

Car less, or car later?

**—Exploring the factors associated with the decreasing car ownership
of Millennial households in the central Puget Sound region between 1989 and 2014**

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Data: May 13th, 2016

Content

Abstract

I. Introduction

II. Literature Review

- a. Economic Factors
- b. Alternative Travel Modes
- c. Changes in Life Stage
- d. Explosion of ICT Use
- e. Built Environment or Location
- f. Limitations on Existing Researches

III. Descriptive Analysis

- a. Research Purpose
- b. Sample Selection
- c. Findings of Descriptive analysis
 - 1) Changes overtime affecting all age groups, especially younger groups
 - 2) Economic factors
 - 3) Changes in life stage
 - 4) Location

IV. Regression Model

- a. Research Purpose
- b. Data and Methods
- c. Model Results
 - 1) Underlying reasons of the change in household car ownership of young households in 2002 and 2014
 - 2) Underlying reasons of the change in household car ownership of young households in 1989 and 2002
 - 3) Underlying reasons of the difference in household car ownership between young households and other households in 2014

V. Conclusions and Implications

VI. References

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Abstract

This research investigates the car ownership of young households (those households mainly composed of young adults 18- to 35-year-olds) in the central Puget Sound region and compares the car ownership of Millennial households (those households mainly composed of adults born in the last two decades of the 20th century, 18- to 35-year-olds in 2015) with that of young households composed of previous generations at the same age using data from the 1989-2014 (11 survey years) household travel surveys conducted by the Puget Sound Regional Council. This study uses descriptive analysis to profile trends and linear regression model to identify and prioritize the factors that associate with the decreased car ownership of Millennial households.

The regression model reveals four major factors that are associated with the decreased car ownership of Millennial households, including changes in life stages and income (size of household, status of marriage, status of having children, number of children in the household, number of employment, household income, etc.), location, the general drop of household car ownership occurring across all age groups (consuming habits, changes over year affect different areas, etc.), and Millennial-specific factors (changing attitude, communication technology use, etc.). For Millennial households in 2014 and young households in 2002, life stages and income, explain 30% to 35% of the decrease in household car ownership; changes in location explain 15% to 20% of the dampening in household car ownership; the general drop of household car ownership occurring across all households explains 30% to 40%; Millennial-specific factors account for the remaining 10% to 20%.

The low portion of Millennial-specific factors in explaining the household car ownership of Millennial households indicates that car ownership of Millennials has high possibility to increase in the future as they age and their economic fortune improve.

I. Introduction

For the last several decades in 20th century, automobile travel experienced a consistent increase. However, recent studies report slower rates of growth or reduction of automobile travel in United States after 2006 (Davis, Dutzik, & Baxandall, 2012; Polzin, Chu & Godfrey, 2014; Puentes, 2012) (see **Figure 1**). Researches reveal that young adults aged between 20 and 39, mainly Millennials, contribute most to this stagnation or reduction of this automobile use (Dutzik, Inglis, & Baxandall, 2014; Polzin, Chu, & Godfrey, 2014) (see **Figure 2**). These researches also indicates that Millennials have different automobile use patterns compared to previous generations did at the same age.

Millennials, or Generation Y are those who were born between 1980 and 2000 and are 15 to 35 years old in 2015. In 2015, the population of them reaches 83 million and represents more than one quarter of the nation's population (Census Bureau, 2015). Meanwhile, Millennials occupy more than one third of American workers today and have surpassed Generation X (those born in the late 1960s to the late 1970s) to become the largest share of the American workforce (Fry, 2015). As mentioned before, their travel behavior already have and will have more remarkable impacts on the travel behavior of the whole society.

Identifying and prioritizing the factors associated with Millennials' travel behavior are of necessity for predicting their travel behavior and providing suggestions for future policy making. Several existing studies have identified the correlated factors, however, only a modest research quantitatively discussed and prioritized them. This paper uses the car ownership of Millennial households (those households mainly composed of Millennials) as an important indicator to research Millennials' travel behavior. The car ownership of Millennial households will be compared with that of young households composed of previous generations at the same age. Descriptive analysis and linear regression model will be applied to identify and prioritize the factors that associate with the decreased car ownership of Millennial households.

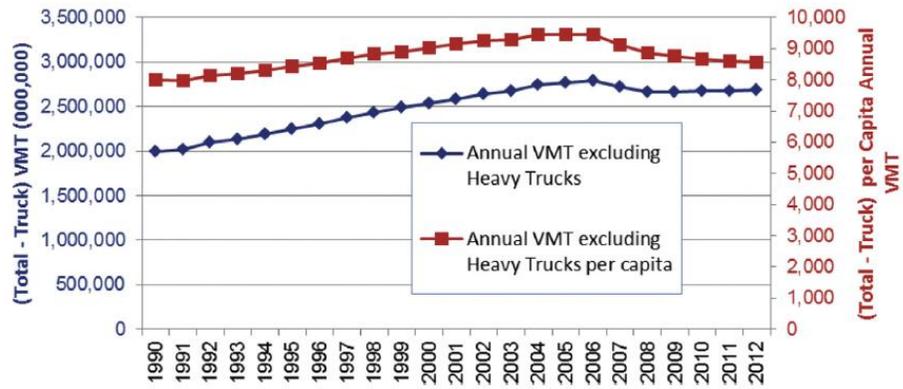


Figure 1 Annual VMT (excluding heavy trucks) and per Capita Trends (Polzin, Chu, & Godfrey, 2014)

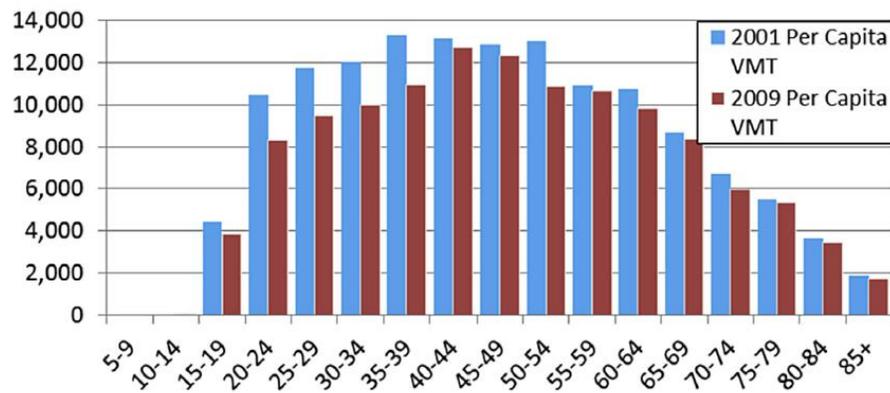


Figure 2 NHTS Person Miles of Travel Change (Polzin, Chu, & Godfrey, 2014)

II. Literature Review

Recent researches, even though limited in numbers, have explored the factors associated with this decreasing car use of young adults, or Millennials. Ten most relevant papers are reviewed here. In these ten papers, five factors are popularly mentioned to explain the unique behavior of the Millennials, including economic factors, alternative travel modes, changes in life stage, explosion of information and communication technology (ICT) use, and built environment or location (see **Table 1**). Other factors mentioned by only one or two researches include race, education, altitude of life style (value), physical exercise, and overall trend of car use.

	Economic factors	Alternative travel modes	Changes in life stage	Explosion of ICT use	Built environment or location
APTA, 2013	√	√	√		√
Blumenberg et al, 2012	√			×	
Delbosc and Currie, 2013	√		√	√	√
Deloitte, 2014	√	√			
Dutzik, Inglis, and Baxandall, 2014	√	√	√		
IFMO, 2013		×	√	√	
McDonald, 2015	√	×	√	√	
MIE, 2014	√	√	√	×	√
Simons et al, 2014	√				√
TransitCenter, 2014		√	√		

Table 1 Factors Associated with the Decreasing Car Use of Young Adults

Note: “√” represents that the research regards it as one possible reason;

“×” represents that the research neglects it as one possible reason.

a. Economic Factors

Among all the eight papers that mention the economic factors as one reason that can cause the Millennials' decreased car use, seven of them strongly suggest tight correlation between economic factors, and one paper, though admits such correlation, casts doubt by presenting the evidence of the diverging trends in economic growth and growth in driving.

Blumenberg et al (2012) reported that “employment status, household income, and other measures of economic status strongly influence all forms of youth and adult travel behavior” after analyzing data from the Nationwide Personal Transportation Survey (NPTS) in 1990 and the National Household Travel Surveys (NHTS) in 2001 and 2009.

Deloitte Touche Tohmatsu Limited (DTTL) fielded a survey in 19 countries with more than 23,000 respondents representing a broad range of cross generational Baby Boomers, Generation X (Gen X), and Generation Y. The report of the survey reveals the three top reasons why Millennials, or Generation Y, don't buy a car are affordability, maintenance costs, and lifestyle needs met by walking / public transit (Deloitte, 2014).

A survey conducted by APTA with 1,000 respondents aged between 22 to 34 years old in six US cities (Boston, MA; Chicago, IL; San Francisco, CA; Seattle, WA; Portland, OR; Washington, DC) shows that the most frequent answers for not using a car or using multiple transportation options to reach a destination are money saving, time saving, and convenience (APTA, 2013).

Delbosc and Currie (2013) explore the travel behavior of young adults via the angle of driving license acquirement. They report a set of causes of the declining in license acquirement including changes in life stage and living arrangements, changes in motoring affordability, location and transport, graduated driver licensing schemes, attitudinal influences and the role of e-communication. Among these causes, they argue life stage factors and affordability influences have stronger links to license decline.

McDonald (2015)'s research paper “*Are Millennials Really the “Go-Nowhere” Generation?*” identifies the decreased travel by American Millennials by adopting descriptive

statistics to profile trends and regression models and using the 1995, 2001, and 2009 National Household Travel Surveys. He concludes that “among young adults, lifestyle-related demographic shifts, including decreased employment, explain 10% to 25% of the decrease in driving; Millennial-specific factors such as changing attitudes and use of virtual mobility (online shopping, social media) explain 35% to 50% of the drop in driving; and the general dampening of travel demand that occurred across all age groups accounts for the remaining 40%.”

Ministry of Infrastructure and the Environment (MIE) (2014)’s report also identifies the economic recession as one of the underlying reason that causes less car use among young adults by arguing that “young people generally find it difficult to own a car in a period of economic recession”.

Simons et al (2014) conduct focus groups with students (mean age of 21±1.1 years) and working young adults (mean age of 23±1.5 years) to investigate the factors that influence transport choice. Among themes of factors, the most important ones are autonomy, travel time, financial cost and vehicle ownership.

Dutzik, Inglis, and Baxandall (2014) admit the significant role of economy in the decline in youth driving, however, they also points out that it is “far from the only cause” by presenting the evidence of the diverging trends in economic growth and growth in driving (see **Figure 3**).

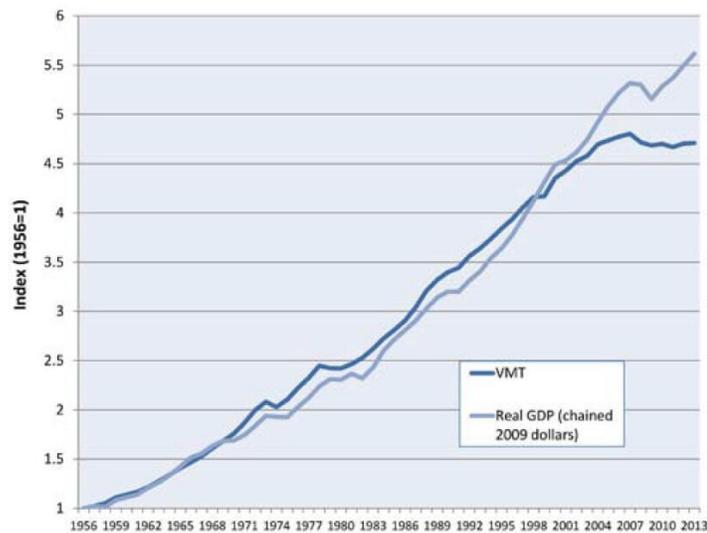


Figure 3 Trends in Growth of Real Gross Domestic Product and Vehicle-Miles Traveled

(Dutzik, Inglis, and Baxandall, 2014)

b. Alternative Travel Modes

Among all the seven papers that discuss the alternative travel modes as or not one reason that can cause the Millennials' decreased car use, five of them strongly support that alternative travel modes can partly explain the decreased car use, and two of them neglect such kind of argument.

When scrutinizing why such kind of disagreement appears, it is noticeable that those five papers which support this argument either focus on the data of one year and compare the travel behavior of Millennial with people at other ages or compare young people in different years without solid data support. The two papers which neglect the assumption that the alternative travel modes partly cause the decreased car use of Millennials both use the national data in 2 or 3 different years. This kind of research method seems plausible and reasonable, however, the result still keeps questionable for alternative travel modes have different impacts on people in different locations. People live in the city may increase their alternative travel modes such as subway, railway, etc., while people live in suburbs may not have such kind of opportunities to use other travel modes other than driving. The overall stable percentage of car use can also be caused by a combination of Millennials who live in the city decreasing their car use and Millennials who live in the suburbs increasing the car use.

The survey conducted by Deloitte Touche Tohmatsu Limited (DTTL) reports that “Millennial consumers are more open to using transportation apps on their smartphones, and are also more open to peer recommendations, compared to other generations” (Deloitte, 2014). This conclusion is evidenced by: 47 percent of the Millennial respondents like using a smartphone app to plan transport; 40 percent of them use car rental services if they were easily available; and 39 percent of them choose to travel by bus, train, or taxi so that they can multi-task.

In the survey conducted by American Public Transportation Association (APTA), the top 5 most preferred modes of transportation responded by young adults aged between 22 to 34 years old are bus, bicycle, rail transit (subway, light rail, street car, or trolley), walking, and driving a

car. Even though the sample number of this research is limited (1,000 young adults in 6 cities throughout US) and the sample selection method is not academically rigorous, this result partly shows the altitude of Millennials on alternative travel modes other than driving a car.

Grimsrud and El-Geneidy (2013, cited by Dutzik, Inglis, and Baxandall in 2014) found that “recent cohorts of young people were more likely to take public transportation than previous generations, even after other factors known to influence transit use are taken into account.”

TransitCenter. (2014)’s research “*Who’s on Board? 2014 Mobility Attitudes Survey*” reports that respondents under 30 are by far the most likely to use transit across all regions, with those over 60 the least likely.

Ministry of Infrastructure and the Environment (MIE) (2014)’s report also considers alternative travel modes as an explanation of the decreasing car use of Millennials and supports this claim by presenting the evidence of “young city dwellers in particular say that they regularly cycle and use public transport in the city”.

However, research conducted by Institute for Mobility Research (ifmo) in 2013 shows that driving kept dominant as the major travel mode for young adults in US during 1993 and 2008 evidence by its overall stable percentage in both the share of trips by mode and the share of mileage by mode for young drivers (age 20–29) (see **Figure 4**).

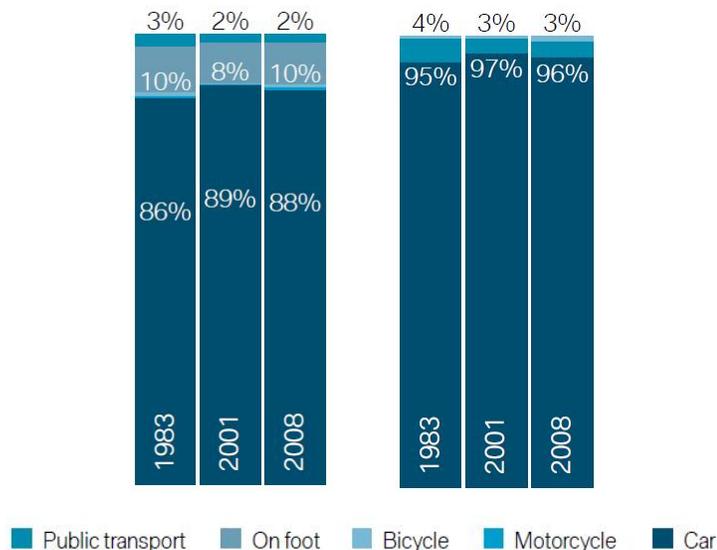


Figure 4 Left: Trends in the share of trips by mode for all young adults (age 20–29)

Right: Trends in share of mileage by mode for young drivers (age 20–29)

McDonald (2015) also neglect the alternative travel modes as a solid reason to explain the decreased car use of Millennials. In his research, he presents the evidence that “average daily transit trips increase very modestly with less than 0.05 trips per day from 1995 to 2009” “for young adults as well as older Americans” to support his conclusion. Meanwhile, McDonald attributes increases in walking to the difference between survey methodology between 1995 and 2001 and does not consider that as a behaviorally significant change.

c. Changes in Life Stage

All the seven papers here strongly support that there are strong correlation between car use and changes in life stage. Life stage here includes age, status of marriage, whether having children, settle down, etc.

Institute for Mobility Research (ifmo) (2013) points out “the increasing prevalence of life situations which do not engender car use” is one of the reason that causes the decreased car use among Millennials. This research supports this argument by providing evidence that overall, the proportion of young people receiving tertiary education is still increasing and corresponding with this development is decreasing workforce participation among young adults and an increase in the age at which people are choosing to start a family.

The survey conducted by American Public Transportation Association (APTA) reports that “Millennials who are parents were more likely to have bought a car, but only slightly more likely to have moved to suburbs than non-parents” (see **Figure 5**) (APTA, 2013).

Delbosc and Currie (2013) regard life stage factors as one of the two most important reasons that can explain the declining driving license acquirement among young adults, which consequently influences the status of car use.

TransitCenter (2014, also cited by Dutzik, Inglis, and Baxandall in 2014) found that “those under age 30 who are parents of school-age children are more likely to take transit than parents

over age 30, even when household income is taken into account”.

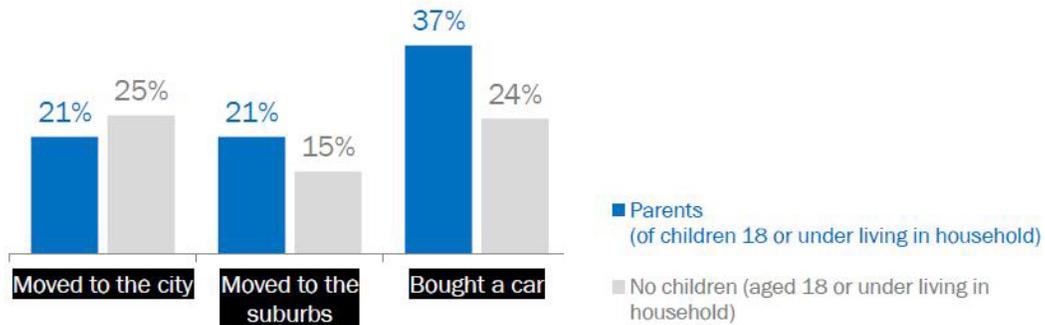


Figure 5 Percentage of Respondents Saying This Occurred within the Past 1-2 years
(Among % Parents & Non-Parents) (APA, 2013)

Ministry of Infrastructure and the Environment (MIE) (2014)’s report attributes car buying to some special events in life such as stepping into the 30–39 age group, settling down, and the birth of a child. Vice versa, this report indicates the reason of less car use is that Millennials have not stepped or have delayed to step into certain life stage.

McDonald (2015)’s quantitative research also reveals that “age” and “presence of own children”, which are important indicators of life stage, are variables that impacts the travel behavior of young adults.

TransitCenter. (2014)’s report “*Who's on Board? 2014 Mobility Attitudes Survey*” concludes that Feelings about public transportation and urbanism vary much more by age than they do by region, with respondents under 30 the most enthusiastic about transit and the most likely to ride it. This finding indicates that when Millennials step into beyond 30 years old, they might decrease transit use and consequently increase car use.

d. Explosion of Information and Communication Technology (ICT) Use

Among all the five papers that discuss the ICT use as or not one reason that can cause the Millennials' decreased car use, three of them strongly support that ICT use can partly explain the decreased car use, while two of them neglect such kind of argument, claiming that ICT use is positively related with car use, meaning the more ICT use, the more car use. However, all these argument have no solid evidence to support. Considering the short time that ICT has stepped into people's life and the difficulty to investigate and measure ICT use, such kind of vagueness is still understandable.

Institute for Mobility Research (ifmo, 2013) regards ICT use as one of the factors associated with the decreased car use. Though direct evidence of this identification remains scarce, the author believes that “with regard to the trends described in this study, the impact of such devices is negligible”.

Delbosc and Currie (2013) also contribute the role of e-communication to the declining in license acquirement of young adults, which also links to the declining car use of the Millennials.

McDonald (2015) considers Millennial-specific factors such as changing attitudes and use of virtual mobility (online shopping, social media) as one of the factors associated with the declined car use. Even though frequent and wide range of ICT use is not the only characteristics of “Millennial-specific factors”, it does represent part of the Millennial's lifestyle.

While Blumenberg et al (2012) report an interesting relationship between ICT use and travel behavior of young adults. They claim that “information and communications technology use is measured as daily web use and, when significant, tends to be associated with more travel, and not less” (Blumenberg et al, 2012). However, this research doesn't reveal the correlation between ICT use and car use.

Ministry of Infrastructure and the Environment (MIE) (2014)'s report also presents the similar argument that intensive use of social media is not thought to result in less mobility evidenced by the fact that “young people in particular say that they see their friends and

acquaintances more because of social media”.

e. Built Environment or Location

All the four papers here support that there are correlation between car use and built environment or location. Built environment or location here includes whether in the city or not, accessibility to public transit modes, convenience to the destination by alternative travel modes.

The survey conducted by American Public Transportation Association (APTA), as mentioned in the previous “change in life stage” part, reports that families who have no children and moved into the city in the last 1-2 years seems have higher possibility to buy a car than those families who have no children and moved to the suburbs. While for families who have children 18 or under, moving to the city or to the suburb doesn’t change their household car ownership (see **Figure 5**).

The element of location, even though not regarded as one of the major reasons, is mentioned by Delbosc and Currie (2013) to explain the declining in license acquirement of young adults, which also links to the declining car use of the Millennials.

Ministry of Infrastructure and the Environment (MIE) (2014)’s report also claims that “a considerable proportion of the studying young adults live in urban areas, where alternatives to the car are readily available, leading to greater use of public transport and bicycles”.

Simons et al (2014) report that though not the most important factors influencing travel modes, environment will still have an impact on that.

f. Limitations on Existing Researches

Researches on exploring the underlying reasons of the declined car use of the Millennials are still limited in number, evidenced by that the ten articles reviewed before are the majority of the related papers. Meanwhile, researches on prioritizing these underlying reason in a quantitative way are scarce. Merely pointing out the most important reasons are not enough, but only prioritizing these underlying reasons can provide clear clues to predict the travel behavior of

this generation in the future and consequently to provide better suggestions for policy making.

III. Descriptive analysis

a. Research Purpose

The literature review identifies a series of factors probably associated with the unique travel behavior of Millennials. The descriptive analysis uses household car ownership and respondents' commuting mode as indicators of travel behavior to narrow down these factors. This section of research also sets foundation for identifying specific variables in the further regression model.

b. Sample Selection

Even though people are classified into different generations and the term “gap” is always used to describe the difference between different generations, the real difference between people in different generations, especially in two adjacent generations, is not discontinuous. For instance, late Generation X are more similar to early Millennials than early Generation X do. Thus, a database that records people's travel behavior every year or every several years in decades of years is the best option to explore the underlying reasons behind the travel behaviors.

The data of travel surveys in the central Puget Sound region are selected as the research database. They have data collect by Puget Sound Regional Council in 1989, 1990, 1992, 1994, 1996, 1997, 1999, 2000, 2002, 2006, and 2014. These travel surveys include both household and personal data. The surveys conducted in 1989, 1990, 1992, 1994, 1996, 1997, 1999, 2000, and 2002 adopted the same questionnaire. The surveys in 2006 and 2014 adopted similar questionnaires as previous surveys. The sample selection methods and the scale of sample pool of them are also close to each other.

Here it is necessary to explain why the national data or data from other metropolitan areas are not adopted. The data of national travel surveys are collected in different ways. National Household Travel Surveys (NHTS) were conducted in 2001 and 2009. National Personal Travel Surveys (NHPS) were conducted in 1983, 1990, 1995. The means of these two set of surveys differ significantly and they do not share many variables of data in common. Meanwhile, they

lack the newest data. The latest survey was conducted in 2009 and the data of NHTS 2015 are to be released late next year. Thus, the data of national travel surveys are not suitable for this research. Concerning the data of other metropolitan areas, Seattle Metropolitan Area has the most travel survey data compared to other metropolitan areas (Metropolitan Travel Survey Archive, n.d.).

c. Findings of Descriptive analysis

1) Changes overtime affecting all age groups, especially younger groups

First, it needs to be clarified that older households and younger households are classified by the age of the eldest labor force in one household. Here, people who are younger than 18 years old or older than 65 years old are not regarded as labors. For instance, a household composed of 4 people whose ages are 4, 25, 30, and 70 is defined as a family at age 30.

Comparison based on this classification shows that the number of vehicles per household decreased remarkably after 2002, especially for young households whose eldest labors are between 18-34 years old (see **Figure 6**). When scrutinizing the change of different types of families, the number of vehicles per household of younger households (18-34) reduces more significantly than that of other families (see **Table 2**). These two patterns are also found in one-person households (see **Figure 7** and **Table 3**).

Other than the fewer and more significantly reduced number of vehicles per household of younger households, the lower percentage of driving to commute among younger adults also reveals the fact that younger group contributes more to the reduced car ownership and car use than over age groups (see **Figure 8**). **Figure 8** shows that in each survey year after 1994, the percentage of younger adults aged 18-34 choosing driving as major commuting mode is slightly lower than that of other age groups. After 2002, the percentage of person of all age groups choosing driving as major commuting mode is reducing. While the percentage of younger adults aged 18-34 choosing to not drive to commute reduced more remarkably. In 2014, the difference between percentage of younger adults aged 18-34 and that of others driving to commute is even

more significant than that of the previous survey years.

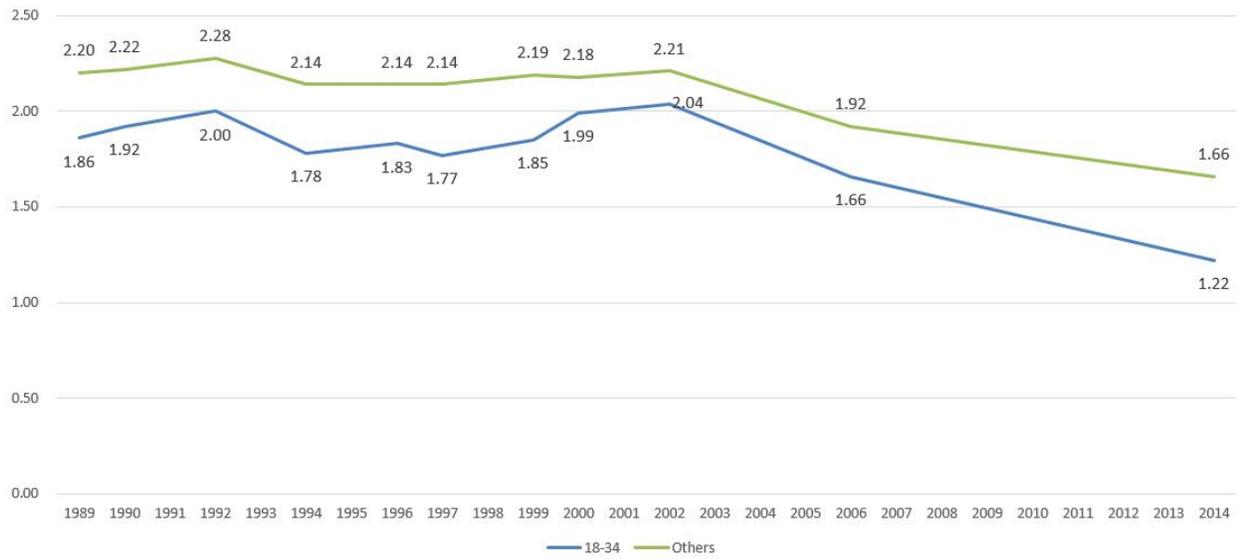


Figure 6 Number of Vehicles per Household of Households in Different Ages

	2002	2006	2014
Age 18-34	2.04	1.66	1.22
		-18.6%	-26.5%
Others	2.21	1.92	1.66
		-13.1%	-13.5%

Table 2 Number of Vehicles per Household of Households in 2002, 2006, and 2014

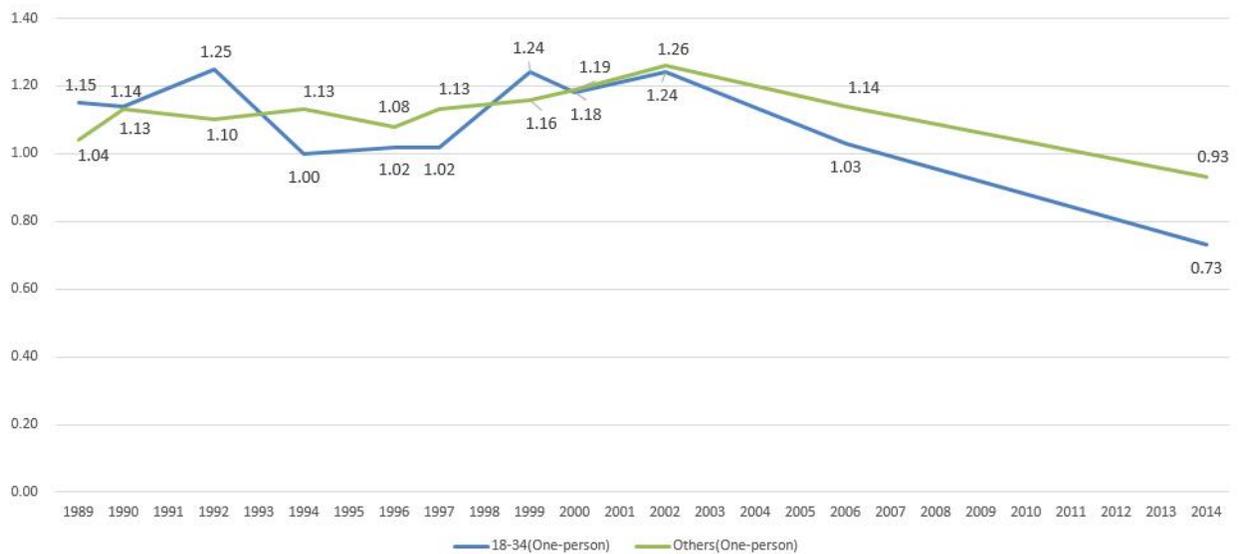


Figure 7 Number of Vehicles per Household of One-person Households in Different Ages

	2002	2006	2014
Age 18-34	1.24	1.03	0.73
		-16.9%	-29.1%
Others	1.26	1.14	0.93
		-9.5%	-18.4%

Table 3 Number of Vehicles per Household of One-person Households in 2002, 2006, and 2014

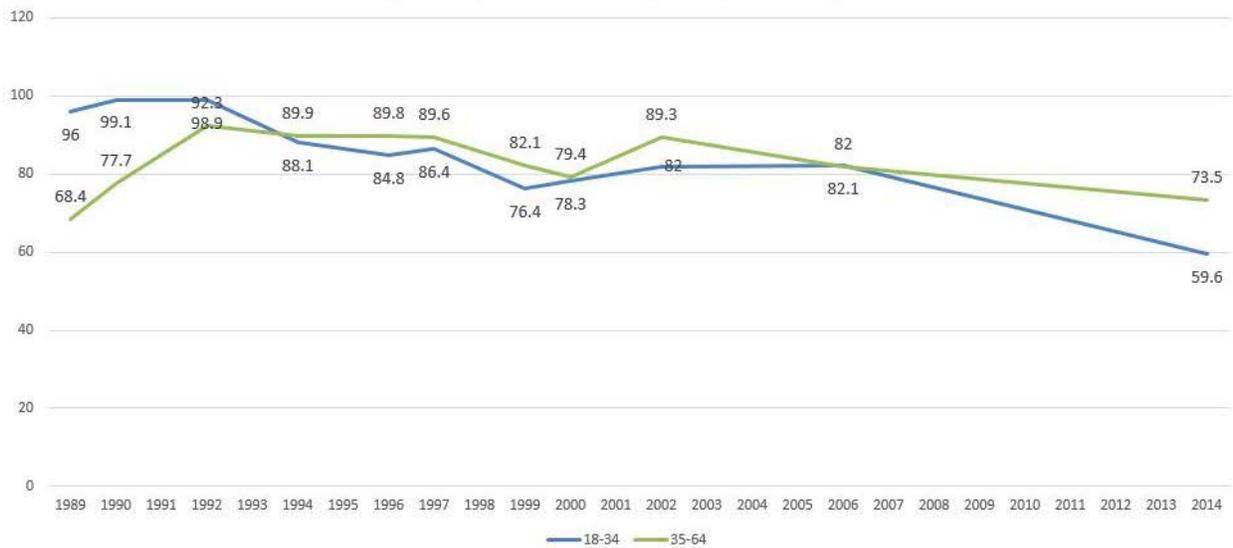


Figure 8 Percentage of Person in Different Ages Choosing Driving as Major Commuting Mode

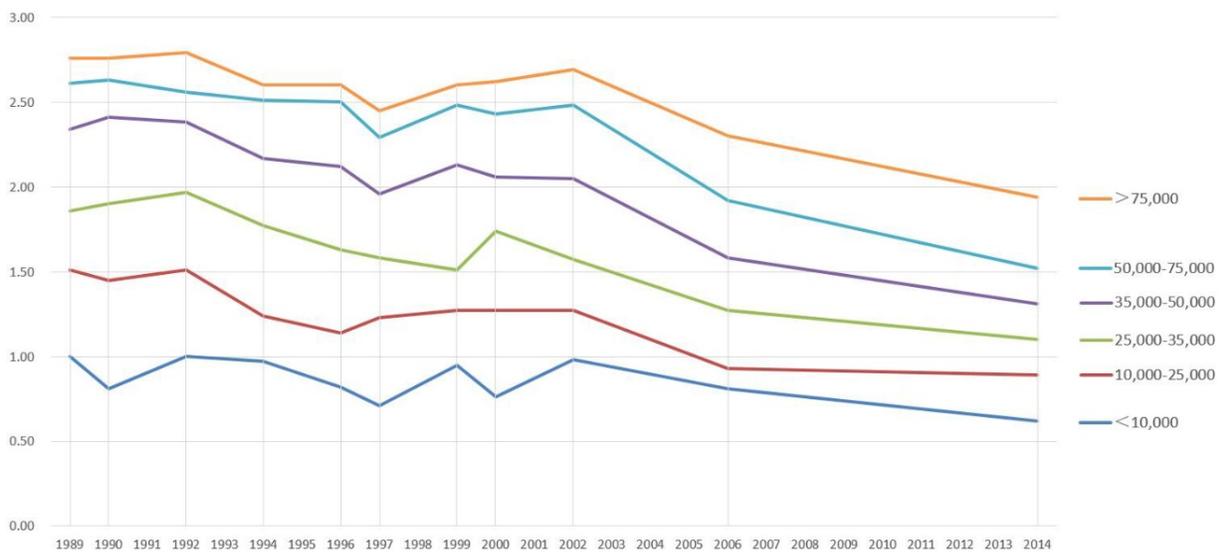


Figure 9 Number of Vehicles per Household of Households in Different Income Groups

2) Economic factors

Generally speaking, families of higher income own more cars than families of lower income. Data analysis shows that in each survey year between 1989 and 2014, average household vehicles of higher-income households is more than that of lower-income households (see **Figure 9**). This clear interrelation indicates income does affect the household car ownership. In addition, after 2002, average household vehicles of all households in different income groups decreased.

3) Changes in life stage

The birth of kids and school enrollment of kids are two strong incentives for households to buy new vehicles. Households with school age kids averagely own more cars than those with pre-school kids. In addition, households with kids averagely own more vehicles than young households (two or more adults, under 35) with no kids (see **Figure 10**). This indicates that changes in life stages affect household vehicle ownership. The birth of kids and school enrollment of kids are two strong incentives for households to buy new vehicles.

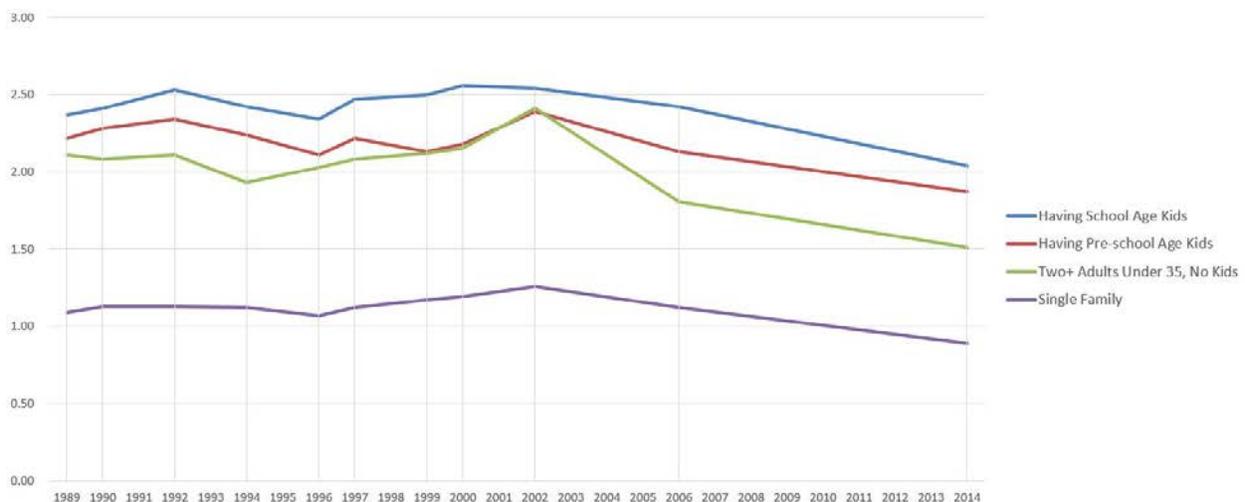


Figure 10 Number of Vehicles per Household of Households in Different Life Stages

Changes in life stages also influence choices in commuting modes. In each survey year, people who have kids, especially school age kids, are more likely to drive to commute compared to single young adults with no kid (see **Figure 11**). Meanwhile, recently between 2006 and 2014, percentage of person choosing driving as main commuting mode kept stable. However, the percentage of young adults with no kid who mainly drive to and from work has significantly decreased during this period of time. This indicates that the groups of young one-person households and young households with no kid contributed most to the reduced car use of the whole society, at least in Seattle Metropolitan Area.

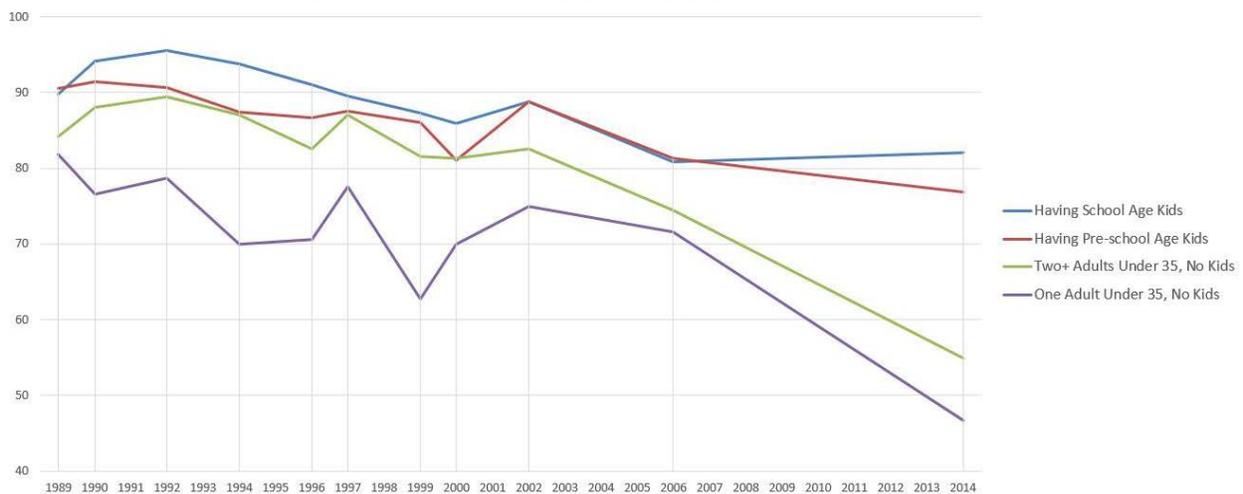


Figure 11 Percentage of Person in Different Life Stages Mainly Driving to Commute

4) Location: Data analysis reveals the negative correlation between the density of the location which the family is located at and number of household vehicles.

Data analysis shows that in each survey year between 1989 and 2014, average household vehicles in areas of higher density is more than that of lower density areas (see **Figure 12**). For families in low-density areas, average household vehicles increased between 1989 and 2002. After 2002, average household vehicles in low-density areas sloped down to a similar level as 1989. Overall, number of average household vehicles in low-density areas is over 2.30 vehicle per household during all the survey years.

For households in median- and low-density areas, average household vehicles kept almost stable between 1989 and 2002. After 2002, average household vehicles in median- and low-density areas both decreased. In addition, average household vehicles in low-density areas decreased more significantly than average household vehicles in high- and median-density areas.

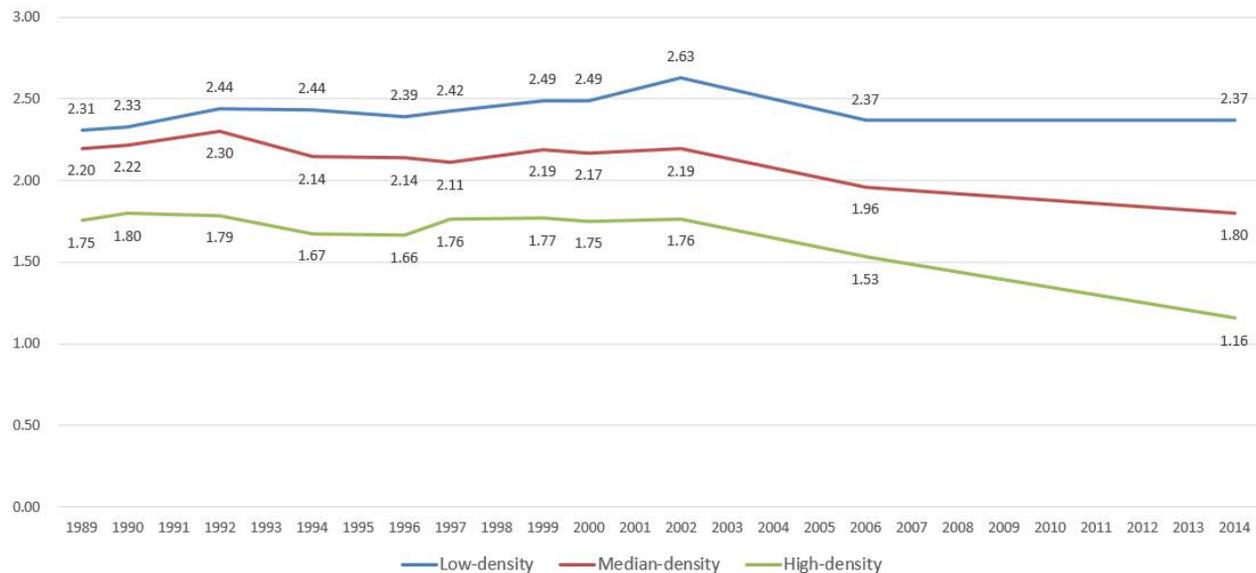


Figure 12 Number of Vehicles per Household in Areas of Different Density

Percentage of person in areas of different density choosing driving as main commuting mode has the similar trend. Percentage of person in low- and median-density areas mainly drive to and from work decreased during 2002 and 2006 (see **Figure 13**). It rebound slightly during 2014 and 2006. While the percentage of person in high-density areas using personal vehicle to commute decreased continuously and significantly during 2002 and 2014. This indicates the reduced car use of people in high-density areas contribute most to the reduced car use of the whole society, at least in Seattle Metropolitan Area.

The density of areas is identified by compactness indices data in *Measuring Urban Sprawl and Validating Sprawl Measures* (Ewing and Hamidi, 2013). High-density areas are areas with compactness indices between 116 and 160. Median-density areas are areas with compactness indices between 75 and 116. Low-density areas are areas with compactness indices between 30 and 75.

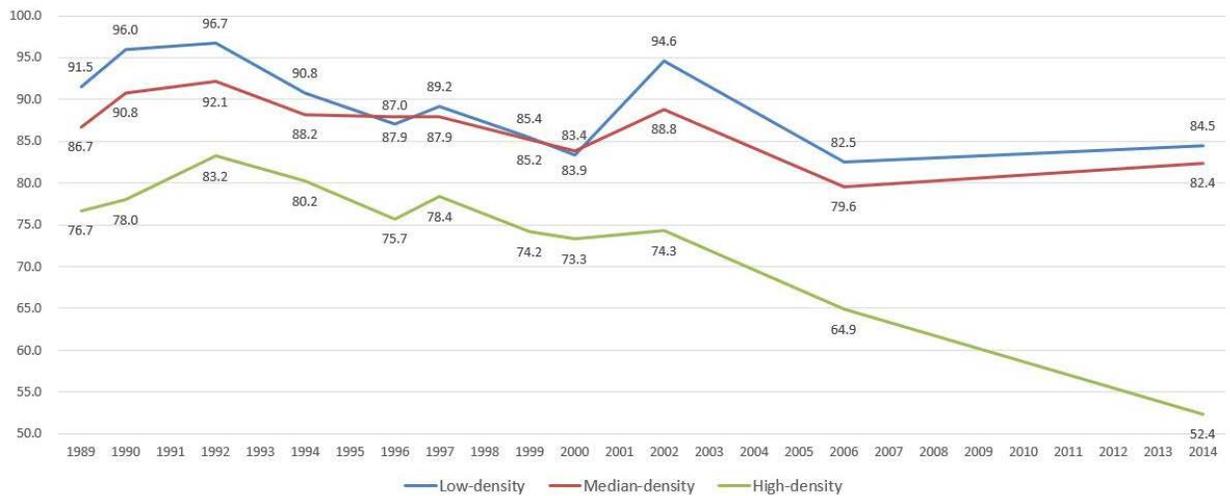


Figure 13 Percentage of Person in Areas of Different Density Mainly Driving to Commute

IV. Regression Model

a. Research Purpose

The descriptive analysis has narrowed down the range of factors that associated with Millennials' unique travel behavior to five categories: the general drop of car use occurring across all households, Millennial-specific factors, economic factors, changes in life stages, and location. On the basis of this, the regression model further explores the relationships between household car ownership and these factors and prioritize these factors by their influence.

b. Data and Methods

Sample Size. The regression model uses the same data base as the descriptive analysis. The difference is that the sample size for regression models is smaller because the households can only be included if there is no missing data for all variables included in the model.

Variables.

1) Changes in life stages: As used in descriptive analysis, the age of the eldest labor force in one household, named "household age" in this research, is used as one indicator of the life stages the households are at. Three age groups including "18-24", "25-34", and "35+" are introduced as dummy variable here. Other indicators of changes in life stages in the model include number of adults and number of children. For households which have two or more children, data analysis shows different correlation between number of children and number of household-owned vehicles compared to that of one-child households. Thus, two variables indicating number of children are used here. One for one-child households, and the other for those households with two or more children.

2) Income: Inflation adjusted household income is used at first. This variable works well for households with no child or only one child. But for households with two or more children, apparently the cost on raising children would influence the amount of money parents can use to buy vehicles. Thus, a new variable of "income \times number of adult/number of all members" (also inflation adjusted) is introduced here. The trial run of the regression model shows that this variable can better predict the household car ownership than the total income of the household. This is also strong evidence that changes in life stages and income of household are two correlated variables. Thus, the variable of "income \times number of adult/number of all members" replaces the original "inflation adjusted household income" as the indicator of household income. Meanwhile, the category of "changes in life stages" and "income" are combined into one new category "changes in life stages & income".

3) Location: As in the descriptive analysis, compactness indices in *Measuring Urban Sprawl and Validating Sprawl Measures* (Ewing and Hamidi, 2013) is applied as indicators of location. In the trial run of the regression model, the variables of “the county the household locates in” and “the city the household locates in” are also tried to be introduced into the regression model. The result shows that the introduction of these two variables cannot better predict the household car ownership.

4) Changes over time affecting all age groups: the dummy variable of the survey year is used as indicator of changes over time affecting all age groups. Meanwhile, all the interaction variables in the categories of “year-life stages & income” and “year-location” are tested for their capability to improve the prediction of the model. The result turns out that the interaction variables of only two years, 2006 and 2014, and other variables can enhance the preciseness of the regression model. In addition, the variable of “number of kids” and “number of employed adults” show no correlation with the survey year.

5) Millennial-specific factors: the interaction variable of year-age is used as indicator of the influence caused by changes over time affecting young generations. The result of trial run of the regression model shows that only the interaction variables of 2006-age and 2014-age can improve the preciseness of the regression model. This result confirms the previous analysis that Millennials have their unique travel behavior.

Evaluating the regression model. The results of the regression model is presented in **Table 4**. Model R^2 value (0.412) is acceptable. Meanwhile, omnibus tests show that most independent variables in the model explain significant variation ($p < 0.05$) in measure of the number of vehicles in the household and are therefore useful in exploring and prioritizing the factors associated with household car ownership.

Table 4 Regression models for household car ownership

		Coeff	Std error	p value
Life stages & Income	Age, years			
	18-24	-0.068	0.07	0.326
	25-34	-0.164	0.028	<0.001
	35+	[ref]		
	Number of adults	0.652	0.015	<0.001
	Number of kid (one-kid households)	0.159	0.022	<0.001
	Number of kids (for households having more than 1 kid)	0.112	0.009	<0.001
	Number of employed adults	0.165	0.009	<0.001
	Household income × number of adult/number of all members	0.386	0.021	<0.001
Location	Compactness Indices	-0.748	0.041	<0.001
Changes over time affecting all age groups	Survey year			
	1989	-0.039	0.036	0.288
	1990	0.052	0.038	0.168
	1992	0.063	0.037	0.09
	1994	-0.031	0.036	0.391
	1996	-0.077	0.036	0.391
	1997	-0.043	0.034	0.209
	1999	-0.106	0.034	0.002
	2000	-0.054	0.031	0.084
	2002	[ref]		
	2006	0.183	0.094	0.050
	2014	0.570	0.087	<0.001
	Year×Life stages & Income			
	2006×Number of adult	-0.045	0.027	0.096
	2014×Number of adult	-0.130	0.024	<0.001
	2006×Household income × number of adult/number of all members	-0.086	0.03	0.004
2014×Household income × number of adult/number of all members	-0.101	0.025	<0.001	
Year×Location				
2006×Compactness Indices	-0.156	0.069	0.024	
2014×Compactness Indices	-0.497	0.062	<0.001	
Millennial-specific factors	Year×Age			
	2006×18-24	-0.429	0.177	0.016
	2006×25-34	-0.039	0.060	0.516
	2014×18-24	-0.250	0.103	0.015
	2014×25-34	-0.074	0.041	0.073
Adjust R ²			0.412	

[ref] = reference category.

c. Model Results

1) Underlying reasons of the difference in household car ownership of young households in 2002 and 2014

For young adults between 2002 and 2014, life stages (size of household, status of marriage, having children or not, number of children, etc.) and income (number of employment, inflation adjusted income, etc.), explain 30% to 35% of the decrease in household car ownership; changes in location explain 15% to 20% of the dampening in household car ownership; the general drop of household car ownership occurring across all age groups (consuming habits, changes over year affect different areas, etc.) explains 30% to 40%; changes over year affecting young adults, or Millennial-specific factors, such as changing attitudes, account for the remaining 10% to 20% (see **Table 4** and **Figure 14**).

Table 4 Predicted household car ownership by age group and decomposition of the underlying reasons by age group and source (2002-2014)

Age, years	2002	2014	Total decrease in average number of household-owned cars	Changes in life stages & Income		Change over time affecting all age groups	Change over time affecting younger generations
				Income	Location		
18-24	2.083	0.972	-1.111 100%	-0.370 33.3%	-0.164 14.8%	-0.327 29.4%	-0.25 22.5%
25-34	2.049	1.246	-0.803 100%	-0.232 28.9%	-0.158 19.7%	-0.339 42.2%	-0.074 9.2%
35+	2.156	1.629	0.527 100%	-0.140 26.6%	-0.099 18.8%	-0.289 54.8%	— —

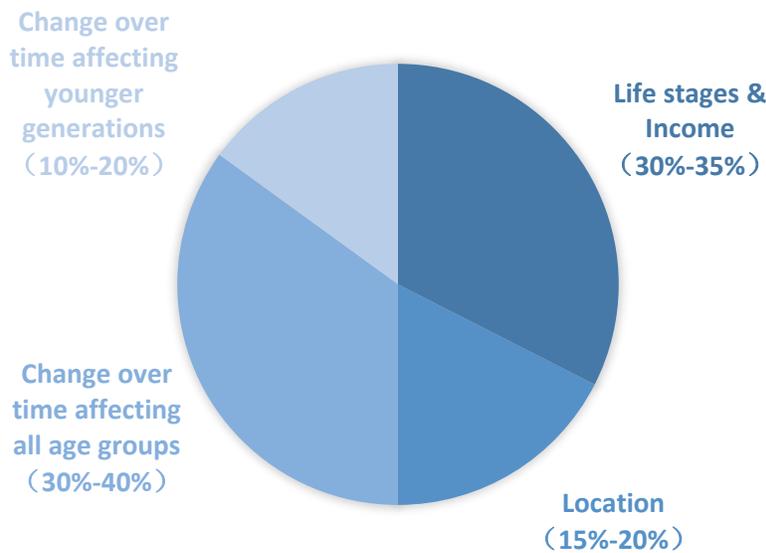


Figure 14 Decomposition of the underlying reasons of decreased household car ownership among young households by source (2002-2014)

2) Underlying reasons of the difference in household car ownership of young households in 1989 and 2002

For young adults between 1989 and 2002, life stages (size of household, status of marriage, having children or not, number of children, etc.) and income (number of employment, inflation adjusted income, etc.), explain 55% to 80% of the increase in household car ownership; changes in location explain 10% to 30% of the increase in household car ownership; the general increase of household car ownership that occurred across and affected all age groups (consuming habits, changes over year affect different areas, etc.) account for the remaining 10% to 20% (see **Table 5** and **Figure 15**).

Table 5 Predicted household car ownership by age group and decomposition of the underlying reasons by age group and source (1989-2002)

Age, years	1989	2002	Total decrease in average number of household-owned cars	Changes in life stages & Income		Change over time affecting all age groups
				Income	Location	
18-24	1.678	2.083	0.405	0.324	0.041	0.039
				100%	80.0%	10.1%
25-34	1.781	2.049	0.268	0.152	0.077	0.039
				100%	56.7%	28.7%
35+	2.108	2.156	0.048	-0.035	0.045	0.039
				100%	-72.9%	93.8%

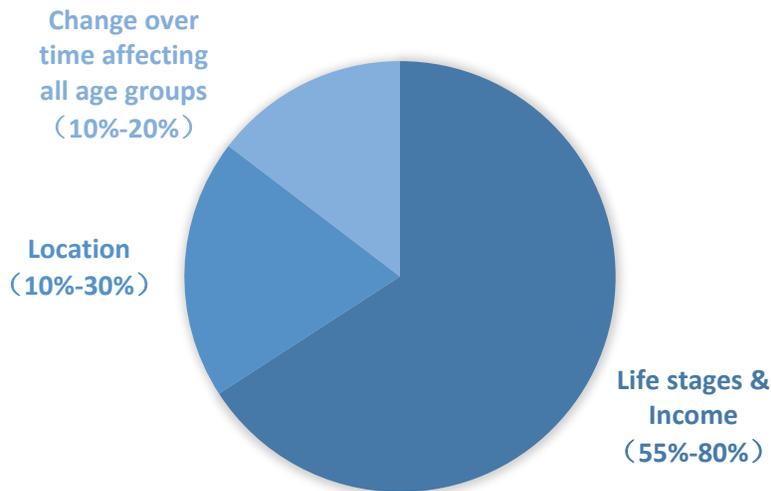


Figure 15 Decomposition of the underlying reasons of increased household car ownership among young households by source (1989-2002)

3) Underlying reasons of the difference in household car ownership between young households and other households in 2014

In 2014, the difference of average number of household-owned vehicles between young households and other households can be explained as: life stages (size of household, status of marriage, having children or not, number of children, etc.) and income (number of employment, inflation adjusted income, etc.), explain 30% to 40% of the difference in household car ownership; changes in location explain 30% to 40% of this difference; changes over time affecting younger generations account for the remaining 20% to 40% (see **Table 6** and **Figure 16**).

Table 6 Predicted household car ownership by age group and decomposition of the underlying reasons by age group and source (1989-2002)

Age group	Reference age group	Total difference in average number of household-owned cars	Changes in life stages & Income		Change over time affecting younger generations
			Location		
18-24	35+	-0.657	-0.185	-0.222	-0.25
		100%	28.2%	33.8%	38.0%
25-34	35+	-0.383	-0.145	-0.164	-0.074
		100%	37.8%	42.8%	19.3%

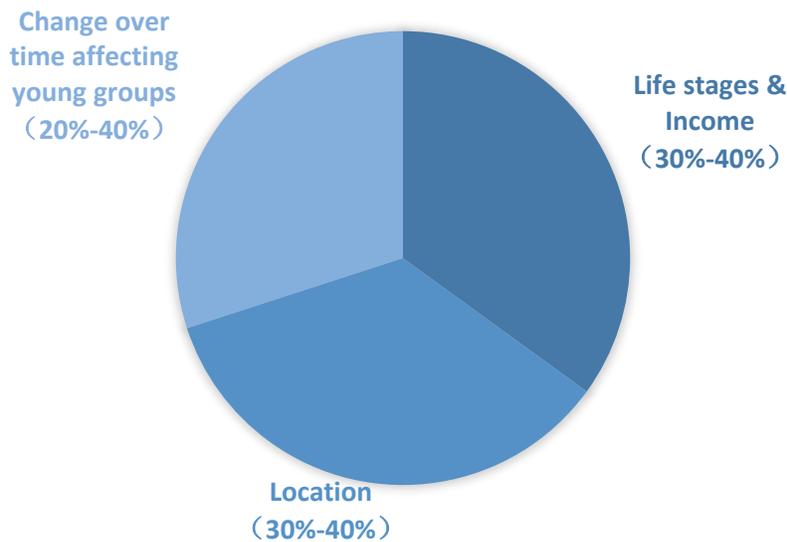


Figure 16 Decomposition of the underlying reasons of the difference of average number of household-owned vehicles between young households and other households by source (2014)

V. Summary and Implications

Millennials exhibit lower levels of automobile use than do previous generations at the same age evidenced by less household car ownership and lower proportion of people driving to commute. Previous researches present five main factors to explain the unique behavior of the Millennials, including economic factors, alternative travel modes, life stages, explosion of ICT use, and built environment or location. This research, via the linear regression model, reveals that for Millennials in 2014, compared to young adults in 2002, life stages and income explain 1/3 of the decrease in household car ownership; changes over time affecting all age groups also explain 1/3 of the dampening in household car ownership; location can explain around 1/6 of the decrease; while change over time affecting younger generations, here Millennial-specific factors can only explain the rest 1/6.

This result provide an important implication for planners and policymakers. Millennials are not such unique as reported for the regression model exhibit Millennial-specific factors only account 1/6 of their decreased car ownership. Even though car ownership of Millennial households is lower than other households, it is likely to increase as Millennials age and their economic fortunes improve, in line with the recovery of the economy of the whole society. The new mobility caused by this probable increase in car ownership needs to be managed by planners and policymakers, at least in the central Puget Sound region.

However, it is a pity that the central Puget Sound region is the only metropolitan area in U.S. that kept a consistent long-range travel survey in the recent three decades. Therefore, the conclusion of this research is limited in the central Puget Sound region. When the author is conducting this research, the 2015-2016 National Household Travel Survey (NHTS) is still undertaken. Whence it is finished, combined with the data from the 1990 and 1995 National Personal Transportation Surveys (NPTS) and 2001 NHTS, the patterns of Millennial's unique travel behavior and those associated factors can be thoroughly explored using the research method applied in this paper.

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