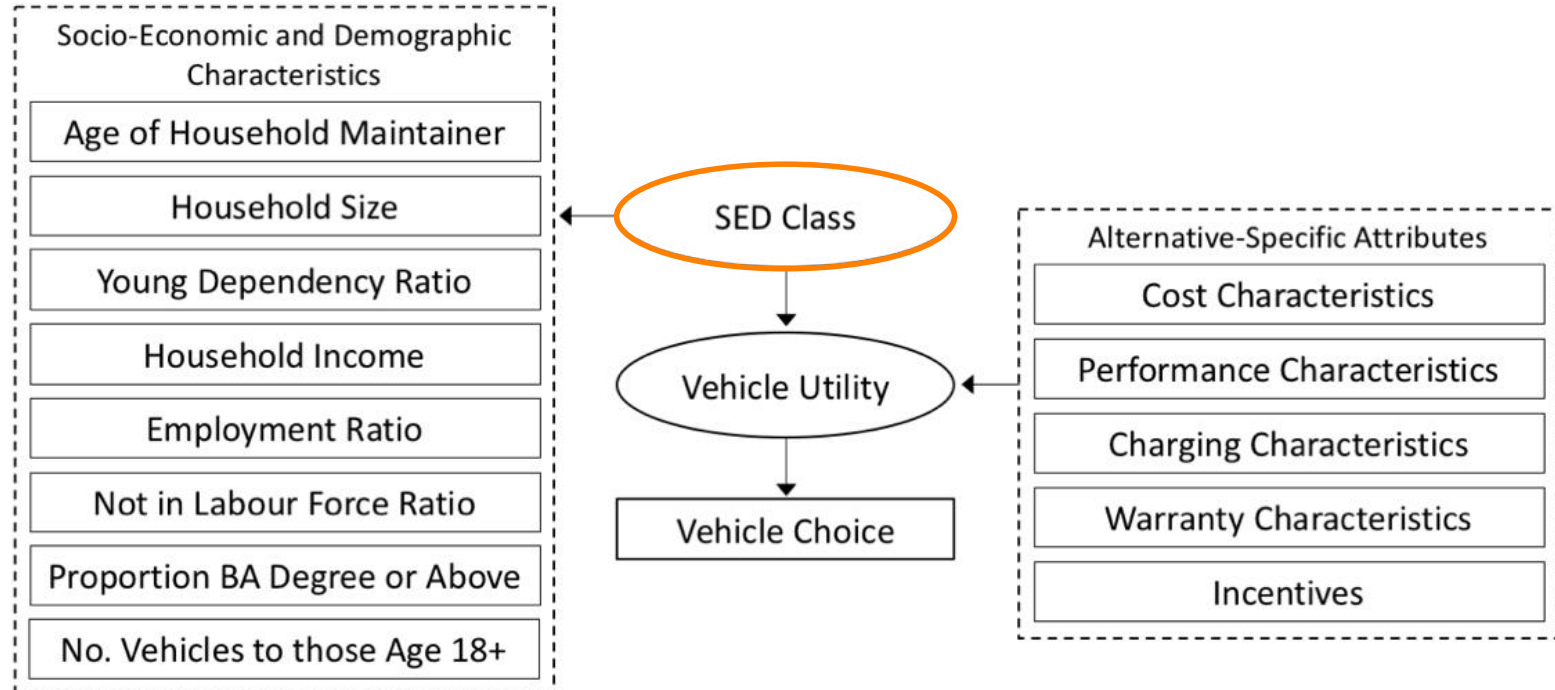
Christopher Higgins
Moataz Mahmoud
Mark Ferguson
Pavlos Kanaroglou

Introduction

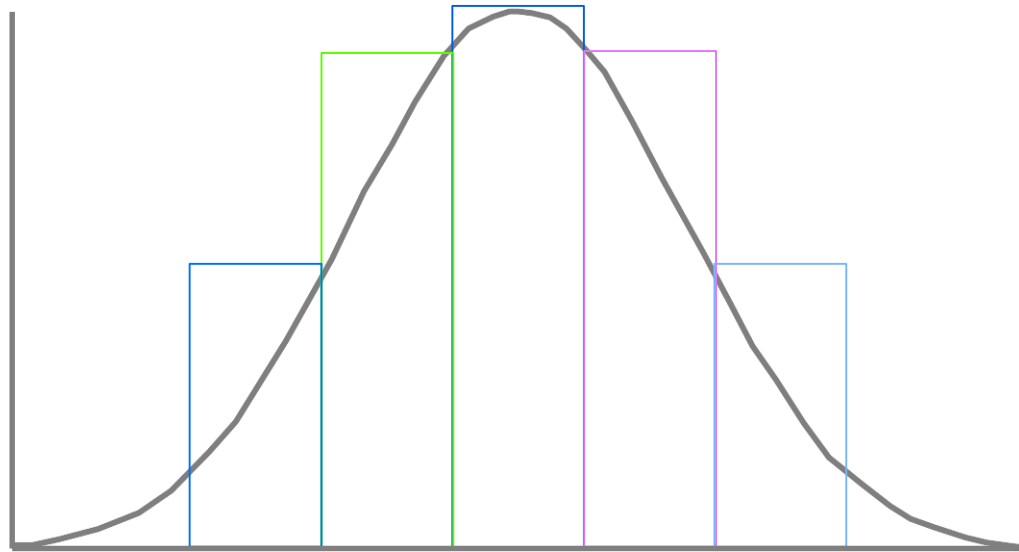
- How to encourage EV use?
 - Who to target, how, and where?
 - Examine decision-making behaviour of household *types*



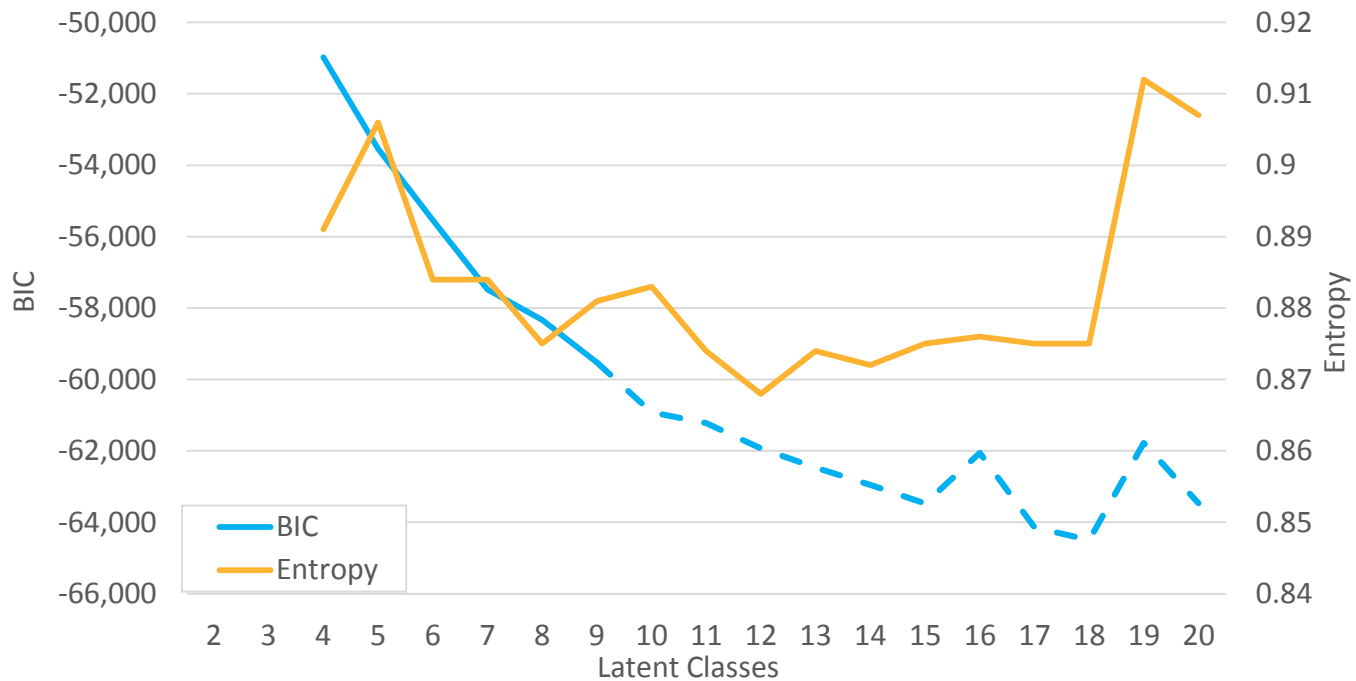
Model Structure



Latent Class Model

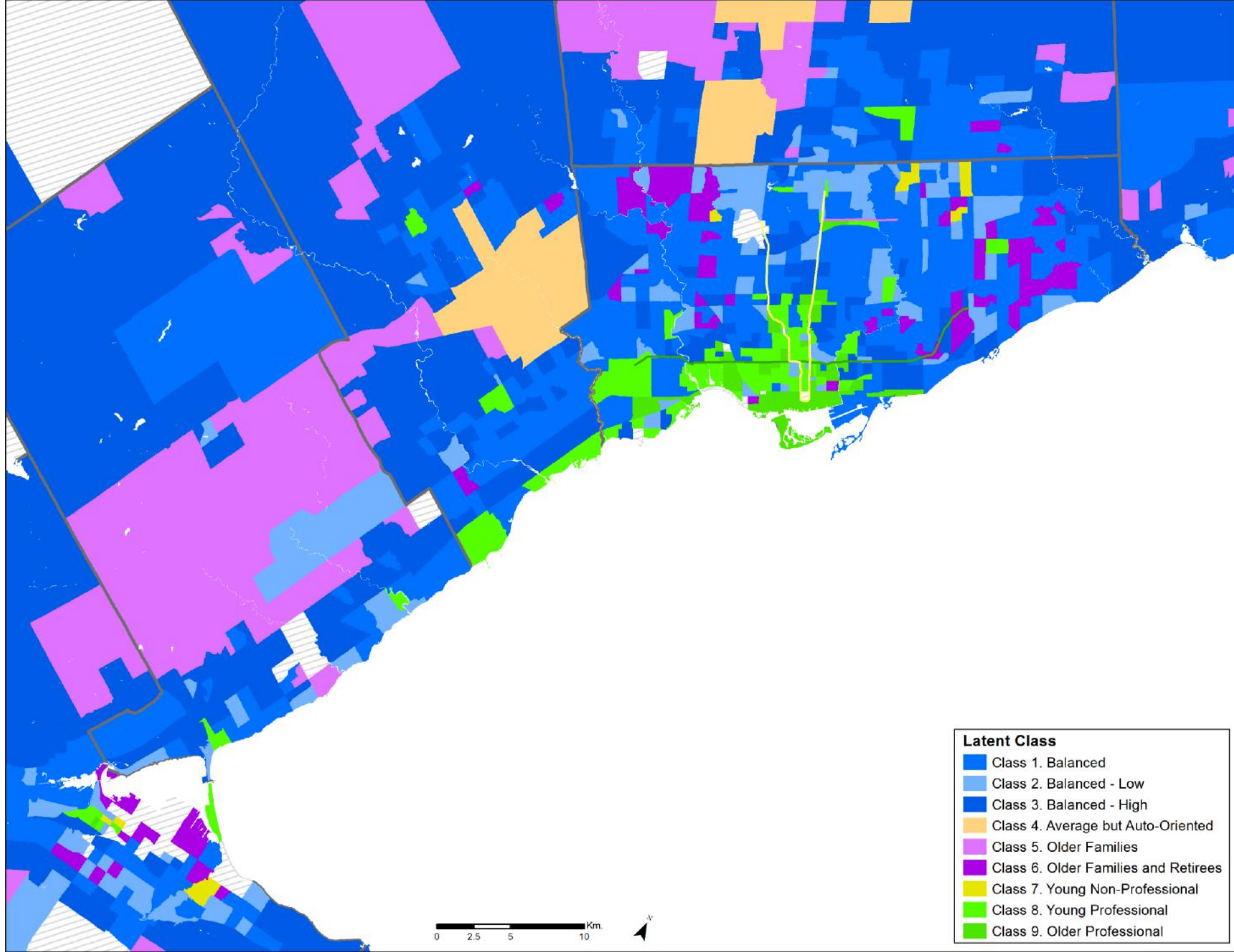


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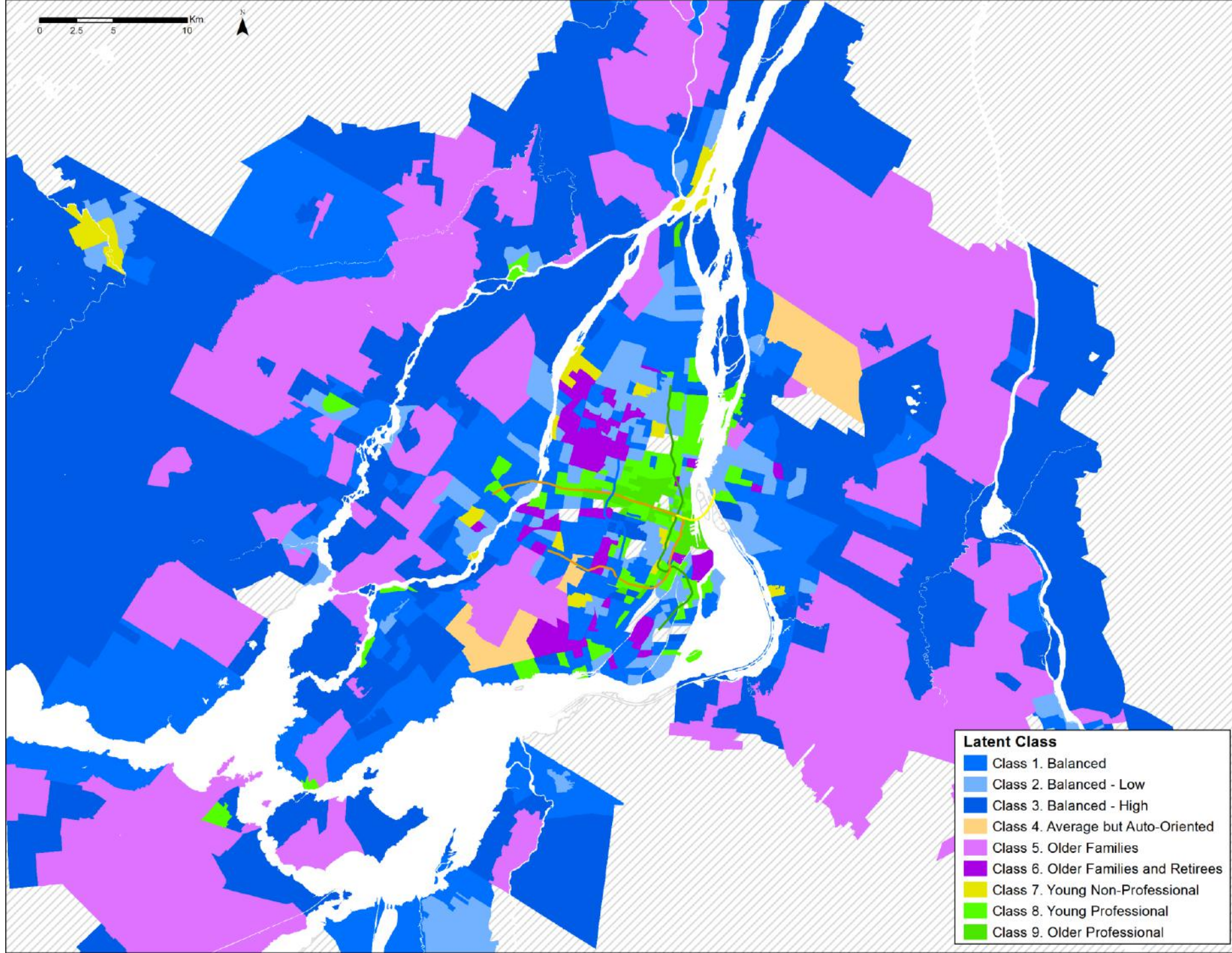


Latent Class Model Results

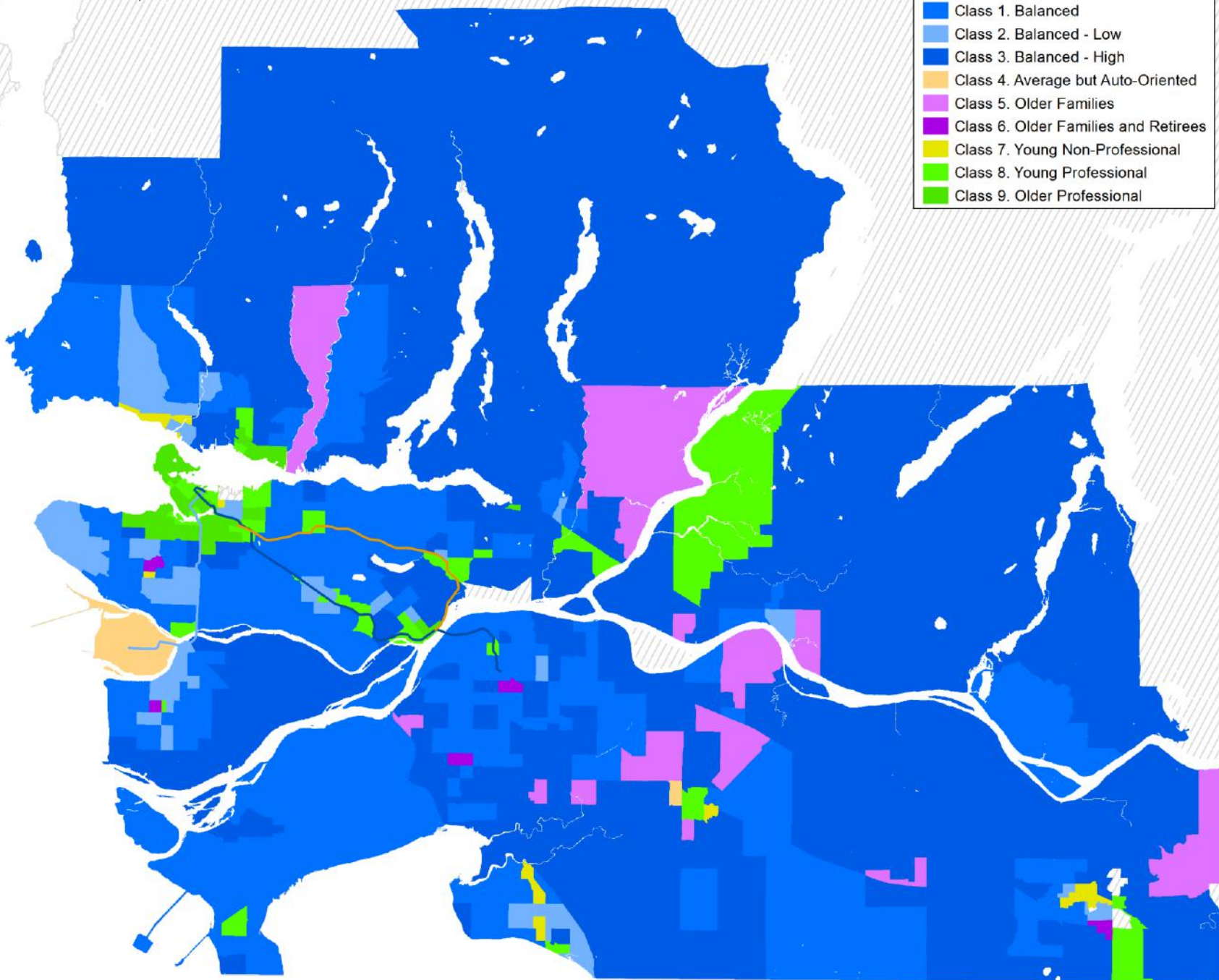
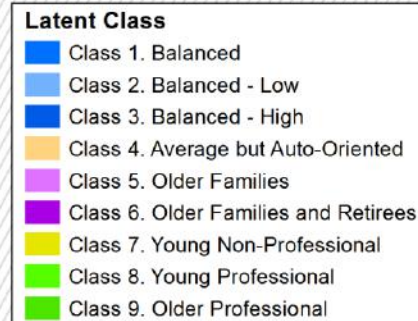
	1.	2.	3.	4.	5.	6.	7.	8.	9.	
	Balanced	Balanced - Low	Balanced - High	Average but Auto-Oriented	Older Families	Older Families and Retirees	Young Non-Professional	Young Professional	Older Professional	Average
<i>Variable</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	(Std. Dev.)
Age of HH Maintainer	34.7 ***	30.9 ***	37.8 ***	35.9 ***	39.5 ***	35.1 ***	25.8 ***	33.6 ***	35.0 ***	34.27 *** (2.6)
Household Size	2.4 ***	2.0 ***	2.6 ***	2.4 ***	2.8 ***	2.3 ***	1.8 ***	1.9 ***	1.8 ***	2.22 *** (0.2)
Young Dependency (%)	0.24 ***	0.18 ***	0.29 ***	0.25 ***	0.37 ***	0.32 ***	0.13 ***	0.16 ***	0.13 ***	0.23 *** (0.05)
Household Income (\$ thou.)	42.88 ***	40.10 ***	44.69 ***	42.63 ***	44.94 ***	39.71 ***	37.64 ***	40.10 ***	41.58 ***	42.77 *** (0.01)
Employed Ratio (%)	0.58 ***	0.52 ***	0.66 ***	0.66 ***	0.73 ***	0.48 ***	0.39 ***	0.63 ***	0.72 ***	0.60 *** (0.03)
Not in the Lbr. Force Ratio	0.37 ***	0.43 ***	0.29 ***	0.30 ***	0.23 ***	0.44 ***	0.56 ***	0.32 ***	0.23 ***	0.35 *** (0.03)
BA Degree or Above (%)	0.23 ***	0.22 ***	0.23 ***	0.25 ***	0.24 ***	0.15 ***	0.18 ***	0.32 ***	0.44 ***	0.25 *** (0.12)
No. Vehicles for those 18+	0.75 ***	0.68 ***	0.86 ***	5.14 ***	0.92 ***	0.54 ***	0.75 ***	0.59 ***	0.57 ***	1.20 *** (0.34)
N (Census)	1,431	623	1,464	27	652	222	108	438	265	5,230
<i>Notes:</i> * indicates statistical significance at the .10% level, ** at the .05% level, and *** at the .01% level or smaller										



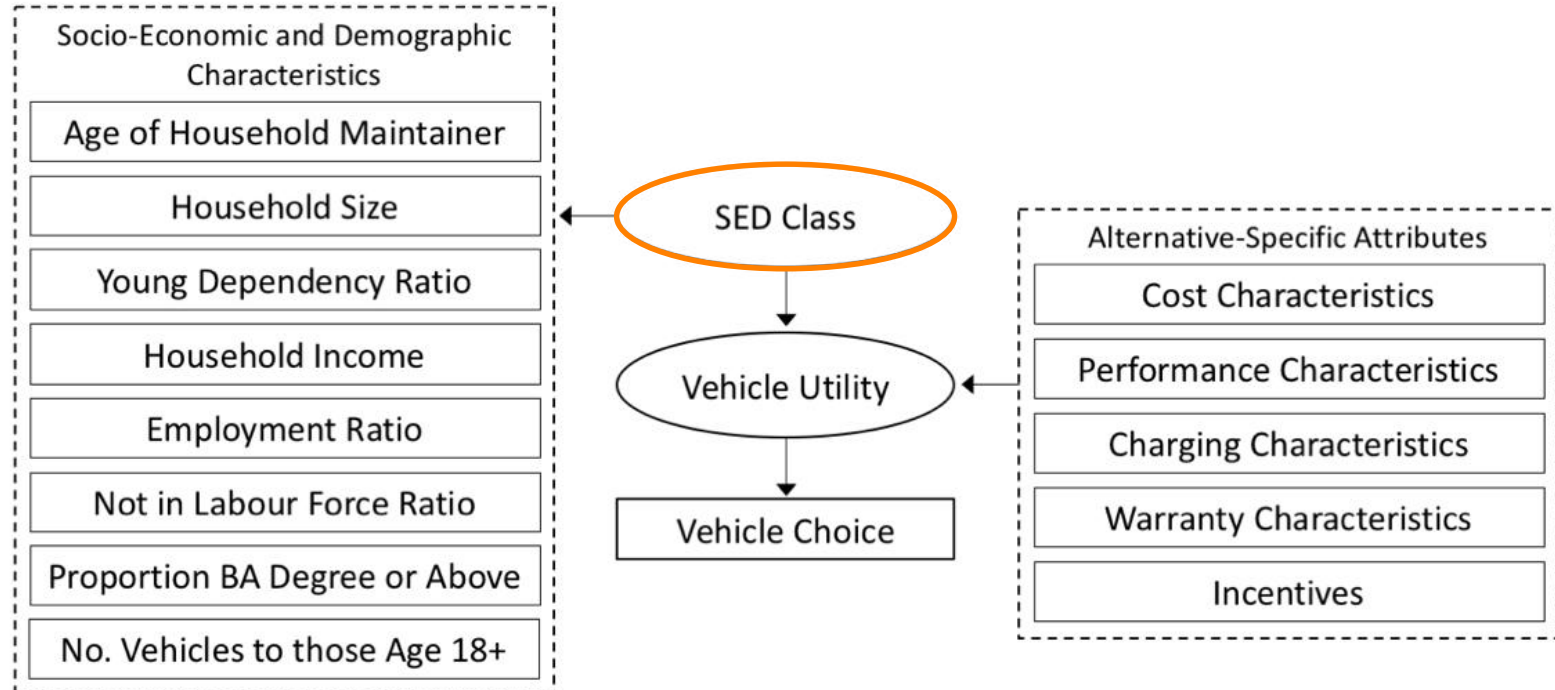
0 2.5 5 10 Km



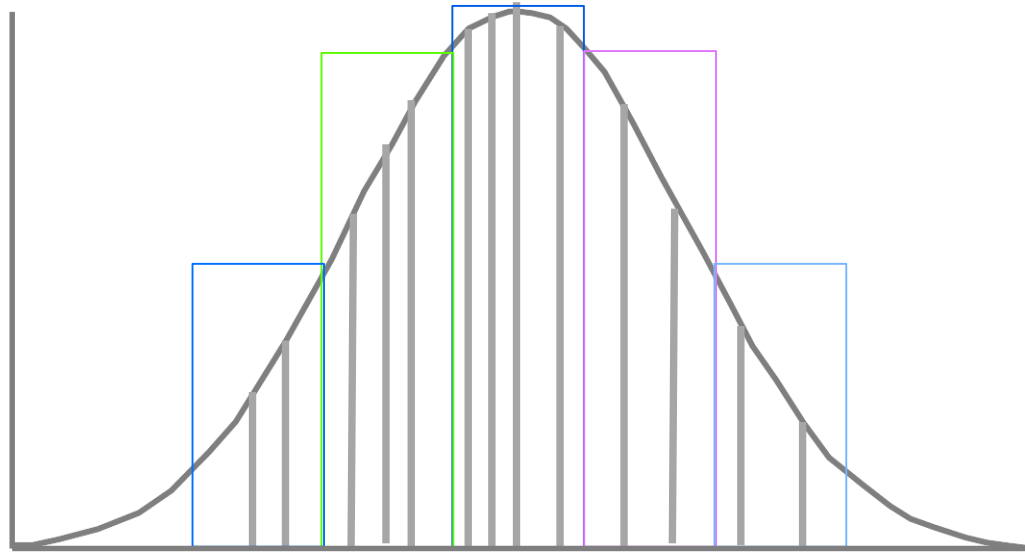
0 2.5 5 10 Km



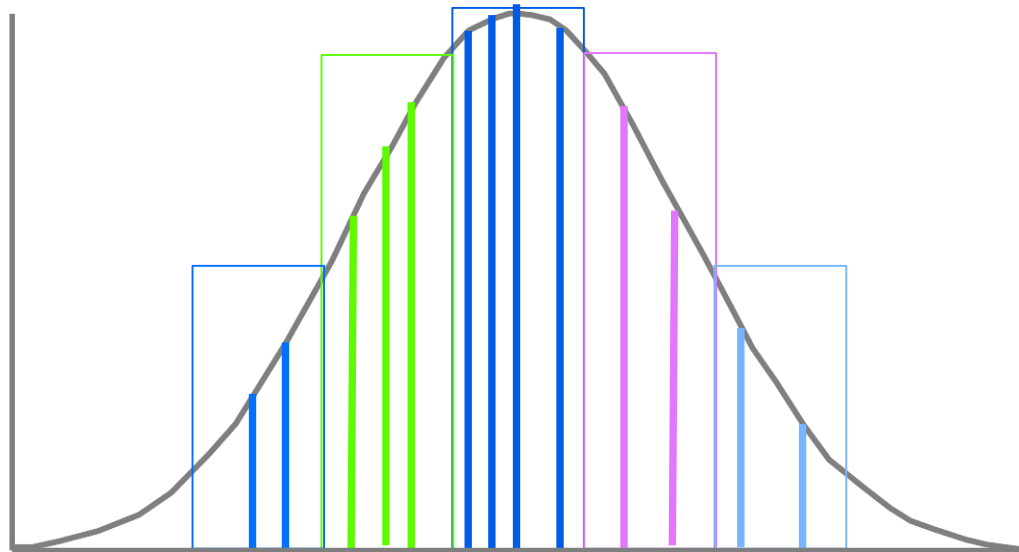
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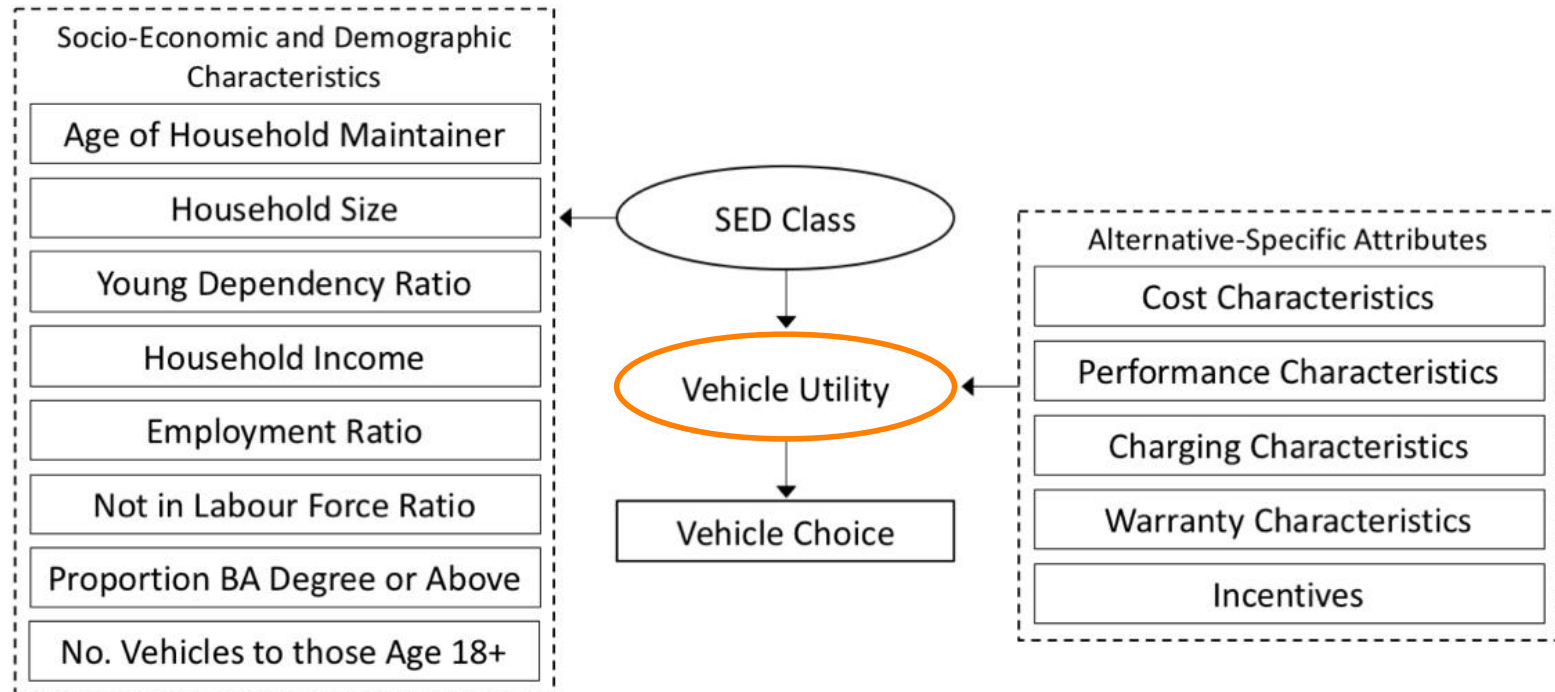
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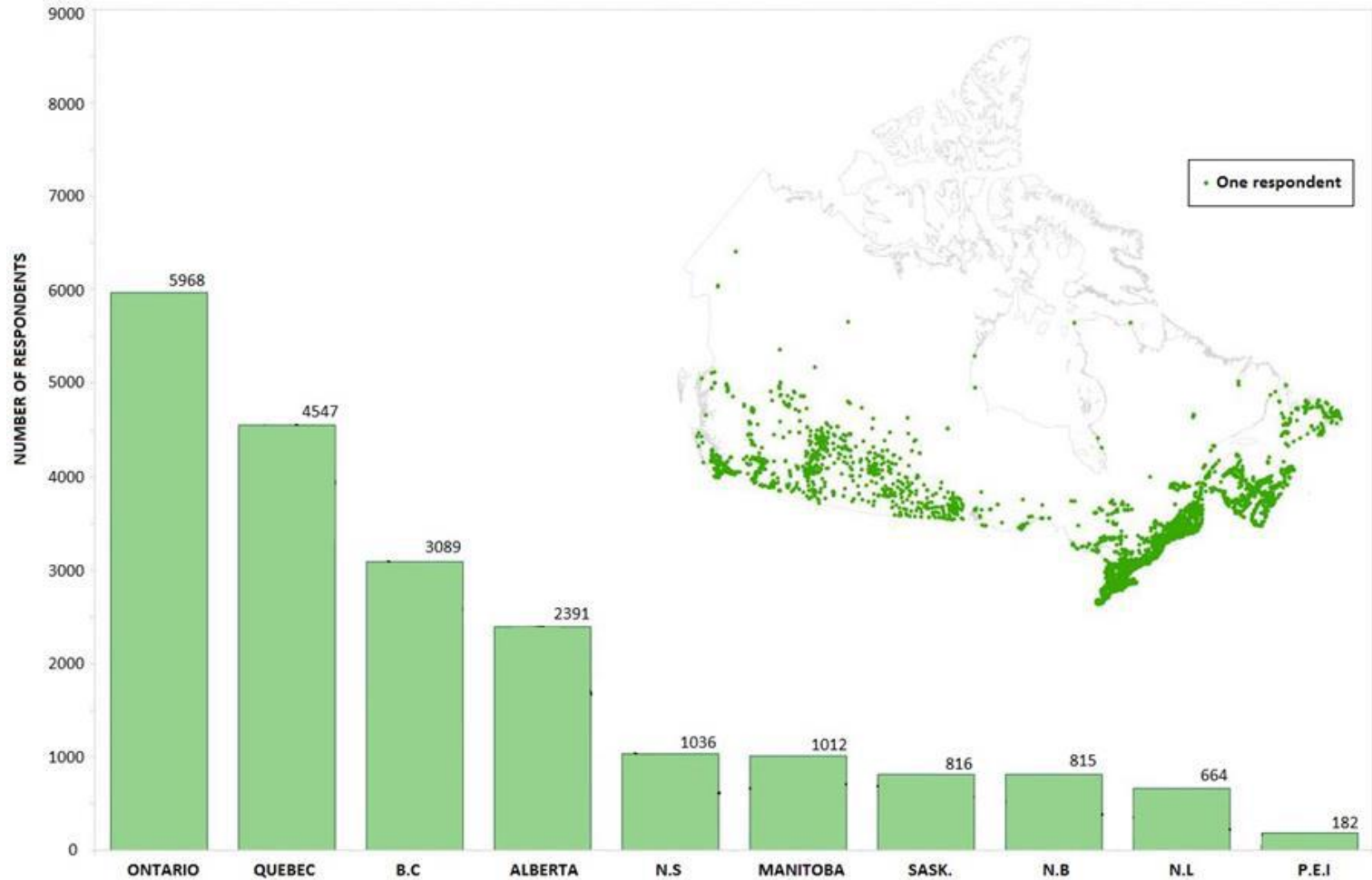
Model Structure



Model Structure



Survey Design



Survey Design

Attributes		ICE	HEV	PHEV	BEV
Purchase Price (\$)	Percentage to ICE	100 75	150 100	200 150 100	200 150 100
Annual Maintenance Cost (\$)	Percentage to ICE	100	100 75	100 75 50	75 50 25
Annual Fuel Charging Cost (\$)	Percentage to ICE	140 120 100	100 80	80 60 40	40 20
Acceleration (0 to 100km/h secs)	Percentage to ICE	100	150 100 50	150 100 50	150 100 50
Cash Incentive (\$)	Absolute	0	0	0 5000 10000	0 5000 10000
Gasoline Range (km)	Percentage to ICE	100	125 75	125 75	0
E-Range (km)	Absolute	0	0	30 60 90	150 250 350
Public Charging Time (hrs)	Percentage	--	--	1100 600 100	2*PHEV levels
Home/Work Charging Time (hrs)	Percentage	--	--	100 75 50	200 150 100

Survey Design

(Scenario 1 of 4: Intermediate Sedan Category)

Please MOUSE OVER any of the 18 picture icons on this screen for more information

Charging		 Gasoline	 Hybrid	 Plug-in Hybrid	 Battery Electric	None of these four vehicles
Charging Station Availability		-----	-----	Twice as available as current gas stations	10% as available as current gas stations	
Charging Time	Public 			2 hr & 48 min	2 hr & 56 min	
	Home/Work 			2 hr	5.25 hr	
Incentives						
Non-cash incentives				- HOV access	- Free Municipal Parking	
Battery Warranty - Years/Km			3 yrs / 58000 km	8 yrs / 160000 km	5 yrs / 96000 km	
Operational						
Gasoline Range		700 KM	875 KM	525 KM	0 KM	
Battery Range		0 KM	0 KM	90 KM	250 KM	
Performance/Acceleration (0 to 100 km/h)		9 Sec	4.5 Sec	13.5 Sec	9 Sec	
Annual CO ₂ Tailpipe Emissions		1.76 tonnes	0.88 tonnes	0.44 tonnes	0.00 tonnes	
Cost						
Vehicle Cost (Price - Cash incentives)		18750-0=\$18750	25000-0=\$25000	25000-10000=\$15000	50000-5000=\$45000	
Annual Maintenance Cost		\$641.25	\$641.25	\$641.25	\$320.00	
Fueling/Charging Cost per Year		\$1137.50	\$812.50	\$325.00	\$325.00	
For the Replacement Vehicle, I would choose		☐	☐	☐	☐	

Discrete Choice Model Results

	1. Balanced	2. Balanced - Low	3. Balanced - High	5. Older Families	6. Older Families and Retirees	7. Young Non-Professional	8. Young Professional	9. Older Professional
<i>Variable</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>
<i>Constants</i>								
Battery Electric	-0.2413 ***	-0.2447 *	-0.1967 **	-0.1947 ***	-0.1504	-0.4273 ***	1.6993 ***	-0.1742 ***
Hybrid	0.0209	-0.4460	-0.2426	-0.1319 *	-0.1894	-0.5560 ***	1.3398 *	0.0361
Plug-in Hybrid	-0.3747	-1.3797 ***	-0.7851 ***	-0.5586 ***	-0.7800 **	-0.8567 ***	1.9459	-0.4760 ***
<i>Vehicle Cost Characteristics</i>								
Price (\$)	-0.0471 ***	-0.0369 ***	-0.0440 ***	-0.0411 ***	-0.0414 ***	-0.0417 ***	-0.0498 ***	-0.0452 ***
Maintenance Cost (\$)	-0.3183 ***	-0.0612	-0.2955 **	-0.1835 ***	-0.1770	-0.2144 ***	-0.7787	-0.2003 ***
Fuel Cost (\$)	0.1267 *	-0.0879	-0.0542	0.0972 ***	-0.0447	0.0792 **	0.3558	-0.0200
<i>Vehicle Performance Characteristics</i>								
Electric Range (km)	0.0005	0.0022 **	0.0007	0.0005 *	0.0015 **	0.0005	0.0001	0.0013 ***
Gasoline Range (km)	0.0005 ***	0.0005 *	0.0004 **	0.0004 ***	0.0005 ***	0.0004 ***	0.0012	0.0005 ***
Acceleration (sec.)	-0.0085	-0.0156	-0.0294 ***	-0.0124 ***	-0.0073	-0.0060	0.0259	-0.0109 ***
<i>Vehicle Charging Characteristics</i>								
Charging Station Availability	0.0026	-0.0107	0.0324	0.0262	-0.0063	0.0553 **	0.2050	0.0231
Charging Time – Public (hours)	-0.0504 ***	0.0360	-0.0293 *	-0.0213 ***	-0.0058	-0.0610 ***	-0.0113	-0.0430 ***
Charging Time – Home (hours)	-0.0123	0.0455	-0.0366	-0.0211 **	0.0149	-0.0452 ***	-0.1220	-0.0433 ***
<i>Vehicle Warranty</i>								
Warranty	0.1000 ***	0.0172	0.0470	0.0785 ***	0.0568 *	0.0834 ***	-0.2655 *	0.0595 ***
<i>Incentives</i>								
Free Parking	0.1222 *	0.0920	0.0863	0.0637 **	0.0592	0.0522	0.6544 **	0.0755 **
Free Toll Road Use	0.0088	-0.1169	-0.0277	-0.0139	-0.0159	0.0465	0.1326	-0.0159
HOV Use	-0.0389	0.0562	0.0819	0.0515 *	0.0496	0.0802 **	-0.0785	0.1061 ***
Cash Incentives	0.0298 ***	0.0393 ***	0.0373 ***	0.0405 ***	0.0267 ***	0.0372 ***	0.0650 *	0.0431 ***
N (Survey)	653	237	741	4,038	316	2,629	30	3,329
Pseudo-R ²	0.055	0.041	0.049	0.054	0.041	0.041	0.105	0.052

Notes: * indicates statistical significance at the .10% level, ** at the .05% level, and *** at the .01% level or smaller. No survey cases correspond to Class 4 and as such, this class is omitted.

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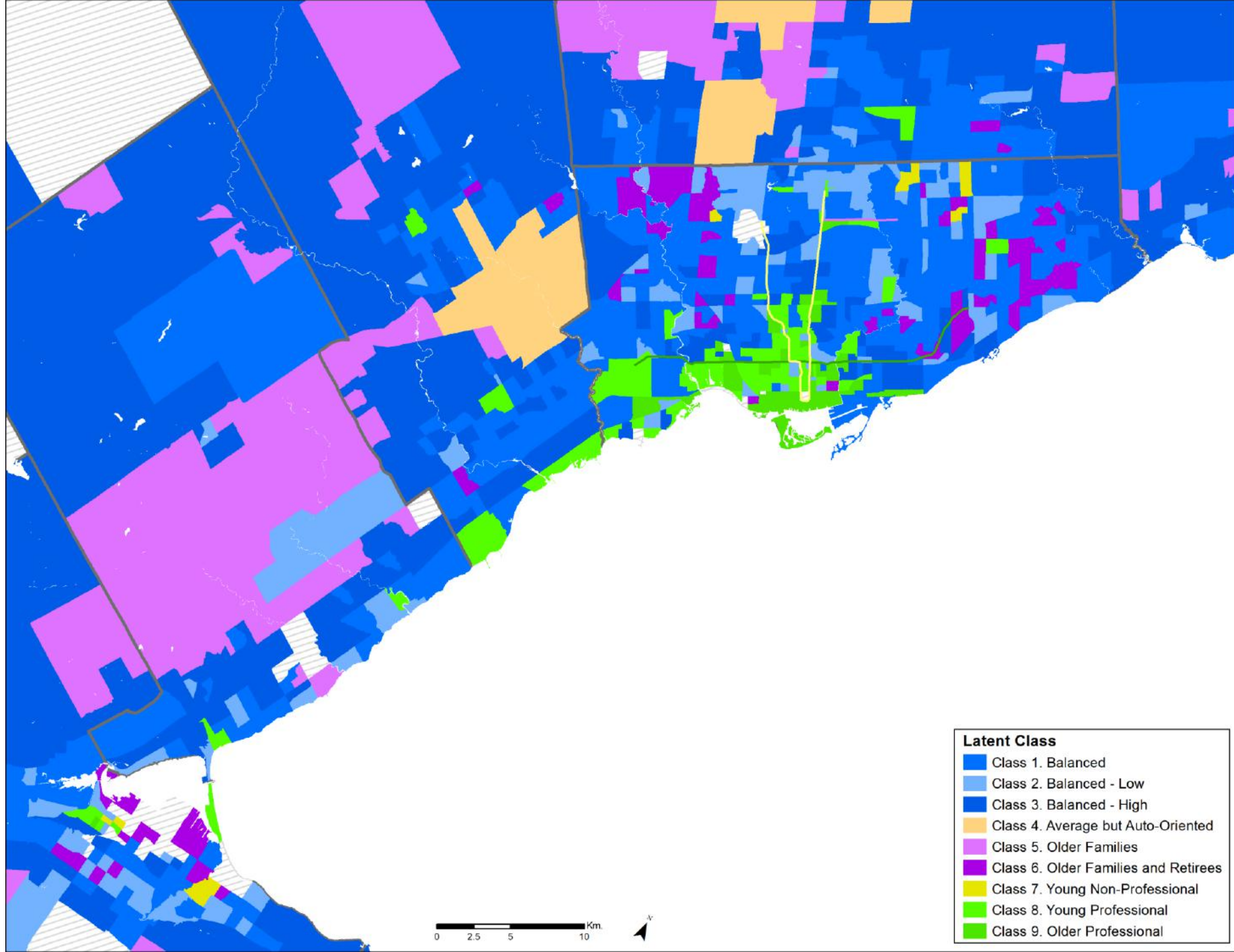
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Conclusion

- A great deal of previous research looking at factors influencing purchase decision
- Little looking at *where*
- Identified SED and spatial submarkets for potential EV adoption
- Young professionals show promise
 - Young, highly-educated, in urban centres
 - Approx 1,522,000 individuals (4%), 882,000 households (5%)

Conclusion

- Older professionals
 - Another promising market with incentives
 - Smaller market – 2% of population and 3% of households
- Results can aid in
 - Marketing
 - Station locations
 - Infrastructure upgrades



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