Latent Class Choice Model

In the following model, we try to determine if different classes of private transit users choose from different sets of alternatives and have different preferences towards certain alternatives. Class 1 does not have bikes and considers: 1) auto, 2) walk, 4) walk to transit, 5) drive to transit, and 6) private transit; Class 2 has bikes and considers all modes of transit; Class 3 does not have a car or bike and considers: 2) walk, 4) walk to transit, and 6) private transit.

1. Estimation Results from the model

Class 1 Model:

Variables	parameters	std_err	t_stat	p_value
ASC(Walk)	0.7625	0.3243	2.3516	0.0187
ASC(Walk to Transit)	0.9160	0.8797	1.0413	0.2978
ASC(Drive to Transit)	-8.9347	4.3607	-2.0489	0.0405
ASC(Private Transit)	11.1984	3.7152	3.0142	0.0026
Travel Time	-6.2914	0.9799	-6.4204	0.0000
Travel Cost(Auto/Drive to Transit)	-0.5678	0.0681	-8.3392	0.0000
Travel Cost(Walk to Transit/Private Transit)	-1.2903	0.3098	-4.1656	0.0000

Class 2 Model:

Variables	parameters	std_err	t_stat	p_value
ASC(Walk)	-0.4067	0.2499	-1.6276	0.1036
ASC(Bike)	-1.2463	0.3326	-3.7469	0.0002
ASC(Walk to Transit)	-0.2859	0.3085	-0.9268	0.3540
ASC(Drive to Transit)	-1.1933	0.3898	-3.0616	0.0022
ASC(Private Transit)	-0.0157	0.2604	-0.0603	0.9520
Travel Time	-0.0000	0.0000	-1.2553	0.2094
Travel Cost	-0.0059	0.0118	-0.4986	0.6181

Class 3 Model:

Variables	parameters	std_err	t_stat	p_value
ASC(Walk to Transit)	-0.6556	0.4298	-1.5252	0.1272
ASC(Private Transit)	-2.1143	1.5412	-1.3718	0.1701
Travel Time	-0.0003	0.0001	-1.9953	0.0460
Travel Cost(Walk to Transit)	0.2686	0.1455	1.8462	0.0649
Travel Cost(Private Transit)	0.0873	0.1175	0.7429	0.4575

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Class Membership Model:
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Variables                                   parameters    std_err     t_stat    p_value
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Class-specific constant (Class 2)              -2.1114     0.6453    -3.2719     0.0011
Class-specific constant (Class 3)              -0.5570     0.5723    -0.9733     0.3304
Car ownership (Class 2)                         0.4882     0.2493     1.9583     0.0502
Car ownership (Class 3)                        -1.8368     0.6962    -2.6383     0.0083
Bike ownership (Class 2)                        0.0269     0.1278     0.2101     0.8336
Bike ownership (Class 3)                        0.4606     0.3441     1.3386     0.1807
Low Income (Class 2)                            0.8346     0.8451     0.9875     0.3234
Low Income (Class 3)                            0.4079     1.1302     0.3609     0.7182
High Income (Class 2)                           0.3088     0.5156     0.5990     0.5492
High Income (Class 3)                           0.0476     0.7352     0.0647     0.9484
Male (Class 2)                                  0.0312     0.4693     0.0665     0.9470
Male (Class 3)                                  0.7709     0.7596     1.0148     0.3102
Distance Traveled (miles) (Class 2)            -0.0021     0.0246    -0.0839     0.9331
Distance Traveled (miles) (Class 3)             0.0026     0.0258     0.0995     0.9208
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2. Model Specification in table format

2.1 Class Membership Model

	Class-specific Constant	Car Ownership	Bike Ownership	Low Income
Class 1	0	0	0	0
Class 2	ASC_{class2}	$\beta_{CarOwnership,\,class2}$	$\beta_{BikeOwnership,\,class2}$	$\beta_{LowIncome,\,class2}$
Class 3	ASC_{class3}	$\beta_{CarOwnership,\,class3}$	$\beta_{BikeOwnership,\,class3}$	$\beta_{LowIncome,\,class3}$

	High Income	Male	Distance Traveled (Miles)
Class 1	0	0	0
Class 2	$\beta_{HighIncome,\,class2}$	$\beta_{Male,\,class2}$	$\beta_{DistanceTraveled,\,class2}$
Class 3	$\beta_{HighIncome,\,class3}$	$\beta_{Male,\,class3}$	$\beta_{DistanceTraveled,\,class3}$

2.2 Choice Model for each class

Class 1: 1) Auto, 2) Walk, 4) Walk to transit, 5) Drive to transit, and 6) Private transit

	ASC	Travel Time	Travel Cost
Auto	0	$\beta_{TravelTime}$	$\beta_{TravelCost,\ auto/DrivetoTransit}$
Walk	ASC_{Walk}	$\beta_{TravelTime}$	0
Walk to transit	$ASC_{WalktoTransit}$	$\beta_{TravelTime}$	$\beta_{WalktoTransit/Private\ Transit}$
Drive to transit	$ASC_{DrivetoTransit}$	$\beta_{TravelTime}$	$\beta_{TravelCost,\ auto/DrivetoTransit}$
Private transit	$ASC_{PrivateTransit}$	$\beta_{TravelTime}$	$\beta_{WalktoTransit/Private\ Transit}$

Class 2: 1) Auto, 2) Walk, 3) Bike, 4) Walk to transit, 5) Drive to transit, and 6) Private transit

	ASC	Travel Time	Travel Cost
Auto	0	$\beta_{TravelTime}$	$\beta_{TravelCost}$
Walk	ASC_{Walk}	$\beta_{TravelTime}$	0
Bike	ASC_{Bike}	$\beta_{TravelTime}$	0
Walk to transit	$ASC_{WalktoTransit}$	$\beta_{TravelTime}$	$\beta_{TravelCost}$
Drive to transit	$ASC_{DrivetoTransit}$	$\beta_{TravelTime}$	$\beta_{TravelCost}$
Private transit	$ASC_{PrivateTransit}$	$\beta_{TravelTime}$	$\beta_{TravelCost}$

Class 3: 2) Walk, 4) Walk to transit, and 6) Private transit

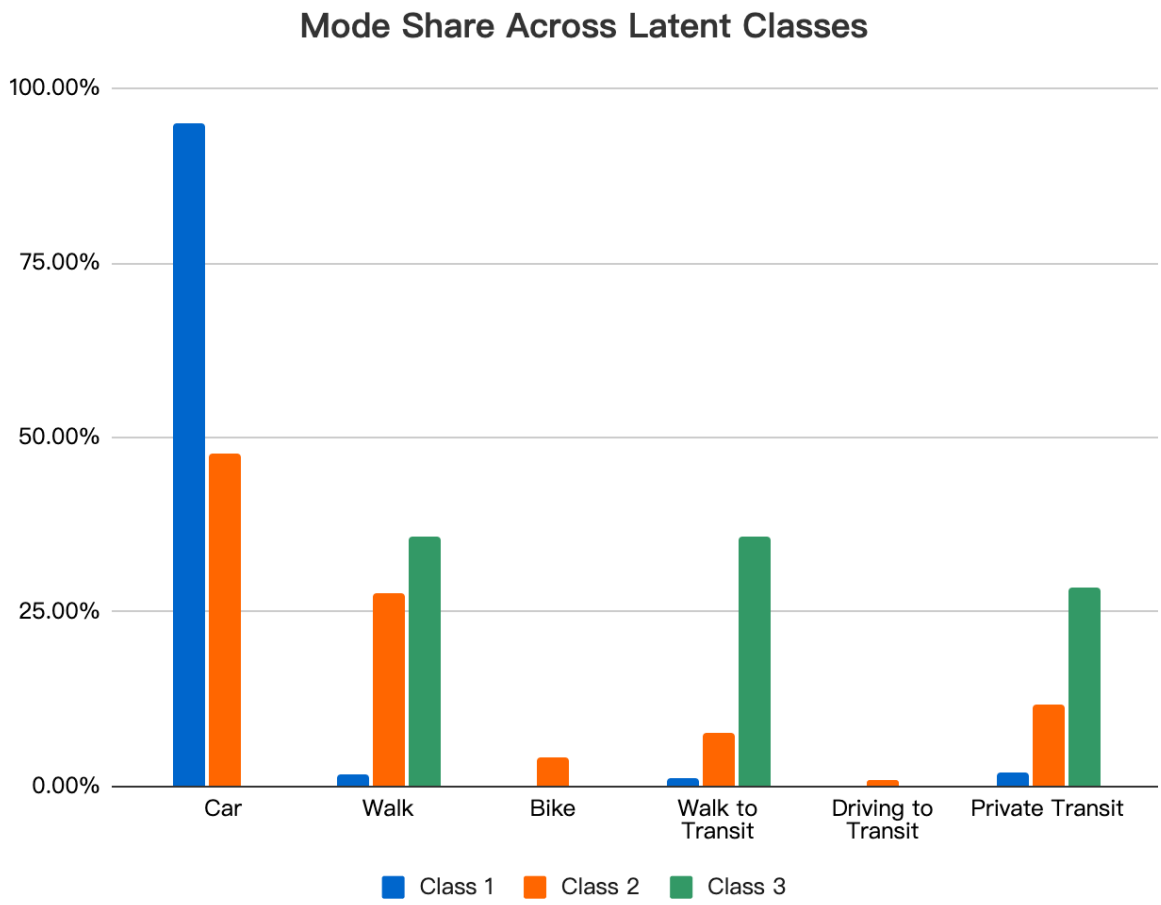
	ASC	Travel Time	Travel Cost
Walk	0	$\beta_{TravelTime}$	0
Walk to transit	$ASC_{WalktoTransit}$	$\beta_{TravelTime}$	$\beta_{TravelCost,\ WalktoTransit}$
Private transit	$ASC_{PrivateTransit}$	$\beta_{TravelTime}$	$\beta_{TravelCost,\ Private\ Transit}$

3. Percent membership and mode share of each class

Detailed data of membership percent of each class and mode share under each class is as follows. The method to compute membership is simply adding up each individual's probability of choosing the class. But in reality, an individual is not divisible, and should consider assigning one individual to the class with the highest probability. In that way, the membership share in our case would be (59.64%, 39.16%, 1.2%) over the three classes. Related data visualization is included within the jupyter notebook part.

Class Membership Share Across Sample			
class 1	0.45	45.26%	
class 2	0.36	36.48%	
class 3	0.18	18.27%	
Mode Share Across Sample			
	Class 1	**Class 2**	**Class 3**
Car	95.02%	47.81%	0.00%
Walk	1.80%	27.65%	35.83%
Bike	0.00%	4.17%	0.00%
Walk to Transit	1.09%	7.61%	35.67%
Driving to Transit	0.00%	0.94%	0.00%
Private Transit	2.08%	11.83%	28.50%

4. Histograms of Task 2 and interpretation



The mode share distribution of Class 1, which includes car but not bike owners, heavily skews towards car/auto as the main choice of transportation with the other modes (walk, walk to transit, and private transit) making up less than 5% of total mode choices in Class 1.

Class 2, which includes people who consider all modes of transportation, still has a distribution that skews towards cars (~47%), however, walking takes up a large portion of the distribution (27.65%) which may reflect that Class 2 primarily accesses places that more convenient by car and walking compared to the other modes.

Class 3, which captures transit riders without bikes and cars, has a relatively even distribution between all three modes (walk, walk to transit, private transit), with private transit taking up less in comparison to the other two modes. This suggests that Class 3 equally goes to walkable and transit-accessible places.