EXPLORING THE UNNOTICED: AN ANALYSIS OF VOLUNTARY AND INVOLUNTARY CARLESS HOUSEHOLDS IN CALIFORNIA

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I. Background

• While everyone in California is talking about driver-less car.



'...Not too fast! Mind that cyclist ... Left here ... Brake ... BRAKE YOU FOOL! ... Careful, there's a dog ...'

But, Why?

• My co-author and I are talking about carless driver.





I. Background

Suman lived in Southern California without a car from 2012 to 2018

Living in Southern California without a car is like:

Living in the top floor of a 6 story building with sea view but without an elevator



OR Having a smartphone without a data plan.



Everyday people like him have more limited opportunities because they don't have a car: limited access to economic opportunities, to health care facilities, to amenities and reduced participation in public life.

An estimated 8.7 percent of U.S. households were without vehicles in 2016.

I. Background

- With current engine technology, motor vehicles are also major contributors to global climate change.
- This has finally received universal attention after Pope Francis' appeal to address this problem.
- There is increasing pressure on the transportation sector to reduce its carbon footprint. California is trying to make its transportation sector Carbon neutral by 2045.
- As a result reducing vehicle-miles traveled and auto dependency have become important policy goals of transportation planning.
- But the path to transitioning away from an autodependent society is still unclear.
- One possible starting point is to learn from the households who currently live without a motor vehicle.







II. Research Purpose

- Unfortunately, our knowledge of carless households is lacking, as is our research on their predicaments.
- These households can be organized in two groups: voluntary and involuntary carless households.
- Understanding the characteristics of voluntary carless households is important because to inform policies that attempt to reduce our dependency on cars and reduce greenhouse gas emissions.
- Understanding the characteristics of involuntary carless households is also important because these households face physical isolation, poor access, and social exclusion.





II. Research Purpose

- This research examined the characteristics of voluntary and involuntary carless households in California.
- We also assess the effects of various socioeconomic, residential, and land use variables on the likelihood that a household is carless, voluntarily or not.







III. Previous Studies (Factors related to car ownership)

- Literature that analyzes factors tied to car ownership mostly focus on households with one or more cars (e.g. Chu, 2002; Dargay & Hanly, 2007; Whelan, 2007; Potoglou & Susilo, 2008; Nolan, 2010...)
- Most of these studies show that **income** is one of the primary determinants of car ownership.
- **Other variables** influencing car-ownership:
 - life stage, number of household workers, number of household members with a driver's license (Chu, 2002 ; Whelan, 2007) ,
 - the cost of ownership (Dargay & Hanly, 2007),
 - the availability of other means of transport (Kim and Kim, 2004)
 - residential self-selection, backyard size, and off-street parking facilities (Cao and Cao, 2014)
 - attitudes and preferences play a significant role in vehicle choice and use (Lois & López-Sáez, 2009)
- The influence of the **built environment** on car ownership has sparked a lot of interest around the world
- Potentially important variables include :
 - measures of density (Chu, 2002; Giuliano, & Dargay, 2006; Goetzke & Weinberger, 2012)
 - diversity (Soltani, 2005; Potoglou & Kanaroglou, 2008; Zegras, 2010)
 - design (Bhat & Guo, 2007; Zegras, 2010)
 - accessibility (Matas, Raymond, & Roig, 2009; Van Acker, & Witlox, 2010)
 - transit availability (Li et al., 2010; Pinjari et al., 2011; Goetzke & Weinberger, 2012;)
 - commute distance/time (Bhat & Guo, 2007; Potoglou & Kanaroglou, 2008)
 - recent analysis of the relationship between historical exposure to the built environment and current vehicle ownership patterns (Macfarlane, Garrow, and Mokhtarian, 2015)

IV. Methodology and Data

- The study analyzes data from the 2012 California Household Travel Survey (CHTS).
 - The survey design was pretested in late fall, 2011, and the main survey effort began in January, 2012
 - Overall, 42,431 households participated in the CHTS. This includes 36,714 non-GPS households and 5,717 GPS households.







IV. Methodology and Data

- One of the purposes of this research is to understand whether carless households are "victims" to their situation or whether they voluntarily choose to live without cars.
- The CHTS asked carless households their reasons for not possessing a car. This is the basis for classifying respondents as "voluntary" or "involuntary" carless household.

Code	Reasons of not having access to a motor vehicle	Classification
1	Do not need a car - can do what I need and want to without a motor vehicle	Voluntary
2	Concerned about impact on environment	Voluntary
3	Can't drive and (1 or 2)	Voluntary
4	No driver's license and (1 or 2)	Voluntary
5	Too expensive to buy	Involuntary
6	Too expensive to maintain (gas/insurance/repairs)	Involuntary
7	Health/age related reasons	Involuntary
8	Cannot get insurance	Involuntary
9	Can't drive	Involuntary
10	No driver's license and (5 or 6 or 7 or 8 or 9)	Involuntary
11	Mentioned both reasons for voluntary and involuntary	Don't know
12	No answer	Don't know

IV. Methodology and Data

Voluntary Carless



Peter Hickman uses saddlebags, a bicycle trailer and a backpack to haul volleyball equipment or whatever else he needs. He hasn't owned a car since 1984. – Photo by Cherly Gerber



Suman Mitra did not have a car because he could not afford one. – Photo by another Involuntary carless person

Carless household Statistics (CHTS 2012)

Carless household type	Frequency	Percent
Voluntary carless households	363	15%
Involuntary carless households	1,049	42%
Don't know/Refused	1,047	43%
Total carless households	2,459	100

Source : Calculated from CHTS 2012



~ 8 % (weighted) Carless Households in California in the 2012 CHTS.

Map1: Home location of CHTS respondents

- •Carless households can be found everywhere in CA
- Voluntarily carless households live in more populated areas, everywhere in CA (not just the bay area)



IV. Methodology

- We analyzed our data using two approaches:
- 1. Simple **univariate analysis** to gauge basic differences between groups of households defined by their ownership of motor vehicles; and
- 2. Multivariate analysis to tease out what factors contributes to the decision to forgo cars or to be an involuntary carless household.

1. Univariate Analysis

- First, we contrasted the characteristics of our three groups of households: voluntary carless households, involuntary carless households, and households with motor vehicles.
- We used F tests and χ^2 tests to test the statistical significance of differences in selected continuous and categorical variables for these three groups.

2. Multivariate analysis

We estimated three binary logit models, where the dependent variable Y_i is defined respectively by:

- Model 1: Y_i = 1 if a household is carless and 0 if it owns one or more vehicles;
 - the goal is to contrast households with and without motor vehicles; the sample size is 32,811
- Model 2: Y_i =1 if a household is voluntarily carless and 0 if it owns motor vehicles;
 - the goal here is to understand how carless households differ from households who own motor vehicles; the sample size is 31,142
- Model 3: $Y_i = 1$ if a household is voluntarily carless and 0 if it is involuntary carless,
 - to understand differences between voluntary and involuntary carless households; the sample size is 1,134
- For these 3 models, our explanatory variables are: household socio-economic and demographic characteristics, dwelling type, and built environment variables.
- Coefficients were estimated via maximum likelihood.

Map2: Location of voluntary carless households and land use entropy index

We calculated the Land use Entropy Index as follows (Silva, Golob, and Goulias, 2006)

 $LEI_{j} = \frac{-1}{\ln(k)} \sum_{n=1}^{k} P_{jn} \ln(P_{jn}),$

where LEI_j is the land use entropy index of block group j; k is the number of land use types and P_{jn} is the area's proportion of land use of type n in block group j



V. Results (Univariate Analysis)

- Voluntary carless households are more likely to have a higher household income and a higher education than involuntary carless households.
- Voluntary carless households tend to be smaller than other households and have a smaller number of workers than households with cars but higher than involuntary carless households.
- Voluntary carless households have fewer children than other households.
- The % of voluntary carless households living in single family detached housing is ~higher than the involuntary group.
- Average population density and the mixed density index of the location of voluntary carless households are significantly higher than for involuntary carless households and households with cars.
- Voluntary carless households are more likely to live in areas with a higher land use entropy index, a higher average network density and better public transport service coverage.







V. Results (Multivariate Analysis)

• All 3 logit models passed diagnostic tests (e.g. link test, likelihood ratio test).

Socio-Economic and Demographic Variables

- Hispanic/Latino households are more likely to be carless (OR=1.27*** for model 1 and 1.52** for model 2) and
- A household is less likely to be carless when the number of workers is larger (OR=0.48*** for model 1 and 0.52*** for model 2).
- African Americans are more likely to be carless (OR=1.84*** for model 1 and 1.67** for model 2).
- Households where educational attainment is low are much more likely to be carless: OR=3.02*** for model 1 and 2.62*** for model 2
- Households with higher income (OR=1.02***) are more likely to be voluntary carless, likewise for the availability of bicycles (OR=1.21**)
- Families with one child are more likely to be voluntarily carless (OR=2.01**).







V. Results (Multivariate Analysis)

Type of Dwelling and Built Environment Variables

- Dwelling type is important: households who live in single family dwellings are less likely to be carless (OR=0.37*** for model 1 and 0.43*** for model 2)
- Most built environment variables are statistically significant for all three models
- Higher Land use entropy values are associated with a higher likelihood that a household is carless (OR=2.58*** for model 1), especially voluntarily (OR=51.77*** for model 2 and OR=13.37*** for model 3)
- Accessibility by transit (percentage of population accessible by transit) is even more important with odds ratios of 250.72***, 4949.89***, and 10.78** for models 1, 2, and 3 respectively.





VI. Conclusions

- Among household characteristics household income, household size, household number of bicycles and number of household workers are determinant factors for a household to be voluntary carless
- Other than household characteristics, a higher residential density and better transit service play an important role in determining whether a household is voluntarily carless or not.
- Higher residential density with better transit facilities encourage low or zero car ownership while avoiding the potentially negative consequences of not owing a car in an automobile-oriented society.

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THANK YOU







Results (Multivariate Analysis)

Table 4: Logit Models Results

	Model 1		Model 2		Model 3	
Variables	(Carless HH		(Voluntary carless vs. HH		(Voluntary carless vs.	
	vs. HH with cars)		with cars)		involuntary carless HH)	
-	Coefficient	OR	Coefficient	OR	Coefficient	OR
Socio-Economic and Demographic Characteristics						
Household (HH) size	-0.37***	0.69***	-0.66***	0.52***	-0.17	0.84
Ratio of HH bicycles to HH Size (>5 years)	-0.03	0.97	0.06	1.06	0.19**	1.21**
Number of HH workers	-0.74***	0.48***	-0.64***	0.52***	0.07	1.07
Annual HH income (\$)	-0.02***	0.98***	-0.01***	0.99***	0.02***	1.02***
Binary: 1=Hispanic or Latino	0.24***	1.27***	0.42**	1.52***	-0.01	0.99
HH ethnicity (baseline=Caucasian)						
Binary:1=African American	0.61***	1.84***	0.51**	1.67**	-0.35	0.71
Binary:1= Other	-0.01	0.99	-0.29*	0.75	-0.11	0.89
Highest HH educational attainment (baseline=graduate						
degree)						
Binary: 1= No high school degree	1.11***	3.02***	0.96***	2.62***	-0.11	0.90
Binary: 1= High school graduate	0.66***	1.93***	0.66***	1.94***	0.00	1.00
Binary: 1= Some college credit but no degree	0.15	1.16	0.03	1.03	0.09	1.10
Binary: 1= Associate degree	0.05	1.05	0.02	1.02	0.23	1.26
Binary: 1= Bachelor degree	-0.21**	0.81	-0.23	0.80	-0.03	0.97
Life cycle stage (baseline=no child)						
Binary: 1= If HH has 1 child	-0.17	0.85	0.58**	1.78**	0.70**	2.01**
Binary: 1= If HH has 2 children	0.10	1.11	0.61	1.84	0.16	1.17
Binary: 1= If HH has 3 or more children	0.48**	1.62**	0.52	1.68	-0.27	0.76
Binary: 1= If HH has older member (>65 years)	-0.39***	0.68***	-0.28*	0.76*	0.23	1.26
Type of Dwelling						
Binary:1=Single family housing	-0.98***	0.37***	-0.85***	0.43***	0.28	1.33
Built Environment variables						
Population density (thousands per square mile)	0.02***	1.02***	0.03***	1.03***	-0.001	0.99
Mixed density index (MDI)	0.08***	1.08***	0.02	1.03	0.04*	1.04*
Land use entropy index (LEI)	0.95***	2.58***	3.95***	51.77***	2.59***	13.37***
Network density (facility miles of pedestrian-oriented	0 00***	1.00***	0.01***	1 0/***	0.02**	1 02***
links per square mile)	0.02	1.02	0.04	1.04	0.03	1.03
Percentage of population accessible by transit	5.52***	250.72***	8.51***	4949.89***	2.38**	10.78***
Constant	-1.26***		-4.87***		-3.21***	
Pseudo R-square	0.38		0.34		0.13	
Number of observations	32,811		31,142		1,134	

Notes: 1. *, **, and *** indicate significance at 10%, 5%, and 1%.