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Goal of Analysis

I am interested in examining how access to alternative modes of transportation affects the utility of vehicle ownership. A city interested in reducing its car dependence could use my changes to the TDM23 model to better understand the potential impact of transit, bike, and pedestrian infrastructure.

TDM23 Analysis

TDM23 is significantly better at identifying vehicle sufficient households than identifying insufficient or zero car households. The original model predicted the following:

TDM23 Prediction	Sufficient	Insufficient	Zero
Sufficient	**54,869**	4,203	1,490
Insufficient	122	**107**	1
Zero	350	1	**1,465**

TDM23 misidentifies ~20% of the dataset's zero vehicle households as being vehicle sufficient. While only 4.72% of all households, zero vehicle households do not have access to the primary mode of transportation across the US.

For vehicle insufficient households the predictions are even less accurate with the model identifying ~54% of them as vehicle sufficient. The distinction between household vehicle sufficiency and insufficiency seems difficult to predict with the current variables. This is potentially due to so few households being insufficient.

For the purposes of my analysis, I am more interested in the factors that decrease the utility of vehicle ownership. Because of this focus, identifying insufficient and zero vehicle households accurately is more important for my model than identifying vehicle sufficient households.

Alternative Modes Analysis

My model explores the effect of introducing predictor variables based on the frequency of use of public transit (train and bus), biking, and walking.

Users are sorted into three usage categories:

1. Daily
2. Weekly
3. Rarely if Ever

I made this distinction because they felt like important benchmarks for vehicle utility. Someone who takes public transit, bikes, or walks every day likely has a different utility than a weekly user or a non-user.

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Transit is not available in every location. The frequency of use of trains and buses in this instance can be interpreted as a proxy for transit accessibility. Similarly, the cycling and walking predictors could be interpreted as a measure of the respective infrastructure for both modes in the user's area.

Alt. Modes Prediction	Sufficient	Insufficient	Zero
Sufficient	**54,699**	4,135	1,074
Insufficient	163	**167**	1
Zero	479	9	**1,873**

Difference in Prediction (TDM23 to Alt. Modes)	Sufficient	Insufficient	Zero
Sufficient	**-170**	-68	-416
Insufficient	-41	**+60**	+8
Zero	+129	+8	**+408**

Including these variables improved the model's predictive ability for zero vehicle households and general accuracy across households. The Alternative Modes model correctly detects zero vehicle households ~14% more often than TDM23 with an increased in balanced accuracy ~7%. The Alternative Modes model has a higher Kappa and lower AIC, indicating that the model performs better than TDM23.

The Alternative Modes model is nearly identical to TDM23 in its predictive ability for insufficient vehicles, both of which are close to random guessing.

Predictive Ability	Accuracy	Kappa	AIC	Sensitivity for Zero Car HH	Balanced Accuracy for Zero Car HH
TDM23	90.15%	0.3128	40,027	49.560%	74.486%
Alt Modes	90.63%	0.3834	37,273	63.363%	81.272%
Difference	**0.48%**	**0.0706**	**2,754**	**13.803%**	**6.786%**

Coefficients Comparison

Coefficients - TDM23

Reference case:

- Sufficient vehicle household
- Medium-income
- High-density neighborhood

Coefficients - TDM23	Insufficient	Zero
Intercept	-4.23	0.13
Worker Count	0.39	-3.16

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Number of Children	0.21	-0.16
Number of Seniors	0.33	-0.50
Number of Extra Drivers	0.19	0.60
If there are 3 drivers	0.83	0.26
If there is a non-Working Driver	1.19	-4.19
Low-Income	0.60	1.95
High-Income	-0.26	0.08
Low Density	-0.30	-0.48
Medium Density	0.81	1.61

Coefficients - Alt. Modes

Reference case:

- Sufficient vehicle household
- Medium-income
- High-density neighborhood
- Bike daily
- Rides transit daily
- Walks daily

Coefficients - Alt. Modes	Insufficient	Zero
Intercept	-1.97	4.47
Worker Count	0.36	-3.32
Number of Children	0.22	-0.13
Number of Seniors	0.35	-0.31
Number of Extra Drivers	0.21	0.79
If there are 3 drivers	0.89	0.17
If there is a Non-Working Driver	1.19	-4.19
Low-Income	0.60	2.05
High-Income	-0.33	-0.24
Low Density	-0.23	-0.19
Medium Density	0.57	1.00
Bikes Rarely if Ever	-0.88	-0.96
Bikes Weekly	-0.56	-0.84
Rides Transit Rarely if Ever	-1.17	-3.13
Rides Transit Weekly	-0.20	-0.84
Walks Rarely if Ever	-0.44	-1.30
Walks Weekly	-0.24	-0.81

Coefficients – Change in Coefficients

Coefficients - Alt. Modes	Insufficient	Zero
Intercept	+2.26	+4.34

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Worker Count	-0.03	-0.16
Number of Children	+0.01	+0.03
Number of Seniors	+0.02	+0.19
Number of Extra Drivers	+0.02	+0.19
If there are 3 drivers	+0.06	-0.09
If there is a Non-Working Driver	0	0
Low-Income	0	+0.1
High-Income	-0.07	-0.32
Low Density	+0.07	+0.29
Medium Density	-0.24	-0.61

The most glaring difference between the two model (besides the addition of extra variables in Alternative Modes) is the intercept value. This difference is likely due to the changes in the reference case introduced by the new predictor variables.

In a scenario where a household has:

- 2 workers
- Low-income
- 1 child
- No seniors
- No other drivers
- Medium density
- Bikes weekly
- Rides transit daily
- Walks rarely if ever

TDM23 finds zero vehicle household utility to be:

0.13 + 2(-3.16) + 1(-0.16) + 1(0.60) = **-5.75**

Alternative Modes finds zero vehicle household utility to be:

4.47 + 2(-3.32) + 1(-0.13) + 1(2.05) + 1(1.00) + 1(-0.84) + 1(-1.30) = **-1.39**

By factoring in the other predictors, Alternative Modes finds an increased utility to zero-household vehicles. This difference suggests that Alternative Modes is capturing significant information that TDM23 is missing. It also suggests that increasing usership of alternative transportation options would decrease vehicle utility, potentially decreasing vehicle usage in the region.

You can find my full analysis code here: https://github.com/evkindler/Travel_Demand/tree/main/P2