Residential Location Choice and Travel Behavior of Young adults:

Coming-to-the-city and Multimodality

by

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THESIS

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SUMMARY

Young adults (Millennials or Generation Y) are generally defined as people who were born between the early 1980s and the early 2000s. They have received increasing attention since the late 2000s due to their different residential choice and travel behavior when compared to prior generations and older cohorts. Young adults drove fewer miles, owned fewer cars, used non-automobile modes at a higher rate (public transit, walk, or bicycle modes), and acquired a driver's license at an older age as compared to prior generations. These travel behavior changes occurred primarily among young adults but not among older age groups in the same period. Further, young adults showed a higher preference for living in cities as compared to older cohorts and previous similarly aged cohorts. A higher proportion of young adults lived in central areas in cities in the 2010s than the 2000s and as compared to other age groups in the same period.

This dissertation examines these two choice behaviors of young adults —their residential choice and travel behavior. This dissertation started from my interest in the question of whether young adults' preference for cities influenced their travel behavior. Given that some travel behavior is influenced by the built environment, it is possible that the urban built environment where people chose to live influenced their travel behavior. But it is also possible that young people's mobility attitudes are different independent of the area they live in. Additionally, the differences within the young cohort has received little attention. There is also some disagreement in the research whether young people prefer cities or suburbs, with different researchers taking opposing view

points. In places showing growth, it is also not clear which particular attributes attract young adults to cities.

In order to inform these gaps in the literature, I tackle the question of young adults location choice and travel behavior in three parts. The first research examines residential location changes of young adults and older adults in the most populous 50 U.S. cities after computing city level and census tract level net migration rates between 2000 and 2010, and between 2010 and 2017. The use of net-migration rates allows me to exclude changes to the cohort that occur as a result of aging-into or aging-out-of the cohort over the period of analysis and to focus on changes due to location decisions (migration between places). This research shows clear evidence of young adult in-migration into cities between 2000-2010 and 2010-2017, with the latter period having higher rates of in-migration on average across the 50 cities. I then build two statistical models: the first seeks to examine what attributes of cities makes them more or less attractive then average to young or old adults. The second examines the location preference of young adults using census tract level data to investigate which attributes of places make them attractive to young adults. This work primarily uses Census and American Community Survey data. This research is presented in Chapter 3.

The second research examines differences in residential location choice within young adults. The research also examines how residential decisions of young adults contrasted with those a decade earlier and against older adults in the same period. Though young adults have some shared experiences such as the recession and the technological changes experienced in the 2000s, they are also ethnically and racially diverse and come from a broad range of socio-demographic backgrounds.

Their tastes in travel behavior and residential choices are also likely to vary greatly. The hypothesis in this research is that there is diversity in location preference among young adults based on their lifecycle and socio-demographic characteristics. For this analysis, longitudinal data from the Panel Study of Income Dynamics (PSID) is used to track location changes and household changes through several years. A principal component analysis is also employed to classify locations and to capture neighborhood characteristics. I then build a multinomial logit model to examine the differences within young adults in regards to location choice and how these vary with the characteristics of the decision makers. The research also examines where a clear cohort effect is visible beyond what can be explained by socio-demographic variables. It highlights for example, that the 2011 cohort of young adults was more likely to choose denser areas with more rental housing, and is closer to downtown as compared to the2001 cohort. This research is presented in Chapter 4.

Last, I examine the relationship between location choice and travel behavior in a more localized setting using data from the Seattle metropolitan area. The research focuses on young adults decision regarding location choice, vehicle ownership, multi-modality, and person miles traveled (PMT) and the interdependence between these variables. It examines how much of the travel behavior changes are due to changes in tastes and to what extent more long term decisions such as location choice and auto-ownership influence short term travel behavior. The research proposes a structural relationship between these four variables where individual variables affect long term decisions of residence and vehicle ownership, and where these, along with socio-demographic variables, in turn influence day-to-day decisions of mode use and person miles travelled. The model is estimated us-

ing the Puget Sound Household Travel survey data from 2006 and 2017. Findings from the model suggest, among others, that young adults showed a preference to living closer to the city and some of the travel behavior shifts were a result of this preference. This analysis is covered in Chapter 5.

The dissertation examines the behavior of adults using several data sources that provide different level of detail and insights into the decisions the cohort made. These sources includes the data products from the census, the Panel Study of Income Dynamics, and the Puget Sound Household Travel survey. The analysis on all of these datasets, collected on different people at different geographic scales and periods, support the finding that the millennial cohort preferred to live in cities at a higher rate and had a higher preference to locate in areas closer to downtown than the prior young generation. The main findings from the dissertation can be summarized as follows:

i) Young adults have come to U.S. cities since 2000 and at higher rate since 2010, while older age groups have left cities in the same period.

ii) There are important city level and neighborhood/census-tract level factors that influence the choices of young adults. The results show employment rate, urban jobs, especially high-income jobs and poverty help explain the migration pattern across the largest cities among young adults. They also show that urban jobs, transportation, distance, density, and retail and recreation jobs used as a proxy for urban amenities are important factors in the location choice within cities.

iii) There is also a diversity in residential location preference within the young adult cohort that depends on their lifecycle stage and socio-demographic characteristics. For instance, highly educated young adults prefer less auto-dependent areas while high income young adults shows high preference in automobile friendly areas.

iv) A time-period difference is also detected that suggests a systematic change in attitudes among millennials more than can be explained by socio-demographic variables: young adults in 2011 (millennials) were more likely to choose areas with more rental housing, are denser and contain higher proportion of well educated people than the young cohort in 2001.

v) There are complex relationships between being a young adult, location choice, and travel behavior. For example, at least in the case of the Puget Sound data, I find that cohort membership influences being close to downtown and auto ownership, however, it has no direct effects on mode choice and PMT. Its effects are only indirect through the residential location and auto ownership decisions. Living close to the city on the other hand has both a direct effect on travel behavior and an indirect one through vehicle ownership decisions.

This dissertation does not simulate young adults' future choice but the findings can provide meaningful points about what their future choices may look like. The first research using net migration shows that young adults are continuing to come to cities in the 2010s. However, despite the 'coming-to-the-city' movement of young adults, the second research points out that members of the young cohort with children prefer living in less dense areas and farther from downtown. It

suggests that as young adults enter another lifecycle stage and start having children, more of them would move into the periphery of cities or into suburbs. In addition, the third research suggests that the travel behavior changes observed among young adults comes not from a general shift in the age cohort but from their residential location decisions. That is, living closer to downtown is a direct cause of the travel behavior shifts, rather than attitude change about mode use. Taken together, it is highly possible that young adults will move into suburbs and consequently, own more cars and drive more just like prior generations as they age, form families and start having children.

CHAPTER 1

INTRODUCTION

Young adults (Millennials or Generation Y) are generally defined as people who were born between the early 1980s and the early 2000s. They have received increasing attention since the late 2000s due to their different residential choice and travel behavior when compared to prior generations and older cohorts in the same period. One of the primary changes among young adults is travel behavior as represented by a decline of vehicle miles traveled (VMT). Studies examining their travel behavior say that young adults drove fewer miles, owned fewer cars, used non-automobile modes more, and acquired a driver's license at an older ages when compared to the prior generation [1–7]. Importantly, these travel behavior changes occurred primarily among young adults but not among older age groups in the same period [2, 5, 7, 8].

Another noticeable change among young adults is their increasing preference to live in cities as compared to older cohorts and previous similarly aged cohorts. After the Second World War, suburbanization occurred in the U.S. as incomes increased, better highway access was provided, and more jobs located in the suburbs [9, 10]. As a result, more than half of the Americans lived in suburbs by the 2000s, especially after getting married and childbirth [10, 11]. Around the late of the 2000s, some studies, however, found that young adults moved to suburbs at lower rates than the prior generations and other age groups and showed a preference to staying at or moving into

central cities [1, 12, 13]. These studies said that a higher proportion of young adults lived in central areas of cities in the 2010s than both the 2000s and as compared to other age groups.

This dissertation examines these two emerging choice behavior of young adults —their residential choice and their travel behavior. Though many studies on young adults have analyzed their choice behavior, there are still some unanswered questions. For example, there are opposing view points on whether young adults are really coming back to the city in the literature. The differences within the young cohort are also not explored sufficiently. Finally, the interdependence between location choice and travel behavior could be explored more fully.

I tackle the question of young adults location choice and travel behavior in three parts. The first research examines residential location changes of young adults and older adults in the most populous 50 U.S. cities after computing city level and census tract level net migration rates between 2000 and 2010, and between 2010 and 2017. This research seeks to establish the pattern of migration observed among young adults and investigate what influences their choices. This research is presented in Chapter 3. The second research examines differences in residential location choice within the young adult cohort. It analyzes if the emerging choice patterns can be explained by the socio-demographic attributes of young adults or if systematic cohort-period effects are present that inform attitudes about different neighborhood attributes. This research is presented in Chapter 4. Finally, I examine the relationship between location choice and travel behavior in a more localized setting using data from the Seattle metropolitan area. The research focuses on young adults decision regarding location choice, vehicle ownership, multi-modality, and person miles traveled

(PMT) and the interdependence between these variables. It helps to untangle how much of the travel behavior shift is due to cohort level changes in travel attitudes and how much of it can be explained by shifting residential location choice. This research is presented in Chapter 5. Chapters 3-5 of this dissertation are written as a stand alone papers. Because each chapter addresses different dimensions of the same issue, the literature review section in each may include parts that cover similar topics. In the next chapter, I provide a brief background of the literature that helps to set the stage for the research and discuss my research question. Chapters 3, 4 and 5 will then discuss each of the questions discussed briefly above. Finally, I draw conclusions and implications of the research in Chapter 6.

CHAPTER 2

BACKGROUND AND RESEARCH QUESTIONS

In this chapter, I will summarize the preference shifts in travel behavior and residential location choice of young adults and the background literature. I will then discuss each of the research questions in detail. This section will introduce the decline of vehicle miles traveled (VMT), or personal miles traveled (PMT), and multimodality of young adults and their preference for city living in general. I also summarize the background experiences of young adults to understand how and why their choices have changed. The specific backgrounds of their preference shifts will be explained in each main paper in chapters 3, 4, and 5.

2.1 The preference shifts of young adults

Statistics and studies say that the preference shifts of young adults in travel behavior and residential location choice have emerged around the early and mid of the 2010s. Studies in the travel behavior change say that VMT (and PMT) of young adults in the U.S. between 2000 and 2010 were declined rapidly through results of empirical analyses using NHTS (National Household Travel Survey) or other travel survey data [5, 8, 14–19]. The studies add that VMT and PMT of older age groups stayed flat or slightly decreased while VMT and PMT of young adults declined substantially, about 20%. McDonald [5] highlights that the number of trips generated by young adults was signifi-

cantly decreased more than the decrease in travel distances. In addition, Kuhnimhof et al. [8], and Thompson and Weissmann [17] say that it is also one of the noticeable changes that young adults have postponed time to buy a car. Taylor et al. [20] state that young adults are less likely to obtain a driver's license and are driving less in 2009 than in 2001.

Another preference shift of young adults is choosing cities for their housing location at a higher rate than the prior generation. In the 2010s, an increase in the number and the share of young adults lived in cities as compared to the early 2000s [12, 21–24]. Literature, including grey literature, indicates that the share of especially college-educated young adults (aged 25-34) living in central neighborhoods within 3-miles from CBD increased between 2000 and 2012 [21] and young adults prefer housing locations where they can access a variety of urban amenities in close distance [17, 25, 26]. They also prefer the neighborhoods with high population density, racial diversity, and walkability available [13, 27].

Many studies have examined the background and reasons in the two preference shifts of young adults. The studies indicate that the main reasons for both shifts are financial issues that came from an economic recession in the late 2000s [5, 11, 14, 20, 28–30]. Consequently, they tend to delay to enter the next lifecycle stages like getting married and childbirth, compared to prior generations [11, 29, 31–33]. The development of Information and Communications Technology (ICT), social media, and e-commerce also have an influence on the preference shifts of young adults [5, 11, 14, 19, 28].

Blumenberg et al. [14] mention that the recession significantly influenced young adults who have a relatively weak economic base more than older groups. Though unemployment rates increased among all ages, the increase for young adults was about twice higher than the other age groups in 2010 [29, 30]. Financial hardship from high unemployment or decreased real income, as well as a very slow wage growth rate, has led young adults to enroll in higher education to get a stable job and better income [11, 29, 33]. However, because of rising college costs and the proportion to enter the college, an amount of student loans of young adults in 2012 seriously increased, compared with 2000 [11, 29, 30]. In addition, after graduation, young adults could not find jobs easily due to a higher unemployment rate more than other age groups [11, 20, 29, 30], and when employed, they stay with the early-career employers longer than previous generation [11].

The financial hardship and the trend to pursue higher education attainment have led them to spend more time and money before starting economic activity and getting a job [33]. This, consequently, has led them to postpone forming families and delaying marriage and childbirth to earn money for a family and pay back the debt. Some studies argue that the changes in living conditions are direct factors that reduced their travel needs, frequencies, and distances and changed housing location [11, 29, 31–33].

These economic hardships and changes in living conditions also influence to change their attitude and behavior directly and indirectly. Young adults have started to decrease transportation expenditure using cheap public transit, bike, or walk modes rather than driving a car. The percentage of the transportation cost among income of young adults, indeed, has slightly decreased, compared with

the past two decades [29]. They are more likely to choose home locations that have better public transit or high accessibility [32], or close car-sharing services such as Zip-car to rent a car only when they need [17]. Furstenberg [33] argues that the travel demands of young adults decreased because they stayed in school longer rather than getting a job and starting an economic activity. This also affects that they remain in cities longer in which many schools are located.

In addition to this, they also started to reduce housing expenditure. The proportion of living in parents' house after graduation is increased continually [11, 29, 31] and if they become economically independent, they tend to choose cheap and a small size of houses to reduce housing costs [34]. The proportion of living in a rental house has greatly increased while the proportion of house owners has decreased much more than the past [11, 31]. They are also more likely to live in dense areas to be able to reach many amenities without driving [17, 34, 35].

The other important change in young adults is ICT and online engagements. Some studies suggest that ICT and new online activities, represented as Facebook, Twitter, or Amazon, influence the travel behavior change of young adults [5, 18, 19, 28]. The studies argue that young adults have adopted new technologies more quickly than older people and that this mass adoption of ICT affects their travel behavior. The observed shifts then maybe in part resulting from offline activities moving to online spaces, for example, substituting online virtual meetings to offline meetings or buying items via e-commerce rather than going to retail shops. This dissertation does not explicitly consider the effect of ICT on location and travel behavior decisions, rather it focuses on the

socio-demographics changes among young adults and the effects of those variables on residential decisions and travel behavior.

2.2 Research topics in dissertation and research questions

2.2.1 Research topics and importance

As shown in the above subsections, young adults have shown two preference shifts in travel behavior and residential location choice. They travelled fewer miles, used non-automobile modes at higher rates, owned fewer cars, and chose to live in cities at a higher rate than both prior generations at the same age and older age groups in the same period.

Despite many and growing studies in the two preference shifts of young adults, there are still some unclear and unanswered questions. It is widely known that built environments factors such as high density, proximity to public transit, or surrounding land use are strongly related to use of public transit and walk modes [36, 37]. Given that some travel behavior is influenced by the built environment [1, 8, 16, 36, 38], it is possible that changes in the urban built environment through location change influenced the travel behavior now observed among young adults. While general relationship between the built environments and travel behavior is studied sufficiently, there are only a few studies that have examined the relationship between city choice, VMT and multimodality among young adults.

The research is also unclear on whether young adults prefer to live in cities or suburbs and findings appear sensitive to the geographic definitions used. Some studies define the urban centers as a 3-mile radius from central business areas, others as core counties, or based on measures of household and employment density. In addition to these, recent studies have claimed opposite narratives in both residential and travel behavior trends. Some studies showed that growth rates among young adults were higher in core areas like city centers since the late of the 2000s more than suburban and rural areas [21–24]. In contrast, the other studies, including gray literature say that the population growth of young adults in suburbs exceeded growth in cities in the same period [39–41]. Similarly, some travel behavior studies of young adults argue that young adults traveled less and became multi-modal in the 2010s when compared to the same aged cohorts in the 2000s. Others however found that young adults were increasingly showing similar travel behaviors as earlier generations, including increasing vehicle ownership as the economy recovered and as they got older [1–3, 5, 6, 14, 20, 42].

Many previous studies stress that young adults' behavior and attitude changes will be very important for future urban planning and policy. One of the arguments is that young adults are now the largest generation in U.S. and are expected to form about 15 million new households by 2020 [5, 11, 32]. Some studies also highlight that habits formed in young ages will influence decision and life in the future [7, 43–46]. Young adults are approximately 75 million in 2015, representing one-third of the total U.S. population. Moreover, considering the first cohort of young

adults already reached their mid-thirties, many of them will continue to be important players in the economy in the decades to come [5, 11].

Figure Figure 1 offers a schematic of the background and the questions that this dissertation addresses. The first research question examines how the residential location of young adults changed and what factors are important in their decision-making. The second research focuses on young adults and examines differences amongst them in location choice. The third research question examines the relationship between city living of young adults and their travel behavior changes including vehicle ownership, multimodality, and person miles travelled (PMT).

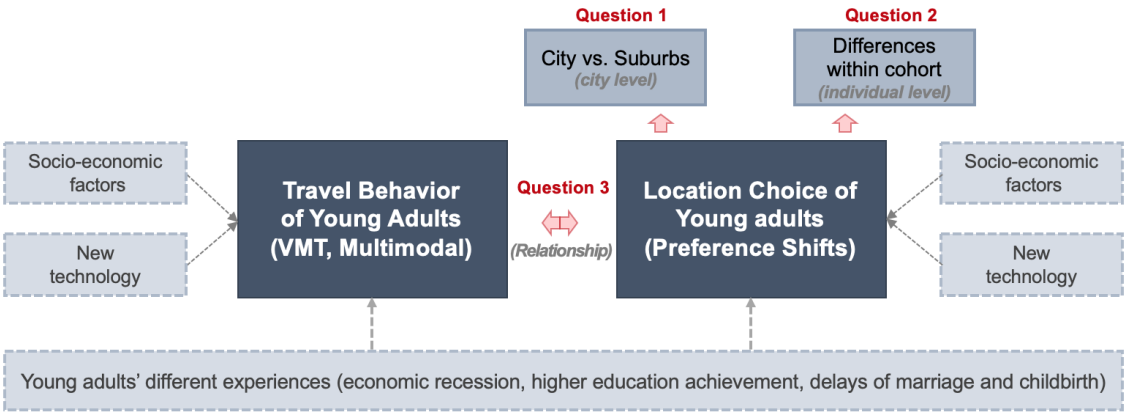

Figure 1: Dissertation research diagram

2.2.2 Research Questions

Research 1: residential location choice among young adults and important factors in their choice

As mentioned above, there have been conflicting arguments in residential location choice of young adults since the mid of the 2010s. In this research, I compute net migration rates based on census data at the city and census tract levels to investigate cohort specific migration patterns. I then investigate the change in rates over time, and explore what features explains the migration patterns to different cities and census tracts. Specifically, I ask:

- Where have young adults preferred to live in the early and middle of the 2010s as compared to the 2000s?
- Which types of cities do young adults prefer to live in among top 50 populous U.S. cities?
- What is the role of different urban factors in explaining migration patterns within cities?

I analyze changes in location choice of young adults and older age groups between 2000 and 2010 and between 2010 and 2017 using net migration rates. Then, I build a multinomial logit model and a fixed-effect regression model to understand important factors in decision-making of the location choice of young adults between cities and within cities. The full manuscript and the analysis are in the chapter 3.

Research 2: preference differences in residential location choice within young adults

Many studies in residential location choice regard young adults as one group and compare choices between them and older age groups or prior generations. However, among young adults, there are differences in background and socio-demographic characteristics that may have implications for their location preference. Thus, the second research focuses on differences within the cohort and asks if there are differences in residential location choice within young adults? This analysis focuses on a lifecycle changes and socio-demographic characteristics among young adults.

I use the longitudinal data (PSID (Panel Study of Income Dynamics) data) to track individual and household choices. Principal component analysis is used to capture neighborhood characteristics. I then employ a multinomial logit model to examine neighborhood choice and explore the differences within young adults in location choice. This is covered in chapter 4.

Research 3: relationship between residential location choice and travel behavior

In research question 3, I examine the relationship between location choice and travel behavior particularly focusing on vehicle ownership, multi-modality, and person miles traveled. I analyze the relationship by proposing a decision structure that ties long term decisions on residential choice and auto ownership with more short term decision on model choice and miles travelled. I ask how the location choice of young adults relates to their travel behavior. Are the travel behavior changes a result of location decisions or is there an additional layer of behavior change that is linked to use of non-automobile modes and less travel. I use the Puget Sound Household Travel survey data in 2006 and 2017 for this analysis and build a structural equation model to examine the effect of socio-

demographic and household variables on the four main variables of interest and simultaneously examine the relationship between them. This is covered in chapter 5.

The results of my dissertation can contribute to understanding the recent choices and behavior of young adults and informs current debates about the choices of young adults. It also provides planning and policy implication regarding what we can expect young adults to do as they age and their life cycle stage changes. The rest of the dissertation is organized as follows. Chapter 3 presents the residential location choice of young adults using net migration rate, Chapter 4 shows the differences in residential location choice within young adults, and Chapter 5 presents the relationship between location choice and travel behavior, respectively. Chapter 6 provides summaries of the findings and offers a discussion of the main findings of my research.

CHAPTER 3

THE MIGRATION PATTERNS OF YOUNG ADULTS: THE ROLE OF JOBS, TRANSPORTATION, AND URBAN AMENITIES

3.1 Introduction

After the Second World War, most American cities experienced a decline in population as housing developments in suburban areas increased. Increasing incomes, better highway access, and more jobs in the suburbs encouraged new developments and movement to suburbs [9, 10]. Though population in cities increased after the 1970s, these occurred in limited population groups and city areas such as neighborhoods near university campuses or centers of white-collar employment [9]. Before World War II only 13% of Americans lived in suburban areas. In contrast, more than half of the U.S. population chose suburbs as their home location in the 2000s [10].

Since the late 2000s some studies have paid attention to a new phenomenon observed among young adults, generally defined as the cohort born between the early 1980s and the 2000s. These studies noted that young adults had started to settle down in cities at higher rates than previous generations [1,12,13,21–23]. However, there were also studies that observed the opposite pattern among young adults. While the former studies showed that the total number and the share of young adults in city centers increased, the latter studies, including 'gray' literature, argued that young adults still chose

to live in suburban areas than in city centers [39–41]. Both sets of studies used similar data source, including the Decennial Census or the American Community Survey (ACS) and analyzed patterns during similar periods between 1990 and 2016. Works by Lee [22] and Drew [47] point out that the difference comes from different ways in which city centers were defined in different studies. The recent study by Lee [22] shows that young adults between the ages of 25-34 made up a higher share of the growth in population per unit area close to central business districts and that, in relative terms among young adults, a higher share of them lived in city centers (0-3 miles and 3-10 miles from downtown) in 2010 as compared to 1990 and 2000.

There are however some still unanswered questions regarding the residential choices of young adults. At the city level, are young adults coming to cities in general or focusing on specific areas of cities? Which types of cities do they prefer and which areas in cities do they choose to live in? In this study, I examine if young adults are really coming to cities by comparing the periods from 2000 to 2010 and from 2010 to 2017 using the notion of net migration. I also examine whether preferences across cities vary based on urban characteristics of locations focusing on jobs, transportation, and urban amenities or if there is an additional cohort effect that signifies changes tastes. Further, the literature has shown that in addition to living in cities, young adults also have shown a shift in travel behavior. They drive less, have lower car ownership, and use public transit and not-motorized modes at a higher rate. Different studies have argued that the shift in travel behavior is associated with their location choice [1, 5, 7, 20].

This study compares net migration from 2000 to 2010 and from 2010 to 2017 in the most populous 50 U.S. cities to examine how the residential choice of young adults in these time periods compares with one another. I also examine a generational difference in net migration between young adults (aged between 20 and 34) and older cohorts (aged 35 or over, hereafter older adults). A multinomial logit model is used to analyze differences across cities and which urban factors, focusing on jobs (urban industry), transportation, and urban amenities, are important in attracting a positive net migration among young adults at the city level. A fixed-effect regression model is also used to examine the location choice of young adults and important urban factors in their decision in a census tract level using the net migration rate.

3.2 Changing Preferences among Young Adults

As mentioned in the introduction, though there is a different narrative in location choice of young adults, more studies display a preference shift for cities for their residence. Their travel behavior is also characterized by less driving and multi-modality. Different authors ascribe different reasons for the shifts among young adults. Ryder [48] suggests that the behavior is an outcome of new and different experiences as compared to past generations as an underlying background. The experiences in young age significantly influence and shape subsequent lifestyle decisions and for characteristics which are differentiated from prior cohorts such as Generation X*ers* (born between 1965 and 1980) or Baby boomers (born between 1946 and 1964) [22, 48]. The unique experiences of today's young adults includes their familiarity and reliance on information and communication technologies (ICT) and their experience of the economic crisis of the late 2000s. Young adults to-

day live in the era of social media, E-commerce and an always on on-person mobile devices filled with many applications. Young adults can meet friends, buy items, order foods, and even, rent a car or a house via the technology, and have the ability to substitute previously in-person activities such as shopping or meeting friends with virtual ones.

Some studies suggest that the preferences of young adults are resulted from the economic circumstances they experienced during the great recession and the subsequent delay in marriage and childbirth that resulted from the downturn [5, 7, 11, 14, 20, 28, 29, 31–33, 49]. The impact of the recession on young adults was substantial. Young adults experienced a higher unemployment rate and had lower disposable incomes than other age groups [11, 20, 29, 30]. The hard economic situation drove young adults to pursue higher education in search of well-paying jobs [11, 33, 50]. As a result, the percentage of young adults receiving higher education degrees has significantly increased during last two decades [11, 29, 33]. These decisions to stay in school delayed their entry into the job market, increased their debts, and delayed marriages and childbirth.

As discussed earlier, there are conflicting claims on the location choice among young adults. Some studies, including grey literature, argue that population growth of young adults in core areas like cities is lower than suburban or rural areas. For example, Kotkin [39] says that the share of the 20-29-years-old group declined in counties where core cities are located and the share increased in less dense areas between 2010 and 2013. Kolko [40] and Frey [41] say that a population growth of young adults in suburban areas exceeded city growth between 2015 and 2016, and 2000 and 2014,

respectively. Frey [41] also shows that the percentage change of young adults living in urban areas (aged 25-34) in 2014 declined as compared to 2000.

Contrary to these research, several studies show an increase in the number and the share of young adults (or millennials) in cities [21–24]. The work of [22] supports a "back-to-the-city" theory among millennials, finding that millennials are more likely to live in central areas (within 3-miles from Central Business District) as compared to suburban areas than a prior generation between 2000 and 2010. He also adds that the areas with increased millennial population have been expanded to outsides of the central areas since 2010 (3-10 miles from CBD). This means that their city preference trend has continued and been steadily growing since 2000. Cortright [21] also says that the share of especially college-educated young adults (aged 25-34) living in central neighborhoods within 3-miles from CBD increased between 2000 and 2012.

Other research focused on young adults' travel behavior, particularly driving miles, vehicle ownership, and mode choice. Young adults have shown lower VMT [1, 3, 5, 20], lower car ownership [2, 6, 8, 49], and a higher rate of public transit use [7, 8, 14, 20] than prior generations at the same age since the late of the 2000s. Numerous studies have shown that built environments factors such as high density, proximity to public transit, surrounding land use, and street network design are strongly related to use of public transit and walk modes [36, 37]. Several studies note that travel behavior shifts among young adults and their preference for cities are associated with each other [1, 7, 8, 20, 42, 49]. The results suggest that young adults prefer to live in cities rather than suburbs and this can be related to decline of VMT and car ownership, and increase of a higher rate

of public transit use. More recently, some studies, however, have argued that young adults have been moving to suburbs and that their car ownership rates are increasing like that of prior generations [3, 42]. Klein and Smart [3] say that residential densities of the home location declined and the car ownership increased as millennials aged (between 1999 and 2013). Delbosc and Ralph [42] show that improving economic and other conditions among millennials' lead to moving to suburbs, higher car ownership rates, and driving more.

In summary, there is still some disagreement on the preferences of young adults though some studies show increasing number and share of young adults in urban centers such as CBDs. This study first examines the location choice of young adults employing the notion of net migration. I select the top 50 populous U.S. cities as of 2010 and compute net migration using the cohort component method to examine population mobility into cities focusing on young adults, aged between 20 and 34, and older adults, aged 35 or over. To the best of our knowledge, there is no study that employ net migration to analyze location shifts of young adults. I first investigate two different arguments in location choice of young adults in a city dimension, the "back-to-the-city" claim and the "sustained suburban growth" argument, looking into whether young adults on the net have entered or left cities between 2000 and 2010, and between 2010 and 2017. Then, I build two statistical models to examine differences in location among young adults, focusing on jobs, transportation, and urban amenities.

3.3 Net Migration Comparison in Top 50 Cities

This study uses the 2000 and 2010 decennial census, and 2006-2010 and 2013-2017 5-year estimates from the American Community Survey (ACS). The data are used to compare net migration trends between 2000 and 2010, and 2010 (using 2006-2010 data) and 2017 (using 2013-2017 data) at the census tract level. The study focuses on the most populous 50 cities in the United States as of 2010 using census tract level data. For city level analysis, the study used aggregated data. A total 11,595 census tracts across the 50 cities are included in the analysis. A total of 646 census tracts with half their area outside city limits were not included in this analysis. Among the 11,595 census tracts, 352 had less than a 1,000 people living in them 2000. Since the population of the census tract is used in the denominator in calculating net migration rates, migration rates for these tracts tended to be excessively high. I merge these less populated census tracts with their adjacent census tracts. After removing missing information on tract level data, I had 11,225 records for the final dataset.

The primary method for the analysis in this paper is the cohort specific net migration rate. Net migration rates between 2000 to 2010 and between 2010 to 2017 are computed for young adults (aged 20-34 in year) and older adults (aged 35 and over) separately for each census tract. Net migration rates are computed utilizing age specific birth and death rates from life tables provided by the Centers for Disease Control [51]. The cohort component methods employs three main demographic components: the surviving population, the newly born population and migration.

The population at some point n years from time t, designated population$_{t+n}$, can be computed by estimating the internal population change due to births and deaths and the external population shift due to net migration between time t and $t+n$. The internal population change is simply the population at time t minus deaths between years at time t and $t+n$ plus births between time t and $t+n$ as shown in equation 1. Because population numbers for year 2000 (t) and 2010 ($t+n$) are known, I can compute net migration in each census tract after accounting for births and deaths using the CDC's life tables as shown below.

$$Population_{t+n} = Survived\ population + births + Net\ migration \tag{3.1}$$

$$Net\ migration = Population_{t+n} - Survived\ population - births \tag{3.2}$$

The net migration rate can then be expressed as:

$$Net\ migration\ rate_{t-(t+n)} = Net\ migration\ \ / Population_t \tag{3.3}$$

However, because the periods over which net migration is computed are unequal (i.e. 2000-2010 and 2010-2017), I use the annualized growth rate for comparing the two periods and in my net migration comparison analysis. This rate is computed as follows:

$$Annualized\ net\ migration\ rate_{t-(t+n)} = \left(\frac{Population_t + Net\ migration_{t-(t+n)}}{Population_t} \right)^{1/n} - 1 \quad (3.4)$$

The annualized net migration rates from 2000 to 2010 and from 2010 to 2017 for the two age cohorts in the most populous 50 U.S. cities are shown in Figure 2. Figure 2-a shows the annualized net migration rate for young adults in 2000-2010 and 2010-2017 sorted from highest to lowest based on the 2010-2017 data. Figure 2-b shows the annualized net migration for older adults for the same cities. Positive net migration rates indicate that more people came into the city than left the city after accounting for aging, birth and deaths. Negative values indicate that on the net more people left the city than came into it.

As can be seen the general patterns for 2000-2010 and 2010-2017 are similar. In both periods, young adults had predominantly positive migration numbers (in-migration) and older age groups show negative net migration numbers signifying out-migration. The higher net in-migration rates between 2010 and 2017 (and the lower net out migration), compared to the 2000-2010 period for most cities, suggests that city living or city preference increased in 2010-2017 for both age groups. The figures also show the generational difference in attitudes toward city living. The 2000-2010 annualized net migration rate for young adults was positive for 45 of the 50 cities. For the same period, 43 of the largest 50 cities had negative net migration rates for the older cohort. Similarly,

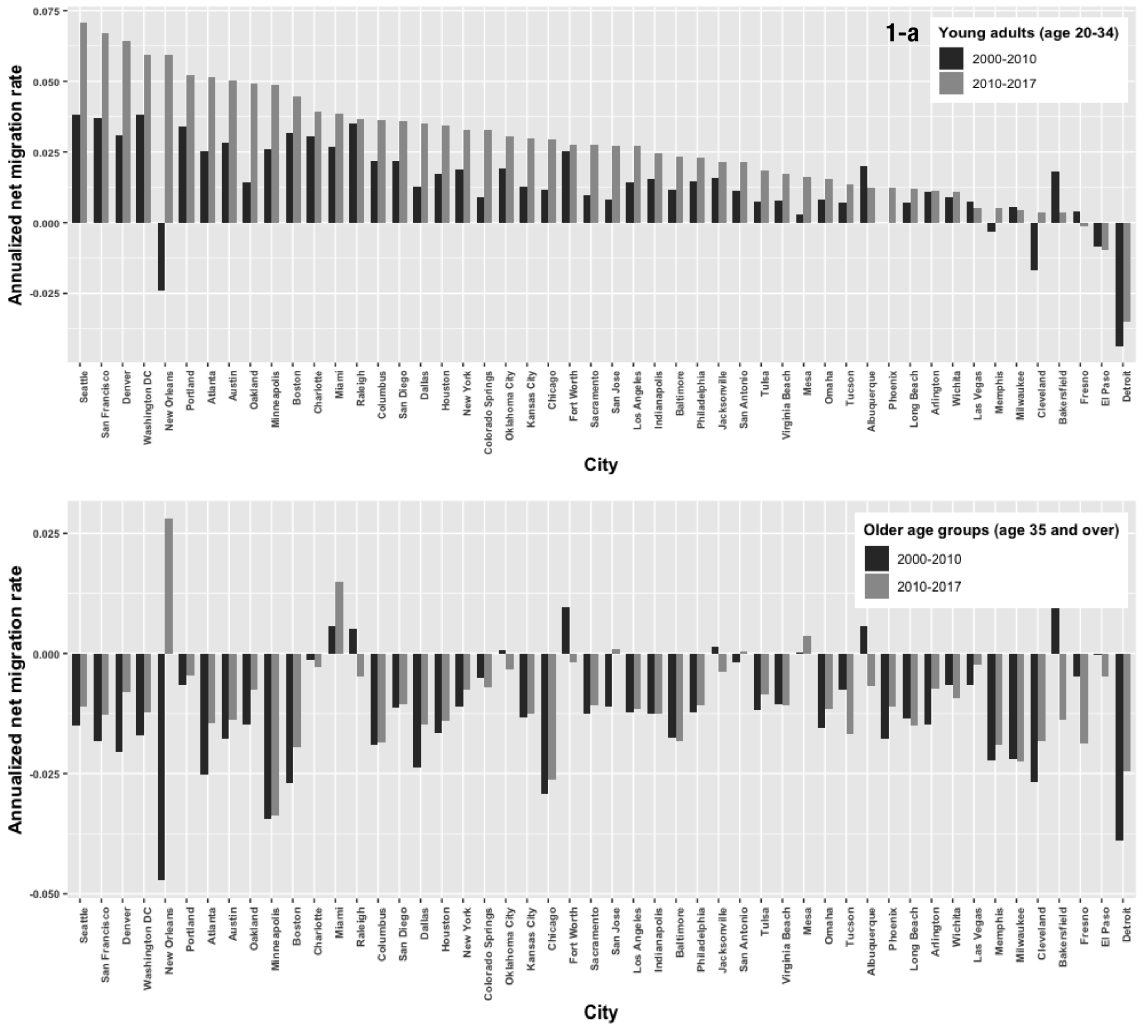

Figure 2: Annualized net migration rates of young adults (1-a) and for older adults (1-b) between 2000 and 2010, and between 2010 and 2017

between 2010-2017, net migration was positive in 47 cities for the young cohort and negative in 45 cities for the older cohort.

Looking at net migration rates over the two periods, average annualized net migration rates where higher in the 2010-2017 period as compared to the 2000-2010 period. The average annualized migration rate for the young cohort went up from 0.014 in 2000-2010 to 0.027 in the subsequent period and that for the older cohort changed from -0.013 to -0.010. Using a paired t-test, the 2010-2017 annualized net migration rate for the young cohort was higher by 0.014 ($p < 0.001$) than that for the 2000-2010 rate. The 2010-2017 mean annualized migration rate for the older cohort was higher by 0.003 ($p > 0.05$) as compared to the earlier period. In short, between 2010 and 2017, higher rates of annualized in-migration were observed for the young cohort than the prior decade and out-migration from the largest cities was slightly slower for the older cohort. The t-test results show statistical difference in annualized migration rates of young adults between the two periods but no difference for older age groups. This means that only young adults have shown significantly increased in-migration to the largest cities in the 2010-2017 period as compared to the 2000-2010 period.

As Figure 2 further shows, there are substantial city to city differences in migration rates in both 2000-2010 and 2010-2017. Young adults came to most cities in both periods but many of them entered some cities, including Seattle and San Francisco while just a few entered cities like Las Vegas or Milwaukee. Interestingly, Los Angeles and Long Beach are adjacent cities but the net migration rate for Los Angeles in 2010-2017 is about 2.5 times higher than Long Beach in the

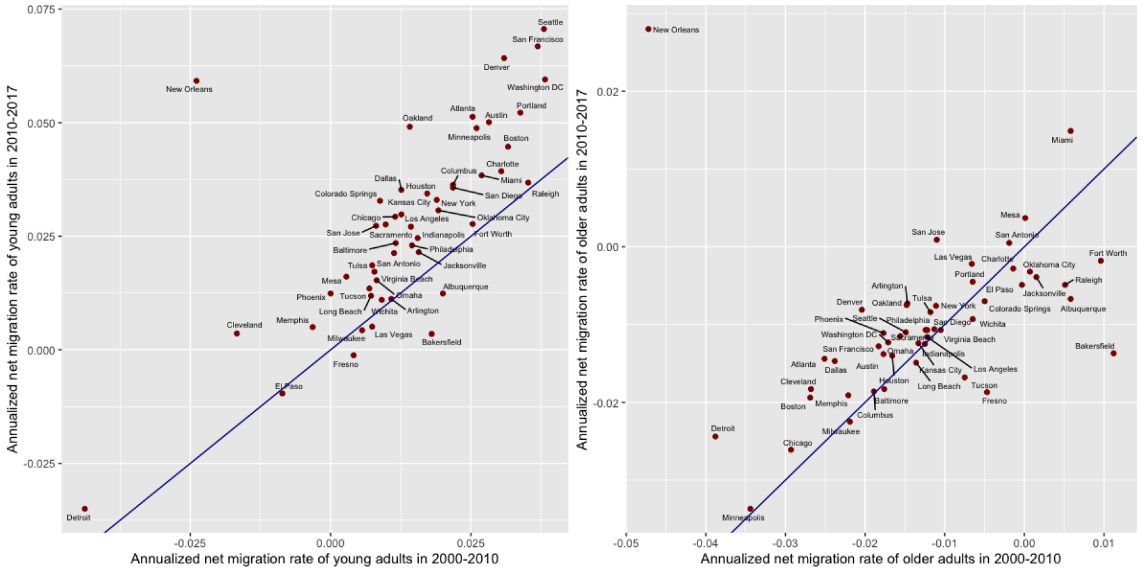

Figure 3: Scatter plots for annualized net migration rates for 2000-2010 and 2010-2017

same period. Another interesting point is that there is a relatively consistency in terms of which cities had the highest and lowest migration rates as Figure 3 shows. If we exclude New Orleans, which had significant shifts over the two periods due to Hurricane Katrina, the top 5 cities in terms of the net migration rates did not change much for the young cohort. Washington, D.C., Seattle, San Francisco, Raleigh, and Portland made up the top five cities in the 2000-2010 and Seattle, San Francisco, Denver, Washington, D.C., and Portland took the top five positions in the 2010-2017. The bottom five for migration rates for the young cohort also remained somewhat stable, with Detroit, El Paso, and Cleveland appearing in both 2000-2010 and 2010-2017 as the least attractive of the largest 50 cities. There was less consistency for the older cohort. In both periods, Mesa

and Miami appeared in the top five list for this cohort, while Detroit, Minneapolis and Chicago appeared in the bottom five in both periods.

3.4 Analysis and Models

In this section, I examine two questions. First, could the city to city differences in migration patterns be explained by city level variables? Specifically, are there city level variables that can allow us to predict the more popular cities for young adults or older adults, and as a result give us insights into what makes certain cities attractive. Second, I examine what features within cities are desirable to the younger cohort. The first analysis looks at cities as a whole and explains city to city variation in migration patterns. The second recognizes that there is much variation in social, built environment, transportation and economic variables within cities using a location choice model. Even as a city is on aggregate gaining young or older populations, there are liable to be places within the city which will experience different rates of in or out migration. The second analysis will therefore use the much smaller census tracts for analysis.

The analysis and models in this study focuses on the 2000-2010 period. The period includes important events including the economic crisis which occurred in the late the 2000s as well as the birth of social media such as Facebook or Twitter. The literature points to both these factors as among the most vital in shaping the preferences of young adults. This study therefore uses the 2000 and 2010 Decennial Census to compute net migration rates during that period. The 2000 Decennial Census and 2006-2010 American Community Survey 5-year estimate data for other variables. A summary

of the variables used in the two models is given in Table I. City level data was used to examine city to city differences in net migration and census tract level data was used to undertake a more disaggregate analysis of the factors that shaped young adults choices in this period.

This study pays special attention to three factors which are important in decisions of residential location and net migration in the literature: jobs (urban industry), transportation and urban amenity. People tend to move into places with high job opportunities and better wages so that employment and wages have been identified as influencing factor in net migration and residential location choice [52, 53]. I broadly capture employment characteristics by the proportion of types of jobs and the proportion of high-income jobs is the summation of the proportions of information, professional, and finance jobs using Census Bureau classification.

Young adults show higher interests in the use of non-automobile modes like public transit [8, 54]. Transportation is measured by the sum of shares of three non-automobile modes used in commuting: public transit, walk, and bicycle modes. For urban amenities, I mean places and entities which enrich urban areas in cultural and leisure opportunities and enable people to experience urban life in various ways. Due to the difficulty in capturing amenities directly, I use a proxy variable measuring the proportion of retail and entertainment jobs.

Further, I also control for housing market changes and socio-demographic variables. These variables are changes in the housing supply, population density, proportion of families in poverty and a racial composition, including diversity index. The proportion of new housing supply may make

TABLE I: Data summary for the most populous 50 U.S. cities (2010)

	City level		Census Tract level	
	Mean	SD	Mean	SD
Total population (2000)	861,514.3	1,082,610	3,837	1,611.9
Total population (2010)	890,848.6	1,098,241	3,968	1930.9
Population of young adults (2000)	217,483.3	269,623	968.7	548.2
Population of older adults (2000)	397,682.3	516,170.7	1771.4	829.4
Net migration rate of young adults	0.1686	0.1689	0.1418	0.6555
Net migration rate of older adults	-0.1050	0.1148	-0.1295	0.5786
Distance to downtown (miles)	-	-	6.5835	4.3238
Population density (per sqmi)	5,460.9	4,599.2	15,015.0	19,656.1
Proportion using non-automobile modes	0.1386	0.1428	0.2308	0.2375
Proportion of families under poverty	0.1483	0.0487	0.1649	0.1404
Proportion of the Black population	0.2243	0.1888	0.2521	0.3134
Proportion of the Hispanic population	0.2505	0.1825	0.2619	0.2633
Diversity index (proportion)	0.6040	0.0956	0.4442	0.1883
Proportion of newly built housing (a decade)	0.1021	0.0599	0.0758	0.1197
Proportion of high-income jobs	0.2108	0.0422	0.2097	0.0988
Proportion of information jobs	0.0254	0.0087	0.0265	0.0275
Proportion of professional jobs	0.1166	0.0280	0.1136	0.0598
Proportion of finance jobs	0.0688	0.0176	0.0695	0.0471
Proportion of construction jobs	0.0613	0.0212	0.0601	0.0527
Proportion of education jobs	0.1960	0.0292	0.2004	0.0816
Proportion of urban amenity jobs	0.1924	0.0266	0.1851	0.0700
Total observations		50		11,225

a place more or less attractive to new locators. To identify how many new housing units are built, I compute the proportion of recently built housing structure between 2000 and 2010. The socio-demographic variables —population density, proportion of families in poverty, and proportion of the black and hispanic population and a racial diversity —are computed and used in the analysis. Lastly, I also include the distance from downtown to each census tract to see young adults' location preference in cities by distance.

Table I shows the data summary of 50 cities and 11,225 census tracts. The mean of net migration rates across cities and census tracts are 0.1686 and 0.1418 for young adults, and -0.1050 and -0.1295 for older adults respectively. Average non-automobile modes usage for commute is about 14% across cities, families are under poverty is 15%, the average of the percent black population is 22%, 25% for the hispanic population, and the average percent of houses built within 10 years is 10%. A racial diversity index is also computed for 2010 using Simpson's diversity index [55]. The variable measures the probability that two persons picked randomly from the city population being of the different race. The average across cities is 0.604.

3.4.1 City to city variation in migration patterns

As I discussed above, there are substantial city to city differences in migration rates across cities. To analyze the city to city differences, I, first, classify these 50 cities to look at which cities have above average or below average migration rates for the young adults and the older cohort. Figure 4 presents these results. The vertical and horizontal axes represent the mean migration rates for each

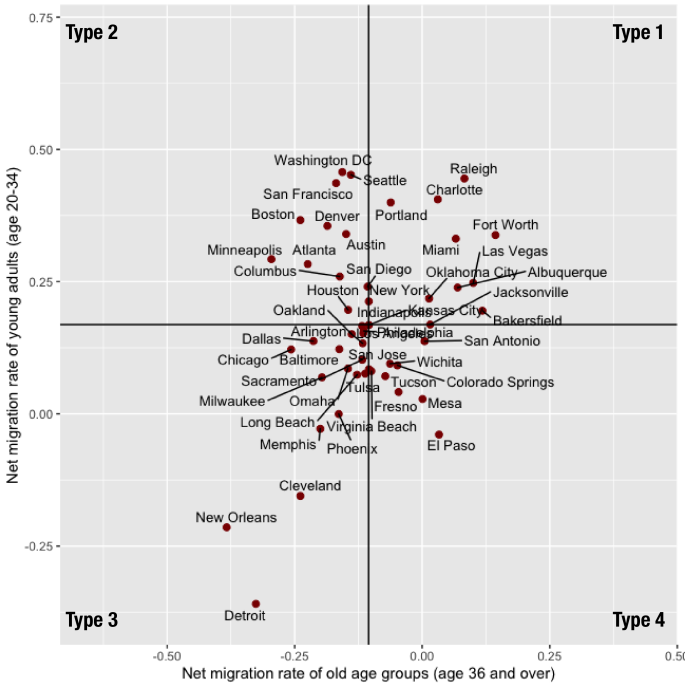

Figure 4: Cities classified based on mean of net migration rates of young and older adults

cohort. Cities to the right of the vertical axis have a lower than average out-migration (or positive in-migration in a few cases) for those aged 36 or above. Those to the left of the vertical axis have higher than average out migration rates for the same cohort. Cities above the horizontal axis have above average in-migration rates for young adults and those below have lower than average young adult in-migration rates (and in some cases experience out migration).

I label cities in each quadrant of Figure 4 as cities of Type 1, 2, 3 and 4, respectively, based on the quadrant they fall in starting from the top-right quadrant and going counter clockwise. There

are 11 Type 1 cities, 11 Type 2 cities, 18 Type 3 cities and 10 Type 4 cities. Of the top 50 cities by population, Type 1 cities are the most attractive for both young and older adults. These include cities such as Miami, Portland, and Fort Worth. Type 3 cities are the least attractive of the top 50 for both cohorts. Detroit, Cleveland, and Memphis fall in this group. The older cohort is leaving Type 2 cities at comparable rates as those in Type 3 but the younger cohort finds them very attractive. Cities such as San Francisco, Washington D.C., Boston and Minneapolis are in this group. Type 4 cities are not losing their older adults at a high rate but the younger cohort is relatively less attracted to these them. Mesa, El Paso and Fresno fall into this group.

To answer what features make certain cities attractive to people in the younger or older age cohort, I build a multinomial logit model. The model tries to classify places into one of the four categories based on variables measured at the city level. The general form of the model is as follows:

$$\ln \frac{P(C_k = l)}{P(C_k = 3)} = \alpha_l + \sum_j \beta_{jl} X_{kj} \tag{3.5}$$

Here, $P(C_k = l)$ is the probability that city k is of Type l, with l taking on values 1, 2, 3, or 4. β_{jl} are j model parameters to be estimated specific for Type l and X_{jk} represents j independent variables measured for city k. As indicated in the equation, the reference category for the modeling is type 3 cities that both net migration rates are lower than the means. The variables included in X describe each city in terms of the urban industry, transportation, urban amenities, housing supply and racial diversity. The results of this model are give in Table II. The total observations in the model are

50 and pseudo R-squared value is 0.53, relatively high. The base category (reference group) in the model is the type 3 cities which both net migration rates are lower than mean.

The reference (base) case for the model is type 3 cities —those that have below average migration rates for both young and old adults. Each column in Table II therefore shows the estimates for the log-odds of choosing that city-type over type 3 cities. What is consistent through all three cases is the importance of the employment rate in distinguishing each city type from type 3 cities. In general, cities that were attractive to young people had strong economies. A 1% increase in percentage of employed people increases the log-odds by 0.43, 0.83, and 0.83 to be type 1, 2, and 4 cities from the reference category. Increasing the percentages of manufacturing jobs and households in poverty decreased the log-likelihoods to become a type 1 city, those that attracted young people and either attracted or saw low out-migration for older age groups. For the type 2 cities, those that attracted young people but lost older adults, the percentage of information and profession jobs was high. In general, these jobs tend to pay higher wages. A 1% in information and professional jobs the odds of being a type 2 city by 1.8 times. On the other hand, having higher concentration of information and professional jobs made it less likely to be categorized as a type 4 city as compared to those that are type 3. Cities were also less likely to be categorized Type 4, those with out-migration for young adults and showing growth or low out-migration for older adults, if they had more wholesale jobs. Higher whole sale jobs were also marginally positively associated with being categorized as a type 1 city ($p = 0.051$).

TABLE II: Multinomial logit model for city to city migration pattern differences

Variables		Type 1	Type 2	Type4
Intercept	Coefficients	-47.16 ***	-88.80 ***	-59.94 **
	Std. Errors	15.40	5.14	25.56
Pct. of employed people	Coefficients	0.43 ***	0.83 ***	0.83 ***
	Std. Errors	0.19	0.13	0.32
Pct. of manufacturing jobs	Coefficients	-1.37 **	-0.23	0.08
	Std. Errors	0.56	0.38	0.17
Pct of wholesale jobs	Coefficients	6.87 .	-1.20	-2.57 *
	Std. Errors	3.52	1.53	1.23
Pct of information & professional jobs	Coefficients	-0.08	0.59 *	-0.70 *
(high-income jobs)	Std. Errors	0.34	0.29	0.36
Pct of retail and entertainment jobs	Coefficients	0.36	0.28	0.11
(urban amenity jobs)	Std. Errors	0.36	0.39	0.32
Pct of households in poverty	Coefficients	-0.56 *	0.18	-0.22
	Std. Errors	0.27	0.20	0.18
Model summary				
Total observations			50	
Residual Deviance			64.38	
Residual Deviance: null model			135.59	
Pseudo R-squared			0.53	

Significance codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1

Though only a few variables are significant, the result highlight the importance of the economy for attractive cities to both or one of the age groups. Another variable that had strong association with the categories was the percentage of new homes built in these cities. However, this variable was not used in the model as it likely grows as a consequence of in-migration rather then being an attractive factor on its own. Interestingly, also, retail and entertainment job concentrations used as urban amenities in the model were not predictive of a city's migration patterns. This maybe because retail and entertainment jobs are non-basic (or local serving) industries while manufacturing, wholesale, information, and professional jobs, significant in the model, are largely basic industries. The model shows that the city's migration patterns are influenced by overall employment rate of the city and employment rates of basic industries rather than non-basic industries.

3.4.2 Location choice of young adults in cities

Following the city level analysis, I look at where young adults choose to live in cities. Specifically, I examine how different variables within cities, measured at the census tract level, are related to the net migration rates observed in the period from 2000-2010 for young adults. The analysis explicitly considers the nested structure of the data where census tracts are grouped under cities. To undertake this analysis, I employ a fixed-effects regression model to examine how different urban factors including urban industry (jobs), transportation, urban amenities, housing supply, and socio-demographic attributes like density or racial composition measured at the census tract, affect net the migration of young adults. I also include the distance of census tracts from downtown to

see how preference within cities varies with distance from the CBD. The form of the model is as follows:

$$M_{ik} = \sum \beta_j X_{ijk} + \alpha_k + \mu_{ik} \tag{3.6}$$

Where, M_{ik} is the net migration rate of young adults between 2000 and 2010 in tract i located in city k; β_j is the coefficient for the j independent variables measured at the census tract level, X_{ijk} are independent variables composed of the several urban factors that affect residential location choice, α_k are unobserved city level fixed effects for city k (not reported below), and μ_{ik} are the error terms.

Table III shows the result of the fixed-effect regression model. The R-squared and adjusted R-squared values are 0.439 and 0.436 respectively. This means that the model fits the data relatively well. First of all, employment is important to choose residential location for young adults.They prefer census tracts providing more opportunities and higher wage of jobs. The proportion of three high-income jobs are positively associated with net migration rates of young adults in all 50 cities after controlling cities' own characteristics. One unit increase in information, professional, and finance jobs raise the net migration rate of young adults by 2.05, 1.04, and 1.18, respectively. Literally, this means that about 21, 10, and 12 more young people per thousand population come to census tracts. Construction jobs also positively influence young adults into cities. This also sup-

TABLE III: Fixed effects regression model for net migration rates for young adults at the census tract level

Variables	**Estimate**	**Std. Error**	**t value**	
(Intercept)	-0.510	0.039	-12.958	***
Proportion of information jobs	2.046	0.196	10.437	***
Proportion of professional jobs	1.043	0.096	10.831	***
Proportion of finance jobs	1.181	0.123	9.568	***
Proportion of construction jobs	0.790	0.105	7.514	***
Proportion of non-automobile modes	0.148	0.049	3.01	**
Proportion of retail and entertainment jobs (Amenities)	0.761	0.077	9.947	***
Distance to downtown (miles)	-0.017	0.001	-11.569	***
Population density (1000 persons per sqmi)	0.003	0.000	7.514	***
Proportion of families under poverty	-0.830	0.044	-18.805	***
Proportion of newly built housing within a decade	2.865	0.042	67.474	***
Diversity index (proportion)	0.603	0.028	21.263	***
Model summary x				
Total observations (census tracts)			11,225	
Residual standard error			0.4923	
Multiple R-sqaured			0.4389	
Adjusted R-squared			0.4359	

Significance codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1

ports previous net migration studies saying that wage and employment opportunity are influential and positive factors on net migration [52, 53].

Higher rates of non-automobile mode use (public transit, walk, and bicycle) in a census tract is associated with an increase in the net migration rates to those census tracts. This is consistent with previous travel behavior studies that the availability of public transit or a bicycle mode is one of the main interests for young adults to choose their home location [2, 3, 8]. A one unit increase in non-auto mode share adds 1.5 persons per 1000 to a census tract. Similarly, the concentration of urban amenities (tested retail and entertainment jobs in the model as a proxy) is also positively associated with net migration among young adults. A one unit increase adds 7.6 persons per thousand to a census tract.

The model result says that location, density and socio-demographic attributes of census tracts are also significant and important in location choice of young adults. Every one-mile increase from downtown is associated with a decreases of 0.017 in the net migration rate of young adults. This means that young adults prefer locations closer to downtown rather than the outskirts of cities all other things equal. Increases in population density (persons per square miles) and the proportion of housing units built within a decade have positive association with the net migration rate. Further, the mode also suggests that the poverty rate in a census tract is negatively associated with the net migration rate of young adults. Increasing diversity in census tracts increases the net migration rate of young adults. This also supports literature [13] which says that 25-34-years-old highly live in the location with greater racial diversity.

3.5 Conclusion and Discussion

Given two opposing narratives of location choice of young adults in literature, this study examines population movements among young adults and an older cohort to explore location preferences. By using the cohort-component method for estimating net migrations, I exclude changes in population/cohort size that are due to aging in or out of a cohort and focus on population movements through migration. I demonstrate that annualized migration rates for young adults is predominantly positive for young adults in the 50 largest cities in the U.S. I also show that statistically, the mean of the in-migration rates for these cities were higher in the period from 2010-2017 than they were in the 2000-2010 period. Overall, the annualized net migration analysis in the top 50 populous U.S. cities showed 1) that young adults came to cities in 2000-2010 and 2010-2017 while older age groups left cities, 2) annualized net migration rates to cities (city preference) doubled among young adults (but only changed slightly in older age groups) in 2010-2017 as compared to 2000-2010, and 3) young adults came to most of the large cities but that there are considerable city to city differences in migration rates in both periods. Based on the analysis, I can say that the data supports the 'coming-to-the-city' thesis among young adults since 2000 and this trend has increased since 2010 as Lee [22] argues.

Building on point (3) above, I examined if I can understand the variation among cities by creating typologies among them based on whether migration rates for younger and older adults were above or below average. The results of the multinomial logit model in a city level finds few systematic

differences between cities when looking at the aggregate data. The strongest indicator for a city being preferred was the employment rate. Further, where cities fell on the migration category depended on the percentage of high-income jobs, wholesale jobs, and manufacturing jobs. Cities that had more households in poverty were less likely to attract both young and adult households. Retail and recreation employment job concentrations were not significant in explaining migration patterns.

The fixed-effect regression model used more disaggregate census tract level migration data. It demonstrates the importance of urban industry, transportation, and urban amenity in location preference among young adults. More high-income jobs (information, professional, and finance jobs) and use of non-automobile modes (public transit, walk, and bicycle modes) are significant indicators for attracting young adults. Young adults also prefer living in census tracts which have lower poverty rates and have less dependence on the automobile. In addition, young adults migration rates shows higher positive association with higher levels of urban amenities, measured as retail and recreation jobs, more recently built housing units. Location, density and population diversity also appear highly important. Young adults migration rates decline as one moves farther out from the center of the city and it increases as population density increases. Further, there is a positive association with higher levels of ethnic diversity in a census tract.

The result of this study provide meaningful implication for planners and policy makers to understand decision making of young adults in choosing cities and locations. This study shows that employment rates and urban industry in information and professional jobs are important predictors

of net-migration rates between cities. Further, urban industry in high-income jobs and construction, transportation, recent housing development, poverty, and racial diversity are important factors associated with the residential location choice in cities of young adults. Given the model results and the literature, providing better environments for young adults such as investment for IT (Information Technology) industries or improvement of non-automobile infrastructure can make them to stay or attract them to choose such cities.

With the findings and implication, this study can also suggest a few points for the future study. Since this study uses the top 50 populous cities throughout U.S., I employ the national-level death and birth rates to compute net migration rates. If we use the death and birth rates at the state or county level, we can compute more accurate net migration rates by region and see regional differences. Another point is that this study focuses on changes at the city level to analyze city preference of young adults. It can be also interesting to analyze the changes and relationship in migration between city and Metropolitan Statistical Areas (MSA). Some cities might attract population from MSAs but both cities and MSAs might attract people from outside MSA. These analyses can provide a more comprehensive narrative of the migration trends of young and older adults.

CHAPTER 4

HAVE THE RESIDENTIAL PREFERENCES OF YOUNG ADULTS CHANGED? EVIDENCE BASED ON THE PANEL STUDY OF INCOME DYNAMICS

4.1 Introduction

The residential choice of young adults has been receiving increasing attention since the late 2000s. In the early 2010s, a larger share of young adults chose to live in cities as compared to the early 2000s while older adults chose suburban locations [12, 21–24]. Young adults also showed a shift in travel behavior in the same period. They drove fewer miles, owned fewer cars, postponed acquiring a driver's license, and used public transit or bicycles at a higher rate [1–3, 5–8].

Despite the growing research body on young adults, there are still some unanswered questions, especially regarding differences in residential location choice within the cohort. This questions are all the more important as young adults make up a large portion of the society and the oldest among them are experiencing lifecycle changes. As of 2015, young adults constitute roughly one-third of the total population at approximately 75 million [5, 11]. Moreover, the first cohort of millennials is reaching their late-thirties and the last cohort just completed high school. The cohort now encompasses people in different lifecycle stages from college freshmen to those with school-age children as well as with different socio-demographic characteristics. It is one of the

main research topics in choice behavior and many studies show that the different life cycle and socio-demographic characteristics are linked to different choice.

There is a large body of evidence that transportation and location decisions are influenced by life-cycle stage, socio-demographic characteristics, and tastes about urban environments. Single or young couple-only households prefer to living in dense areas while old households or households with children do in non-central places like suburbs [56–59]. The presence of children also influences whether one owns a car or drives more [20, 54]. Low-income families and highly educated people tend to choose central cities while high income families show a tendency to choose residential-oriented areas [57, 59, 60]. Transportation preferences and accessibility can influence residential location choice [61–64]. Available transportation options in different parts of the city as well as urban amenities such as restaurants, parks or retail stores can be an important factor in the location choice [25]. The individual and household characteristics, including lifecycle stage and socio-demographic attributes influence people's choice behavior and their choice varies by the characteristics.

Given the diversity of life cycle stages and socio-demographics, this study focuses on differences within young adults regarding their residential choice. Though some studies have examined the residential location choice of young adults, the studies regard young adults as one group and compare their choice with older adults. As many studies in the choice behavior, young adults can choose different locations and show different preference in residential choice by lifecycle stages and socio-demographic characteristics. This study also examines period difference of young adults, a differ-

ent choice between 2000 and 2010. When considering that young adults is the largest population group in U.S. and show new and different choice patterns from prior generation, the understanding of the difference in location choice within young adults is important and can be a starting point for policy. This study develops indices for neighborhood, resident's socio-demographic, and transportation characteristics, and urban amenities using Principal Component Analysis (PCA) and uses these measures to explore how they affect residential choices and how different in their choices. The analysis also compares the location preferences of young adults compare with older adults to show generation difference.

4.2 Background

Both the academic and grey literature show that the residential location choice of today's young adults differs from that of prior young cohorts. In general, residential location choice is influenced by factors such as price, school quality, proximity to work or family, transportation options, availability of open spaces, among other variables. The life cycle stage of a household is also an important factor that influences residential choice. Single-person households or young couple-only households show a preference to denser areas and rented apartment houses [57–59, 65]. Young or single-person households or households without a car are more likely to choose areas with significant commercial land use [59].

However, when households enter another stage in their lifecycle, these preferences shift. Households with children prefer to live in areas that are less dense, have fewer commercial land uses,

and with larger housing units —common features of suburban locations [56–60, 65–67]. What is different about today's young adults is that they are choosing to live in cities at higher rates relative to prior generations at the same age [1, 11, 12, 23]. Further more, their transportation choices are also different. They drive fewer miles, own fewer cars, and use more non-automobile dependent modes such as public transit when compared with prior generations [2, 3, 5, 14]. Today, the oldest of this cohort is going through a lifecycle transition begging the question whether these preferences carry over into the next lifecycle.

Several studies show an increase in the number and the share of young adults (or millennials) living in cities [21–24]. The work of Lee [22] finds that millennials are more likely to live in central areas (within 3-miles from Central Business District) as compared to suburban areas than a prior generation between 2000 and 2010. He also adds that the areas with increased millennial population have expanded from the central regions since 2010. This means that their city preference has continued and been steadily growing since 2000. Grey literature also indicates that the share of especially college-educated young adults (aged 25-34) living in central neighborhoods within 3-miles from CBD increased between 2000 and 2012 [21] and that that young adults prefer housing locations where they can access a variety of urban amenities in close distance [17, 25, 26].

Studies on the travel behavior of young adults also show a different trend from the prior generation. Young adults have lower vehicle miles traveled (VMT) [1,3,5,20], lower car ownership [2,6,8,49], and a higher rate of public transit use [7,8,14,20] than the prior generation at the same age. Several studies note that travel behavior shifts among young adults and their preference for cities can be

associated with each other [1, 7, 8, 20, 42, 49]. It is widely known that built environments factors such as high density, proximity to public transit, surrounding land use, and street network design are strongly related to use of public transit and walk modes [36, 37]. More recently, however, some studies have argued that young adults have been moving to suburban life and that their car ownership rates are increasing [3].

This study seeks to understand differences within the young adult cohort by controlling for several socio-demographic and lifecycle characteristics and how those relate to their residential choices. These characteristics include education, income, the presence of children, race, and poverty. It also compares these residential preferences with the shifts in preference seen in an older adults cohort. The analysis is based on data from the Panel Study of Income Dynamics (PSID) on residential changes coupled with economic and socio-demographic data from the Census Bureau covering 89 cities in 43 states across the United States. The approach and data are discussed in the next section.

4.3 Approach and Data

Our goal in this analysis is to examine difference within young adults in the residential location choice. In particular, I look at the difference in residential choice among young adults and between young adults and older adults observed a decade apart. I relate these choices with neighborhood, individual, and household characteristics like a life cycle variable. Our other intent is to compare changes over time within age cohorts as well as between young and older adults. For these pur-

poses, I extract data from the PSID on people who have made a residential location change between the years of 1996-2001 (the 2001 cohort hereafter) and another group that made residential moves between 2006-2011 (the 2011 cohort). This data is paired with census data that describes the housing, socio-demographics and other variables that bear on residential choice. Finally, this data is used to do principal component analysis and develop multinomial logit models of neighborhood choice.

The data used in the study comes from several sources. The core data for socio-economic characteristics of individuals and households and their location data comes from the Panel Study of Income Dynamics (PSID) for 2001 and 2011. The PSID is a multigenerational family panel survey data that started in 1968 and continues to this day on a biannual basis. It contains a broad set of individual and household variables. I also use the confidential census tract location supplement provided by the PSID for each family to determine if a residential move had occurred and populate relevant neighborhood information for each family's residence based on census data. These neighborhood socio-demographic and economic data come from the 2000 Decennial Census, the 2010 American Community Survey (ACS), and the Economic Census data for years 2002 and 2012.

I are primarily interested in residential location choice in urban areas in the United States. Our analysis thus focuses on large cities and metropolitan statistical areas (MSAs) with core city populations of 250,000 or more. In order to have broad geographic coverage, if no city in a state matched this criteria, I selected the most populous cities as long as their populations were 100,000 or higher. Cities such as Birmingham, Alabama, Boise, Idaho, and Des Moines, Iowa were added

to the list by this latter criteria. In all, these criteria led to the selection of 89 cities representing 70 MSAs in 43 states to be included in the analysis. The table of cities is provided in the Appendix A.

Once the list of cities have been identified, the sample from the PSID was selected as follows. First, I extract families who lived in one of the 43 states in 2001 and 2011 and identify the head of the family. I then look back six years to 1995 and 2005 respectively and retain only those heads of families who have moved residences at least once in these periods. I use a six year window because the PSID is collected biannually. This leads to a 2001 sample of people who moved between 1995-2001 and a 2011 sample of people who moved between 2005-2011. Each sample is then divided into two based on the head's age as young adult (aged 18-35) or older adults (aged 36 or higher). The selection criteria yields 1,065 and 1,738 individuals in the young adult group in 2001 and 2011, respectively. A total of 1,719 and 1,899 individuals were in the older age group for 2001 and 2011 respectively. The group classified as young adults in 2011 are millennials born between the early 1980s and the early 2000s.

The descriptive summary of socio-demographic information for PSID subjects in this analysis is provided in Table IV. As expected, average family income was lower for the younger cohort in each period. Within cohort, reported incomes were higher in 2001 than in 2011. This could partly be due to the economic crisis of the late 2000s. The proportion of families that the family income was higher than 75% of all samples showed the same pattern with the average of family income: lower for the young adults and in 2011. Overall education level of young adults was slightly higher

TABLE IV: Data summary for movers in the PSID data (1996-2001 & 2006-2011)

	Young adults (ages 18-35)		**Older group (ages 36 or over)**	
Variable	2001	2011	2001	2011
Avg age	29.51	29.40	49.64	50.96
Avg family income ($ in 2011)	59,734	48,838	74,910	65,742
Prop of high income family ($\geq$ 75%)	0.223	0.166	0.334	0.266
Avg completed education year	13.05	13.39	12.88	12.86
Prop of bachelor's degree holders or higher	0.208	0.272	0.227	0.234
Avg number of children in households	1.154	1.116	0.904	0.859
Prop of vehicle ownership in households	0.874	0.831	0.846	0.805
Prop of the Black population	0.337	0.419	0.359	0.399
Prop of households in poverty (150%)	0.117	0.204	0.121	0.164
Observations	1,065	1,738	1,719	1,899
Total observations	2,803		3,618	

than the older adults. A higher percentage of young adults also had a bachelors degree or more in 2011 than 2001. There was no change in this percentage for the older group between 2001 and 2011. The average number of school-aged children was higher for young adults and in 2001. Vehicle ownership was lower for both groups in 2011 as compared to 2001. The proportion of households under 150% of poverty thresholds was similar in 2001 between two age groups while the gap increased in 2011.

The geographical unit for this analysis is the ZIP Code Tabulation Area (ZCTA) which is the smallest geography for which the Economic Census data is available. ZCTAs are generalized areal

representations of ZIP code service areas created by Census Bureau. Based on the 2000 Decennial Census, 2011 ACS and the 2002 & 2012 Economic Census, neighborhood (ZCTA) variables were gathered for all of the ZCTAs in the selected MSAs. The final dataset for the analysis includes three kinds of neighborhood information: 1) attributes based on the housing stock such as size, price, type, tenure, and built year of housing structures, 2) attributes based on individual and family units such as race, education level, poverty, presence of children, 3) attributes related to transportation and urban amenities which look at the commute mode share, vehicle ownership, and the number of urban amenities in an area.

Urban amenities data, which is the count of business establishments, comes from the 2002 and 2012 Economic Census data for each ZCTA. I divide the types of amenities into four groups following the work of Rosso et al. [68]. The first group of urban amenities is retail stores related to daily life, such as food and beverage stores like grocery markets, clothing stores, laundries, and gas stations. The second group is composed of restaurants and cultural amenities, which include food and drinking places, accommodations, museums, and venues for performing arts or sports. The third group is office and service amenities, which include workplaces or public services, offices, schools, hospitals, religious places, and civic facilities. The fourth group is composed of other amenities which are relatively distant from the daily lives or activities of most people such as waste management.

The final neighborhood data includes a total of 26,822 ZCTAs to be used with the 2001 PSID sample and 23,870 ZCTAs for the 2011 sample across the 43 states. Because of the breadth of

the available neighborhood variables and significant correlations among some variables, I employ principal component analysis (PCA) to reduce the number of the variables while capturing the essential dimensions of neighborhoods as described in the next section.

4.4 Analysis and Model

4.4.1 Characterizing the ZCTAs based on Census Data

As discussed previously, the selected PSID samples have moved into their residential locations between 1995-2001 and or 2005-2011, respectively. In this analysis, I assume that their location decisions are a result of a utility-maximizing decision that takes into consideration a variety of physical, social and demographic attributes of their neighborhoods. Prior to developing the residential choice models, PCA is used to reduce the variables characterizing neighborhoods. The analysis is applied to 22 variables identified in the literature as important to residential choice. These are used to characterize neighborhoods at the ZCTA level along the two dimensions discussed. Housing and neighborhood characteristics and resident's socio-demographic characteristics are captured in one PCA. The second PCA is only for transportation and urban amenities which is one of main interests in this study.

The results are given in Table V. Only principal components (PCs) with Eigenvalues greater than one are reported. The analysis reduced the 22 variables to six principal components. Only PCs with Eigenvalues greater than 1 are retained. Four principal components describe the physical and

TABLE V: Principal Component Analysis using area characteristics

Housing, Neighborhood, and Resident's Socio-Demographic Characteristics				
	*PC*1	*PC*2	*PC*3	*PC*4
Median of the number of rooms	0.3618			
Pct of rented housing units	-0.3842			
Pct of households in poverty	-0.3832			
Pct of unemployed people	-0.3096			
Pct of the white population	0.3115		-0.3164	
Pct of detached housing units	0.3205			-0.3223
Population density		0.3923		
Distance from downtown to housing location		-0.3847		
Median of housing value (CPI 2011)		0.4329		
Pct of people received bachelor's degree or higher		0.4615		
Average of the number of households			0.5337	
Pct of households with school age children			0.5283	
Pct of housing built within two decades				0.7127
Pct of vacant housing units				
Eigenvalues	4.1104	2.7439	2.0861	1.0114
Cumulative Proportion	0.2936	0.4896	0.6386	0.7649
Transportation and Urban Amenity Characteristics				
	*PC*5	*PC*6		
The number of retail stores	0.4739			
The number of restaurants or recreation facilities	0.4865			
The number of public and service facilities	0.4662			
The number of other amenities	0.4405			
Pct of automobile use for work travel		-0.5959		
Pct of public transit use for work travel		0.3499		
Pct of walk use for work travel		0.5424		
Pct of bike use for work travel		0.3418		
Eigenvalues	3.8153	2.1614		
Cumulative Proportion	0.4769	0.7471		

socio-demographic characteristics of neighborhoods and two describe the transportation and urban amenities. In each case, the retained principal components explain about 75% of the variance in the original variables. Only factor loadings greater than 0.3 in magnitude are shown in Table V. Intuitive descriptions of each principal component is provided in Figure 5.

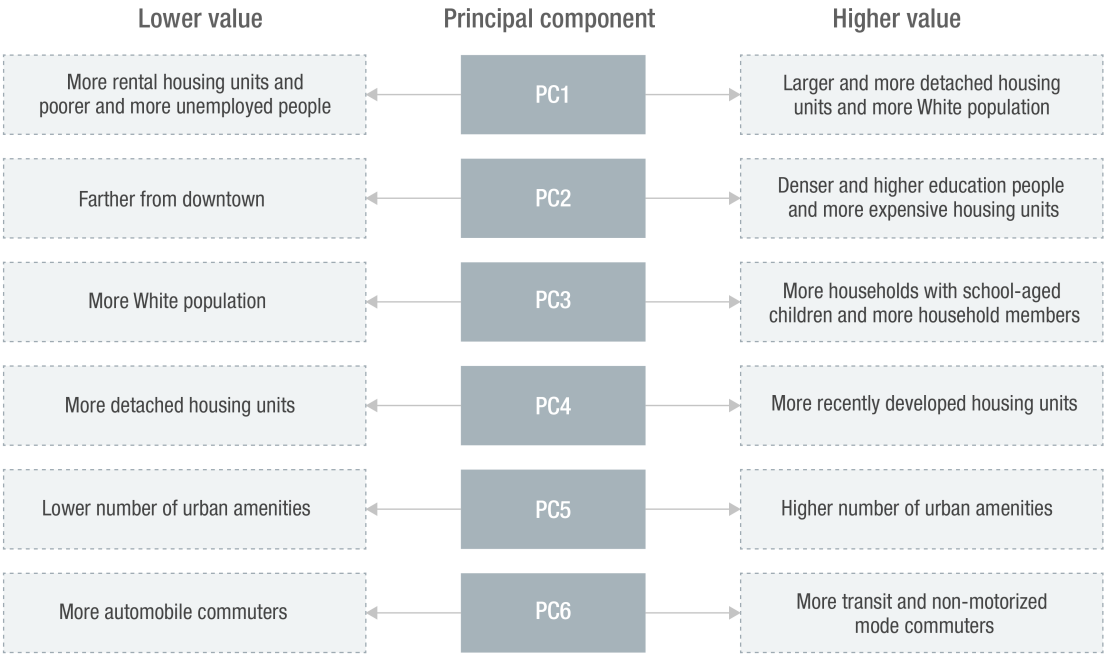

Figure 5: Intuitive interpretations for the principal components

Finally, as a check of how well these principal component variables capture different neighborhoods, I mapped the computed scores for the Chicago region. In general, the PCs align with what I

know of the area. These six principal components are then computed for each of ZCTAs in the 43 states to be used in the residential location choice analysis in the next section.

4.4.2 Residential Location Choice Model Results

I build statistical models with two purposes: 1) to examine difference within young adults in residential location choice, and 2) to examine differences between two different age cohorts. Two multinomial logit residential choice models are estimated, one for young adults and another for the older group, each with a period dummy variable to distinguish between the 2001 and 2011 samples. The period dummy is meant to capture any taste differences within the young and older cohorts between 2001 and 2011. The independent variables in the models are the principal components condensed from 22 variables described above. In addition, I control for decision-maker attributes which are lifecycle and socio-demographic variables and interactions with area variables captured by principal component analysis.

To undertake the modeling, a choice set had to be generated for each individual. A set of 30 locations within the urban area that the person is making a move are generated as alternatives for each decision maker. These include 29 ZCTAs randomly selected from the respondent's urban area and the one that is actually chosen by the PSID family. Each area is characterized by the neighborhood variables developed through the PCA. Since the alternatives are not labeled alternatives, there are no main effects for socio-demographic variables. The final models include four principal components from the housing, neighborhood, and resident's characteristics, and two PCs from

transportation and urban amenity categories. I also include decision-makers' education level, income, the presence of children, the presence of a vehicle, poverty and race as interaction terms with principal component variables. A year/period dummy variable designating 2001/2011 is included to see the differences in residential decisions between the two times as well.

Table VI shows the results of the two multinomial logit models. The left columns describes the result of residential location choice of young adults, and the right columns have the estimates for older adults. Lifecycle and socio-demographic variables are presented in the model as interactions to the main effects of the principal components. These variables are for high income, signifying a respondent's income is among the top 25% in the PSID data; high education, which signifies whether the person has a bachelors degree or higher; and poverty, which signifies if the family was in poverty (150% of poverty threshold) either in 2001 or 2011. Also included are other categorical variables such as race (1= Black, 0= otherwise), presence of school-aged children (1=yes, 0 = no), and automobile ownership (1=yes, 0 = no).

The Pseudo R^2 values of the two models are 0.198 for young adults and 0.178 for the older adults. When comparing location decisions between young adults and the older adults, the main effects of the principal component variables have similar directions in general (though magnitudes differ). If we, however, consider the effect of interaction terms, the difference within each age group, we can see their different preferences in location decisions.

TABLE VI: Multinominal logit model for residential location choice

	Young Adults			**Older Adults**		
	Coefficients	z-value		Coefficients	z-value	
Intercept	-0.0335	-0.2325		-0.1825	-1.3273	
Housing, Neighborhood, and Resident's Socio-Demographic Characteristics						
*PC*1	-0.1945	-4.7653	***	-0.1079	-3.3007	***
*PC*1 * High education	0.0966	3.5653	***	0.1257	4.7405	***
*PC*1 * High income	0.0763	2.5084	*	0.1484	5.9267	***
*PC*1 * Presence of children	0.0562	2.3392	*	0.0192	0.9133	
*PC*1 * Black	-0.2463	-9.9506	***	-0.3251	-14.5946	***
*PC*1 * Vehicle ownership	0.1429	3.9559	***	0.0871	2.9421	**
*PC*1 * Year 2011	-0.0603	-2.5206	*	-0.0146	-0.7053	
*PC*2	0.1292	2.4423	*	0.1702	4.0469	***
*PC*2 * High education	0.2051	5.9319	***	0.1274	3.9698	***
*PC*2 * High income	0.1305	3.3322	***	0.1140	3.6527	***
*PC*2 * Presence of children	-0.0959	-3.1555	**	0.0444	1.6726	.
*PC*2 * Poverty	-0.1405	-3.0758	**	-0.1669	-3.9428	***
*PC*2 * Black	0.3308	10.0093	***	0.3715	12.5853	***
*PC*2 * Vehicle ownership	0.0245	0.5157		-0.1364	-3.4738	***
*PC*2 * Year 2011	0.0652	2.1924	*	0.0282	1.1045	
*PC*3	-0.0226	-0.4450		-0.0170	-0.4182	
*PC*3 * High education	-0.0591	-1.6321		-0.0742	-2.3050	*
*PC*3 * High income	0.0721	1.7976	.	0.0095	0.3102	
*PC*3 * Presence of children	0.1034	3.3823	***	0.1277	4.9502	***
*PC*3 * Poverty	0.0124	0.2892		0.0844	2.0928	*
*PC*3 * Black	0.4148	12.9000	***	0.3884	13.8499	***
*PC*3 * Year 2011	0.0063	0.2117		0.0570	2.2750	*
*PC*4	-0.2140	-2.8370	**	-0.0941	-1.6067	
*PC*4 * High income	0.0788	1.4675		0.0848	1.9902	*
*PC*4 * Black	-0.1833	-3.9678	***	-0.2189	-5.3781	***
Transportation and Urban Amenity Characteristics						
*PC*5	0.2245	6.1223	***	0.1619	5.4322	***
*PC*6	-0.1351	-2.6425	**	-0.0951	-2.2823	*
*PC*6 * High education	0.1618	4.2290	***	0.0619	1.6388	
*PC*6 * High income	-0.1018	-2.2004	*	0.0190	0.5156	
*PC*6 * Poverty	0.0495	1.1056		0.1005	2.3935	*
*PC*6 * Black	-0.0965	-2.7165	**	-0.1481	-4.5973	***
*PC*6 * Vehicle ownership	-0.1009	-2.2829	*	-0.1053	-2.8030	**
Model Summary						
N	2,803			3,618		
Pseudo R^2	0.1980			0.1780		
Loglikelihood	-7636.6			-10102		
Loglikelihood ratio test (chisq)	3769.8	***		4375.7	***	

Significance codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1

1) Housing, neighborhood, resident's socio-demographic characteristics principal components

Principal component 1: *PC*1 captures the types of housing stocks based on the median number of rooms, the percentage of rental housings, and the percentage of detached housing, and residents based on the percentage of poverty, the percentage of unemployed, and the percentage of the white population. Higher values of *PC*1 capture areas with larger and more detached housing units and larger white population while lower values of *PC*1 indicate more rental housing units and poorer and more unemployed residents. Young adults were less likely to choose areas with as *PC*1 increased. Black respondents were also less likely to choose such areas as well. The 2011 cohort of young adults were less likelier than the 2001 cohort to choose areas as *PC*1 increased. However, young adults who were well educated, had high income, were vehicle owners, or had school-aged children preferred areas with higher values of *PC*1.

Older adults also were also less likely to choose areas high in *PC*1; Black older adults even less so. Older adults that had higher levels of education, higher income and were vehicle owners were more likely to prefer areas with higher *PC*1 scores. As opposed to what I notice with the younger cohort, there was no difference in tastes between the 2000 and 2011 older cohort.

Principal component 2: The second principal component (*PC*2) looks at population density, distance from downtown, housing value, and highly educated people was positive for both age groups in the models. *PC*2 increases with population denser, percent of people with higher education, and more expensive housing units and declines for areas that are farther from the CBD. Both cohorts

were attracted to areas that scored higher in this dimension (denser, more highly educated people and higher housing prices). In the younger cohort, higher education, high income, or being black increased the preference for such areas. Preference for *PC*2 decreased in young adults when they had school-aged children or were under poverty. Similar to young adults, for the older cohort, higher education, high income, being black all increased the probability of choosing such neighborhoods. Preferences for *PC*2 among older adults declined if they were in poverty or had a vehicle. Period effects were only important for the younger cohort. All other things equal, the younger cohort in 2011 was more likely to choose the areas with high population density, more highly educated people, and more expensive housing units, as compared to the 2001 younger cohort.

Principal component 3: The principal component *PC*3 measures mainly the characteristics of residents in neighborhoods. *PC*3 indicates that an area's population is on balance more household members and more households with children when positive or more white population when negative. The main effect of *PC*3 is insignificant in both age groups. Young adults who were black or had children were more likely to choose areas that score high on *PC*3. The older cohort who were black, had children, or poor also had a positive association with *PC*3 and more likely to choose the areas with more household members and more households with children. The period effect for the older cohort was significant indicating a higher likelihood of choosing the areas as compared to their 2001 counterparts.

Principal component 4: The values for *PC*4 are larger in neighborhoods with more residential development within 20 years (1980 - 2000 for the 2001 cohort and 1990 - 2010 for the 2011 cohort

) and lower in those with fewer detached housing units. Young adults in general were more likely to choose areas as $PC4$ decreased (neighborhoods with more detached housing units). The preference increased if the cohort in young adults is the black population, which means that black young cohort are more likely to choose more detached housing areas. The older adults were in generally not influenced by $PC4$. High income older adults preferred to choosing areas with more recently development housing buildings while black in older adults preferred to living in more detached housing areas.

2) Transportation and urban amenity characteristics principal components

Principal component 5: $PC5$ increases with as the number of retail stores, restaurants, office, public facilities like schools or open spaces, and other amenities increases in an area. In both age groups, areas with higher $PC5$ (higher number of amenities) were more likely to be chosen as a residential location. Young adults weighted a one increase in this variable more favorably than the older adults. No interactions were significant for this variable.

Principal component 6: $PC6$ declines as commute mode share for automobile increases and it increases as mode share for public transit, walking and biking increase. In both the young and old cohort, the baseline estimates (main effects) for this variable were significant negatively. They are more likely to choose more automobile dependent neighborhoods. Interestingly, within the young adults, some differences can be observed on account of socio-demographic variables. High income, black, or vehicle ownership in the young cohort increased the negative tendency and made it more likely that people would choose a more automobile dependent neighborhood. The young

cohort with high education, on the contrary, removed the negative tendency in *PC*6 and appeared to prefer transit-walk-bike friendly neighborhoods. In the older cohort, black respondents and vehicle owners preferred areas with lower *PC*6 while ones in poverty chose transit-walk-bike friendly neighborhoods.

4.5 Discussion

This study mainly examines differences in residential location choices within young adults and compare young adults' location choice with older adults in 70 metropolitan statistical areas in 43 states in the United States. Principal component analysis is used to reduce the dimensions of urban neighborhood variables into a few variables. A neighborhood choice model was then estimated and the interaction of neighborhood variables with lifecycle and socio-demographic variables of decision-makers and a period variable were tested. The results show that a host of different neighborhood, individual, cohort and period variables affect the location choice.

Over the years, different research has shown that young adults have been making residential choices that favor cities and transit/non-motorized modes. The unknown question to focus on in this study was whether difference in socio-demographic characteristics and lifecycle of young adults and a period would strengthen or moderate these choices. Main effects for the principal component measure that I estimated in general had the same sign for young and old adults though the magnitude differs. The differences were seen based on interaction terms of socio-demographic and lifecycle variables in both age groups.

Young adults in general preferred areas with more rental housings and were lower income (scored lower on $PC1$). They were also attracted to denser areas with higher priced housing units (high $PC2$), areas with fewer detached housing units (low $PC4$), those with higher number of urban amenities (high $PC5$), and more automobile friendly environments (low $PC6$). Young adults with high levels of education were more likely to choose areas that are less auto-dependent. The effect of education in transportation differs from other characteristics in young adults. Only young adults with higher education showed a positive preference to transit-walk-bike friendly neighborhoods.

The period/year variable indicates that today's young adults are different in the way they choose residential areas only in limited ways. The year interaction of young adults is significant on only $PC1$ and $PC2$, which both captured housing stocks (type, size, price, and tenure) and residents (density, education level, and race), and location (distance from downtown). In both cases, the 2011 cohort in young adults strengthened the main effect of the PCs. The 2011 cohort was, increasingly, more likely to choose areas with more rental housing, poorer, and more unemployed residents (i.e. favored decline in $PC1$) and areas with denser, higher education people, and more expensive housing units (i.e. favored increases in $PC2$). These preferences in rental housing and denser areas, and higher education attainment confirm what is known in the literature.

The opposing results can be explained by bipolarization of residential location choice of the 2011 cohort. The data shows that 42.8% of the 2011 cohort in the lowest income quantile chose locations in the bottom 25% in $PC1$ (favored places that were low in $PC1$) while 27.1% of the 2001 cohort

chose these locations. Also, 46.0% of the 2011 cohort holding bachelor's degree or higher chose locations in the top 25% in $PC2$ (favored places with high $PC2$) while 32.6% of the 2001 cohort chose these locations. This suggests bipolarization of the choice between the low income and the more highly educated segments within the 2011 cohort.

Since the 2020 Census (American Community Survey) and 2017 Economic Census are not yet available, this study had to use and compare the choices made in the early 2000s with the early 2010s. Notwithstanding the slightly old data, this study has meaningful findings that demonstrate the different preferences within young adults in residential location choice, including a period difference. This study also provides implications for the role that urban amenity and transportation variables play in residential choice and how these preferences are strengthened or moderated by life cycle and other personal characteristics.

CHAPTER 5

THE ROLE OF RESIDENTIAL CHOICE ON THE TRAVEL BEHAVIOR OF YOUNG ADULTS

5.1 Introduction

As the vehicle miles travelled by young adults rapidly decreased after the mid of the 2000s, many researchers started to pay attention to the underlying causes for these travel behavior changes. In the late of the 2000s and the early part of the 2010s, studies showed that young adults drove less, owned fewer cars, postponed acquiring a driver's license, and used multiple modes including public transit and bicycles at a higher rate than similarly aged cohorts before them [1–3, 5–8]. What is of note is that these travel behavior changes occurred primarily among young adults and not among older age groups in the same period [7]. Some studies in the mid of the 2010s, however, suggested that the travel behavior change of young adults is reverting back to patterns of prior generations [3, 42]. In this study, I define young adults as people who were born born between the early 1980s and 2000s (including millennials) [5, 11] and study how their travel behavior is affected by their residential choice.

Another change among young adults that has received attention is their residential location choice marked by a higher preference for city living as compared to older Americans and prior similarly

aged cohorts [1,12,22,23]. A higher number and higher proportion of young adults lived in central cities in the early and mid of the 2010s than the early of the 2000s. In the same periods, the older age groups chose to live outside of cities much more than the inside [21–24].

One interesting point related to the travel and residential preference shifts of young adults is that the shifts may be associated each other. It is widely known that built environments factors such as high density, proximity to public transit, surrounding land use, and street network design are strongly related to use of public transit and walk modes [36, 37]. Given that some travel behavior is influenced by the built environment [1, 4, 7, 20, 36, 42], It is possible that the observed behavior choices, including higher use of public transit and less automobile travel, among young adults results not only from their preference shifts, but may also be reinforced by the choice of city living given the better facilities that cities provide for non-automobile transportation as compared to suburbs. There, however, exist few studies that examine the impact of residential location choice toward cities among young adults on their travel behavior changes: the decline of travel distances, car ownership, and the preferences for public transit, walking, and bicycling. This study aims to fill that gap focusing on young adults' choice behavior.

To examine the relationship between travel behavior change of young adults and their residential location choice, I aim to analyze residential location choice trend of young adults and older age groups, and the relationship between their choice trend and travel behavior. In this study, I focus on city choice, vehicle ownership, mode choice of non-automobile modes, and traveled distance and classify the four main factors by terms. As Figure 6 show, I classified residential location choice as

long-term decision, vehicle ownership as medium-or long-term, and mode choice and traveled distance as short-term choice. Once the residential location is decided, the choice is retained relatively long term, compared with other variables. The vehicle ownership is also classified as a medium or long term decision with the same reason. The mode choice and travel distance are changeable in a relatively short term and can be affected by the medium and long term decisions. People may change their decisions for travel modes and distances day-by-day.

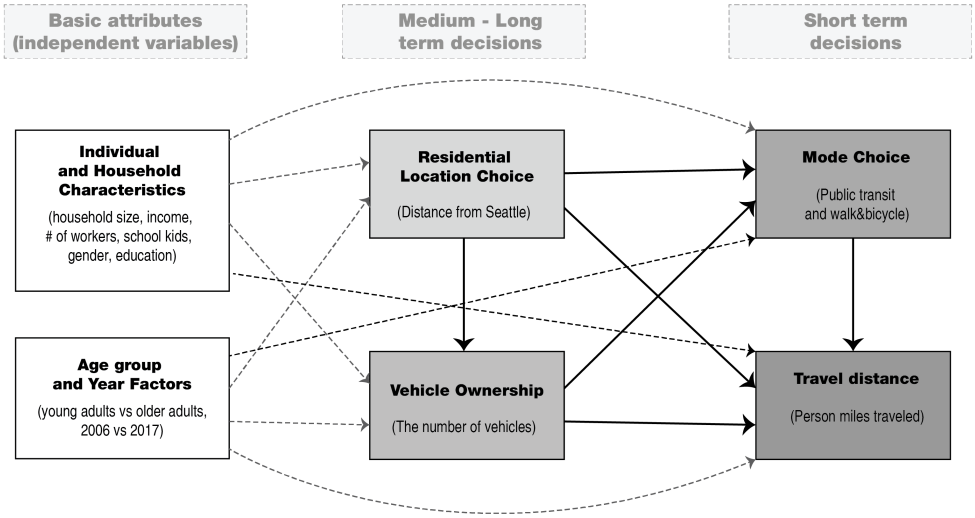

Figure 6: Research framework

The core question for this study is how residential location choice (a long-term decision) influences travel behavior, vehicle ownership (a medium-term decision), mode choice and traveled distance

(short-term decisions). This study also examines differences between young adults and older age groups, and between the mid of the 2000s and the 2010s. To answer the core question, I explore 1) whether residential location choices of young adults and older age groups in 2017 differ from those in 2006 in terms of distance to downtown, 2) whether the residential location decision influences vehicle ownership of young adults, and 3) whether the changes in residential location and vehicle ownership influence mode choice and PMT in 2017 as compared to 2006 and which characteristics, including individual and household attributes, significantly impacted their choices. I also analyze both the direct and indirect effects of the residential location choice and three factors in travel behavior of young adults each other.

The rest of the study is organized as follows: Section 2 summarizes the literature about preference shifts of young adults. In Section 3, the data and research approach used in this study are discussed. Section 4 describes the direct and indirect effects of residential location choice, car ownership, mode choices, and the decline of distance travelled with statistical models. Section 5 says conclusion and discussion.

5.2 Background

Many studies have examined travel behavior of young adults since the late of the 2000s. Studies analyzing differences between the 1995, 2001 and 2009 NHTS (National Household Travel Survey) show that vehicle miles traveled (VMT) and personal miles traveled (PMT) of young adults declined sharply in 2009 compared to 2001 and when compared other age groups [5, 7, 14]. The

VMT and PMT for other age groups between the two years stayed flat or only slightly decreased in 2009 while those of all young adults between 20 and 39 decreased by about 20%. Several studies including [2, 8, 17, 20] state that young adults are less likely to obtain a driver's license and driving less in 2009 than 2001. Many studies examine the reasons why these changes have emerged among young adults since around 2010. The studies indicate that the main reasons for the shifts in travel behavior are high unemployment rate resulted from economic recession, delays of marriage and/or childbirth, and increased reliance on Information and Communication Technologies (ICT).

Studies pointed to the economic downturn, expanded adoption of Information and Telecommunication Technologies, and different life cycle choices (e.g. delaying family formation) as reasons for the shift in travel behavior among young adults. First, the deterioration of socioeconomic conditions caused by the economic recession in the late of 2000s seriously influenced travel behavior changes [5, 14, 20, 28, 49]. Blumenberg et al. [14]especially mention that the economic downturn significantly affected young adults who have relatively weak economic base more than older groups. After the economic recession, unemployment rates increased among all ages but the rate among young adults was about twice higher than the other age groups in 2010 [29, 30]. These studies argue that the increase in unemployment rate and, consequently, the decrease in disposable income among young adults are direct factors that reduced their travel needs, frequencies and distances.

Second, as their unemployment rate increased, many young adults started to enroll in higher education [11, 29, 33]. Furstenberg [33] say that travel demand and distance of young adults decreased

because they stayed in school longer and delayed starting economic activity. The deterioration of the economic circumstances and the increased education period have led them to postpone forming households. The different life cycle from prior generations due to them delaying marriage and childbirth influenced travel needs and frequency of young adults as compared to similar cohorts of the prior generation [11, 29, 31–33]. In addition, higher educational attainment led to a large increase in their student loan debt. This further aggravated their weak economic base and delayed their economic independence from their parents which would have led to living alone and owning a car after graduation [11, 29, 30].

Last, other studies suggest that ICT and various online engagements influence the travel behavior changes of young adults [5, 18, 19, 28]. These studies say that young adults have adopted new technologies more easily than older people and that this mass adoption of ICT affects their travel behavior. The observed shifts then may be in part resulting from offline activities moving to online spaces, for example, substituting online virtual meetings to offline meetings or buying items via e-commerce rather than going to retail shops. More recently, however, some studies have argued that the rate of car ownership of young adults are becoming increased slightly like prior generations as economic situation is become better and they are aging [3, 42]. Residential densities of the home location of young adults declined and their car ownership rate increased as millennials aged between 1999 and 2013 [3]. As the economic and living conditions including stable employment or decreased debts of millennials is getting improved in the mid of the 2010s, they have started to move to suburbs, own more cars, and drive more distance [42].

In addition to travel behavior, another major change among young adults is their residential location preference which emerged at a similar time as their travel behavior change in the late of the 2000s. Some studies show that the number and the share of young adults, including millennials in cities has increased [1, 21–24]. A recent study by Lee [22] says that millennials are more likely to live in urban core areas within 3 miles from Central Business Districts than a prior generation did between 2000 and 2010. He also shows that the areas where millennials prefer to live have expanded to outside of the urban core since 2010 in a 3 to 10 mile radius from CBD.

5.3 Approach and Data Analysis

The data used in this study is the 2006 and 2017 Household Travel Survey data collected by Puget Sound Regional Council, the planning agency for the central Puget Sound region. The Puget Sound region is centered on Seattle and the coastal area of the Northwest in Washington state. The Household Travel Survey collected a travel diary on one day and socio-demographic information of the households and individual household members. The 2006 Household Travel Survey has data on 10,516 persons from 4,746 households and their 87,600 trips. The 2017 Household Travel Survey has a total of 6,254 individuals from 3,285 households and their 52,492 trips. The samples are from four counties in the central Puget Sound regions: King, Kitsap, Pierce, and Snohomish Counties.

I divided the samples in both data into two groups by ages: young adults aged between 18 and 34 and older age groups aged 35 or over. Since I am interested in location choice, which is a

household decision, and travel behavior, which maybe an individual decision, each record is related with a household age based on the householder and an individual age based on the traveller. For instance, in a household with three adults where the householder is aged 34 (young adults), a spouse aged 32 (young adults), and a parent of the householder aged 70 (older age group), the household decisions are related to the householder (young adults) but transportation decisions are related to the individual travelers.

As mentioned above, residential location, vehicle ownership, mode choice, and travel distance are main interests in this study. To measure changes in the four factors, this study uses four variables. First is the distance from downtown to a centroid of the census tract in which people's housing is located. The distance is computed from Seattle's city hall which is located in downtown Seattle. The distance is used to measure the residential location choice and location change of both age groups between 2006 and 2017. Vehicle ownership is measured as the number of vehicles in households. Mode choice (or more appropriately mode use) is measured on a continuous scale as the proportion of total distances travelled by non-automobile modes during the survey period. This covers the proportion of distances covered by public transit, walking and bicycling as a primary mode for each trip. Finally, person miles of travel (PMT) is also computed to capture total traveled miles of each individual on an assigned survey day. I analyze where each age group chose to live, changes in car ownership, use of non-automobile modes, and PMT in 2017compared with 2006 using the four variables. The analysis used the weights that were provided for 2006 and 2017 in

TABLE VII: Summary of the Household Travel Survey in 2006 and 2017 by age group (weighted)

	2006		2017	
	Young adults	Older age groups	Young adults	Older age groups
The number of households (by householder's age)	331	2440	908	1133
The number of households (by traveler's age)	669	3205	1264	1425
Summarized by householder's age				
Household size	2.39	2.86	2.51	2.76
The number of vehicles	1.76	2.34	1.69	2.20
Pct. of households with children ($\leq$ 18 years old)	28.86	43.19	17.03	34.01
Pct. of households living in Seattle (city)	27.47	16.70	33.24	14.84
Average distance to downtown Seattle (miles)	15.83	17.57	14.85	18.23
Summarized by individual's age				
Pct. of male	51.52	52.63	54.45	49.68
Pct. of education level (high school or below)	17.98	15.56	24.26	13.83
Pct. of education level (college or associate degree)	30.96	30.59	21.70	22.35
Pct. of education level (bachelor degree or higher)	51.96	53.85	54.03	63.82
Total number of trips	3.84	4.09	3.63	4.28
Pct. of miles traveled by non-automobile modes	18.10	11.91	26.14	12.76
Person miles of travel (miles)	32.12	33.39	26.17	32.84

the Household Travel Survey. However, since the weights for the two periods are computed on different scales, I rescale these weights so that each year's sum to 100.

The summary of the weighted data is provided in Table VII. I removed survey participants who have missing information in core individual or household characteristics, and invalid trip informa-

tion such as a persons with no mode information for daily trips. Also, only individuals who traveled at least once for home-based work or work related trip are selected and used in the analysis and the model. The data has 331 young adult households in 2006 and 908 in 2017, and 2440 older age households in 2006 and 1133 in 2017 based on the householder's age. I also have 669 and 1264 individuals in young adults in 2006 and 2017 respectively, and 3205 and 1425 individuals in older age groups in 2006 and 2017 respectively. The table is summarized by two age group classification: householder's age as a household level and individual's age as an individual level.

The average household size of young adults is slightly lower than that of older age groups in both years. The household size of young adults in 2017 (2.51) is slightly higher than 2006 (2.39) while that of older age groups in 2017 (2.76) is similar but slightly lower than 2006 (2.86). The summary shows that both age groups owned slightly less cars in 2017 (1.69 for young adults and 2.20 for older age group), compared to 2006 (1.76 and 2.34, respectively). Young adults owned less cars by about 0.5 than older age groups in both years. The percentage of households of young adults living in Seattle increased from 27.47% to 33.24% in 2017 and their average distance from downtown Seattle decreased 15.83 miles to 14.85. On the other hand, older age groups show the opposite trends. The percentage of households living in Seattle decreased from 16.70% to 14.84% in 2017 and the average distance increased from 17.57 miles to 18.23 in 2017. This means that, as literature says, young adults prefer choosing to live in cities at a higher rates in the 2010s, compared with the 2000s while older age groups have the opposite decision, 'going out to suburbs'.

Next is the summary of the individual level by individual age classification. Based on the weighted data, the percentage of with high school degrees or below increased from 17.98% to 24.26% by 2017. The percentage with bachelor degrees or higher also increased from 51.96% to 54.03% in 2017. For the older age group, the percentage who completed high school or below decreased and the percentage with a bachelor degree or higher greatly increased in the same period from 53.85% to 63.82%. These numbers are similar to what 2013-2017 ACS 5-year estimate data says for Seattle.

The number of trips for the two age groups shows opposite trends. While the number of trips of young adults decreased from 2006 to 2017 (3.84 to 3.63 trips per day), that of older age groups increased from 4.09 to 4.28 trips per day in the same period. The summary also shows that the percentage of miles traveled by non-automobile modes increased slightly for older adults from 11.91% to 12.76% between 2006 and 2017 while the percentage for young adults increased appreciably by about 8%, from 18.10% to 26.14%. The difference in use of non-automobile modes between young adults and older age group increased from about 6% (18.10% - 11.91%) in 2006 to about 14% (26.14% - 12.76%) in 2017. The PMT of young adults in 2006 was similar to the older age group whereas in 2017 the PMT of both age groups decreased and young adults traveled much less miles, compared to older age groups. To summarize, young adults in 2017 had fewer number of trips, traveled fewer miles, and used more non-automobile modes to travel as a percentage of all travel when compared to young adults in 2006. These results are in line with the findings from the literature analyzing travel behavior of young adults.

5.4 Models and results

To examine the relationship between residential location choice, vehicle ownership, mode choice, and travel distance and how these have shifted between 2006 and 2017 for the two age cohorts, I employ a structural equation model (SEM). SEM enables to test causal relationships in theoretical models or to account for the actual relationship between a number of observed variables [69, p.143], including direct and indirect effects.

I conduct a path analysis in SEM using Stata to examine the effect of individual and household characteristics on residential location choice, vehicle ownership, mode choice, and travel distance respectively, and simultaneously analyze overall effects using weights. The proposed path model is as shown in Figure 6. Four multiple regression models are built in one structural equation model: a residential location choice model using the distance from downtown Seattle as a dependent variable, a vehicle ownership model using the number of vehicles, a mode choice model using the percentage of miles by non-automobile modes, and a travel distance model using person miles of travel.

As the diagram shows individual and household characteristics, age group and year indicators, are included in the all four models as a common independent variables. For the residential location choice model, the choice is decided by individual and household characteristics, and age group and year factors in line with the literature. Vehicle ownership is determined by household attributes and year. I hypothesize that vehicle ownership is affected by the housing location, considering that

suburban and rural residents need cars much more than city residents due to limitation of available transportation modes.

I hypothesize that mode choice and travel distance are determined by attributes such as household income, education level, year, or age as well as by housing location and vehicle ownership. I also hypothesize that travel distance depends on both long term and short terms decisions: housing location, vehicle ownership, and mode choice. The hypotheses for the model can be summarized follows: medium and long term decisions of location and car ownership are determined by individual, household, age (age groups), and the period of decision making (measured here by the year dummy variable), and short term decisions of mode choice and travel distance are influenced by sociodemographic factors, the period of decision making, and simultaneously by the medium and long term decisions regarding location and vehicle ownership.

The result of the structural equation model and its evaluation are given in Table VIII and the direct, indirect, and total effects of the model are displayed in Table IX. Each of the four models in the SEM is discussed below separately. I use age group indicators from household holder's age in the residential location choice and vehicle ownership models and individual's age in the mode choice and travel distance models. Since the model uses the weights, they are robust models and only residual stats for the model evaluation are valid in Stata [70]. The *SRMR* (Standardized Root Mean squared Residual) and *CD* (Coefficient of Determination) of the model is 0.011 and 0.484 respectively. Based on the *SRMR* (where small values indicate a good fit) and the *CD*, which is like an R^2 for the whole model [71, P. 152], the proposed model fits the data well.

TABLE VIII: Results of robust structural equation model examining residential location choice, vehicle ownership, mode choice, and travel distance

	Coefficients	Robust Std. Err.	z-value	
Distance from downtown Seattle for residential location choice				
Intercept	22.833	1.439	15.87	***
Household size	0.569	0.241	2.36	**
Household income ($1000)	-0.026	0.005	-4.80	***
Some college or associate degree	-1.878	1.428	-1.32	
Bachelor's degree or higher	-7.057	1.308	-5.39	***
Year 2017 * Young adults (head)	-2.371	1.411	-1.68	.
Year 2017 * Older age groups (head)	1.484	0.829	1.79	.
Year 2006 * Young adults (head)	-1.675	0.661	-2.53	*
Variances	94.538	5.052		
The number of vehicles for vehicle ownership				
Intercept	0.260	0.154	1.68	.
The number of workers	0.611	0.058	10.55	***
School-age children	0.211	0.063	3.35	***
Household income ($1000)	0.005	0.007	7.12	***
Some college or associate degree	0.149	0.105	1.42	
Bachelor's degree or higher	0.005	0.108	0.04	
Year 2017 * Young adults (head)	-0.241	0.109	-2.22	*
Year 2017 * Older age groups (head)	-0.128	0.662	-1.93	.
Year 2006 * Young adults (head)	-0.247	0.532	-4.65	***
Distance from Seattle	0.018	0.003	5.96	***
Variances	0.750	0.050		
Percentage of miles traveled by non-automobile modes for mode choice				
Intercept	30.407	4.047	7.51	***
Household income ($1000)	0.041	0.023	1.81	.
Some college or associate degree	2.236	2.904	0.77	
Bachelor's degree or higher	5.950	3.107	1.92	.
Year 2017 * Young adults	6.043	4.775	1.27	
Year 2017 * Older age groups	-0.457	2.208	-0.21	
Year 2006 * Young adults	4.017	1.820	2.21	*
Distance from Seattle	-0.512	0.101	-5.07	***
The number of vehicles	-7.631	0.984	-7.75	***
Variances	1010.483	74.217		
Total person miles of travel for PMT				
Intercept	13.801	3.322	4.15	***
Household size	0.631	0.727	0.87	
Some college or associate degree	3.974	2.370	1.68	.
Bachelor's degree or higher	9.689	2.092	4.63	***
Year 2017 * Young adults	-3.277	2.614	-1.25	
Year 2017 * Older age groups	-1.240	1.689	-0.73	
Year 2006 * Young adults	0.538	1.127	0.48	
Distance from Seattle	0.462	0.085	5.45	***
The number of vehicles	1.680	0.806	2.08	*
Pct of miles traveled by non-automobile modes	-0.051	0.021	-2.42	**
Variances	420.722	21.671		
Model Summary and Goodness of fit measures				
N		6,563		
Log pesudolikelihood		-1823.309		
Standardized Root Mean Square Residual (SRMR)		0.011		
Coefficient of Determination (CD)		0.484		

Significance codes: 0 *** 0.001 ** 0.05 * 0.1 .

Note: model was fit with robust; only stats (residuals) valid.

TABLE IX: The total and indirect effects of the robust structural equation model

	Total effects			**Indirect effects**		
	Coefficients	Robust Std. Err.	Sig.	Coefficients	Robust Std. Err.	Sig.
Distance from downtown Seattle for residential location choice						
Household size	0.569	0.241	*	-	-	-
Household income ($1000)	-0.026	0.005	***	-	-	-
Some college or associate degree	-1.878	1.428		-	-	-
Bachelor's degree or higher	-7.057	1.308	***	-	-	-
Year 2017 * Young adults (head)	-2.371	1.411	.	-	-	-
Year 2017 * Older age groups (head)	1.484	0.829	.	-	-	-
Year 2006 * Young adults (head)	-1.675	0.661	*	-	-	-
The number of vehicles for vehicle ownership						
Household size	0.010	0.005	*	0.010	0.005	*
The number of workers	0.611	0.058	***	-	-	-
School-age children	0.211	0.063	***	-	-	-
Household income ($1000)	0.004	0.007	***	-0.000	0.005	*
Some college or associate degree	0.115	0.104		-0.034	0.025	
Bachelor's degree or higher	-0.122	0.102		-0.125	0.030	***
Year 2017 * Young adults (head)	-0.284	0.109	***	-0.042	0.027	
Year 2017 * Older age groups (head)	-0.101	0.068		0.027	0.016	.
Year 2006 * Young adults (head)	-0.277	0.056	***	-0.030	0.013	*
Distance from Seattle	0.018	0.003	***	-	-	-
Percentage of miles traveled by non-automobile modes for mode choice						
Household size	-0.369	0.166	*	-0.369	0.166	*
The number of workers	-4.659	0.753	***	-4.659	0.753	***
School-age children	-1.616	0.516	***	-1.612	0.516	***
Household income ($1000)	0.022	0.023		-0.199	0.008	*
Some college or associate degree	2.319	3.110		0.083	1.172	
Bachelor's degree or higher	10.494	3.177	***	4.544	1.169	***
Year 2017 * Young adults	6.043	4.775		-	-	-
Year 2017 * Older age groups	-0.447	2.222		0.010	0.742	
Year 2006 * Young adults	4.017	1.820	*	-	-	-
Year 2017 * Young adults (head)	3.381	1.189	***	3.381	1.189	***
Year 2006 * Young adults (head)	2.973	0.686	***	2.973	0.686	***
Distance from Seattle	-0.649	0.099	***	-0.137	0.027	***
The number of vehicles	-7.631	0.984	***	-	-	-
Total person miles of travel for PMT						
Household size	0.300	0.146	*	0.300	0.146	*
The number of workers	1.461	0.482	***	1.461	0.482	***
School-age children	0.505	0.218	*	0.505	0.218	*
Household income ($1000)	-0.004	0.006		-0.004	0.006	
Some college or associate degree	2.986	2.236		-0.746	0.781	
Bachelor's degree or higher	5.480	1.980	***	-4.008	0.791	***
Year 2017 * Young adults	-3.619	2.633		-0.300	0.271	
Year 2017 * Older age groups	-0.720	1.724		0.501	0.456	
Year 2006 * Young adults	0.334	1.136		-0.199	0.122	
Year 2017 * Young adults (head)	-1.829	0.780	*	-1.829	0.780	*
Year 2006 * Young adults (head)	-1.475	0.431	***	-1.475	0.431	***
Distance from Seattle	0.528	0.081	***	0.068	0.018	***
The number of vehicles	2.393	0.717	***	0.379	0.158	*
Pct of miles traveled by non-automobile modes	-0.050	0.021	*	-	-	-

Significance codes: 0 *** 0.001 ** 0.05 * 0.1 .

5.4.1 Residential location choice

The residential location choice model shows that households with more members choose farther location from Seattle than smaller households, if all other things are equal. Increasing $1,000 of household income decreases the housing distance by 0.026 miles. While some college or associate degree holders have are similar to lower education decision makers in terms of distance from downtown of Seattle, highly educated people having a bachelor or higher degree choose locations closer to downtown by about 7 miles than those with high school or lower education.

One interesting result is an opposite preference in location choice between young and older adults in 2017 when compared to older adults in 2006, if we accept generous significance up to 0.1. Younger adults in 2017 were on average 2.3 miles closer to the city than older ones in 2016. Older adults in 2017 on the other hand had locations that were 1.5 miles farther than the average older household in 2006. Younger adults in 2006 were on average 1.6 miles closer to downtown Seattle as compared to the 2006 older cohort. This is in line with a higher preference to city living among millennials that has been broadly discussed in the literature. The model suggests that by 2017 the pattern of settlement has led to greater separation between older adults and young adults with the old cohort moving farther away from the center and the younger adults moving closer into the city center than the 2006 cohorts.

5.4.2 Vehicle ownership

The vehicle ownership model says that the number of vehicles in a household increases with the number of workers, number of school-age child and with income. It can be reflected that more workers and school-age kids are generally linked with more chances to use a car like dropping off or picking up. Young adults in 2006 and 2017 owned fewer cars than older adults but there is no distinct period difference among young adults as the coefficients of both years are almost the same. Older adults in 2017 also owned fewer cars when compared to older adults in 2006. Distance of the respondent's residence from Seattle is positively associated with the vehicle ownership. While there is no direct period effect (year effect) on vehicle ownership, because there is a period effect on *residential distance from downtown*, young adults in 2017 would be expected to have fewer vehicles because they on average live closer to downtown Seattle.

5.4.3 Mode choice

The mode choice/mode usage model regresses proportion of miles travelled by non-automobile modes on individual and household characteristics, distance from downtown Seattle and vehicle ownership. If we also accept the generous significance up to 0.1, the model result suggest that a high income and highly educated persons take more non-automobile modes for daily trips. Though young adults in 2017 and older age groups in 2017 show a big differences, both are statistically insignificant. Young adults in 2006 had a higher use of non-automobile modes when compared with older adults in 2006. By 2017, the generational divide is not apparent and both cohorts were

behaving similar to the 2006 older cohort. However, because both distance from Seattle and number of vehicles are both negatively related to non-auto mode use, indirect generational effects may be present.

5.4.4 Distance traveled

The fourth model is also a linear regression model which examines the causal relationship between person miles of travel (PMT) and individual and household variables as well as the residential choice, vehicle ownership, and mode choice. The model says that those with high levels of education travel more miles per day. Interestingly, the age groups and year indicators are also statistically insignificant in the model. Instead, the model shows that the distance from downtown Seattle and the number of vehicles, and the percentage of traveled distance by non-automobile modes influence total person miles of travel. Increasing distance of home location from downtown Seattle and the number of owned vehicles increases PMT. On the other hand, PMT declines as the proportion of non-auto mode distance increases.

Based on the above model results, young adults in 2017 (millennials) show no direct effect in mode choice and distance traveled. The variable (Year 2017 * Young adults), however, is significant in both the residential location choice and vehicle ownership models. Given that the distance from downtown explaining location choice and the number of vehicles in the mode choice and PMT models are the statistically significant, I can imply that these two variables indirectly influence the mode choice and PMT. This is confirmed by the total and indirect effects of the robust structural

equation model shown in Table IX. Total effects, a left column in the table are a summation of direct effects shown in Table VIII and indirect effects, a right column.

Though young adults in 2017 don't display a direct period and cohort effect on non-automobile mode use and PMT, these variables are indirectly influenced by their location choice. The direct linkage of cohort and period to living closer to downtown among young adults in the residential location model and their reduced vehicle ownership influence increasing use of non-automobile modes. Similarly, the direct effects of the city preference and owning fewer cars and indirect effects of using non-automobile modes help reduce traveled distance of young adults in 2017. When it comes to the total effects, young adults in 2017 use about 3.4% more non-automobile modes and travel about 1.8 miles less than older adults in 2006. Young adults in 2006 also show the same pattern as the 2017 cohorts compared with older age groups in 2006 but the percentage and miles are slightly less than 2017 cohorts about 0.4% and 0.3 miles. This shows that the preference in travel behavior of young adults has been retained in 2017 as literature argues: less owning cars, more use of public transit, walk, and bicycle modes, and less distance traveled.

5.5 Conclusion and Discussion

This study begins with a research hypothesis that travel behavior changes of young adults in the 2010s (traveling less distance, using more non-automobile modes, and owning less cars) is in part influenced by their preference for residential location choice and each other. I also hypothesize that medium and long term decisions (residential location and vehicle ownership) influence short term

decisions (mode choice and traveled distance). To examine our research hypothesis, I use 2006 and 2017 Household Travel Survey data by Puget Sound Regional Council and build a structural equation model with weighted travel data. I selected the SEM to analyze the effect of individual and household characteristics on residential location choice, vehicle ownership, mode choice, and travel distance respectively, and simultaneously examine overall effects each other.

The surveyed regions centered on Seattle and surrounding four counties might is widely as a hub of high tech industries. Many big and small high tech companies are concentrated on Seattle and surrounding areas, including head quarters of global companies like Boeing and Amazon in Seattle and Microsoft in just outside of a Seattle boundary. It is highly possible that many highly educated people live in or around Seattle and work at the highly knowledge-intensive industries. As the above summary Table VII shows, there is very high, doubled, ratio of bachelor or higher degree holders in the Puget Sound regions, compared with the national average, about 25% based on 2010 American Community Survey. Even if I consider the special industrial characteristics of Puget Sound regions, this paper provides several significant important contributions for travel behavior changes of young adults in the mid of the 2010s compared with mid of the 2000s and older age groups. Also the structural equation model with weighted data illustrates the mutual relationship between the travel behavior (vehicle ownership, mode choice, and traveled distance) and residential location choice.

The findings from the structural equation model show that young adults in 2017 prefer home locations closer to downtown of Seattle than the same cohort in 2006 and older age groups, and they

also tend to own fewer cars when compared with older adults. While young adults in 2017 own slightly more cars than the same cohort in 2006 in the model, the total effects, which are summation of direct and indirect effects, say young adults in 2017 own slightly fewer cars than young adults in 2006 because of indirect effects emanating from their residential location choice.

The findings also show an interesting result in PMT of highly educated young adults. The direct effect estimates suggest that highly educated adults have higher PMTs as compared to those with lower levels of education. However, the overall effect of being highly educated is smaller as a result of the reductions in PMT due to the indirect effects of living close to downtown and and higher use of non-automobile modes. Overall, while PMTs for those with higher levels of education is higher, this is counteracted by their location choice and mode choice decisions.

The mode choice and distance traveled are not directly affected by age variables. However, residential location choice and vehicle ownership of young adults in 2017 indirectly influences mode choice and traveled distance. Living closer to downtown and owning fewer cars also indirectly influences young adults in 2017 to use more non-automobile modes like public transit, walking and bicycling. Living closer to downtown, owning fewer cars, and using more non-automobile modes indirectly influenced young adult's PMT in 2017. Overall, what I find is that even though young adults in 2017 may display travel behavior shifts, these shifts were not just occurring in and of themselves. Young people showed a preference to living closer to the city and some of the travel behavior shifts were a result of this preference and its indirect effects on a number of variables

associated to the travel behavior. The models demonstrate that the observed shifts in day to day travel have roots in longer term decisions having to do with place and ownership of vehicles.

CHAPTER 6

SUMMARY AND DISCUSSION

6.1 Summary of dissertation

The research in this dissertation started from my interest in the travel behavior changes of young adults seen in the late 2000s. I have also been interested in the residential location choice of young adults which were also being observed at the same time. In three chapters, this dissertation attempted to fill existing gaps in the literature by examining: (i) what is happening in the largest U.S. cities in regards to the location choice of young adults and what variables explain it at an aggregate and disaggregate geographic levels, (ii) the differences within the cohort in regards to their location choice, and (iii) how the longer term location decisions of young adults affects their short term travel behavior.

The analysis presented here used different data sources that provide different level of detail and insights into the location and travel decisions the young cohort made. These sources includes the data products from the census, the Panel Study of Income Dynamics, and the Puget Sound Household Travel survey. The consistency in the findings using these various data sets provides assurance that returning to cities is a real phenomenon among young adults. Aggregate analysis shows clearly

higher rates of in-migration to cities and more disaggregate analysis shows a preference to locating closer to downtown than the prior young cohort.

The main findings of the work presented here can be summarized as follows:

i) Young adults have come to U.S. cities since 2000 and at higher rate since 2010, while older age groups have left cities in the same period.

ii) There are important city level and neighborhood/census-tract level factors that influence the choices of young adults. The results show employment rate, urban jobs, especially high-income jobs and poverty help explain the migration pattern across the largest 50 cities among young adults. They also show that urban jobs, transportation, distance, density, and retail and recreation jobs, the latter used as a proxy of urban amenities, are important factors in the location choice within cities.

iii) There is also a diversity in residential location preference within the young adult cohort that depends on their lifecycle stage and socio-demographic characteristics. For instance, highly educated young adults prefer less auto-dependent areas while high income young adults shows high preference in automobile friendly areas.

iv) A time-period difference is also detected that suggests a systematic change in attitudes among millennials more than can be explained by socio-demographic variables: young adults in 2011

(millennials) were more likely to choose areas with more rental housing, are denser and contain higher proportion of well educated people than the young cohort in 2001.

v) There are complex relationships between being a young adult, location choice, and travel behavior. For example, at least in the case of the Puget Sound data, I find that cohort membership influences being close to downtown and auto ownership, however, it has no direct effects on mode choice and PMT. Its effects are only indirect through the residential location and auto ownership decisions. Living close to the city on the other hand has both a direct effect on travel behavior and an indirect one through vehicle ownership decisions.

6.2 Policy implication and Future Directions

The findings identified in this dissertation in combination of previous literature provide a couple of implications for planners and policy makers. This dissertation does not simulate young adults' future choice but the findings can provide meaningful points about what their future choices may look like. The first research using net migration shows that young adults are continuing to come to cities in the 2010s. However, despite the 'coming-to-the-city' movement of young adults, the second research points out that members of the young cohort with children prefer living in less dense areas and farther from downtown. It suggests that as young adults enter another lifecycle stage and start having children, more of them would move into the periphery of cities or into suburbs. Further, the third research suggests that the travel behavior changes observed among young adults comes not from a general transportation specific shift in the age cohort, but rather

from their residential location decisions. That is, living closer to downtown is a direct cause of the travel behavior shifts rather than attitude change about mode use.

Taken together these findings suggest that if conditions in cities don't change in ways that make them attractive to the life cycle of young adults, it is very likely that their behaviors will become like that of prior generations —suburbs, more cars, and more driving. Given declining marriage rates and fertility rates, the number of people who follow this path may be smaller than what it otherwise would have been [72, 73]. There is also the possibility that attitudes formed and environments experienced in younger age may continue to shape travel behavior and future location choice [20, 44–46]. Still, cities need ways to build on these gains and to make them selves more attractive to older adults. One direction of research that can inform this would be to look at what cities that have growth or low out-migration rates for older adults are doing right, particularly in their growing areas, focusing on questions of schools, amenities, open space, affordability, etc. to accommodate the life cycle change. Young people are interested in cities, it is up to planners and policy makers to encourage them to stay as they age and to attract even more of them.

APPENDICES

Appendix A

THE LIST OF CITIES

City	State	Population (2010 Census)	MSA
Albuquerque	New Mexico	545,852	Albuquerque, NM MSA
Anaheim	California	336,265	Los Angeles-Long Beach-Anaheim, CA MSA
Anchorage	Alaska	291,826	Anchorage, AK MSA
Arlington	Texas	365,438	Dallas-Fort Worth-Arlington, TX MSA
Atlanta	Georgia	420,003	Atlanta-Sandy Springs-Roswell, GA MSA
Aurora	Colorado	325,078	Denver-Aurora-Lakewood, CO MSA
Austin	Texas	790,390	Austin-Round Rock, TX MSA
Bakersfield	California	347,483	Bakersfield, CA MSA
Baltimore	Maryland	620,961	Baltimore-Columbia-Towson, MD MSA
Billings	Montana	104,170	Billings, MT MSA
Birmingham	Alabama	212,237	Birmingham-Hoover, AL MSA
Boise	Idaho	205,671	Boise City, ID MSA
Boston	Massachusetts	617,594	Boston-Cambridge-Newton, MA-NH MSA
Bridgeport	Connecticut	144,229	Bridgeport-Stamford-Norwalk, CT MSA
Buffalo	New York	261,310	Buffalo-Cheektowaga-Niagara Falls, NY MSA
Charleston	South Carolina	120,083	Charleston-North Charleston, SC MSA
Charlotte	North Carolina	731,424	Charlotte-Concord-Gastonia, NC-SC MSA
Chicago	Illinois	2,695,598	Chicago-Naperville-Elgin, IL-IN-WI MSA
Cincinnati	Ohio	296,943	Cincinnati, OH-KY-IN MSA
Cleveland	Ohio	396,815	Cleveland-Elyria, OH MSA
Colorado Springs	Colorado	416,427	Colorado Springs, CO MSA
Columbus	Ohio	787,033	Columbus, OH MSA
Corpus Christi	Texas	305,215	Corpus Christi, TX MSA
Dallas	Texas	1,197,816	Dallas-Fort Worth-Arlington, TX MSA
Denver	Colorado	600,158	Denver-Aurora-Lakewood, CO MSA
Des Moines	Iowa	203,433	Des Moines-West Des Moines, IA MSA
Detroit	Michigan	713,777	Detroit-Warren-Dearborn, MI MSA

Appendix A (Continued)

El Paso	Texas	649,121	El Paso, TX MSA
Fargo	North Dakota	105,549	Fargo, ND-MN MSA
Fort Wayne	Indiana	253,691	Fort Wayne, IN MSA
Fort Worth	Texas	741,206	Dallas-Fort Worth-Arlington, TX MSA
Fresno	California	494,665	Fresno, CA MSA
Greensboro	North Carolina	269,666	Greensboro-High Point, NC MSA
Henderson	Nevada	257,729	Las Vegas-Henderson-Paradise, NV MSA
Honolulu	Hawaii	337,256	Urban Honolulu, HI MSA
Houston	Texas	2,100,263	Houston-The Woodlands-Sugar Land, TX MSA
Indianapolis	Indiana	820,445	Indianapolis-Carmel-Anderson, IN MSA
Jackson	Mississippi	173,514	Jackson, MS MSA
Jacksonville	Florida	821,784	Jacksonville, FL MSA
Kansas City	Missouri	459,787	Kansas City, MO-KS MSA
Las Vegas	Nevada	583,756	Las Vegas-Henderson-Paradise, NV MSA
Lexington	Kentucky	295,803	Lexington-Fayette, KY MSA
Lincoln	Nebraska	258,379	Lincoln, NE MSA
Little Rock	Arkansas	193,524	Little Rock-North Little Rock-Conway, AR MSA
Long Beach	California	462,257	Los Angeles-Long Beach-Anaheim, CA MSA
Los Angeles	California	3,792,621	Los Angeles-Long Beach-Anaheim, CA MSA
Louisville	Kentucky	597,337	Louisville/Jefferson County, KY-IN MSA
Manchester	New Hampshire	109,565	Manchester-Nashua, NH MSA
Memphis	Tennessee	646,889	Memphis, TN-MS-AR MSA
Mesa	Arizona	439,041	Phoenix-Mesa-Scottsdale, AZ MSA
Miami	Florida	399,457	Miami-Fort Lauderdale-West Palm Beach, FL MSA
Milwaukee	Wisconsin	594,833	Milwaukee-Waukesha-West Allis, WI MSA
Minneapolis	Minnesota	382,578	Minneapolis-St. Paul-Bloomington, MN-WI MSA
Nashville	Tennessee	601,222	Nashville-Davidson?Murfreesboro?Franklin, TN MSA
New Orleans	Louisiana	343,829	New Orleans-Metairie, LA MSA
New York	New York	8,175,133	New York-Newark-Jersey City, NY-NJ-PA MSA
Newark	New Jersey	277,140	New York-Newark-Jersey City, NY-NJ-PA MSA
Oakland	California	390,724	San Francisco-Oakland-Hayward, CA MSA
Oklahoma City	Oklahoma	579,999	Oklahoma City, OK MSA
Omaha	Nebraska	408,958	Omaha-Council Bluffs, NE-IA MSA
Philadelphia	Pennsylvania	1,526,006	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA
Phoenix	Arizona	1,445,632	Phoenix-Mesa-Scottsdale, AZ MSA
Pittsburgh	Pennsylvania	305,704	Pittsburgh, PA MSA

Appendix A (Continued)

Plano	Texas	259,841	Dallas-Fort Worth-Arlington, TX MSA
Portland	Oregon	583,776	Portland-Vancouver-Hillsboro, OR-WA MSA
Providence	Rhode Island	178,042	Providence-Warwick, RI-MA MSA
Raleigh	North Carolina	403,892	Raleigh, NC MSA
Riverside	California	303,871	Riverside-San Bernardino-Ontario, CA MSA
Sacramento	California	466,488	Sacramento?Roseville?Arden-Arcade, CA MSA
Saint Paul	Minnesota	285,068	Minneapolis-St. Paul-Bloomington, MN-WI MSA
Salt Lake City	Utah	186,440	Salt Lake City, UT MSA
San Antonio	Texas	1,327,407	San Antonio-New Braunfels, TX MSA
San Diego	California	1,307,402	San Diego-Carlsbad, CA MSA
San Francisco	California	805,235	San Francisco-Oakland-Hayward, CA MSA
San Jose	California	945,942	San Jose-Sunnyvale-Santa Clara, CA MSA
Santa Ana	California	324,528	Los Angeles-Long Beach-Anaheim, CA MSA
Seattle	Washington	608,660	Seattle-Tacoma-Bellevue, WA MSA
Sioux Falls	South Dakota	153,888	Sioux Falls, SD MSA
St. Louis	Missouri	319,294	St. Louis, MO-IL MSA
Stockton	California	291,707	Stockton-Lodi, CA MSA
Tampa	Florida	335,709	Tampa-St. Petersburg-Clearwater, FL MSA
Toledo	Ohio	287,208	Toledo, OH MSA
Tucson	Arizona	520,116	Tucson, AZ MSA
Tulsa	Oklahoma	391,906	Tulsa, OK MSA
Virginia Beach	Virginia	437,994	Virginia Beach-Norfolk-Newport News, VA-NC MSA
Washington	District of Columbia	601,723	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
Wichita	Kansas	382,368	Wichita, KS MSA

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RESEARCH INTERESTS

Data/Spatial Analysis, Demographic Change, Travel Behavior, Urban Spatial Structure, Transportation Planning and Policy, Housing Location Choice and Policy, Land Use, Smart Cities, Millennials, and Minority

EDUCATION

University of Illinois at Chicago, Chicago, Illinois

Doctoral Program in Urban Planning and Policy
August 2014 – February 2020 (degree conferred: May 2020)
Concentration: Transportation Planning
Advisor: Dr. Nebiyou Tilahun
Dissertation: *"Residential Location Choice and Travel Behavior of Young Adults: Back-to-the-city and Multimodality"*

- Essay 1: The Migration Patterns of Young Adults: The Role of Jobs, Transportation, and Urban Amenities.
- Essay 2: Have the Residential Preferences of Young Adults Changed? Evidence Based on the Panel Study of Income Dynamics
- Essay 3: The Role of Residential Location Choice on Travel Behavior of Young Adults.

University of Texas at Austin, Austin, Texas

Master of Science in Community and Regional Planning, May 2010
Concentration: Land Use and Land Development Planning

Hanyang University, Seoul, Korea

Bachelor of Science in Urban Planning, Aug. 2006
Concentration: Urban Design and Land Use Planning

SKILLS

Software	Data Management and Programming	R, (Python)
	Data and Spatial Analysis	R, ArcGIS, Stata, SPSS
	Visualization and Design	Illustrator, Tableau, Photoshop, SketchUp
	Microsoft Office and Documentation	Word, Excel, PowerPoint, LaTeX

Techniques and Skills	Big Data Management and Machine Learning Techniques	National-Level Data Collection, Exploration, Preparation (merging and cleaning, converting), Propensity Score Matching, Principal Component Analysis, Decision Trees
	Quantitative Methods	Cross Sectional and Longitudinal Analysis, Multiple Regression, Logistic, Fixed and Random-Effect, Multinomial Logistic, Multilevel Models (Hierarchical Linear Model), Structural Equation Modeling, Cluster Analysis, Difference-in-Difference Analysis, Weighted Statistical Estimates, Diversity Analysis

PUBLICATIONS

Peer-Reviewed Articles

Jaeyong Shin and Seong-Hee Kim (2013). The Economic Effect of Physical Features and Urban Design Quality on Land Prices: With Special Emphasis on the Commercial Area in Austin, Texas. *Journal of the Korean Urban Management Association.* 26(4).

Nebiyou Tilahun, Jaeyong Shin, Joseph Persky, Moyin Li, and Moira Zellner. (under review). The Geography of Poverty: The Effects of Place and Family on Adult Poverty. *The Annals of Regional Science*.

Book

Kyo-Un Sim, Seong-Hee Kim, Kyung-Hoon Cho, Jun-Won Seo, and Jaeyong Shin (2012). *Ideas of People Making A City*, Office for Civic Solutions Press.

Works in Progress

Jaeyong Shin and Nebiyou Tilahun. The Migration Patterns of Young Adults: The Role of Jobs, Transportation, and Urban Amenities. *(final review for submission)*

Jaeyong Shin and Nebiyou Tilahun. Have the Residential Preferences of Young Adults Changed? Evidence Based on the Panel Study of Income Dynamics. *(final review for submission)*

Jaeyong Shin and Nebiyou Tilahun. The Role of Residential Location Choice on Travel Behavior of Young Adults. *(final review for submission)*

Sage Kim, Jaeyong Shin, and Nebiyou Tilahun. The Differences in Intergenerational Changes by Race: The Effects of Neighborhood Environments on Family Income. *(working on manuscript)*

Referred Conference Presentations

Jaeyong Shin and Nebiyou Tilahun (2020). The Role of Transportation, Urban Amenities, and Life Cycle on the Residential Location Choice of Young Adults, accepted for presentation at *Transportation Research Board 99th Annual Meeting (TRB)*, Washington D.C.

Jaeyong Shin and Nebiyou Tilahun (2020). Net Migration and Cities: The Role of Transportation and Urban Characteristics in Affecting Population Shifts, accepted for presentation at *Transportation Research Board 99th Annual Meeting (TRB)*, Washington D.C.

Jaeyong Shin and Nebiyou Tilahun (2019). The Difference Tastes of Transportation, Urban Amenities, and Residential Location Choice in Young Adults, accepted for presentation at *the Association of Collegiate Schools of Planning (ACSP)*, Greenville, NC.

Jaeyong Shin and Nebiyou Tilahun. (2018). The Effect of Changes in Central Cities on Net Migration of Young People, *Presented at the Association of Collegiate Schools of Planning (ACSP)*, Buffalo, NY.

Jaeyong Shin and Nebiyou Tilahun. (2017). Back to the City: Exploring Differences in the Location Choice Patterns and Travel Behavior among Millennials, *Presented at the Association of Collegiate Schools of Planning (ACSP)*, Denver, CO.

Jaeyong Shin and Nebiyou Tilahun. (2017). Are Young Adults Really Flocking Back to the City?: An Analysis of Migration Trends Under Evolving Transportation and Urban Environments, *Presented at Transportation Research Board 96th Annual Meeting (TRB)*, Washington D.C.

PROFESSIONAL EXPERIENCES

University of Illinois at Chicago

Research Assistant, November 2019 –February 2020

- Work for a state project 'Illinois Census 2020: Map The Count' with Illinois Department of Human Services.
- Manage Census data and analyze how to increase engagement in Census 2020 – creating models and indexes estimating engagement and build strategies to induce more participation of Illinois population with various organizations

University of Illinois at Chicago

Research Assistant, June 2019 – November 2019

- Work for a jointed research project 'The effects of intergenerational transmission of neighborhood context on cancer risk' with School of Public Health.
- Managed longitudinal data, the Panel of Study of Income Dynamics (PSID) from 1968 to 2017 and U.S. Census data from 1970 to 2010 using R.

University of Illinois at Chicago

Research Assistant, August 2016 – May 2019

- Worked for Urban Data Visualization Lab (UDVL) in the Department of Urban Planning and Policy, which is the university's lab for spatial analysis and data visualization.
- Worked on geospatial data analysis using spatial queries and data management in ArcGIS and R, including population changes in Chicago by races between 2000 and 2010.

University of Illinois at Chicago

Research Assistant, August 2014 – May 2017

- Worked for a research project 'An agent-based model for simulating the process of social exclusion' sponsored by the University of Glasgow.
- Managed and combined more than 800,000 records of about 200,000 household's data from longitudinal data (PSID) from 1968 and national-level cross-sectional Census data (about 150,000 unique census tracts).

Korea Research Institute for Human Settlements, Korea

Assistant Research Fellow, July 2013 - July 2014

- Researched in establishing housing policies of national public housing which was president's pledge and one of the main governmental policies.
- Analyzed housing environments of the secondary poverty class using survey and interview data and assisted in estimating demand and supply of national public housing.

Seoul Institute, Korea

Assistant Research Fellow, April 2012 - July 2013

- Researched to propose a new management policy for urban infrastructure in Seoul, which was operated by private or semi-private sectors.
- Investigated the present situation of the urban infrastructure by document and literature reviews and examined urban infrastructure legislation in Seoul and South Korea.

Office for Civic Solution, Korea,

Assistant Planner, September 2010 - February 2012

- Assisted in developing revitalization plans and strategies for regional and community developments.
- Assisted in writing proposals for regional development projects.

COURSES TAUGHT

UPP461 – Geographic Information Systems for Planning and Policy

University of Illinois at Chicago, Fall 2019 (Teaching Assistant)

AWARDS

George Krambles Transportation Scholarship Award
University of Illinois at Chicago, January 2018

George Krambles Transportation Scholarship Award
University of Illinois at Chicago, January 2017

Urban Planning and Policy Department Doctoral Award
University of Illinois at Chicago (Four-year tuition and research assistantship), August 2014-August 2018

Urban Design Competition for Urban Regeneration in Incheon
The Incheon Urban Development Corporation, Korea, October 2007

Idea Competition for Making Livable Cities
The Korea National Housing Corporation, Korea, April 2007